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MADURASIA OBSCURELLA JACOBY: A NEWLY RECORDED SPECIES FROM PAKISTAN (COLEOPTERA: CHRYSOMELIDAE: GALERUCINAE)

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(Received for publication: 15.09.2012)

ABSTRACT

The Madurasia obscurella Jacoby of the sub-family Galerucinae of the family Chrysomelidae is described in detail with reference to its genital complex and is also compared with its closest allies.

Key words: Madurasia obscurella, Galerucinae, Chrysomelidae, Coleoptera, Pakistan.

INTRODUCTION

Maulik(1936) described the monotypic species Madurasia obscurella Jacoby from Nilgiri hills with reference to its colour patterns and few external features,. Menon and Saxena (1970) worked on common pulse Galerucid beetles at Delhi and examined a large number of specimens showed variation in size, colour and degree of development of basal appendage or lobe on the claws.

Gupta and Singh (1984) described the biology of Madurasia obscurella Jacoby as an important pest during the rainy season of pulses.

Reddy and Varma (1986) observed the attack of green mosaic virus (SBMV) by a new vector Madurasia obscurella Jacoby.

Hashmi and Tashfeen (1992) did not listed the above species in their checklist “Coleoptera of Pakistan”.


MATERIALS AND METHODS

The specimens of Madurasia obscurella Jacoby is collected on graminaceous plants from Punjab (Dhadder) by searching and sweeping technique. For the study of genitalia the abdomen was removed from base and boiled in 10% KOH solution for about 3-5 minutes then washed with tap water and dissected in the same medium. The examination of various structures were made placing these on cotton threads under glycerine and the diagrams were drawn with the help of eye piece graticule. The abdomen and genitalia were preserved in microvials with a drop of glycerine and pinned with the specimens (Kamaluddin, 1993 Rizvi and Kamaluddin, 2011).

Genus Madurasia Jacoby


Diagnostic features:

Body small, broad, broader at base, narrowed in front, pronotum subquadrate-shaped, lateral margins convex, anterior and posterior margins rounded, scutellum triangular-shaped, small, broad, legs long, slender, claws simple.

Comments:

Madurasia is most closely related to other Galerucinae genera by their general characters but it can be differentiated in having legs with all claws simple, anterior angle of pronotum with distinct tubercles.

Type species: Madurasia obscurella Jac.

Distribution: Pakistan, India.

Madurasia obscurella Jacoby.  
(Figs 1-5)


Body shape and coloration:

Body small, ovate, broad, light brown, except dark brown head, antennae and legs, eyes black.

Head:

Head slightly broader than long, antecocular distance short, about 1/3rd the length posterior of
head including eyes, length antecocular distance 0.20mm, posterior of head including eyes 0.55mm, width of head 1.0mm, interocular distance 0.5mm, antennae 11-segmented, basal segment shortest, third and fourth equal, fifth longest, length of segments i.0.3mm, ii.0.4mm, iii.0.4mm, iv.0.5mm, v.0.5mm.

Thorax:

Pronotum almost rectangular-shaped, anterior margin sinuated, posterior margin convex, lateral margins convex, anterior and posterior angles acutely produced, width of pronotum more than 2X of its length, length of pronotum 0.8mm, 1.75mm, scutellum much broader than long, length of scutellum 1.75mm, width 0.25mm, elytra short, narrowed at base, lateral margins broadly convex, length of elytra 3.5mm, width 1.5mm.

Abdomen:

Abdomen convex beneath. Total body length 6.05mm.

Male genitalia (Figs.2-5):

Aedeagus (Fig.2 and 3) narrowed, tubular anteriorly sub-acutely produced, posteriorly acutely produced into sharp end, genital orifices with a pair of thorn-like conjunctival appendage, membranous conjunctival lobe moderate with dot-like coronutis, tegumen (Fig.4) Y-shaped, posterior angles about equal in length, posterior arm with truncated apex, anterior arms narrowed with pointed apex, sub-genital plate (Fig. 5) broad U-shaped, base broad, apex pointed.

Material examined:

Two males, Pakistan, Punjab, Dhaddar, 2.11.1985, on wild bushes, leg. Azhar Ali Khan, lodged at the collection of Syed Kamaluddin.

Comments:

Madurasia obscurella is the only species recorded from Pakistan which can be differentiated by pronotum almost qudri-angular anterior angles of pronotum with distinct tubercle and by the other characters as mentioned and description.

DISCUSSION

Madurasia obscurella Jacoby is a monotypic species and is recorded from oriental region. In Pakistan the present species is collected from Punjab on graminaceous plants.

The genus Madurasia plays sistergroup relationships with other Galerucinae genera by their synapomorphies like the general characters of antennae, pronotum and legs with all claws simple, anterior angles of pronotum with distinct tubercles in male the membranous conjunctival lobe with dot like coronutis.

REFERENCES


Madurasia obscurella Jacoby (Coleoptera): A newly recorded species from Pakistan

Fig. 1. *M. obscurella* Jacoby

Fig. 2

Fig. 3

Fig. 4

Fig. 5

0.5mm
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CLADISTIC ANALYSIS OF THE GALERUCINAE SPECIES (COLEOPTERA: CHRYSOMELIDAE: GALERUCINAE) FROM PAKISTAN

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(Received for publication: 25.09.2012)

ABSTRACT
The cladistic analysis of 22 species belonging to 12 genera of the sub-family Galerucinae is carried out from Pakistan using their apomorphic characters. A cladogram is constructed and included taxa are discussed by their sistergroup and outgroup relationships on the basis of synapomorphies and autapomorphies.

Key words: Chrysomelidae, Cladistic, Coleoptera.

INTRODUCTION
The Galerucinae is the largest sub-family of the family Chrysomelidae which without exception live on green plants. Adults and larvae of leaf beetles feed on all sorts of plant tissues, many of them are pests of various economically important plants like colorado potato beetle, the asparagus beetle, the cereal leaf beetle and various flea beetles.

Maulik(1936) in his fauna of British India including Ceylon and Burma described ninety genera of sub-family Galerucinae of the family Chrysomelidae.

Kamaluddin et al. (1995) reviewed the tribe Nebrini from Pakistan, northern areas and Kashmir including 12-species formulating a key and their distributional ranges. They also gave a cladogram and analysed cladistically included taxa by their apomorphies, Kamaluddin et al. (1996) also attempted the cladistic analysis of the tribe Carabini from Indo-Pakistan.

Kamaluddin and Hashmi (1999) revised the genus Leisthus Frolich of the family Carabidae from Pakistan and also discussed the cladistic analysis. Kamaluddin and Attique (2004) attempted cladistic analysis of 11-genera and 18-species of the family Dysticidae from Pakistan and discussed the apomorphies found in the group.


Peris- Falipo et al. (2011) studied the diversity of Cerambycidae in the protected Mediterranean landscape of the Natural park of Carassal de La Font Roja in Spain and offers new information about the faunistic diversity of Cerambycidae with data on the family's ecology of 27- species.

Attique and Kamaluddin (2005) gave the information of Cybister lateralimarginalis (Dee Geer) of the family Dytiscidae from Pakistan with reference to its genitalia. They also discussed cladistic relationship and systematic position by its apomorphic characters.

Hashmi et al. (2005) revised the genus Calosoma Weber of the family Carabidae with two new species from Pakistan and discussed the cladistic analysis of the included taxa.

MATERIALS AND METHODS
The external characters and genitalia of both sexes were studied and scanned and the taxa are compared, with those found in the out group within the subfamily Galerucinae. A cladogram is constructed showing relationships of the included taxa a, b, c, d, e etc. and any character ascending order reflect derived, more derived, specially derived status.
CLADISTIC ANALYSIS OF THE REPRESENTATIVES OF SUB-FAMILY GALURECINAE

CHARACTERS

a. Carnivorous insects

a1. Phytophagous insects (Galerucinae and Halticinae)
b. Body dull colour

b1. Body usually unicolours (Merista and Sphenoraria)
b2. Body unicolours (Aulacophora excavata to Aulacophora foveicollis)
b3. Body generally varying in colour (Galerupipla to Aulacophora)
b4. Body bicolor or shaded (Aulacophora intermedia and Aulacophora viridus)
b5. Upper surface of body shining, body reddish brown (Oides flava and Oides livida)
b6. Body yellow or reddish with black spots (Oides bengalensis to Oides affinis)
b7. Entire body ochraceous (Aulacophora foveicollis to Merista)
b8. Entire body bluish (Aulacophora excavata to Oides foveicollis)
c. Body without spots

c1. Body with few spots or without spots on pronotum and elytra

c2. Body with large number of spots on pronotum and elytra (Merista and Sphenoraria)
d. Elytra and pronotum jet black

d1. Elytra reddish with a large vertical spot (Oides andrewsi and Oides affinis)
d2. Elytra yellowish with a moderate vertical spot and one or two basal or apical small spots (Oides bengalensis and Oides neobengalensis)
d3. Elytra bicolor (Aulacophora bicolor)
d4. Elytra and pronotum dark brown (Aulacophora viridus)
d5. Elytra black pronotum orange (Aulacophora intermedia)
e. Head and elytra without spots

e1. A spot at base of head (Sphenoraria bicolor)
e2. Elytra with median vertical and a small outer basal spots (Oides neobengalensis)
e3. Elytra with a median vertical and a small outer basal spots and a small apical black spots (Oides bengalensis)
e4. Median vertical black spot very broad cover half the elytral area (Oides affinis)
e5. Median vertical black spot narrow cover ¼th of elytral area (Oides andrewsi)
e6. Elytra with five spots (Merista)
e7. Elytra with seven spots (Sphenoraria)
f. Body highly broad

f1. Body usually broad or ovate (Oides to Aulacophora)
f2. Body generally broad (All species of Oides)
f3. Body generally narrowed (All species of Aulacophora)
f4. Body broadly ovate (Taphinellina to Bijukta)
f5. Body usually elongated (Leptoxena and Galeruca)
f6. Body elongated (Erganoides)
g. Head remarkably visible

g0. Head remarkably visible

g1. Head visible (Halticinae)
g2. Head beneath the pronotum (Galerucinae)
h. Width of head much broader than long

h1. Width of head 2.25X of its length (Taphinellina bengalensis)
h2. Width of head distinctly more than 1.5X of its length (Oides affinis)
h3. Width of head slightly more than 1.5X of its length (Merista quadrifasciata)
h4. Width of head slightly less than 1.5X of its length (Oedicerus cyanipennis)
h5. Width of head slightly more than its length (Oides andrewsi)
i. Antennae many segmented

i1. Antennae less than ½ the body length (Galerucinae and Halticinae)
i2. Antennae 9 or 10 -segmented (Halticinae)
i3. Antennae 11 -segmented very close together in front of eyes (Galerucinae)
i4. Antennae with basal segment equal to 2nd segment (Bijukta flaviventure)
i5. Antennae with basal segment much shorter than 2nd segment (Aplosonyx chalabeus)
j. Anteocular distance equal to posterior of head including eyes

j1. Anteocular distance much shorter than posterior of head including eyes (Taphinellina and Oedicerus)
j2. Anteocular distance about half the length posterior of head including eyes (Aplosonyx and Bijukta)
j3. Anteocular distance ½ or more than half the length posterior of head including eyes (Aulacophora foveicollis and Aulacophora excavata)
j4. Anteocular distance 1/3rd the length posterior of head including eyes (Aulacophora intermedia and Aulacophora viridus)
j5. Anteocular distance slightly shorter than posterior of head including eyes (Merista)
j6. Anteocular distance 1/4th the length posterior of head including eyes (Taphinellina)
j7. Anteocular distance 1/5th the length posterior of head including eyes (Galeruca)
j8. Anteocular distance 1/6th the length posterior of head including eyes (Leptoxena)
k. Posterior of head including eyes equal to anteocular distance

k1. Posterior of head including eyes 1.5X the length of anteocular distance (Aulacophora foveicollis)
k2. Posterior of head including eyes 2.5X the length of anteocular distance (Aulacophora excavata)
k3. Posterior of head including eyes 3X the length of anteocular distance (Oides flava)
Cladistic analysis of Galerucinae species (Coleoptera) from Pakistan

k4 Posterior of head including eyes about 3X the length of antecocular distance (Oides andrewsi)
k5 Posterior of head including eyes 4X the length of antecocular distance (Oides livida)
k6 Posterior of head including eyes 5X the length of antecocular distance (Oides affinis)
l3 Anterior margin of pronotum straight
l0 Anterior margin of pronotum much shorter than posterior margin of pronotum (Madurasia obscurella)
m0 Width of pronotum equal to its length
m1 Width of pronotum slightly more than 2X of its length (Oedicerus)
m2 Width of pronotum 2X of its length (Bijukta)
m3 Width of pronotum slightly more than 5X (Taphinellina)
m4 Width of pronotum slightly longer than its length (Aplosonyx)
n0 Anterior margin of pronotum longer than posterior margin of pronotum
n1 Anterior margin of pronotum usually equal to posterior margin (Aulacophora)
n2 Anterior margin of pronotum much shorter than posterior margin (Oides)
o0 Anterior margin of pronotum straight
o1 Anterior margin of pronotum deeply concave (Galeruca)
o2 Anterior margin of pronotum sinuated (Leptoxena)
p0 Anterior angle of pronotum thorn-like
p1 Anterior angle of pronotum simple (Galerupipla to Erganoïdes)
p2 Anterior angle of pronotum rounded (Merista)
p3 Anterior angle of pronotum sub-acute (Aulacophora excavata)
p4 Anterior angle of pronotum acute (Oides livida)
p5 Anterior angle of pronotum toothed (Oides flava)
p6 Anterior angle of pronotum with distinct tubercle (Madurasia obscurella)
qu1 Lateral margins of pronotum straight
q0 Lateral margins of pronotum deeply concave (Aulacophora)
q2 Lateral margins of pronotum highly convex (Aulacophora bicolor)
r0 Posterior margin of pronotum straight
r1 Posterior margin of pronotum medially sproduced (Aulacophora viridus)
r2 Posterior margin of pronotum sinuated (Aulacophora intermedia)
s0 Pronotum yellowish
s1 Pronotum reddish (Oides andrewsi and Oides affinis)
s2 Pronotum reddish (Oides bengalensis and neobengalensis)
t0 Width of pronotum equal to its length

u0 Elytra shining
u1 Elytra smooth devoid of hairs (Leptoxena to Aulacophora)
u2 Elytra roughly punctate or variolase (Leptoxena)
u3 Elytra smoothly punctate (Oides to Aulacophora)
u4 Elytra with clothing of hairs (Galerupipla)

v0 Width of scutellum equal to its length
v1 Width of scutellum slightly more than its length (Oides flava)
v2 Width of scutellum much more than its length broad (Oides livida)
x0 Legs with one claw
x1 Legs with all claws bident and appendiculated (Galerupipla to Erganoïdes)
x2 Legs with all claws appendiculated (Taphinellina to Erganoïdes)
x3 Legs with all claws simple (Madurasia obscurella)
x4 Legs with all claws bident (Galerupipla)

y0 Hind femora smooth
y1 Hind femora dilated (Halticinae)
z0 Claws used for clinging.
z1 Claws used for digging (Halticinae)

za0 Abdomen well exposed at repose
za1 Abdomen enclosed at repose (Oides bengalensis and Oides neobengalensis)
za2 Abdomen exposed at repose (Oides andrewsi and Oides affinis)
zb0 Aedeagus simple short
zb1 Aedeagus simple tubular (Leptoxena to Aulacophora)
zb2 Aedeagus elongated tubular (Taphinellina to Bijukta)
zb3 Aedeagus complicated (Erganoïdes)
zb4 Aedeagus complicated barrell- shaped (Galerupipla)
zb5 Aedeagus posteriorly narrowed and truncated, anterioriorily narrowed and rounded (Bijukta)
zc0 Aedeagus straight
zc1 Aedeagus curved with indistinct thecal appendage (Oides andrewsi)
zc2 Aedeagus S-shaped with well developed ventral and dorsal thecal appendage (Oides affinis)
zd0 Aedeagus with apex rounded
zd1 Aedeagus with apex shortly acute (Oides neobengalensis)
zd2 Aedeagus with apex truncated (Oides bengalensis)
ze0 Aedeagus with out thecal appendage
ze1 Aedeagus with minute or without thecal appendage (Aplosonyx and Bijukta)
ze2 Aedeagus with dorsal and ventral thecal appendage (Taphinellina and Oedicerus)
zf6 Theca without appendages
zf1 Thecal appendage simple (Leptoxena to Aulacophora)
zf2 Thecal appendage smooth (Taphinellina to Bijukta)
zf3 Thecal appendage short blade like besets with hairs (Erganooids)
zf4 Theca with a pair of moderate ventral and a pair of large dorsal thecal appendage (Galerupipla)
zg1 Membranous conjunctival lobe absent
zg0 Membranous conjunctival lobe present (Oides bengalensis)
zg2 Membranous conjunctival lobe short (Taphinellina)
zg3 Membranous conjunctival lobe large (Oides affinis)
zg4 Membranous conjunctival lobe very large (Oedicerus)
zg5 Membranous conjunctival lobed with cornuti (Aulacophora fovicollis)
zh1 Posterior arm of tegumen shorter than anterior arm
zh0 Posterior arm of tegumen equal to anterior arm (Merista)
zh2 Posterior arm of tegumen 2X the anterior arm (Aulacophora excavata)
zh3 Tegumen with anterior arm short, median arm smooth with apex truncated (Oides bengalensis)
zh4 Tegumen with anterior arm very large median dilated with apex sub-acute (Oides neobengalensis)
zh6 Spermatheca simple
zh1 Spermatheca sickle-shaped unilobed (Aulacophora intermedia to Aulacophora excavata)
zh2 Proximal, end of spermathecal bulb moderate (Aulacophora viridus)
zh3 Proximal, end of spermathecal bulb dilated (Aulacophora intermedia)
zh4 Spermatheca beak -shaped bilobed (Aulacophora bicolor)

4. CHARACTER STATES
4.1 Feeding habit (a):
Phytophagus in nature. The representatives of the sub-families Galerucinae and Halictinae shows their synapomorphic condition (a1).
4.2 Body colour (b):
Body usually unicolorus in Merista quadrifractiata and Sphenoraia bicolor shows their synapomorphic condition (b1). In Aulacophora excavata and Aulacophora fovicollis body strictly unicolorus shows their derived synapomorphic condition (b2). Body generally varying in colour in Galerupipla brunae to Aulacophora excavata shows their more derived synapomorphic condition (b3). In Aulacophora intermedia and Aulacophora bicolor body bicolor or shaded shows their special synapomorphic condition (b4). Upper surface of body shining reddish brown in Oides flava and Oides livida shows their specially derived synapomorphic condition (b5). In Oides bengalensis to Oides affinis the body is yellow or reddish with black spots shows their specially more derived synapomorphic condition (b6). Entire body ochraceous in Aulacophora fovicollis show its autapomorphic condition (b7). In Aulacophora excavata entire body blush show its derived autapomorphic condition (b8).
4.3 Spots on body (c):
Body with few spots or without spots on pronotum and elytra in Galerupipla bruchae to Aulacophora excavata shows their synapomorphic condition (c1). In Merista quadrifractiata to Sphenoraia bicolor body with large number of spots on pronotum and elytra shows their derived synapomorphic condition (c2).
4.4 Color of elytra and pronotum (d):
Elytra reddish with a large vertical spot in Oides andrewsi and Oides affinis show their synapomorphic condition (d1). In Oides bengalensis and Oides neobengalensis elytra yellowish with a moderate vertical spot and one or two basal or apical small spots shows their derived synapomorphic condition (d2).
Elytra bicolor in Aulacophora bicolor show its autapomorphic condition (d3). In Aulacophora viridus elytra and pronotum dark brown show its derived autapomorphic condition (d4). Elytra black and pronotum orange in Aulacophora intermedia show its more derived autapomorphic condition (d5).
4.5 Spots on body (e):
A spot at base of head in Sphenoraia bicolor show its autapomorphic condition (e1). In Oides neobengalensis elytra with a median vertical and a small outer basal spots show its derived autapomorphic condition (e2). Elytra with a median vertical and a small outer basal and a small apical black spot in Oides bengalensis show its more derived autapomorphic condition (e3). In Oides affinis median vertical black spot very broad cover half of the elytral area show its special autapomorphic condition (e4). Median vertical black spot cover 1/4th of the elytral area in Oides andrewsi show its specially derived autapomorphic condition (e5). In Merista quadrifractiata elytra with 5-spots show its specially more derived autapomorphic condition (e6). Elytra with 7-spots in Sphenoraia bicolor show its specially remarkable autapomorphic condition (e7).
4.6 Body shape (f):
Body usually broad or ovate in the representatives of the genera Oides and Aulacophora shows their synapomorphic condition (f1). In all the representatives of the genus Oides, body generally broad shows their derived synapomorphic condition (f2). Body generally narrowed in all the representatives of the genus Aulacophora, shows their more derived
synapomorphic condition (f3). In *Taphnellina bengalensis* to *Bijukta flaviventure* body broadly ovate shows their specially derived synapomorphic condition (f4). Body usually elongated in *Leptoxena eximia* and *Galeruca himalyana* shows their specially more derived synapomorphic condition (f5). In *Eryngnoides flavicollis* body elongated show its autapomorphic condition (f6).

4.7 Head (g): Head visible in all the representatives of the subfamily Helticinae shows their synapomorphic condition (g1). In all the representatives of the subfamily Galericinae head beneath the pronotum show their derived synapomorphic condition (g2).

4.8 Head width/length (h): Width of head 2.25 times of its length in *Taphnellina bengalensis* show its autapomorphic condition (h1). In *Oides affinis* head distinctly more than 1.5 times of its length show its derived autapomorphic condition (h2). Width of head slightly more than 1.5 times of its length in *Merista quadrifasciata* show its more derived autapomorphic condition (h3). In *Oedicera cyanipennis* width of head slightly less than 1.5 times of its length show its specially derived autapomorphic condition (h4). The width of head slightly more than its length in *Oides andrewsi* show its specially more derived autapomorphic condition (h5).

4.9 Segments of antennae (i): Antennae less than half the body length in all the representatives of the subfamilies Galericinae and Helticinae shows their synapomorphic condition (i1). In all the representatives of the sub-family Helticinae antennae 9 or 10-segmented shows their derived synapomorphic condition (i2). Antennae 11-segmented very close together in front of eyes in all the representatives of the sub-family Galericinae shows their more derived synapomorphic condition (i3).

In *Bijukta flaviventure* antennae with basal segment equal to second segment shows its autapomorphic condition (i4). Antennae with basal segment much shorter than second segment in *Apolsonyx chalybaeus* show its derived autapomorphic state (i5).

4.10 Anteocular distance/ posterior of head including eyes (j):

Anteocular distance much shorter than posterior of head including eyes in *Taphnellina bengalensis* and *Oedicerus cyanipennis* shows their synapomorphic condition (j1). In *Apolsonyx chalybaeus* and *Bijukta flaviventure* anteocular distance about half the length posterior of head including eyes shows their derived synapomorphic condition (j2). Anteocular distance half or more than half the posterior of head including eyes in *Aulacophora fovicollis* and *Aulacophora excavata* shows their more derived synapomorphic condition (j3). In *Aulacophora intermedia* and *Aulacophora viridus* anteocular distance 1/3rd the length posterior of head including eyes shows their specially derived synapomorphic condition (j4). Anteocular distance slightly shorter than posterior of head including eyes in *Merista quadrifasciata* show its autapomorphic condition (j5). In *Taphnellina bengalensis* the anteocular distance 1/4th the length posterior of head including eyes show its derived autapomorphic condition (j6).

Anteocular distance 1/5th the length posterior of head including eyes in *Galeruca himalyana* show its more derived autapomorphic condition (j7). In *Leptoxena eximia* the anteocular distance 1/6th the length posterior of head including eyes show its specially more derived autapomorphic condition (j8).

4.11 Length posterior of head including eyes/ anteocular distance (k): Posterior of head including eyes 1.5-times length anteocular distance in *Aulacopliora fovicollis* show its autapomorphic condition (k1). In *Aulacopliora excavata* the posterior of head including eyes 2.5-times the length anteocular distance show its derived autapomorphic condition (k2). The posterior of head including eyes 3-times the length anteocular distance in *Oides flavus* show its more derived autapomorphic condition (k3). In *Oides andrewsi* the posterior of head including eyes about or slightly more than 3-times the length anteocular distance show highly derived autapomorphic condition (k4). Posterior of head including eyes 4-times the length anteocular distance in *Oides livida* show its specially derived autapomorphic condition (k5). In *Oides affinis* posterior of head including eyes 5 times the length anteocular distance show its specially more derived autapomorphic condition (k6).

4.12 Shape of pronotum (l): In *Galerupipla brunea* to *Eryngnoides flavicollis* pronotum almost rectangular-shaped shows their synapomorphic condition (l1). Pronotum rectangular-shaped in *Galerupipla brunea* to *Sphenoraria bicolor* show their derived synapomorphic condition (l2). From *Taphnellina bengalensis* to *Eryngnoides flavicollis* pronotum slightly rectangular, quadrate or spherical shows their more derived synapomorphic condition (l3). In *Madurasia obscurella* pronotum almost quadrangular-shaped show its autapomorphic condition (l4).

4.13 Pronotum width/ length (m):

Width of pronotum slightly more than 2.5-times of its length in *Oedicera cyanipennis* show its autapomorphic condition (m1). In *Bijukta flaviventure* width of pronotum 2-times of its derived length show its autapomorphic condition (m2). Width of pronotum slightly more than 1.5-times of its length in *Taphnellina bengalensis* show its more derived autapomorphic condition (m3).

In *Apolsonyx chalybaeus* width of pronotum slightly longer than its length show its specially derived autapomorphic condition (m4).

4.14 Anterior margin/ posterior margin of pronotum (n):
Anterior margin of pronotum usually equal to posterior margin in all the representatives of the genus *Aulacophora* shows their synapomorphic condition (n1). In all the representatives of the genus *Oides* anterior margin of pronotum much shorter than posterior margin of pronotum shows their derived synapomorphic condition (n2).

4.15 Anterior margin of pronotum (o):

Anterior margin of pronotum deeply concave in *Galeruca himalyana* show its autapomorphic condition (o1). In *Leptoxena eximia* anterior margin of pronotum sinuated show its derived autapomorphic condition (o2).

4.16 Anterior angles of pronotum (p):

Anterior angles of pronotum simple from *Galerupipla bruchae* to *Erygnoides flavicolis* shows their synapomorphic condition (p1). In *Menista quadrifasciata* anterior angles of pronotum rounded show its autapomorphic condition (p2). Anterior angles of pronotum sub-acute in *Aulacophora excavata* show its derived autapomorphic condition (p3). In *Oides livida* anterior angles of pronotum toothed show its more derived autapomorphic condition (p4). Anterior angles of pronotum toothed in *Oides flava* show its specially derived autapomorphic condition (p5). In *Madurasia obscurella* anterior angles of pronotum with distinct tubercle show its specially more derived autapomorphic condition (p6).

4.17 Lateral margins of pronotum (q):

Lateral margins of pronotum from *Aulacophora intermedia* to *Aulacophora excavata* shows their synapomorphic condition (q1). In *Aulacophora bicolor* lateral margins of pronotum highly convex show its autapomorphic condition (q2).

4.18 Posterior margin of pronotum (r):

Posterior margin of pronotum medially produced in *Aulacophora viridus* show its autapomorphic condition (r1). In *Aulacophora intermedia* posterior margin of pronotum sinuated show its derived autapomorphic condition (r2).

4.19 Color of pronotum (s):

Pronotum reddish in *Oides andrewsi* and *Oides affinis* shows their synapomorphic condition (s1). In *Oides bengalensis* and *Oides neobengalensis* pronotum black shows their derived synapomorphic condition (s2).

4.20 Pronotum width/length (t):

Width of pronotum about 1.5-times of its length in *Aulacophora intermedia* show its autapomorphic condition (t1). In *Aulacophora viridus* width of pronotum 2-times of its length show its derived autapomorphic condition (t2).

4.21 Elytra (u):

Elytra smooth devoid of hairs from *Leptoxena eximia* to *Aulacophora excavata* shows their synapomorphic condition (u1). In *Leptoxena eximia* and *Galeruca himalyansis* elytra roughly punctate or variolose shows their derived synapomorphic condition (u2). Elytra smoothly punctate in all the representatives of the genera *Oides* and *Aulacophora* shows their more derived synapomorphic condition (u3). In *Galerupipla brunea* elytra with clothing of hairs show its autapomorphic condition (u4).

4.22 Scutellum width/length (v):

Width of scutellum slightly more than its length in *Oides flava* show its autapomorphic condition (v1). In *Oides livida* width of scutellum much more than its length show its derived autapomorphic condition (v2).

4.23 Lateral margins of elytra (w):

Lateral margins of elytra remarkably convex in *Leptoxena eximia* show its autapomorphic condition (w1). In *Galeruca himalyana* lateral margins of elytra sinuated show its derived autapomorphic condition (w2).

4.24 Legs with claw (x):

Legs with all claws bifid or appendiculated from *Galerupipla bruchae* to *Erygnoides flavicolis* shows their synapomorphic condition (x1). From *Taphinellina bengalensis* to *Erygnoides flavicolis* legs with all claws appendiculate shows their derived synapomorphic condition (x2). Legs with all claws simple in *Madurasia obscurella* shows its autapomorphic condition (x3). In *Galerupipla brunnea* legs with all claws bifid show its derived autapomorphic condition (x4).

4.25 Hind femora (y):

Hind femora dilated in all the representatives of the sub-family Halticinae show their synapomorphic condition (y1).

4.26 Function of claws (z):

Claws used for digging in all the representatives of the sub-family Halticinae shows their synapomorphic condition (z1).

4.27 Abdomen (za):

Abdomen enclosed at repose in *Oides bengalensis* and *Oides neobengalensis* shows their synapomorphic condition (za1). In *Oides andrewsi* and *Oides affinis* abdomen exposed at repose shows their derived synapomorphic condition (za2).

4.28 Structure of aedeagus (zb):

Aedeagus simple and tubular in *Leptoxena eximia* to *Aulacophora excavata* shows their synapomorphic condition (zb1). In *Taphinellina bengalensis* to *Bijukta flaviventure* the aedeagus elongated tubular shows their derived synapomorphic condition (zb2). In *Erygnoides flavicolis* the aedeagus complicated show its autapomorphic state (zb3). The aedeagus complicated barrel shaped in *Galerupipla bruchae* show its derived autapomorphic condition (zb4). In *Bijukta flaviventure* the aedeagus posteriorly narrowed and truncated, anteriorly narrowed and rounded show its more derived autapomorphic condition (zb5).

Aedeagus posteriorly sub-rounded anteriorly truncate produced in *Aplosonyx chalybaeus* show its specially derived autapomorphic condition (zb6).
4.29 Shape of aedeagus (zc):
Aedeagus curved with indistinct thecal appendage in Oides andrewsi show its autapomorphic condition (zc1). In Oides affinis the aedeagus S-shaped with well developed ventral and dorsal thecal appendages show its derived autapomorphic condition (zc2).

4.30 Apex of aedeagus (zd):
Aedeagus with apex sharply acute in Oides neobengalensis shows its autapomorphic condition (zd1). In Oides bengalensis the apex of aedeagus truncated show its more derived autapomorphic condition (zd2).

4.31 Aedeagus with thecal appendage (ze):
In Aplosonyx chalybaeus and Bijukta flaviventure the aedeagus with minute or with out thecal appendages shows their synapomorphic condition (ze1). The aedeagus with dorsal and ventral thecal appendages in Taphinellina bengalensis and Oedicerus cyanipennis shows their derived synapomorphic condition (ze2).

4.32 Thecal appendages (zf):
Thecal appendages simple in Leptoxena eximia to Aulacophora excavata shows their synapomorphic condition (zf1). In Taphinellina bengalensis to Bijukta flaviventure thecal appendage smooth shows their derived synapomorphic condition (zf2). The thecal appendage short, plate-like besets with hairs in Eryngnoides flavicornis show its autapomorphic condition (zf3). In Galerupipla bruchae theca with a pair of moderate ventral and a pair of large dorsal thecal appendage show its derived autapomorphic condition (zf4).

4.33 Membranous conjunctival lobe (zg):
Membranous conjunctival lobe present in Oides bengalensis show its autapomorphic condition (zg1). In Taphinellina bengalensis membranous conjunctival lobe short show its derived autapomorphic condition (zg2). The membranous conjunctival lobe large in Oides affinis show its more derived autapomorphic condition (zg3). In Oedicerus cyanipennis membranous conjunctival lobe very large show its specially derived autapomorphic condition (zg4). The membranous conjunctival lobe large with cornuti in Taphinellina bengalensis show its specially more derived autapomorphic condition (zg5).

4.34 Arms of tegumen (zh):
Posterior arm of tegumen equal to anterior arms in Merista quadrifasciata show its autapomorphic condition (zh1). In Aulacophora excavata posterior arm of tegumen two times the anterior arms shows its derived autapomorphic condition (zh2). Tegumen with anterior arm short and posterior arms smooth with apex truncated in Oides bengalensis show its more derived autapomorphic condition (zh3). In Oides neobengalensis the tegumen with anterior arm very large and medially dilated with apex sub-acute show its specially derived autapomorphic condition (zh4).

4.35 Spermatheca (zi):
Spermatheca sickle-shaped and unilobed in Aulacophora intermedia to Aulacophora excavata shows their synapomorphic condition (zi1). In Aulacophora viridis the proximal end of spermathecal bulb moderate show its autapomorphic condition (zi2). Proximal end of spermatheca dilated in Aulacophora intermedia show its derived autapomorphic condition (zi3). In Aulacophora bicolor spermatheca beak-shaped and bilobed show its more derived autapomorphic condition (zi4).

DISCUSSIONS ON CLADOGRAM

The present cladogram (Fig.1) shows the relationship of twenty two species and thirteen genera of the sub-family Galerucinae of the family chrysomelidae includes 122 apomorphic characters. All the representatives of the sub-family Galerucinae plays sister-group relationship to each other by their synapomorphies like, head beneath the pronotum (g2) and antennae 11-segmented and very close to each other in front of eyes (13) and outgroup relationships with Helticinae (i2), claws usually used for digging (z1) and hind femora dilated (y1).

Among the representatives of the Galerucinae the Madurasia obscurella plays outgroup relationships by its autapomorphics in having legs with simple claws (x3) and anterior angle of pronotum with distinct tuburcles (b6) and sistergroup relationship with rest of the representatives of the sub-family in having legs with all claws bifid or appedicate (x1) and pronotum almost rectangular shaped (f1).

The rest of the species falls into two groups the first group includes Taphinellina bengalensis, Oedicerus cyanipennis, Aplosonyx chalybaeus, Bijukta flaviventure and Erganoides flavicornis and seconds group includes rest of the 16-species. Among first group Erganoides flavicornis plays outgroup relationships by its autapomorphics like body elongated (t6) and thecal appendage short plate-like besets with hairs (zf3) and sister group relationships with rest of species of first group by their synapomorphics like body broadly ovate (t4) and thecal appendage smooth (zf2). Among rest of the species Taphenellina bengalensis and Oedicerus cyanipennis play sister group relationships to each other by their synapomorphic like anteocular distance much shorter than posterior of head including eyes (j1) and aedeagus with dorsal and ventral thecal appendages (ze2) and outgroup relationships with Aplosonyx chalybaeus and Bijukta flaviventure by their synapomorphics anteocular distance half the length posterior of head including eyes (j2).
The second group includes 16-species in which *Merista quadrifasciata* and *Sphenoraria bicolor* play sister group relationships to each other by their synapomorphies like body usually unicolour (b1) and large number of spots on pronotum and elytra (c2) and outgroup relationships with rest of the taxon by their synapomorphy, body generally varying in color (b3). Among these *Gallerupipla brunnea* plays outgroup relationships by its autapomorphies elytra with clothing of hairs (u4) and aedeagus complicated barrel-shaped (zb4) and sister-group relationship with 13-species by their synapomorphies elytra smooth devoid of clothing hairs (u1) and thecal appendages simple (zf1). Among rest of the 13-species the the *Leptoxena eximia* and *Galeruca himalyensis* plays sistergroup relationships with each other by their synapomorphies like body usually elongated (f5) and elytra roughly punctuate or variolate (u2) and outgroup relationships with the species of *Oides* and *Aulacophora* by their synapomorphics like body usually broad or ovate (f1) and elytra smoothly punctuate (u3). Among the species of the genera *Oides* and *Aulacophora*, the species of the genus *Oides* viz. *bengalensis*, *neobengalensis*, *andrewsi*, *affinis*, *flava*, and *livida* plays sister-group relationships with each other by their synapomorphies like anterior margin of pronotum much shorter than posterior margin of pronotum (n2) and outgroup relationships with the species of the genus *Aulacophora* viz. *bicolor*, *intermedia*, *viridus*, *foveicollis*, and *excavata* by their synapomorphies, body generally narrowed (f3) and anterior margin of pronotum usually equal to posterior margin of pronotum (n1). With in the genus *Oides*, the species *flava* and *livida* plays sister-group relationships with each other by their synapomorphies like body reddish brown and upper surface shining (b5) and outgroup relashionships with rest of the species of the genus *Oides* by their synapomorphy body yellow or reddish with black spots (b6). In rest of the species of the genus *Oides*, the *bengalensis* and *neobengalensis* plays sistergroup relationship by their synapomorphies like pronotum black (s2) and abdomen enclosing by elytra at repose (za1) and outgroup relationships with *andrewsi* and *affinis* by their synapomorphies pronotun reddish (s1) and abdomen exposed at repose (za2).

Among the species *Aulacophora*, the *A bicolor* plays outgroup relationship by its autapomorphy, spermatheca beak-shaped and bilobed (zi4) and sister-group relationships with *A. intermedia*, *A. viridis*, *A. foveicollis* and *A. excavata* by their synapomorphies like lateral margins of pronotum sinuated (d1) and spermatheca sickle-shaped and uni-lobed (zi1). The rest of the species *A. intermedia* and *A. viridis* plays sister group relationship with each other by their synapomorphies like body bicolor or shaded (b4) and anteoocular distance about 1/3rd the length posterior of head inclucluing eyes (j4) and outgroup relationships with *A fovicolis* and *A excavate* by their synapomorphies like body unicolorous (b2) and anteoocular distance about half or more than half the length posterior of head including eyes (j3).
Cladistic analysis of Galerucinae species (Coleoptera) from Pakistan

Figure-1. Cladogram showing the relationship (cladistic analysis) of 22 species and 13 genera of subfamily Galerucinae of the family Chrysomelidae of Galerucinae species.
REFERENCES


EFFECTS OF PESTICIDE ON POPULATION REDUCTION OF SPIDERS AND SUCKING PESTS IN COTTON CROP

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(Received for publication: 11.05.2012)

ABSTRACT

The experiment was conducted to observe the effects of pesticides on the population reduction of pests and predatory spiders in cotton crop. The results revealed that maximum populations of pests as well as spiders were recorded in untreated cotton as compared to treated cotton. Maximum populations of pests and spiders were recorded in July-August when the cotton was lush green with more numbers of pests. Confidor at 300 ml reduced the populations of pests as well as spiders. Maximum reduction percent (77.77%) of spiders was recorded. Similarly Maximum reduction percent of whitefly (79.16%), jassid (92.90%) and thrip (98.04%) was recorded throughout study period.

Key Words: Predatory spiders, sucking pests, Population, Pesticides, Cotton.

INTRODUCTION

Cotton, Gossypium hirsutum L., is known as the “white gold” of Pakistan. It is the most important and economy dependent crop of Pakistan (Hakim et al., 2011). Area under cultivation of cotton crop in Pakistan during 2009-2010 was 3031.5 thousand hectares with production of 12452.5 thousand bales (Anonymous 2010). Its yield for the last few years has been reduced due to heavy attack of insect pest. Cotton crop is attacked by a number of insect pests, namely jassid, thrip, whitefly, mealy bug, mite, termite and bollworm complex which cause significant damage to the crop. The damages caused by the insect pests take a heavy toll of the crop at various stages of its development (Younas et al., 1980; Hormchan et al., 2001; Aheer et al., 2009; Hasnain, et al. 2009).

The growers of Pakistan heavily depend on use of pesticides to reduce pest damage and get better yields. There has been a tremendous increase in pesticide application in Pakistan. Indiscriminate use of pesticides has created many problems of pest resistance to pesticides, resurgence and emergence of new pests as well as environmental contamination. Pesticides not only kill the harmful insect pests, but also kill the naturally occurring biological control agents which have the potential to control these pests. Pesticides also have residual effects on crop, fruits, vegetables and human health (Im and Kim 1999; Soomro 2005).

Importance of biological control for the pest management has been addressed by many workers but with limited reports on the selection of insecticides that are compatible with natural enemies of pests in crops (Bottrell and Adkisson 1977). Among the naturally occurring biological control agents spiders are predatory arthropods which feed on insects and some other arthropods. They can play important roles in pest control. More than 35000 species of spiders have been identified in the world (Ghavami 2006). Farzana et al., (2012) recorded 23 species under 17 genera and 9 families from FR Peshawar, Pakistan. Martin and Sunderland (2003) reported the feeding capacity of Lycosidae in reducing insect population and host range, which includes lepidoptera, homoptera and heteroptera. Stanislav (2004) reported Zodariid spiders as voracious feeders on ant. After ants prefer termite, beetle, aphid, cricket, grass hopper, etc. Similarly, Cerruti et al., (2007) reported that several of Pieris rapae were significantly reduced due to spider activities.

Spiders are known to be highly sensitive to some insecticides (Everts et al., 1991; Mansour et al., 1992; Stark et al., 1995). Only a few studies on the effects of pesticides on functional response of spiders have been published so far (Deng et al., 2007). Keeping in view the importance of spiders as biological control agents and the effects of pesticides on the functional response of spiders, present study was conducted. The results of this study will be useful tool in the selection of safe pesticides for
natural enemies and for integrated pest management program.

MATERIALS AND METHODS

The experiment on efficacy of pesticides on population reduction of pests as well as spiders was carried out in cotton crop during 2010. The variety used was NIAB-78. For this purpose 2 acres of sprayed cotton and 2 acres of unsprayed cotton grown at Entomology section, ARI, Tandojam were put under observation at fortnight intervals. Two sprays of Confidor at -300 ml were applied on two acres of cotton crop on July 15 and August 15, 2010. For recording the population of pests and spiders, fifty plants were randomly selected from two acres of cotton field. Five leaves per plant were observed for sucking pests and whole plants were observed for spider population. The population in un-treated cotton was considered as pre treatment and population of pests and spiders in treated cotton was considered as post treatment. The paired T-test of spider population in un-treated and treated cotton was also determined. The reduction percent of pests and spiders was calculated with the formula shown below:

\[
\text{Pre treatment} - \text{Post treatment} \times 100
\]

RESULTS

The data in Table-1 indicate that mean populations of spiders in un-sprayed cotton remained higher (0.4-1.0) per plant as compared to treated cotton. The reduction percent of spiders varied from 25-77.77 percent throughout study period. Maximum reduction percent (77.77%) was recorded from 2\(^{nd}\) fortnight of July, 2010. Minimum reduction percent (25%) was recorded during 1\(^{st}\) fortnight of July. Similarly, the whitefly mean population per plant remained higher (3.1-4.8) from July-September in un-treated cotton as compared to treated cotton. White fly population reduction percent was recorded from 64-79.16 percent during July-September. Maximum reduction percent (79.16%) was recorded from 2\(^{nd}\) fortnight of July, 2010. Minimum reduction percent (64%) was recorded during 1\(^{st}\) fortnight of September. The jassid population in un-treated cotton remained higher (10.5-16.2) per plant from July-2\(^{nd}\) fortnight of August as compared to treated cotton. The reduction percent of jassid due to two spray applications in treated cotton ranged from 86.79-92.90 percent. Maximum reduction percent of jassid (92.90%) was recorded from 1\(^{st}\) fortnight of August, 2010. Minimum reduction percent of jassid (86.79%) was recorded during 1\(^{st}\) fortnight of July. Similarly, thrips population remained present on cotton from July-Sept with mean population range of (2.3-24.7) per plant in untreated cotton. The population reduction percent of thrip due to pesticides in treated cotton was recorded from 82.60-98.04 percent. Minimum reduction percent (82.60%) was recorded during 1\(^{st}\) fortnight of July and maximum reduction percent of thrips (98.04%) was recorded during 1\(^{st}\) fortnight of August, 2010. Paired T-test result showed that all the pests and spiders populations in untreated cotton and treated cotton were statistically significant (P<0.05).

DISCUSSION

Maximum populations of pests as well as spiders were recorded in un-treated cotton as compared to treated cotton, which received two applications of pesticides. The predatory spiders were present after the arrival of sucking pests on cotton. The spiders have ability to capture the immature as well as mature/adult prey through the webs prepared by spinnerets in their posterior abdominal tip. Maximum populations per plant of pests and spiders were recorded in July-August due to lush green condition of the crop and maximum number of pests. The studies further showed that pesticide Confidor at 300 ml dose caused reductions not only in the populations of sucking pests but also in the population of predatory spiders, there is a need to bring awareness in growers about potential of spiders and adverse effects of pesticides on natural enemies including cotton spiders.

The results of present study agreed with Tanaka (2000) who examined toxicity of nine insecticides to predators of rice plant hoppers with first instars of four spider species i-e, Pardosa pseudoanulata, Tetragnatha maxillosa, Ummeliata insecticeps and Gnathonarium exsiccatum. Among all pesticides, Deltamethrin was the most toxic to spider. The results indicated the spiders are susceptible to synthetic parathryoids. Pekar (2002) tested susceptibility of immature individuals of the spider Theridion impressum to 17 pesticides in the laboratory. All tested acaricides, pirimiphos-methyl (Actellic), flufenoxuron (Cascade), fluvinate+thiometon (Mavrik), and bifenthrin (Talstar) showed high toxicity. William (2006) determined the effects of pesticide malathion on the courtship and mating behavior of the lycosid, Rabidosa rabida. Mating behavior was severely disrupted and resulted in most dosed males being killed by females without achieving copulation. Chaiwong et al., (2011) determined ethiprole, clothianidin, dinotefuran and thiamethoxam were mostly harmless to moderately harmful to the spiders.
Table-1. Weekly means reduction percent of pests and spiders due to pesticide applications in cotton during 2010

<table>
<thead>
<tr>
<th>Date of observation</th>
<th>Spiders / plant in unsprayed cotton</th>
<th>Spiders / plant in sprayed cotton</th>
<th>Reduction %</th>
</tr>
</thead>
<tbody>
<tr>
<td>15-07-2010</td>
<td>0.4</td>
<td>0.3</td>
<td>25.00%</td>
</tr>
<tr>
<td>30-07-2010</td>
<td>0.9</td>
<td>0.2</td>
<td>77.77%</td>
</tr>
<tr>
<td>15-08-2010</td>
<td>1.0</td>
<td>0.3</td>
<td>70.00%</td>
</tr>
<tr>
<td>30-08-2010</td>
<td>0.6</td>
<td>0.2</td>
<td>66.66%</td>
</tr>
<tr>
<td>15-09-2010</td>
<td>0.8</td>
<td>0.4</td>
<td>50.00%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Date of observation</th>
<th>White fly / plant in unsprayed cotton</th>
<th>White fly / plant in sprayed cotton</th>
<th>Reduction %</th>
</tr>
</thead>
<tbody>
<tr>
<td>15-07-2010</td>
<td>3.1</td>
<td>1.1</td>
<td>64.50%</td>
</tr>
<tr>
<td>30-07-2010</td>
<td>4.8</td>
<td>1.0</td>
<td>79.16%</td>
</tr>
<tr>
<td>15-08-2010</td>
<td>3.6</td>
<td>0.9</td>
<td>75%</td>
</tr>
<tr>
<td>30-08-2010</td>
<td>3.8</td>
<td>0.9</td>
<td>76.31%</td>
</tr>
<tr>
<td>15-09-2010</td>
<td>3.4</td>
<td>1.2</td>
<td>64%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Date of observation</th>
<th>Jassid / plant in unsprayed cotton</th>
<th>Jassid / plant in sprayed cotton</th>
<th>Reduction %</th>
</tr>
</thead>
<tbody>
<tr>
<td>15-07-2010</td>
<td>10.6</td>
<td>1.4</td>
<td>86.79%</td>
</tr>
<tr>
<td>30-07-2010</td>
<td>10.5</td>
<td>0.9</td>
<td>91.42%</td>
</tr>
<tr>
<td>15-08-2010</td>
<td>14.1</td>
<td>1.0</td>
<td>92.90%</td>
</tr>
<tr>
<td>30-08-2010</td>
<td>16.2</td>
<td>1.3</td>
<td>91.97%</td>
</tr>
<tr>
<td>15-09-2010</td>
<td>11.1</td>
<td>1.2</td>
<td>89.18%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Date of observation</th>
<th>Thrip / plant in unsprayed cotton</th>
<th>Thrip / plant in sprayed cotton</th>
<th>Reduction %</th>
</tr>
</thead>
<tbody>
<tr>
<td>15-07-2010</td>
<td>2.3</td>
<td>0.4</td>
<td>82.60%</td>
</tr>
<tr>
<td>30-07-2010</td>
<td>5.3</td>
<td>0.5</td>
<td>90.56%</td>
</tr>
<tr>
<td>15-08-2010</td>
<td>20.5</td>
<td>0.4</td>
<td>98.04%</td>
</tr>
<tr>
<td>30-08-2010</td>
<td>24.7</td>
<td>1.6</td>
<td>93.52%</td>
</tr>
<tr>
<td>15-09-2010</td>
<td>12.9</td>
<td>0.7</td>
<td>94.57%</td>
</tr>
</tbody>
</table>
Pictures of the predatory spiders recorded from cotton crop during experimental work.

- Miturgidae: *Cheiracanthium inclusum* (Hentz, 1847)
- Corinnidae: *Castianeira zetes* (Simon, 1897)
- Salticidae: *Thyene imperialis* (Rossi, 1846)
- Sparassidae: *Heteropoda nilgirina* (Pocock, 1901)
- Araneidae: *Aculepeira ceropegia* (Walckenaer, 1802)
- Lycosidae: *Lycosa mackenziei* (Gravely, 1924)
Taxonomic position of Predatory spiders recorded from Cotton crop.

<table>
<thead>
<tr>
<th>S. #</th>
<th>Family</th>
<th>Scientific Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Araneidae</td>
<td>Aculepeira ceropegia (Walckenaer, 1802)</td>
</tr>
<tr>
<td>2</td>
<td>Corinnidae</td>
<td>Castianeira zetes (Simon, 1897)</td>
</tr>
<tr>
<td>3</td>
<td>Oxyopidae</td>
<td>Oxyopes salticus <em>(Hentz, 1845)</em></td>
</tr>
<tr>
<td>4</td>
<td>Thomisidae</td>
<td>Thomisus lobosus (Tikader, 1965)</td>
</tr>
<tr>
<td>5</td>
<td>Thomisidae</td>
<td>Thomisus projectus (Tikader, 1960)</td>
</tr>
<tr>
<td>6</td>
<td>Theridiidae</td>
<td>Argyrodes argentatus (OP Cambridge, 1880)</td>
</tr>
<tr>
<td>7</td>
<td>Lycosidae</td>
<td>Pardosa pseudoannulata (Bosenberg &amp; Strand, 1906)</td>
</tr>
<tr>
<td>8</td>
<td>Lycosidae</td>
<td>Lycosa mackenziei (Gravely, 1924)</td>
</tr>
<tr>
<td>9</td>
<td>Lycosidae</td>
<td>Hippasa agelenoides (Simon 1884)</td>
</tr>
<tr>
<td>10</td>
<td>Lycosidae</td>
<td>Lycosa tista (Tikader, 1970)</td>
</tr>
<tr>
<td>11</td>
<td>Salticidae</td>
<td>Phlegra bresnieri (Lucas, 1846)</td>
</tr>
<tr>
<td>12</td>
<td>Salticidae</td>
<td>Thyene imperialis (Rossi, 1846)</td>
</tr>
<tr>
<td>13</td>
<td>Salticidae</td>
<td>Dendryphantes rudis (Sundevall, 1832)</td>
</tr>
<tr>
<td>14</td>
<td>Miturgidae</td>
<td>Cheiracanthium melanostomum (Thorell, 1895)</td>
</tr>
<tr>
<td>15</td>
<td>Miturgidae</td>
<td>Cheiracanthium inclusum (Hentz, 1847)</td>
</tr>
<tr>
<td>16</td>
<td>Sparassidae</td>
<td>Heteropoda nilgirina (Pocock, 1901)</td>
</tr>
</tbody>
</table>

**CONCLUSION**

Maximum populations of pests as well as spiders were recorded in un-treated cotton as compared to treated cotton. Maximum populations of pests and predatory spiders were recorded in July-August when the cotton was lush green with more numbers of pests. Confidor at 300 ml reduced the populations of pests as well as spiders.

**ACKNOWLEDGEMENTS**

The authors are thankful to Pakistan Science Foundation (PSF) for providing the funds for this project entitled: “Documentation of predatory spiders and their role in suppression of pests of major crops in Sindh” (Project Grant No. PSF / Res / S-SAU / Agri-382). We are also thankful to Sindh Agriculture University, Tandojam, Pakistan, for their help and support throughout the course of this study in Pakistan.

**REFERENCES**


THE RESPONSE OF DIFFERENT RICE VARIETIES AGAINST THE WHITEBACKED PLANTHOPPER, SOGATELLA FURCIFERA (HORVATH) (HOMOPTERA: DELPHACIDAE) UNDER FIELD AND GREEN HOUSE CONDITIONS

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(Received for publication: 22.05.2012)

ABSTRACT

Twenty two rice varieties, 6 medium maturing, 7 early maturing coarse rice and 9 fine rice varieties were tested against the Whitebacked Planthopper, Sogatella furcifera (Horvath) (Homoptera: Delphacidae) under field and green house conditions. The experiments were conducted at Rice Research Institute, Dokri during the year 2008. Two observations WBPH (White backed Plant hopper) to count (nymphs and adults) were taken during the experiments. The first and second observations of WBPH were observed on 60-65 and 80-85 DAT (Days after Transplanting) respectively. Interval between the observations was 20 days in both field and green house conditions.

High populations of WBPH were recorded on 80-85 DAT. The result showed that variety BG 276-5 was noted comparatively susceptible and variety IR15323-78 was observed resistant from the Medium Maturing coarse rice varieties. No significant difference was observed between Early Maturing (DR-83xDR-200, DR-64, and DR-64xDR83) rice varieties in the first observation. The rice variety DR-83xS.Kangni is comparatively more susceptible than the other varieties. Population per hill was recorded 2.20 and 3.10 under field and green house condition, respectively. The variety DR-64xDR-83 is comparatively more resistant than the other varieties. Low WBPH population was recorded in Early Maturing Rice varieties DR-64, and DR-64xDR-83. In fine rice varieties, the maximum population of WBPH per hill was observed in variety DR-65 (0.41 and 0.70) and Basmati 370 (0.41 and 0.80) in field and green house. The experimental results show that Medium Maturing rice varieties are more susceptible for WBPH than early maturing and Fine rice varieties.

Key words: WBPH, rice varieties, field and green house.

INTRODUCTION

Rice is grown on over 145 million hectares in more than 110 countries in the world. Rice is one of the world’s most important crops providing staple food to nearly entire of the Global population (FAO, 2004). It is staple food for 2.7 billion people in developing countries of Asia (Salim et al., 2003). Almost 90% of the rice is grown and consumed in Asia (Khush and Brar, 2002). Rice plays an important role in the economy of Pakistan and 23 % annually income shared by rice crop. In Pakistan, rice is 2nd important cash crop after cotton and 2nd cereal crop after wheat (Dhuyo and Soomro, 2007 and 2008).

The first appearance of whitebacked planthopper, Sogatella furcifera (Horvath), was recorded during 1976, infesting the popular semi dwarf rice variety IR-6 in tenant cultivation at Rice Research Institute, Dokri. The plant dryings of various degrees and hopper burns caused, made to believe and rate this insect as important insect-pest of rice During 1979 and 1980 crop seasons, the insect appeared in severe form and caused plant dryings and hopper burns of various sizes in Larkana, Shikarpur, Jacobabad and Dadu districts. In Lower Sindh, infestation was observed at one site near Badin, where local rice variety Ganja was infested by this insect at panicle initiation stage (Mahar, et al. 1978 & Parihar et al., 2010).

Out of 29 species of Genus Sogatella, only 13 species are found in Asian countries and only five are known to attack the rice plant. The whitebacked planthopper, Sogatella furcifera (Horvath) is the serious pest of rice. The other species are S. kolophon, S. longifureifera, S. panicicola and S. serokata. As far as Sogatella furcifera (Horvath) is concerned, it is distributed in USSR, Mangolia, Japan, Korea, China, Taiwan, India Sri Lankka, Indonesia, Australia and Pacific Islands. (Suenaga, 1956 & Nasu, 1975). It is considered a serious pest only in rice producing regions of Asia. (Pathak, 1968). Sogatella furcifera Horvath has a wide range of host plants. It is reported to repeat some generations on graminaceous grasses like Echinochloa glabrescens, Cynodon dactylon, Leersia japonica, Zizaina latifolia, Glyceria acutiflora,
besides *Oryza sativa* (Suenaga, 1956). In addition to rice, millets and maize are also alternate hosts of the insect (Pathak, 1968, Solangi & Riffat 2011). But, under our conditions, the host plants other than the rice plant have not so far been observed.

Mostly, the infestations occur during end of September or early October, when rice crop is about 75 to 90 days old i.e at panicle emergence stage. As such, there is plant drying in fully emerged panicle plants or the panicles emerge partially in a late crop. At one site in lower Sindh, the insect infested the local Ganja variety in earlier stages i.e 55-60 DAT. Under such conditions, the plants did not produce heads, appeared black due to growth of sooty mould and the plants were sticky- black covered with nymphs, adults and the casted skins. The development of the sooty mould on the honey dew excreted by the insects checks the plant growth. This is in confirmation with Okada (1977). A yellowish discoloration develops on plants when there is heavy attack of whitebacked planthopper (Atwal, *et al.*, 1967).

**MATERIALS AND METHODS**

The experiments were conducted at experimental area of Rice Research Institute, Dokri. Six medium maturing, 7 early maturing coarse rice and 9 fine rice varieties were tasted against the Whitebacked Planthopper, *Sogatella furcifera* (Horvath). Designs of experiments were RCBD (Randomized Complete Block Design) with three replications. The nursery was sown on 23rd, 25th and 28th June 2008, transplanting were done on 24th, 29th and 30th July, 2008 for medium, early and fine rice varieties respectively. Two observations of WBPH count (nymphs and adults) were taken. The plot size was maintained 10.2x6.2 M. Total sample of hills was taken 24 from each replication; number of infested hills and WBPH population were recorded. 10 samples were also taken from the green house. Average population of WBPH per hill was calculated.

Rising of Medium Maturing coarse rice was done under control condition (Green house) in wooden boxes. The same 6 medium maturing, 7 early maturing coarse rice and 9 fine rice varieties were evaluated under artificial pressure of the WBPH in green house. The varieties were transplanted in wooden boxes. The population of WBPH were collected from field and introduced in the wooden boxes. Two observations of WBPH population were counted. Interval between the observations was 20 days.

**Statistical analysis:**

The data were averaged, tabulated and statistically analyzed using statistical program MSTAT.

**RESULTS**

The first observation of WBPH (White Backed Plant Hopper) Fig. 1 was observed on 65 DAT (Days after Transplanting). Interval between the observations was 20 days. More populations of WBPH were recorded on 80-85 DAT. The result showed that variety BG276-5 was recorded comparatively susceptible and variety IR15323-78 was noted resistant from the Medium Maturing coarse rice varieties. No significant difference was observed between Early Maturing (DR-83xDR-200, DR-64, and DR-64xDR83) Rice varieties in the first observation.

The rice variety DR-83xS.Kangni is comparatively more susceptible than the other varieties. Population per hill was recorded 2.20 and 3.10 under field and green house condition. The variety DR-64xDR-83 is comparatively more resistant than the other varieties. Less WBPH population was recorded in E. M. rice varieties DR-64, and DR-64xDR-83.

In fine rice varieties, the maximum population of WBPH per hill was observed in variety DR-65(0.41 and0.70) and Basmati 370 (0.41 and0.80) in field and green house.

Nine scented rice, entries, seven early maturing and six medium maturing coarse entries were screened against WBPH under field and green house conditions.

Rice varieties Basmati-370, IR-6 and DR-83 (Dokri-83) were used as check varieties for Fine, Medium maturing and early maturing rice, respectively. According to yield data scented entries, DR-61 and DR-67 were noted same group and yield 3299 and 3234Kg/ha respectively were recorded. Results indicated that population of WBPH was noted not less (0.2/hill) from the medium maturing rice entries IR 5323-78 but also high yield 5200kg/ha. No significant differences from the entries BG-276-5, DR-82, IR13639-34, DR-92 and IR-6 were recorded. Early maturing rice entries against WBPH, yield 5687 and 5699kg/ha were observed from DR-83 and Dr-64xDR-83 early maturing rice varieties respectively. The rice varieties also noted same group. It was also observed that stem and leaf sheath of IR 15323-78 were hard than the variety BG-276-5. Leaf sheath of BG-276-5 is very soft and Whitebacked Planthopper prefer for feeding.
DISCUSSION

Nine scented rice entries, seven early maturing and six medium maturing coarse rice entries were screened against WBPH under field and green house condition. Statistics was done on the recorded yield data from the field experiments. Medium maturing and early maturing rice, respectively. According to yield data of scented entries, DR-61 and DR-67 were noted same group and yield 3299 and 3234 Kg/ha. Respectively were recorded. Result indicated that population of WBPH was noted not only less (0.2/hill) from the medium maturing rice entries IR-15323-78 but also high yield 5200 Kg/ha. No significant differences from the entries BG-276-5, DR-82, IR 13639-34, DR-92 and IR-6 were recorded. Early maturing rice entries were comparatively more resistance than the medium maturing rice entries against WBPH. Yield 5687 and 5699 Kg/ha were observed from DR-83 and DR-64x DR-83 early maturing rice varieties respectively. The rice varieties also noted same group.

CONCLUSION

The results show that Medium Maturing coarse rice varieties are more susceptible for WBPH than early maturing coarse and fine rice varieties. Fine rice varieties are more resistant for WBPH than the Early and Medium Maturing coarse rice varieties.

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Table-1. Details of 22 varieties of rice crop, showing fine early and medium.

<table>
<thead>
<tr>
<th>#</th>
<th>Fine</th>
<th>Early</th>
<th>Medium</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>Lateefy</td>
<td>DR-83 (Cheek)</td>
<td>BG-276-5</td>
</tr>
<tr>
<td>02</td>
<td>DR-65</td>
<td>DR-83xDR-92</td>
<td>IR 13639-34</td>
</tr>
<tr>
<td>03</td>
<td>DR-66</td>
<td>DR-83xDR-46</td>
<td>DR-92</td>
</tr>
<tr>
<td>04</td>
<td>DR-61</td>
<td>DR-83xS. Kangani</td>
<td>DR-82</td>
</tr>
<tr>
<td>05</td>
<td>DR-67</td>
<td>DR-83xDR-2000</td>
<td>IR-15323-78</td>
</tr>
<tr>
<td>06</td>
<td>Basmati 370 (Cheek)</td>
<td>DR-64</td>
<td>IR 6 (Check)</td>
</tr>
<tr>
<td>07</td>
<td>Ambreen</td>
<td></td>
<td></td>
</tr>
<tr>
<td>08</td>
<td>Gighai 77</td>
<td></td>
<td></td>
</tr>
<tr>
<td>09</td>
<td>Sunhri Sugdasi</td>
<td></td>
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</table>

Table-2. First observation of WBPH count on medium maturing coarse rice varieties.

<table>
<thead>
<tr>
<th>#</th>
<th>Varieties</th>
<th>Hills Obs.</th>
<th>Hills Inf.</th>
<th>Total Pop.</th>
<th>Pop./Hill</th>
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<td>F</td>
<td>G. H.</td>
<td>F</td>
<td>G. H.</td>
<td>F</td>
</tr>
<tr>
<td>1</td>
<td>BG-276-5</td>
<td>24</td>
<td>10</td>
<td>17</td>
<td>9</td>
</tr>
<tr>
<td>2</td>
<td>IR-13639-34</td>
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<td>10</td>
<td>20</td>
<td>8</td>
</tr>
<tr>
<td>3</td>
<td>DR-92</td>
<td>24</td>
<td>10</td>
<td>18</td>
<td>9</td>
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<tr>
<td>4</td>
<td>DR-82</td>
<td>24</td>
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<tr>
<td>5</td>
<td>IR-15323-78</td>
<td>24</td>
<td>10</td>
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<tr>
<td>6</td>
<td>IR-6 (Check)</td>
<td>24</td>
<td>10</td>
<td>12</td>
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</tbody>
</table>

Table-3. 2nd observation of WBPH count on medium maturing coarse rice varieties.

<table>
<thead>
<tr>
<th>#</th>
<th>Varieties</th>
<th>Hills Obs.</th>
<th>Hills Inf.</th>
<th>Total Pop.</th>
<th>Pop./Hill</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>F</td>
<td>G. H.</td>
<td>F</td>
<td>G. H.</td>
<td>F</td>
</tr>
<tr>
<td>1</td>
<td>BG-276-5</td>
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<td>10</td>
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<tr>
<td>3</td>
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<td>24</td>
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</tr>
<tr>
<td>4</td>
<td>DR-82</td>
<td>24</td>
<td>10</td>
<td>20</td>
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<td>5</td>
<td>IR-15323-78</td>
<td>24</td>
<td>10</td>
<td>5</td>
<td>2</td>
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<tr>
<td>6</td>
<td>IR-6 (Check)</td>
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</tr>
</tbody>
</table>

Obs.=Observed, Inf.=Infested, Pop.=Population, F=Field, G.H.=Green House

Table-4. 1st observation of WBPH count on early maturing coarse rice varieties.

<table>
<thead>
<tr>
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<th>Varieties</th>
<th>Hills Obs.</th>
<th>Hills Inf.</th>
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<th>Pop. / Hill</th>
</tr>
</thead>
<tbody>
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<td>F</td>
<td>G. H.</td>
<td>F</td>
</tr>
<tr>
<td>1</td>
<td>DR-83</td>
<td>24</td>
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<td>2</td>
<td>DR-83xDR-92</td>
<td>24</td>
<td>10</td>
<td>12</td>
<td>5</td>
</tr>
<tr>
<td>3</td>
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<td>24</td>
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<td>11</td>
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</tr>
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<td>4</td>
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<td>12</td>
<td>4</td>
</tr>
<tr>
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<td>DR-83xDR-2000</td>
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<td>10</td>
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<td>24</td>
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<td>9</td>
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<tr>
<td>7</td>
<td>DR-64xDR-83</td>
<td>24</td>
<td>10</td>
<td>9</td>
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</table>
Response of different rice varieties against WBPH under field and greenhouse condition

Table-5. 2nd observation of WBPH count on early maturing coarse rice varieties.

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<th>Pop. / Hill</th>
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<tr>
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<td>24</td>
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<td>20</td>
<td>9</td>
</tr>
<tr>
<td>3</td>
<td>DR-83xDR-46</td>
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<td>4</td>
<td>DR-83xS. Kangani</td>
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<td>10</td>
<td>12</td>
<td>7</td>
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<tr>
<td>5</td>
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<td>24</td>
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<td>24</td>
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</table>

Table-6. 1st observation of WBPH count on fine varieties.

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<th>Hills Inf.</th>
<th>Total Pop.</th>
<th>Pop. / Hill</th>
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</thead>
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<td>F</td>
<td>G.H.</td>
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<tr>
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<td>DR-65</td>
<td>24</td>
<td>10</td>
<td>5</td>
<td>2</td>
</tr>
<tr>
<td>3</td>
<td>DR-66</td>
<td>24</td>
<td>10</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>4</td>
<td>DR-61</td>
<td>24</td>
<td>10</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>5</td>
<td>DR-67</td>
<td>24</td>
<td>10</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>6</td>
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<td>24</td>
<td>10</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>7</td>
<td>Ambreen</td>
<td>24</td>
<td>10</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>8</td>
<td>Gighai 77</td>
<td>24</td>
<td>10</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>9</td>
<td>Sunhrri Sugdasi</td>
<td>24</td>
<td>10</td>
<td>5</td>
<td>1</td>
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</table>

Table-7. 2nd observation of WBPH count on fine varieties.

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<th>Varieties</th>
<th>Hills Obs.</th>
<th>Hills Inf.</th>
<th>Total Pop.</th>
<th>Pop. / Hill</th>
</tr>
</thead>
<tbody>
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<td>G.H.</td>
<td>F</td>
<td>G.H.</td>
</tr>
<tr>
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<td>10</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
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<td>DR-65</td>
<td>24</td>
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<td>2</td>
</tr>
<tr>
<td>3</td>
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<td>24</td>
<td>10</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>4</td>
<td>DR-61</td>
<td>24</td>
<td>10</td>
<td>4</td>
<td>4</td>
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<td>5</td>
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<tr>
<td>8</td>
<td>Gighai 77</td>
<td>24</td>
<td>10</td>
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<td>3</td>
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<tr>
<td>9</td>
<td>Sunhrri Sugdasi</td>
<td>24</td>
<td>10</td>
<td>6</td>
<td>3</td>
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</table>

Table-8. Yield data of scented, early and medium maturing rice entries.

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<tr>
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<th>Scented entries</th>
<th>Early maturing entries</th>
<th>Medium maturing entries</th>
</tr>
</thead>
<tbody>
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<td></td>
<td>Name</td>
<td>Yield Kg/ha</td>
<td>Name</td>
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<tr>
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<td>Lateefy</td>
<td>3180B</td>
<td>DR-83(check)</td>
</tr>
<tr>
<td>2</td>
<td>DR-65</td>
<td>3104B</td>
<td>DR-83XDR</td>
</tr>
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<td>3</td>
<td>DR-66</td>
<td>3100B</td>
<td>DR-83XDR</td>
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<tr>
<td>4</td>
<td>DR-61</td>
<td>3299A</td>
<td>DR-83XDR-2000</td>
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<td>5</td>
<td>DR-67</td>
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<td>DR-64</td>
</tr>
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<td>DR-64XDR-83</td>
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<td>7</td>
<td>Ambreen</td>
<td>31055B</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Gighai</td>
<td>3100B</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Sunhrri Sugdasi</td>
<td>3106B</td>
<td></td>
</tr>
</tbody>
</table>
Figure-1. Population of nymphs and adults of *Sogatella furcifera*

Figure-2. The method of collection of *Sogatella furcifera*

Figure-3. Population of nymphs (white) and adults (black) of *S. furcifera*
STUDIES ON THE DISTRIBUTION PATTERN OF WHITEFLY *BEMISIA TABACI* GENN ON OKRA CROP IN SINDH-PAKISTAN

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(Received for publication: 19.07.2012)

ABSTRACT

The okra, *Abelmoschus esculentus* crop was sown at Latif Farm, Sindh Agriculture University, Tandojam during the 3rd week of March 2011. The population variation was recorded from 25 randomly selected plants in relation to the temperature and relative humidity on Sabz-Pari variety. It was observed that the population of adults and crawlers of whitefly was abundant on the top portion of the plant as compare to low. The adult mean population of whitefly was recorded at peak levels as 40.20±1.02 while crawler mean population of whitefly was at its peak 28.80±0.31 and the mean population of whitefly adults and crawlers at its peak was 40.20 and 28.80 due to the effect of temperature (30.40°C) and relative humidity 80%.

Key Words: *Bemisia tabaci*, Okra, Population, Sabz-Pari Variety, Temperature, Humidity.

INTRODUCTION

Okra, *Abelmoschus esculentus* L., (Malvaceae) also known as lady finger is a favorite vegetable of the poor and the rich peoples. It is a warm season crop growing best during summer with irrigation or during rainy season, but can be grown all the year round in tropical, subtropical and temperate zones. Chaudhry (1979) reported that the cultivated Okra/Bhindi is of old world origin and apparently introduced to Egypt in 7th century. Whiteflies, *Bemisia tabaci* was described over 100 years ago as a tobacco pest in Greece and has since become one of the most important pests of world Agriculture. It is widely polyphagous, feeding on over 500 species of plants to 74 families. Its hosts include vegetable, field and ornamental crops etc.

A major constraint in vegetable production is the effective prevention and control of pests and diseases, which cause high yield losses (Tindall, 1983). Vegetable losses due to pests can be as high as 25%, which can result in severe income loss to small scale farmers. Significant loss in Okra due to pests has been placed at about 54% by (Choudary & Dadheeck, 1989, Nath et al., 1992).

This crop is attacked by large number of insect pests, which greatly reduce its quality and yield. These pests include leaf eaters, sapsuckers and fruit borers. Among the sapsuckers are the nymphs and adults of cotton aphid, *Aphis gossypii* that cause leaf distortion and cupping. *B. tabaci* attacks more than 540 plant species of 77 plant families (Greathead 1986 & Basu 1995). In addition to this, Mazumder et al., (1996) reported severe incidence of *Bemisia tabaci* on okra cultivation. But, there is no work has been done on this pest from this region. Keeping in view the intensity of white fly on okra an important vegetable crop of Sindh the study was designed to assess the abundance of whitefly in relation to crop phonology.

MATERIALS AND METHODS

Okra crop was sown in the 3rd week of March, 2011 at Latif Farm, Sindh Agriculture University, Tandojam. The row to row and plant to plant distance was 2 to 2.5 inches respectively. The population variation was recorded from 25 randomly selected plants of a variety Sabz Pari. Five leaves (one from bottom, two each from middle & top) were selected from each plant. The temperature (°C) and relative humidity (RH %) were also recorded. Observations were conducted in a randomized block design. The size of plot was 14 x 46 ft. and following observation has been recorded:

1. Adult of whitefly: For the adults of whitefly observations were taken on okra crop to record the pest population in simple randomly selected plants.

2. Crawlers (nymphs) of whitefly: The whitefly crawlers were observed on okra crop for recording the population. A magnifying glass (ordinary) was used randomly on the plants because the crawlers were so minute.

Statistical analysis: Whitefly population of adults and crawlers on each section of okra crop with the help of student paired test and mean population of whitefly and standard error (X + SE) were also observed.
RESULTS

The present finding on the distribution and abundance of whitefly Bemisia tabaci on okra crop revealed that population of adults and crawlers of the whitefly on the this plants at its different level i-e (top, middle & bottom) is significantly differ from each other it was also observed that population of pest increased gradually and reached its peak from in the months of May to July then it steadily begin to Decreased ( Table I - II Figs 1-2) The adult population of whitefly at the top of plant reached its peak on 3rd June the mean was 2.86 while minimum population recorded on 26th July 2011 was 0.62 and on contrary to this , the adult population in the middle was reported peak on 13th May mean was 1.26 whereas the minimum population was recorded at the bottom on 13th May mean was 1.12 while, the minimum population on 26th April, mean was 0.32. The crawlers / nymphs of whitefly at top leaves were recorded randomly with a help of magnifying glass. The peak population was recorded on 31th May, the mean was 1.48 and minimum population recorded on 26th July, the mean was 0.48. The crawler population was at the middle level showed that peak population was observed on 17th June.

The minimum population was recorded on 26th July, the means 0.32 while the crawler population at the bottom leaves showed that the peak population was recorded on 21st June, and the mean was 1.32. The minimum population recorded on 29th April, the mean was 0.36. The crawler population of whitefly on okra crop at the top, middle and bottom of the plant showed the significant difference. Further, present study also indicated that temperature and relative humidity also contributed to enhance the multiplication of whitefly adult and crawler population in field. The adult population of whitefly observed at its peak on 3rd June, the mean was 40.20 at the temperature of 30.40°C and relative humidity at 80.00%. The minimum population recorded on 26th July, at the temperature of 40.40°C and relative humidity was 41.00% (Table- III).

DISCUSSION

After the sowing of okra crop on 3rd week of March, 2011 the crop was permitted to grow to the sufficient height and girth. It was observed that one month after the sowing the pest appeared on the crop first of all whitefly Bemisia tabaci Genn., and then other pests. These insect pests specially sucking complex was found mostly desapping underside of the turned leaves. At the initial stage of the attack of the pest population was negligible. The pest population was recorded from April 26th, 2011 after one month of the sowing. The population of whitefly was relatively lower in April and started increasing later and was at its peak during May-June and started decreasing to the end of July.

The population of whitefly on okra crop increased with the increased range of temperature and relative humidity, wetness and rainfall supported by Dhamdhere et al. (1985) monitored the high infestation activity of population increased with increased humidity. The crawlers (nymphs) decreased after the month of July ranging about 40-70 nymphs/leaf, so it is not in agreement with Flint & Parks (1990) who determined 20-121 nymphs/leaf on 16th October. This may have been due to different Geographical locations.

The whitefly population increases with the cooler, or with warm weathers with high relative humidity and little rainfall and spread of the whitefly on the crop so it is not in agreement with the Aslam, & Gebara. (1995) they stated that the cooler weather with high relative humidity% (RH) and rainfall is detrimental to whitefly multiplication and spread. The results of this study are in agreement with the studies conducted by Pun and Darais-Wamy (2000), who reported that relative increase in temperature and humidity had positive effect on disease incidence, thus increasing the whitefly populations on the crop.

CONCLUSIONS

It is concluded that the whitefly population increased as the growth improved, the peak months were May to July as observed in the results. The overall population of whitefly insect pest was relatively lower in April. Furthermore the temperature and relative humidity contributed to the population abundance and the population variation of the whitefly both adults and crawlers.

RECOMMENDATIONS

On the basis of the present study the following recommendation could be made:

The whitefly population of both adults and crawlers (nymphs) are harmful for the okra crop, and the heavy infestations cause serious loss to the crop. It was therefore, recommended that high temperature and dry season special windy weather is ideal for sowing the okra crop. The crop can be saved by the utilization of natural enemies, as recommend by (Solangi & Riffat 2011, Solangi et al., 2011) cultural control and adopting different biological techniques and it must be in mind that little rainfall and high relative humidity could be proved harmful for the crop because it provide good environment for the multiplication of whitefly population so crops should not be sown in this season.

REFERENCES


### Table-1. Adult population of whitefly *Bemisia tabaci* on each section of okra crop per leaf during 2011.

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<th>Middle</th>
<th>Bottom</th>
</tr>
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<td>0.50</td>
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<tr>
<td>29</td>
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<td>0.60</td>
</tr>
<tr>
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</tr>
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<td>06</td>
<td>1.06</td>
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<td>0.68</td>
</tr>
<tr>
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<td>29</td>
<td>0.86</td>
<td>0.63</td>
<td>0.48</td>
</tr>
</tbody>
</table>

$t = 7.70, P<0.05$ Top Middle, $t = 1.40, P<0.05$ Middle and Bottom, $t = 8.28, P<0.05$ Bottom and top with the help of student paired test i.e., t-test.
Table-2. Crawler population of whitefly *Bemisia tabaci* on each section of okra crop per leaf during 2011

<table>
<thead>
<tr>
<th>Date</th>
<th>Top</th>
<th>Middle</th>
<th>Bottom</th>
</tr>
</thead>
<tbody>
<tr>
<td>April, 26</td>
<td>0.66</td>
<td>0.52</td>
<td>0.52</td>
</tr>
<tr>
<td>29</td>
<td>0.62</td>
<td>0.56</td>
<td>0.36</td>
</tr>
<tr>
<td>May, 03</td>
<td>0.86</td>
<td>0.74</td>
<td>0.48</td>
</tr>
<tr>
<td>06</td>
<td>0.74</td>
<td>0.44</td>
<td>0.52</td>
</tr>
<tr>
<td>09</td>
<td>0.76</td>
<td>0.6</td>
<td>0.44</td>
</tr>
<tr>
<td>13</td>
<td>1.42</td>
<td>0.72</td>
<td>0.76</td>
</tr>
<tr>
<td>17</td>
<td>1.44</td>
<td>0.76</td>
<td>0.8</td>
</tr>
<tr>
<td>20</td>
<td>1.06</td>
<td>0.78</td>
<td>0.7</td>
</tr>
<tr>
<td>23</td>
<td>1.34</td>
<td>0.50</td>
<td>0.36</td>
</tr>
<tr>
<td>27</td>
<td>1.06</td>
<td>0.70</td>
<td>0.8</td>
</tr>
<tr>
<td>31</td>
<td>1.48</td>
<td>0.7</td>
<td>0.64</td>
</tr>
<tr>
<td>June, 03</td>
<td>1.46</td>
<td>0.82</td>
<td>0.8</td>
</tr>
<tr>
<td>06</td>
<td>1.14</td>
<td>0.64</td>
<td>0.44</td>
</tr>
<tr>
<td>10</td>
<td>0.86</td>
<td>0.66</td>
<td>0.52</td>
</tr>
<tr>
<td>14</td>
<td>0.94</td>
<td>0.52</td>
<td>0.44</td>
</tr>
<tr>
<td>17</td>
<td>1.04</td>
<td>1.02</td>
<td>0.96</td>
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<td>21</td>
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<td>0.88</td>
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<tr>
<td>24</td>
<td>1.32</td>
<td>0.72</td>
<td>0.76</td>
</tr>
<tr>
<td>28</td>
<td>1.28</td>
<td>0.68</td>
<td>0.64</td>
</tr>
<tr>
<td>July, 07</td>
<td>0.96</td>
<td>0.66</td>
<td>0.68</td>
</tr>
<tr>
<td>05</td>
<td>1.12</td>
<td>0.62</td>
<td>0.56</td>
</tr>
<tr>
<td>08</td>
<td>1.26</td>
<td>0.56</td>
<td>0.64</td>
</tr>
<tr>
<td>12</td>
<td>0.86</td>
<td>0.9</td>
<td>0.68</td>
</tr>
<tr>
<td>15</td>
<td>0.58</td>
<td>0.54</td>
<td>0.48</td>
</tr>
<tr>
<td>19</td>
<td>0.86</td>
<td>0.53</td>
<td>0.68</td>
</tr>
<tr>
<td>22</td>
<td>1.00</td>
<td>0.50</td>
<td>0.40</td>
</tr>
<tr>
<td>26</td>
<td>0.48</td>
<td>0.32</td>
<td>0.44</td>
</tr>
<tr>
<td>29</td>
<td>0.62</td>
<td>0.60</td>
<td>0.52</td>
</tr>
</tbody>
</table>

* t = 5.56, P<0.05 Top Middle, t = 0.75, P<0.05 Middle and Bottom, t = 5.70, P<0.05 Bottom and top with the help of student paired test i.e., t-test.
### Table-3. Mean population of adults and crawlers of whitefly in relation to temperature (°C) and relative humidity (RH %) on okra crop during 2011

<table>
<thead>
<tr>
<th>Date</th>
<th>Adult</th>
<th>Crawler</th>
<th>Temperature °C</th>
<th>Relative humidity (RH %)</th>
</tr>
</thead>
<tbody>
<tr>
<td>April, 26</td>
<td>15.4</td>
<td>14.4</td>
<td>36.30°C</td>
<td>47%</td>
</tr>
<tr>
<td>29</td>
<td>19.6</td>
<td>13.6</td>
<td>35.50°C</td>
<td>49%</td>
</tr>
<tr>
<td>May, 03</td>
<td>22.0</td>
<td>18.4</td>
<td>34.20°C</td>
<td>47%</td>
</tr>
<tr>
<td>06</td>
<td>21.2</td>
<td>14.4</td>
<td>36.50°C</td>
<td>46%</td>
</tr>
<tr>
<td>09</td>
<td>27.0</td>
<td>15.8</td>
<td>38.30°C</td>
<td>48%</td>
</tr>
<tr>
<td>13</td>
<td>32.8</td>
<td>25.2</td>
<td>38.40°C</td>
<td>49%</td>
</tr>
<tr>
<td>17</td>
<td>31.6</td>
<td>26.0</td>
<td>37.50°C</td>
<td>53%</td>
</tr>
<tr>
<td>20</td>
<td>28.4</td>
<td>22.4</td>
<td>39.30°C</td>
<td>44%</td>
</tr>
<tr>
<td>23</td>
<td>26.6</td>
<td>20.2</td>
<td>38.50°C</td>
<td>62%</td>
</tr>
<tr>
<td>27</td>
<td>30.0</td>
<td>21.6</td>
<td>37.40°C</td>
<td>58%</td>
</tr>
<tr>
<td>31</td>
<td>34.2</td>
<td>25.0</td>
<td>33.50°C</td>
<td>66%</td>
</tr>
<tr>
<td>June, 03</td>
<td>40.2</td>
<td>28.8</td>
<td>30.40°C</td>
<td>80%</td>
</tr>
<tr>
<td>06</td>
<td>34.2</td>
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<td>33.30°C</td>
<td>55%</td>
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<tr>
<td>17</td>
<td>34.8</td>
<td>25.6</td>
<td>35.20°C</td>
<td>58%</td>
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<tr>
<td>21</td>
<td>30.4</td>
<td>26.4</td>
<td>32.40°C</td>
<td>70%</td>
</tr>
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</tr>
<tr>
<td>28</td>
<td>28.8</td>
<td>22.8</td>
<td>38.30°C</td>
<td>53%</td>
</tr>
<tr>
<td>July, 07</td>
<td>30.0</td>
<td>19.6</td>
<td>39.40°C</td>
<td>62%</td>
</tr>
<tr>
<td>05</td>
<td>18.2</td>
<td>20.2</td>
<td>37.50°C</td>
<td>46%</td>
</tr>
<tr>
<td>08</td>
<td>25.8</td>
<td>21.0</td>
<td>38.60°C</td>
<td>45%</td>
</tr>
<tr>
<td>12</td>
<td>30.8</td>
<td>21.0</td>
<td>38.30°C</td>
<td>48%</td>
</tr>
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<td>25.0</td>
<td>13.6</td>
<td>39.50°C</td>
<td>42%</td>
</tr>
<tr>
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<td>22</td>
<td>23.8</td>
<td>17.0</td>
<td>40.40°C</td>
<td>54%</td>
</tr>
<tr>
<td>26</td>
<td>12.4</td>
<td>9.6</td>
<td>40.50°C</td>
<td>41%</td>
</tr>
<tr>
<td>29</td>
<td>17.2</td>
<td>13.8</td>
<td>39.40°C</td>
<td>37%</td>
</tr>
</tbody>
</table>
Fig. 1  Adult mean population ± S.E. of whitefly on okra crop.

Fig. 2  Crawler population mean ± S.E. of whitefly on okra crop.
DISTRIBUTION AND INCIDENCE OF TETTIGONIOIDEA (ENSIFERA) ORTHOPTERA FROM SINDH PAKISTAN

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(Received for publication: 20.05.2012)

ABSTRACT

At present 8 species belonging to 2 sub-families i-e Phaneropterinae and Conocephalinae of Tettigonioidea were collected from Sindh and their distribution have been recorded at districts level. Conocephalus maculates (Le Guillou) and Euconocephalus incertus Walker was reported significantly in the greater numbers i-e 26.40% and 29.94% while Trigonocorypha unicolor Stoll and T. angustata Uvarov was reported 15.19% and 14.30% followed by 7.5% for Phaneroptera roseate Walker and 6.3% for P. spinosa B.-Beienko from Sindh. In addition, the single collected individuals of Ducetia japonica Thunberg and Elimea sp. of Phaneropterinae were considered rare.

Key words: Tettigonioida, Phaneropterinae, Conocephalinae, Distribution, Rare, Sindh.

INTRODUCTION

Grasshoppers are the largest and most diverse group of insects. Grasshoppers have several advantages for such studies, relating to its great body size easy catch ability and high dominance so, that it became a main invertebrate group for biological indication in its wider sense. They are often the main invertebrate consumer in grasslands and are to be important food source for many groups of predators e.g. birds, lizards etc. The grasshopper insect fauna generally are grouped as short-horned grasshopper (Caelifera) and long-horned grasshopper (Ensifera). Various representative of Ensifera have been studied by Hebard (1922); Ragge (1956, 1964, 1980); Bailey (1975, 1979); Kleukers et al., (1996); Ingrisch (1998); Ingrisch & Gorochov (2007); Gorochov & Kang (2002); Gorochov (2004); Decleer et al., (2000); Landeck et al.,(2005) from the different part of world. But, considerable taxonomic work has been done on Caelifera of Pakistan e.g. (Ahmed, 1980; Wagan, 1990; Wagan & Naheed 1997; Yousaf, 1996 Riffat & Wagan, 2007ab, 2008abc, 2009, 2010, 2011, Solangi & Riffat 2011, Solangi, et al., 2011) but, no attention would be paid to long-horned grasshoppers, the Ensifera. As some of the species belonging to Tettigonioida are important pests of agricultural crops, orchard and forest. It is important to identify them accurately so that diagnosis of an economic problem can be properly made as there is no published record on the distribution of Tettigonioida from Sindh.

Tettigonioida are phytophagous insects therefore one would expect a considerable number of plant pests in this sub-family Phaneropterinae (Otte & Naskrecki, 2004). Many species are ecologically associated with forest biocenoses, damaging trees and shrubs in addition to herbaceous plant. These facts extend the range of injuring the plants of forest, fruits, orchards and berry shrubs. Hopefully, this work will be first of its kind and will be great help to agencies dealing with pest control in Sindh.

MATERIALS AND METHODS

Collection of grasshoppers

The adults of Tettigonioida were collected from the agriculture fields of rice, forests, fruit orchards, grapevine, berry shrubs, hilly, semi desert & desert areas, trees, shrubs, herbs and grasses with the help of traditional insect hand-net (8.89 cms in diameter and 50.8 cms in length) as well as by hand catching. The collection was made during the year 2011 in the months of March to November from various districts of Sindh (Map. I, Table I).
Killing and preservation of grasshoppers

The following method has been adapted from Vickery & Kevan, (1983). Collected material brought in to the laboratory was killed by means of potassium cyanide in standard entomological killing bottles. The specimens were not left too long (½ hours) in cyanide because the color changed particularly that of green specimens all collected specimens were thoroughly examined under the stereoscopic dissecting binocular microscope and sorted out according to sub-families and species wise. Pinning of the specimens was made within few hours. As the specimens were flexible there was a little danger of losing any part through the necessary manipulation, further the parts could be stretched as desired. Mounting was done according to the following standard procedure.

The insect pins were inserted on the pronotum posterior to transverse sulcus slightly to the right of median dorsal carina. The left wings were set with the long axis of the body nearly at right angle to the pin and the head was directed slightly downwards. The posterior legs were bent beneath the body to minimize the possibility of breaking and to occupy the least amount of storage space. The abdomen was so set that it dropped below the wings and not obscured by the hind legs as several taxonomic characters are found on the terminal end and these were not to be hidden till the specimens were dried thoroughly. The body parts had to be supported with extra pins so that it can dry in the desired position and also special attention was paid to the antennae, wings and legs in order to display important taxonomic characters. Dust and other extraneous matter were removed with the help of a dry camel hairbrush. The fully dried specimens were removed from stretching boards and were stored in standard entomological boxes with labels showing locality, date of collection and collector name. Naphthalene balls were placed in boxes to prevent the attack of ants and other insect.

Identification of the specimens

Identification of specimen was carried out under the Stereoscopic Dissecting Binocular Microscope with the help of keys and description available in literature and on the “web site (http://www.orthotera.org) Orthoptera Species File Online” Some of the species identification was confirmed by Dr. J. C Hartley, Department of Zoology, University of Nottingham U.K and Late Prof. Dr. D.K. McE, Kevan Lyman Entomological Museum & Research laboratory McGill University Canada.

RESULTS AND DISCUSSION

During the present study a total of 678 specimens belonging to 2 sub-families i-e Phaneropterinae and Conoecephalinae of Tettigonioida were collected from Sindh and their distribution have been recorded at districts level. (Table II) showed that Conoecephalus maculates (Le Guillou) and Euconoecephalus incertus Walker was reported in the significantly greater numbers i-e 26.40% and 29.94% respectively in the surveyed districts of the Sindh while Trigonocorypha unicolor Stoll and T.angustata Uvarov was reported 15.19% and 14.30% followed by 7.5% for Phaneroptera roseate Walker and 6.3% for P.spinosa B.-Beienko. Conoecephalus maculates and Euconoecephalus incertus have wide range of distribution in Sindh while Trigonocorypha unicolor and T.angustataalso formed the intermediate position in collected stock of Tettigonioidea. Wagan (2008) did not record a single individual of Phaneroptera roseate and P.spinosa of Phaneropterinae from Sindh while at present we have collected fair numbers of Phaneroptera roseate and P.spinosa from this region. Further, the single collected individuals of Ducetia japonica Thumberg and Elimea sp. of Phaneropterinae were considered rare as shown in Table (II & III). They were recorded for the first time from this area. Unfortunately, almost nothing is known on the life history of these species. Thus we cannot interpret those facts. It may be that D.japonica and Elimea sp. have limited distribution ranges or are restricted to specialized habitats. It might also be that they show a distinct seasonality only appearing in certain season of the year, or they live in higher vegetation strata where they are over looked. After the addition of these 2 species in Phaneropterinae present study recommends that extensive survey in Sindh province may lead to addition of new wealth in fauna of Tettigonioida of Sindh.

Kocarek & Holusa, ( 2006) observed that Phaneropterinae occupies a wide range of open habitats from xerothermic to wetlands including ruderal habitats but it mostly consumed tall herb or lower shrub by vegetation everywhere present study is agreed with this statement while Kleukers et al., (1996); Decleer et al., (2000) and Landeck et al.,(2005) has reported its distribution in Western Europe. It is clear that the distribution of this super-family is insufficiently known from this region . Over all percentage of Tettigonioida ( Table III) in various districts of Sindh was reported significantly higher in Hyderabad, Jamshoro and Dadui-e (14.89, 12.38 & 11.50%) respectively while very less numbers have been reported from Shaheed Benazirabad and T. M. Khan it might be due to less surveys or due to different geographical conditions of the region. Present findings suggest that, the distributions of many of previously recorded species have been extended to new localities.
Table I. Study sites for collection of Tettigonioidae (Ensifera) from various districts of Sindh

<table>
<thead>
<tr>
<th>Study sites</th>
<th>Latitude (N)</th>
<th>Longitude (E)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Badin (B)</td>
<td>24°38'</td>
<td>68°54'</td>
</tr>
<tr>
<td>Dadu (D)</td>
<td>26°45'</td>
<td>67°45'</td>
</tr>
<tr>
<td>Ghotki (G)</td>
<td>28°05'</td>
<td>69°21'</td>
</tr>
<tr>
<td>Hyderabad (HYD)</td>
<td>25°23'</td>
<td>68°24'</td>
</tr>
<tr>
<td>Jacobabad (JAC)</td>
<td>28°20'</td>
<td>68°29'</td>
</tr>
<tr>
<td>Jamshoro (JAM)</td>
<td>25°25'</td>
<td>68°15'</td>
</tr>
<tr>
<td>Karachi (KHI)</td>
<td>24°53'</td>
<td>67°00'</td>
</tr>
<tr>
<td>Khairpur (KH)</td>
<td>27°32'</td>
<td>68°49'</td>
</tr>
<tr>
<td>Larkana (LAR)</td>
<td>27°32'</td>
<td>68°18'</td>
</tr>
<tr>
<td>Matari (M)</td>
<td>25°36'</td>
<td>68°27'</td>
</tr>
<tr>
<td>Shaheed Benazir Abad (SBA)</td>
<td>26°15'</td>
<td>68°25'</td>
</tr>
<tr>
<td>Sukkur (SUK)</td>
<td>27°05'</td>
<td>68°47'</td>
</tr>
<tr>
<td>Tando Allah Yar (TAY)</td>
<td>25°27'</td>
<td>68°43'</td>
</tr>
<tr>
<td>Tando M. Khan (TMK)</td>
<td>25°07'</td>
<td>68°32'</td>
</tr>
<tr>
<td>Thatta (TH)</td>
<td>25°43'</td>
<td>67°58'</td>
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</table>

Table II. Showing the collection of different species of Tettigonioidae from Sindh

<table>
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<th>Subfamily and species</th>
<th>Districts</th>
<th>B</th>
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<th>G</th>
<th>HYD</th>
<th>JAC</th>
<th>JAM</th>
<th>KH</th>
<th>KHI</th>
<th>LAR</th>
<th>M</th>
<th>SBA</th>
<th>SUK</th>
<th>TAY</th>
<th>TMK</th>
<th>TH</th>
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<tbody>
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<td>+</td>
<td>+</td>
<td>+</td>
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<td>+</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>+</td>
<td>+</td>
<td></td>
<td></td>
</tr>
<tr>
<td>P. roseata</td>
<td></td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
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<td>+</td>
<td>+</td>
<td></td>
<td></td>
</tr>
<tr>
<td>P. spinosa</td>
<td></td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>+</td>
<td>-</td>
<td>-</td>
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<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td></td>
<td></td>
</tr>
<tr>
<td>T. unicolor</td>
<td></td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
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<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>+</td>
<td>-</td>
<td>+</td>
<td></td>
<td></td>
</tr>
<tr>
<td>T. angustata</td>
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<td>+</td>
<td>+</td>
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<td>-</td>
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<td>+</td>
<td>+</td>
<td>-</td>
<td>+</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D. japonica</td>
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<td>-</td>
<td>-</td>
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<td>Conocephilinae</td>
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<td>+</td>
<td>+</td>
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Table III. Percentage of different Tettigonioidae species collected from various districts of Sindh

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<th>T. unicolor</th>
<th>T. angustata</th>
<th>D. japonica</th>
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Fig. 1a. *P. roseata* Walker

b) *P. spinosa* B.-Beienko

c) *T. unicolor* Stoll
d) *T. angustata* Uvarov

e) *C. maculates* (Le Guillou)
f) *E. incertus* Walker
ACKNOWLEDGEMENTS

This study was financially supported by Pakistan Science Foundation Islamabad for Research Project (PSF/RES/S-SU/BIO (423)). The first author is highly grateful to Prof. Dr. M. Tahir Rajput, Dean, Faculty of Natural Sciences, University of Sindh, for his continuous interest and provision of all possible facilities for smooth running of this research project.

REFERENCES


TOXICOLOGICAL STUDIES OF NEEM OIL (a.i. AZADIRACHTIN) AND TWO SYNTHETIC INSECTICIDES AGAINST TRIBOLIUM CASTAEUM HERBST

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(Received for publication: 13.12.2012)

ABSTRACT

Experiments were carried out to evaluate the toxicity of two synthetic pyrethroids i.e. cypermethrin and imidacloprid and a botanical neem oil (a.i. Azadirachtin) against red flour beetle, Tribolium castaneum Herbst, at different concentrations using bioassay techniques. In repellency assay, both pyrethroids along with neem oil repelled the T. castaneum adults significantly. The results showed that both pyrethroids have the toxic effects even on low doses whereas the neem oil had no toxic effects but it repelled and deterred the insects which also enhanced their residual effects on grain seeds. Fumigation toxicity with sublethal concentrations of the compound significantly reduced the oviposition potentials of adults and thus the neem oil can be used as a safe grain protectant.

Keywords: Neem oil (Azadirachtin), Insecticides, stored grain pest, T. castaneum.

INTRODUCTION

Stored grain insect pests cause contamination, spoil and deteriorate the quality of stored products and substantial economic damage, due to the loss of products lowering weight, germination rate and grain trade and a decrease of the nutritional value (Burkholder and Fustinin, 1991). The Food and Agricultural Organization (FAO) of the United Nation estimates that 5-10% of grain is lost between harvest and consumption. The rice weevil, red flour beetle and rusty grain beetle are the cosmopolitan insects of stored grain. Fumigants and insecticides are widely used to control the insect pests and to protect the stored commodities from insect infestation and contamination but their continuous misuse leads the problem of undesirable residues (Menash et al., 1979) and the development of resistance in certain insect species. Some grain protectants particularly organophosphate have high mammalian toxicity and the residues of these insecticides left in water, fruits and vegetable (Anwar et al., 2011; Tahir et al., 2001) may cause health concerns because they are conventional neurotoxins that effects the human nervous system (Tahir, 2000), so due to their persistency in food and effects in the environment (Tahir et al., 2008) their negative impact is being felt off and on and there is a need for searching alternative, effective, safe, pest control methods. The use of residual insecticide protectants is a common preventive measure to protect stored products from insect damage. Many of these are effective at relatively low doses rates and can provide long term protection range from 6-12 months (Athanassiou et al., 2008) which may cause health hazards. Plant extracts and botanical pesticides are also used to control the stored grain pests with their effects on cholinesterase (Tahir et al., 1992; 1999; Stefanazzi et al., 2011). Neem oil active ingredient Azadirachtin with low mammalian toxicity has been reported to control many insects and also give ideal protectants for stored grain, with excellent residual contents (Anwar et al., 1993; Siddiqui et al., 2002 & 2009). Toxicity of insecticides and botanicals against stored product is reported but little work is done on their residual toxicity.

MATERIALS AND METHODS

Insects

The test insects Tribolium castaneum (Herbst) were used in this study. The culture strain was obtained from public sector godowns in Karachi and was reared in the laboratory in sterilized jam jars covered with muslin cloth tied with rubber bands. Whole meal flour was used as culture medium. The culture was maintained in the laboratory at 30±2°C temperature and 65±5 relative humidity. Each jar was set up with 20 pairs of adult insects and the newly emerged adults were utilized for toxicological studies.

Commercial grade insecticides Cyperkil, 10 EC (Cypermethrin, pyrethroid), R.B Avari enterprises (pvt) Ltd. And Imidacloprid 20% SL (Acetmiprid), Capricor Associate were purchased from the local...
market. The Neem (Azadirachta indica) fruits were collected from the neem tree grown in the university campus, Karachi and the oil was extracted from the seed from the local market. Different concentrations of insecticides and neem oil i.e. 1.0%, 0.5%, 0.25%, 0.125%, 0.0625%, and 0.03125% were prepared by dissolving the 1% stock solution of each in acetone.

Different dilutions of insecticides and neem oil were used in bioassay. The 6.0 cm diameter of Whatman filter paper impregnated with one ml of different concentrations of tested compounds were placed in 6.0 cm diameter petriplates (10 adult insects (male / female 5:5) / petriplate). The control plates had no compound and check plates had only acetone. Three replicates of each dose were run. After evaporation and drying of petriplates 10 adults of same size and weight were introduced to each petriplate. The mortalities were recorded at 24, 48 and 96 HAT (hours after treatment). The experimental data were statistically analysed.

A 6.0 cm diameter Whatman filter paper was placed in 6.0 cm diameter petriplate. One ml of the appropriate testing concentrations (0.125%) of each compounds were added to filter paper. The solvent was allowed to evaporate for 15 seconds and 10 insects, were placed in petriplates. Acetone and untreated plates were kept as check and control respectively. They were kept in the laboratory at 30±2°C temperature and 65±5 relative humidity. Mortality of insects were observed daily until endpoint mortality was reached. Results from all replicates were statistically analyzed.

The edges of 6.0 cm diameter of petriplates were treated with the lowest doses (0.125%) of tested compounds while the center remained untreated and repellency was tested through choice or no choice method.

The effects of these chemicals on fecundity was also tested and the survived male and females from the treated plates were released in jars with food to observe the residual effects on fecundity.

RESULTS

The effects of the tested compounds Commercial grade insecticides Cyperkil, 10 EC (Cypermethrin, pyrethroid), R.B Avari enterprises (pvt) Ltd. and Imidacloprid 20% SL (Acetamiprid), Capricor Associate and Neem oil (Azadirachta indica) against red flour beetle are presented in tables 1, 2 and 3 respectively. The effects of the different concentrations of insecticides and neem oil i.e. 1.0%, 0.5%, 0.25%, 0.125%, 0.0625%, and 0.03125% at 24, 48 and 72 HAT (hours after treatment) indicated that cypermethrin possessed the highest toxic effects at conc. ranging (0.03-1%) i.e 10-90% , 13-90% and 16-96% mortality percentages were recorded at 24, 48 and 96 HAT respectively, whereas Imidacloprid at conc. ranging (0.03-1%) i.e 6-80% , 10-73% and 13-83% mortality percentages were recorded at 24, 48 and 96 HAT respectively and neem oil with lowest toxic effects. at conc. ranging (0.03-1%) i.e 0-36%, 0-36% and10-50% mortality percentages were recorded at 24, 48 and 96 HAT respectively. (Table1,2 and 3). The 0.125% concentration of each compound was tested for residual toxicity and it was observed that insects survived for 18, 17 and 15 days at 0.125% conc. of cypermethrin, Imidacloprid and Neem oil respectively showing the residual effects. In repellency test the insect avoided the treated surface and gathered around the untreated area whereas the fecundity was also inhibited in treated survived insects. It is clear that all the tested compounds would be more or less effective for controlling red flour beetle but cypermethrin was found most effective one.

DISCUSSION

The present study revealed the reduction of pest population by using neem oil which is in line with the previous findings of Anwar et al., 1993 and Siddiqui et al., 2002 and 2009. This also suggest that the use of plant products may be of value of combating the growing threat of insecticides resistance (Mamun et al., 2009 and Mujeeb and Shakoori, 2007, 2012). These findings, considered together, suggest that neem oil show potential to be developed as natural insecticides/fumigant for control of stored product pests.

However, for the practical application of the neem oil and two pesticides as novel insecticides/fumigants further studies on the safety of the neem oil and two tested compounds towards human and on the development of formulations are necessary to improve the efficacy and stability, and to reduce cost.

The insecticides along with neem oil also possessed the residual activity against the red flour beetle (Figure 1) which is in favour of previous findings that essential oil of Illicium difengpii was found potent fumigant against stored product insects (Chu et.al., 2012) while the sub lethal concentrations of some terpenes can reduce the population by reducing the oviposition in red flour beetle (Chaubey 2012). Similarly the insects treated with tested compounds reduce the fecundity and thus can be used as efficient insecticidal tool against red flour beetle as fumigants and can replace the conventional comparatively toxic fumigant methyl bromide. However, before using on commercial scale further investigation is needed to confirm the results.

ACKNOWLEDGEMENT

This work was funded by Dean Faculty of Science Research projects.
Table 1. Percent mortality of cypermethrin against *T. castaneum*

<table>
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<tr>
<th>S. No</th>
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<th>0.06%</th>
<th>0.12%</th>
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<td>48</td>
<td>13.3±1.30</td>
<td>43.30±3.49</td>
<td>50.0±0.8</td>
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<td>90.0±0.82</td>
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<tr>
<td>3</td>
<td>96</td>
<td>16.7±1.64</td>
<td>50.0±4.44</td>
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<td>90.0±0.0</td>
<td>96.7±0.5</td>
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Mean values ± S.D are the average of three replicates.

Table 2. Percent mortality of imidacloprid against *T. castaneum*

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Mean values ± S.D are the average of three replicates.

Table 3. Percent mortality of neem-oil against *T. castaneum*

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Mean values ± S.D are the average of three replicates.
REFERENCES


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Cell No.:________________________      E-mail address:_________________

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No. of Publication: _________________________________________________

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BIODIVERSITY OF RICE SPIDERS IN TANDO MUHAMMED KHAN AND BADIN DISTRICTS OF SINDH-PAKISTAN

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(Received for publication: 15.05.2012)

ABSTRACT

Biodiversity of spiders was determined through survey of rice crops grown at different locations of Tando Muhammad Khan and Badin Districts from July to October 2011. The result revealed that 4 families, 6 genera and 4 species of spiders were identified. Fortnightly population of all spider species varied from (0.24-0.48) per plant in the month of July at all locations of both districts. The population multiplied gradually and reached at peaks (0.64-0.88) per plant in October at all locations. Correlation between mean spider population and temperature in Tando Muhammad Khan and Badin districts was negative with values ($R^2= 0.7637$) and ($R^2= 0.6736$), respectively. Similarly, correlation with R.H% at both districts was positive with ($R^2= 0.6195$) and ($R^2= 0.1562$), respectively.

Key Words: Spider fauna, spatial distribution, Rice, Correlation, Temperature.

INTRODUCTION

Agriculture plays a pivotal role in the economy of Pakistan. It contributes about 24% to national GDP and employs 44% of the total labor force (Hakim et al. 2011). Rice is an essential cash crop and one of the main export items of Pakistan. It accounts for 6.4 percent of value added in agriculture and 1.4 percent in GDP. Pakistan grows high quality rice to meet both domestic demand and for exports. The area under rice cultivation in Pakistan was 2883 hectares with annual production of 6883 tones. The average rice yield was 2387 Kg per hectare during the year 2009-2010 (Economic Survey 2010). Pakistan ranks fourteenth in terms of rice production and sixth in rice export in the world. The yield of rice in Pakistan is low as compared to China and India. This decline in yield is attributed to several factors such as traditional methods of cultivation, unavailability of irrigation water, low level of soil fertility and higher incidence of pests and disease (Anonymous 2008).

Rice crop is attacked by 70 species of insect pests in Pakistan. Of these, Stem borers, white backed plant hopper, leaf folder and grasshoppers are the pests of economic importance (Saleem 2002, Anis et al. 2010). Sugarcane shoot borer, Chilo infuscatus and Gurdaspur borer, Acigona steniellus have been recorded from Afghanistan, Central Asia, India, Korea, Malaysia and Philippines. In Pakistan sugar cane borers are widely distributed in all the sugarcane growing areas of the country (Hashmi 1994).

For many decades, insecticides particularly granules have been widely used to control rice pests. However, the continuous use of a wide range of pesticides has caused many side effects, including loss of biodiversity, the problem of secondary pests, insecticide resistance, residual toxicity, the resurgence of insect pests, and environmental pollution (Im and Kim 1999). Recently, many efforts have been made to combine various non-chemical control methods with insecticides in systems of Integrated Pest Management (IPM). Many uses of parasitic and predatory natural enemies to control agricultural pests have been reported (Van den Bosch et al. 1992).

Spiders are among the most abundant invertebrate predators in agro-ecosystem (Pearce and Zalucki, 2006). Spiders are predators’ of arthropod pests. There are 40,000 species of spiders which are found all over the world in almost every kind of habitat. They mainly prey on insects, although they may also feed on various other kinds of prey. The population densities and species abundance of spider communities in agricultural fields can be as high as in natural ecosystems. Many researchers have provided descriptions of spider species abundance or composition in a variety of agro-ecosystems (Witniewska and Prokopy 1997). A
rice field is a complex agro ecosystem, containing many aquatic, semi-aquatic, and terrestrial species (Oraze et al., 1988). Spiders are well represented among the many predators found in this habitat.

Hence keeping in view the importance of spiders in rice ecosystem as biotic agents, the present study was planned. This study will provide base-line data and useful information necessary to start an Integrated Pest Management Program of rice insect pests in Pakistan.

MATERIALS AND METHODS

Biodiversity of spiders was determined through survey of rice crop grown at different villages of Tando Muhammad Khan and Badin districts from July to October 2011. For this purpose, four villages from each district were selected. The locations/ villages of Tando Muhammad Khan district were Jati village, Wasan village, Ayub stop and veesar village. Whereas, the locations / villages of Badin district were Nazar pur village, Khoso village, Khaskheli village and Keeria village. The rice varieties grown were Royal-777, Guard, Pukhraj and KS-282. Twenty five (25) rice plants out of 2 acres were randomly selected from each field and put under observation. Spiders were collected through hand sort method with the help of plastic jars. Collected spiders were put separately in vials (4x3 cm) containing 70% alcohol and 5 drops of glycerin. Spiders were monitored at fortnightly interval. The collected spiders were sent to Dr. Abdul Ghafoor, Chairman and Associate Professor, Zoology Department, G.C. University, Faisalabad for identification. Fortnightly mean population of rice spiders per plant was calculated. Correlation of spiders with abiotic factors was determined.

RESULTS AND DISCUSSION

The taxonomic position of rice spiders shown in Table-1 indicates that 4 families, 6 genera and 4 species were identified. The families of order Araneae identified were: Lycosidae, Theraphosidae, Tetragnathidae and Araneidae, whereas, the list of identified genera included: Pardosa, Haplocatus, Tetragnatha, Aculepeira, Cyclosa, and Arigiope. The results of present study agree with those of Sebastian et al. (2005) who observed 1130 individuals belonging to 92 species, 47 genera and 16 families of spiders associated with irrigated rice ecosystem in Kerala, India. Paik et al. (1979) reported that spiders living in rice fields in Korea comprise 27.96% of all Korean spiders, and can be classified into 22 families, 99 genera and 175 species. Joon and Kim (2003) stated that Spiders play an important role in regulating insect pests in the agricultural ecosystem. There are a large number of species, many of them with high population densities. There are 22 families, 99 genera and 175 species of spiders in Korean rice fields. Yan et al. (1997) reported that 373 species, 109 genera and 23 families of spider have been identified in rice fields of China. Farzana et al. (2012) recorded 23 spider species under 17 genera and 9 families from Peshawar. Tahir and Butt (2009) studied the biodiversity and predatory efficacy of the spiders in rice field from central Punjab Pakistan and recorded 44 spider species. Mukhtar (2004) reported 124 species belonging to 51 genera and 17 families from Punjab.

The data shown in Table-2 indicate that spider population (0.24-0.48) per plant was recorded in the month of July in all the locations of two districts. The population multiplied gradually and reached to peaks (0.64-0.88) per plant in October at all locations. Thereafter, the crop was harvested. Correlation between mean spider population and temperature in Tando Muhammad Khan and Badin districts was negative with values (R²= 0.7637) (Fig: 1) and (R²= 0.6736) (Fig: 2), respectively. Similarly, correlation with R.H% at both districts was positive (R²= 0.6195) (Fig: 3) and (R²= 0.1562) (Fig: 4), respectively.

Generally, transplantation of rice takes place in May-June. The pesticide cartap granule is applied at 5kg per acre 1-2 times to rice crop. The spider fauna was recorded with temperature range of (28.32-32.17) with (75-80.12 R.H %) during the study period. The spider population remained higher with decreased temperatures and increased relative humidity percent. No significant differences in the population of spiders in both districts were observed. The spider population multiplied after the increase of rice pests at advanced stage of crop. Negative correlation was observed between mean spider population and temperature of Tando Muhammad Khan and Badin districts. Similarly, positive correlation was observed between spiders and R.H% of both districts.

Table-1. Taxonomic position of Rice Spiders

<table>
<thead>
<tr>
<th>#</th>
<th>Family</th>
<th>Technical Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Araneidae</td>
<td>Aculepeira ceropegia (Walckenaer)</td>
</tr>
<tr>
<td>2</td>
<td>Lycosidae</td>
<td>Pardosa sp. (C.L. Koch)</td>
</tr>
<tr>
<td>3</td>
<td>Araneidae</td>
<td>Cyclosa sp. (Menge)</td>
</tr>
<tr>
<td>4</td>
<td>Theraphosidae</td>
<td>Haplocatus sp. (Simon)</td>
</tr>
<tr>
<td>5</td>
<td>Araneidae</td>
<td>Arigiope trifasciata (Forskal)</td>
</tr>
<tr>
<td>6</td>
<td>Tetragnathidae</td>
<td>Tetragnatha extensa (Linnaeus)</td>
</tr>
<tr>
<td>7</td>
<td>Tetragnathidae</td>
<td>Tetragnatha sp. (Latreille)</td>
</tr>
<tr>
<td>8</td>
<td>Tetragnathidae</td>
<td>Tetragnatha maxillosa (Thorell)</td>
</tr>
</tbody>
</table>
Figure 1-8. Spider fauna associated with rice crop. Name, family and locality is given on next page.
Table-2. Fortnightly Mean Population of Rice Spiders per Plant from July-October at different locations of Tando Muhammad Khan and Badin Districts
Biodiversity of rice spiders in Tando Muhammed Khan & Badin districts of Sindh-Pakistan

Monthly Mean Population of Rice Spiders per Plant from July-October at T.M.K and Badin Districts

Monthly Mean Temperature from July-October at T.M.K and Badin Districts

Monthly Mean R.H% from July-October at T.M.K and Badin Districts
Fig-1. Regression analysis between predatory spider and temperature of T. M. Khan District.

Fig-2. Regression analysis between predatory spider and temperature of Badin District.
Fig-3. Regression analysis between predatory spider and R.H% of T.M. Khan District.

Fig-4. Regression analysis between predatory spider and R.H% of Badin District.
CONCLUSION

Biodiversity of spiders was determined through survey of rice crops grown at different locations of Tando Muhammad Khan and Badin Districts. Four families, six genera and four species of spiders were identified. Population of all spider species varied from (0.24-0.48) per plant in the month of July at all locations of both districts. The population multiplied gradually and reached at peaks (0.64-0.88) per plant in October at all locations. Correlation between mean spider population and temperature in Tando Muhammad Khan and Badin districts was negative. Correlation with R.H% at both districts was positive.

ACKNOWLEDGEMENTS

We are highly grateful to Pakistan Science Foundation (PSF) for providing the funds for this project entitled: “Documentation of predatory spiders and their role in suppression of pests of major crops in Sindh” (Project Grant No. PSF / Res / S-SAU / Agri-382). We are also thankful to Sindh Agriculture University, Tandojam, Pakistan, for its help and support to conduct this research in different districts of Sindh, Pakistan.

REFERENCES


ASSESSMENT OF RESISTANCE VARIABILITY IN DIFFERENT COTTON (GOSSYPIUM HIRSUTUM L.) GENOTYPES AGAINST SUCKING COMPLEX

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(Received for publication: 13.10.2012)

ABSTRACT

In the present research studies, different conventional cotton genotypes were screened out for their resistance against sucking complex under natural field conditions at the experimental farm of Nuclear Institute of Agriculture, Tandojam. The genotypes NIA-79 and NIA-78 produced significant results in terms of least infestation by sucking complex (jassids, thrips and whiteflies) and significantly higher cotton yields as compared to other genotypes tested. Whereas the susceptible reactions were apparent in the genotypes, S3-PST, S1-AST and NIA-Ufaq where significantly higher population of sucking insect pests and lower cotton yields were investigated. The studies manifested that the tolerant genotypes may be helpful to minimize the possible use of insecticides and to improve future integrated pest management (IPM) programme regarding cotton sucking pests.

Keywords: Cotton, Screening, Genotypes, Resistance, Sucking pests, Infestation.

INTRODUCTION

Cotton (Gossypium hirsutum L.), is the major cash crop of Pakistan known as “white gold”. It contributes a huge share in the foreign exchange earnings of the country (Ahmad et al. 2011a). Besides, hundreds of ginning factories and textile mills are heavily dependant upon cotton which provides employment to millions of people across the country (Khuhro et al. 2012). Pakistan is the fourth largest producer of cotton in the world, the third largest exporter of raw cotton and the fifth largest consumer of cotton. In Pakistan, it is grown on an area of about 3031.5 thousand hectares having cotton lint production of 12452.5 thousand bales with average yield of 699 kg / ha (Anonymous, 2010). This per hectare yield is very low as compared to other major cotton producing countries. There are many reasons responsible for the low yield of cotton but insect pest infestation is one of the major reasons (Anonymous, 2006).

Cotton crop is infested by wide range of insect pests at various stages of crop growth compared to any other crop (Uthamasamy, 1994). Cotton crop is susceptible to the attack of 96 insect pests and mites (Yunus et al. 1980). The complex pest spectrum of cotton is divided into two categories; sucking insect pests and chewing insect pests. Important sucking insect pests are green leaf hopper, Amrasca biguttula (Ishida), thrips, Thrips tabaci (Lindeman), aphids, Aphis gossypii (Glover), whitefly, Bemisia tabaci (Gennadius), red cotton bug, Dysdercus koenigii (Fabricius) and dusty cotton bug, Oxyccaranus hayalinipennis (Costa) which occupy major pest status and contribute to lower yields (Gosh, 2001; Ahmad et al. 2002). Sucking pest complex damages the cotton crop very severely. They lower the vitality of the plant by sucking the cell sap. The intensity of their attack may be so severe that it can cause major reduction in the crop yield. They reduce the annual potential of agriculture production by 25% (Anonymous, 1999). A huge number of broad-spectrum insecticides are being used annually for the control of these pests which are continuously affecting the biotic and abiotic factors of the environment (Ahmad et al. 2011b). Non selective use of pesticides leads to water pollution, soil degradation, pest resistance and resurgence and ozone depletion (Naem et al. 2012). One of the safe measures to evade such a situation is to grow resistant cotton cultivars. Finding out of resistance in different genotypes of cotton, which are generally grown in Punjab and Sindh provinces, respectively is a pre-requisite for the success of such a strategy. A number of researchers have conducted different research studies regarding screening of cotton genotypes against sucking pest complex, in Pakistan, like Hassan et al. (2000), Bashir et al. (2001), Shad et al. (2001), Khan et al. (2003), Amjad et al. (2009) etc. but these efforts should be continued as with each passing year new genotypes are being introduced by the breeders. A breeder while breeding for higher yield has also a set
of other desirable traits in his mind that he wants to incorporate in a variety. Among these traits the ability of a genotype to withstand pest attack is of major importance. Therefore, it is important to screen out different cotton genotypes developed by breeders from time to time against sucking pests to find out their degree of resistance. This will help the farmers' community in selecting the most suitable genotype for increased crop production. For this purpose the present studies were executed to find out the response of different cotton genotypes towards various sucking insect pest complex.

MATERIALS AND METHODS

Field trials were carried out at the Nuclear Institute of Agriculture, Tandojam. Ten cotton genotypes were tested for their resistance to sucking complex under field conditions. The genotypes selected for the experiment were included Chandi-95, Sohni, Sadori, NIA Ufaq, NIA78, NIA79, S1-AST, S2-AST, S3-AST and S3-PST. The seeds of all the test genotypes were acquired from Plant breeding and Genetics Division of Nuclear Institute of Agriculture, Tandojam. The clean, pure, non-contaminated seeds with any other cotton genotypes, and reasonably free of any unfamiliar substrates were used. The experimental area was divided into 30 plots with 1m bed buffer between the plots each with plot size of 6 m x 3 m having row to row and plant to plant distance of 0.75 m and 0.30 m respectively. All the ten cotton genotypes were grown under natural field conditions and normal agronomic practices were followed for raising the crop with application of recommended doses of fertilizers. The investigational field was kept open for thorough observing the three leaves (One each from top, middle and bottom) from randomly selected five plants in each replication and transformed to per leaf basis. The data obtained from these test genotypes on sucking complex in comparison to yield were used to assess the resistance or susceptibility depicted by them. In each plot yield was recorded by picking the cotton two times during cropping season. The data were subjected to analysis of variance using computer software Statistix. Significance of difference in mean population of insect pests and seed cotton yield was sorted out with LSD (5% significance level).

RESULTS

1. Cotton jassid

Data regarding jassid infestation in different months revealed (table 1) that the population of jassid was below ETL and non significantly different in June however maximum per leaf (0.44) was observed on genotype NIA-Ufaq followed by S3-PST (0.11). The month of July showed above ETL but non significantly different jassid infestation among the tested genotypes. Maximum was recorded on NIA-Ufaq (2.77) whereas the lowest on NIA-79 (1.21). In the month of August, infestation varied significantly and genotype NIA-79 proved to be the most tolerant for holding reduced jassid population of 0.97 per leaf while genotype S1-AST attracted maximum per leaf jassid population (2.44) followed by S2-AST (2.41). Jassid infestation was again happened to be non significantly different and below ETL in September. The overall mean infestation data revealed NIA-79 as the most tolerant genotype for showing lowest per leaf jassid incidence (0.60) followed by NIA-78 (0.86). The genotype NIA-Ufaq, S3-PST, S1-AST and Sohni attracted higher number of jassids of 1.39, 1.29, 1.27 and 1.18 per leaf respectively and hence were the susceptible.

2. Cotton thrips

Data regarding thrips infestation was found to be non significantly different in the month of June but varied significantly during July where the genotype NIA-79 produced significant results in term of reduced thrips infestation of 6.52 per leaf followed by NIA-78 (7.77). The genotype S3-PST, S1-AST and S2-AST showed heavy per leaf thrips attack of 17.06, 12.48 and 12.44 respectively. Significant differences among different genotypes regarding thrips infestation were also apparent in the month of August. NIA-79 again performed excellent showing lowest thrips population (2.17) followed by NIA-78 (3.86). S3-PST genotype was found to be the most susceptible for attracting maximum thrips population (9.47). The same pattern was also true for the month of September where NIA-79 proved to be the most successful genotype followed by NIA-78 and S3-PST performed poor. The over all seasonal mean of thrips infestation confirmed NIA-79 as the most tolerant genotype showing minimum per leaf thrip infestation (2.22) followed by NIA-78 (2.99) whereas S3-PST attracted maximum number of thrips (8.15) and was the most susceptible one.

3. Cotton whitefly

The population of whitefly started from the end of June and remained active up to September. Data on the infestation of whitefly revealed significant differences among different genotypes in the month
of June. The genotype NIA-79 was found to be the most tolerant where no whitefly attack was observed followed by Chandi and Sohni. S3-PST exhibited significantly more whitefly susceptibility showing 0.88 per leaf population of whitefly. The data recorded in the month of July also varied significantly among different genotypes. NIA-79 again proved to be the most tolerant genotype showing lowest (0.73) per leaf whitefly infestation whereas S3-PST was observed as the most susceptible one showing higher pest attack of 2.99 per leaf. Same was the case recorded in August where NIA-79 attracted lowest (1.11) whitefly population and S3-PST maximum (5.30). The data recorded in the month of September showed non significant differences however the lowest was recorded on NIA-79 (0.11) and maximum on S3-PST (0.93). The over all seasonal mean revealed NIA-79 to be the most tolerant genotype exhibiting resistance against whitefly attack (0.48) followed by NIA-78 (0.79). S3-PST attracted higher number of the pest (2.52) and was the most susceptible one of all genotypes tested followed by S1-AST (1.69).

4. Cotton yield

The seed cotton yield recorded from different cotton genotypes showed variable results which may be due differences in their degree of tolerance to sucking pest infestation. Significantly higher yield in kg per hectare was recorded from genotype NIA-79 (4131) followed by NIA-78 (4087) which may be due to the fact that these two genotypes showed some degree of tolerance to the attack of sucking complex. The genotype S3-PST performed very poor and gave significantly lower yield in kg per hectare (2686) followed by S1-AST (2801).

DISCUSSION

The infestation of different sucking pests (jassids, thrips and whiteflies) varied greatly on all the tested cotton genotypes and so was the yield. The sucking pests were more considerable part of pest complex in all tested cotton genotypes. It is obvious from the data presented above that the tolerant genotypes were NIA-79 and NIA-78 exhibiting least pest infestation and higher yield whereas the susceptible reactions were apparent in genotypes S3-PST and S1-AST leading to produce lower yields. There are different physio-morphic traits of cotton genotypes responsible for resistance or susceptibility to insect pest attack. Many researchers have conducted experiments on screening of cotton cultivars and found CRIS-82 and MNH-536 susceptible, while CRIS-467 and CRIS-134 were found tolerant to A. devastans. Similarly Shad et al. (2001) also observed variability among the tested genotypes for their resistance to jassid population. Fairbanks et al. (1999) evaluated cotton varieties for comparative tolerance to thrips feeding in the field condition and reported tolerant and susceptible genotypes. Mumtaz et al. (1997) identified NIAB-26 as the most resistant among the seven varieties tested against whitefly. Wahla et al. (1998) also found a variable tolerance among the tested genotypes to whitefly. However, Hernandez et al. (1999) studied upland cotton varieties against whitefly incidence and revealed no significant differences in seed cotton yield. More or less similar results regarding whitefly population but on different tested genotypes are documented by Raza and Afzal, 2000 and Bashir et al. 2001.

CONCLUSION

It can be concluded from the present research findings that the attack of different insect pests varied greatly on all the tested genotypes and so was the yield. The genotypes NIA-79 produced significant results in term of least infestation by the sucking complex and maximum cotton yield followed by NIA-78. Maximum sucking pest abundance was examined on the genotypes S3-PST and S1-AST. The study manifested that the tolerant genotypes may be helpful to minimize the possible use of insecticides and to improve future integrated pest management programme.

REFERENCES


Table 1. Mean per leaf population of jassid on different cotton genotypes.

<table>
<thead>
<tr>
<th>Genotypes</th>
<th>Mean monthly infestation per leaf</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>June</td>
<td>July</td>
</tr>
<tr>
<td>Chandi</td>
<td>0.00 A</td>
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</tr>
<tr>
<td>Sohni</td>
<td>0.00 A</td>
<td>2.18 A</td>
</tr>
<tr>
<td>Sadori</td>
<td>0.00 A</td>
<td>2.10 A</td>
</tr>
<tr>
<td>NIA-Ufaq</td>
<td>0.44 A</td>
<td>2.77 A</td>
</tr>
<tr>
<td>NIA-78</td>
<td>0.00 A</td>
<td>2.10 A</td>
</tr>
<tr>
<td>NIA-79</td>
<td>0.00 A</td>
<td>1.21 A</td>
</tr>
<tr>
<td>S1-AST</td>
<td>0.00 A</td>
<td>2.44 A</td>
</tr>
<tr>
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<td>1.85 A</td>
</tr>
<tr>
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<td>0.00 A</td>
<td>1.99 A</td>
</tr>
<tr>
<td>S3-PST</td>
<td>0.11 A</td>
<td>2.70 A</td>
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</table>

Means followed by similar letters are not significantly different (P<0.05).
### Table-2. Mean per leaf population of thrips on different cotton genotypes.

<table>
<thead>
<tr>
<th>Genotypes</th>
<th>Mean monthly infestation per leaf</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>June</td>
<td>July</td>
</tr>
<tr>
<td>Chandi</td>
<td>0.00  A</td>
<td>11.03 AB</td>
</tr>
<tr>
<td>Sohni</td>
<td>0.00  A</td>
<td>11.03 AB</td>
</tr>
<tr>
<td>Sadori</td>
<td>0.22  A</td>
<td>8.41 B</td>
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<tr>
<td>NIA-Ufaq</td>
<td>0.00  A</td>
<td>10.25 AB</td>
</tr>
<tr>
<td>NIA-78</td>
<td>0.00  A</td>
<td>7.77 B</td>
</tr>
<tr>
<td>NIA-79</td>
<td>0.11  A</td>
<td>6.52 B</td>
</tr>
<tr>
<td>S1-AST</td>
<td>0.00  A</td>
<td>12.48 AB</td>
</tr>
<tr>
<td>S2-AST</td>
<td>0.22  A</td>
<td>12.44 AB</td>
</tr>
<tr>
<td>S3-AST</td>
<td>0.22  A</td>
<td>7.75 B</td>
</tr>
<tr>
<td>S3-PST</td>
<td>2.33  A</td>
<td>17.06 A</td>
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Means followed by similar letters are not significantly different ($P<0.05$).

### Table-3. Mean per leaf population of whitefly on different cotton genotypes.

<table>
<thead>
<tr>
<th>Genotypes</th>
<th>Mean monthly infestation per leaf</th>
<th>Mean</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>June</td>
<td>July</td>
</tr>
<tr>
<td>Chandi</td>
<td>0.11  B</td>
<td>1.51 BC</td>
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<tr>
<td>Sohni</td>
<td>0.11  B</td>
<td>1.77 BC</td>
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<tr>
<td>Sadori</td>
<td>0.44 AB</td>
<td>1.51 BC</td>
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<tr>
<td>NIA-Ufaq</td>
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<td>1.96 B</td>
</tr>
<tr>
<td>NIA-78</td>
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<td>0.99 BC</td>
</tr>
<tr>
<td>NIA-79</td>
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<td>0.73 C</td>
</tr>
<tr>
<td>S1-AST</td>
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<td>1.99 B</td>
</tr>
<tr>
<td>S2-AST</td>
<td>0.22 B</td>
<td>1.41 BC</td>
</tr>
<tr>
<td>S3-AST</td>
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<td>1.82 B</td>
</tr>
<tr>
<td>S3-PST</td>
<td>0.88 A</td>
<td>2.99 A</td>
</tr>
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</table>

Means followed by similar letters are not significantly different ($P<0.05$).

### Table-4. Cotton yield of different cotton genotypes.

<table>
<thead>
<tr>
<th>Genotypes</th>
<th>Yield gm /plot (18 m²)</th>
<th>Yield kg/ha</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chandi</td>
<td>6467 BC</td>
<td>3592 BC</td>
</tr>
<tr>
<td>Sohni</td>
<td>6143 CD</td>
<td>3412 CD</td>
</tr>
<tr>
<td>Sadori</td>
<td>6735 B</td>
<td>3741 B</td>
</tr>
<tr>
<td>NIA-Ufaq</td>
<td>5917 D</td>
<td>3287 D</td>
</tr>
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<td>NIA-78</td>
<td>7358 A</td>
<td>4087 A</td>
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<td>NIA-79</td>
<td>7437 A</td>
<td>4131 A</td>
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<td>S1-AST</td>
<td>5043 E</td>
<td>2801 E</td>
</tr>
<tr>
<td>S2-AST</td>
<td>5985 D</td>
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<tr>
<td>S3-AST</td>
<td>7270 A</td>
<td>4038 A</td>
</tr>
<tr>
<td>S3-PST</td>
<td>4835 E</td>
<td>2686 E</td>
</tr>
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Means followed by similar letters are not significantly different ($P<0.05$).
Cotton jassid
Cotton thrip
Cotton whitefly

Experimental Plot
Experimental plot

Data collection
Data collection

Cotton at flowering stage
Cotton at boll opening stage
IMPORTANCE OF AQUATIC PLANTS PISTIA STRATIOTIS & EICHHORNIA CRASSIPES IN REFRESHMENT OF ENVIRONMENT AND IN BIOLOGICAL CONTROL OF MOSQUITO LARVAE ON FIELD LEVEL

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(Received for publication: 25.07.2012)

ABSTRACT

The aquatic plants *Pistia stratiotis* commonly called as water lettuce and *Eichhornia crassipes* commonly called as water hyacinth were used for biological control of mosquito larvae with locally available, larvivorous fish, *Tilapia mossambicus* commonly called as Mozambique or mouth breeder. The two types of plants and the fish gave interesting and satisfactory results. The plants were released @ 10 plant/m², while the fish @ one fish/m². The plants and the fish was used in sewage, stagnant and polluted water, in which mostly the *Culex* spp. of the mosquito develops. The fishes were released after one week of the release of plants. Both plants were released 50% each (5+5= 10 plant/m²) in the beginning stage to see the successful propagation of the plant type. The successful plant was used in that area and the observations were made weekly in the start for one month and then after the successful propagation of the plants, on monthly basis. The observation were made upto six months, on monthly basis. The results were recorded, tabulated and analyzed. The satisfactory results were achieved in six months giving maximum, and better results. Both plants, covered the surface of water, reduce the area of water, cleaned the water, and suppressed the bad smell of sewage water. Whereas the fish predated on the mosquito larvae, and the larvae population was reduced remarkably in six month. The population of mosquito larvae remained controlled upto 99%. The environment of that experimental place become odourless, giving beautiful scene (Nazara). As the *P. stratiotis* and *E. crassipes* are the main breeding host of *Anopheles* and *Mansonia* mosquitoes, therefore in the present work the *Tilapia* fish was used which not only controlled the *Culex* mosquitoes in sewage water but also controlled the population of *Anopheles*, *Aedes* and *Mansonia* mosquitoes in this experiment.

Key Words: Importance, aquatic plants, *P. stratiotis*, *E. crassipes*, biological control, mosquito larvae, field level.

INTRODUCTION

The mosquitoes not only disturb our sound sleep but also cause different diseases. The people can kill few hundred mosquitoes if the fumigation is done on daily basis, because the mosquitoes are coming on daily basis in our houses, but the fumigation is not a permanent solution to control mosquitoes, because only adult mosquitoes are being killed in this method. The fogging also remains un-effective in complete mosquito control. In reality the mosquitoes may be controlled if the breeding places of the mosquito larvae are destroyed (Tariq & Zafar 2000, Tariq, 2001) by chemical spray method or the breeding of the mosquitoes are controlled by water management (Qadri et al. 2007) or biological control method (Ahmed et al., 1988, Tariq et al. 2009). In the general mosquito control we give stress only on adult mosquito control but the breeding places of the mosquitoes in larval stage mostly remains un-controlled. The mosquitoes are coming from these breeding places not in hundreds, thousands, lacs but in millions. So we should also give stress and concentration to larval stage control of the mosquitoes. In the present paper two aquatic local plants and a local larvivorous fish has been used practically on field level for biological control of mosquitoes, which is safe, sound and harmless to human beings as well as to our environment.

MATERIALS AND METHODS

The *Pistia stratiotis* was first collected from District Sukkhar and kept in ponds near Biological Research Centre, University of Karachi. This plant was cultured near Muskan gate in sewage water continuously entering in University. *Eichhornia crassipes* was first collected from District Thatta from a simnali, it was also kept in sewage water near Biological Research Centre, University of Karachi. Then it was taken to different experimental places. *Tilapia mossambicus* was purchased from Itwar bazaar market. This fish is abundantly and easily available locally so no need of culturing or breeding of this fish was realized. Although it was stocked in Biological Research Centre, University of Karachi.
Method of Application

The mosquito mostly *Culex fatigans* larvae of different stages in breeding places were identified, in different areas in Karachi and other areas of Sindh. These experimental places were measured and the area was calculated. The average number of larvae/100ml were calculated by taking 100 ml water from five different places of experimental area. The plants were introduced @ 10 plant/m² of each *P. stratiotis* and *E. crassipes*, whereas the fish *Tilapia mossambicus* was released @ one fish/m².

RESULTS

The water bodies were investigated for the presence and absence of the mosquito larvae by naked eye observation. Then average value of the mosquito larva was calculated by taking five observations from five different points of the mosquito breeding place area by dipping method. This average mosquito larvae value was called as pretreatment value. Then the chosen plant was released and the fishes were released according to the calculated estimate. The first observation after release of fishes was noted after one month, the other on second month. In this way continuously six observations were made for six months. The increase and growth of the plant was also noted by its increasing population. The presence of the fishes either they are alive or not was also taken into consideration and if the fishes were not found they were released again. The post-treatment monthly observation was noted in the same way as stated above for pretreatment. The data was recorded in the form of table and was analyzed accordingly, as shown in Table 1.

The control was set in Orangi Town Karachi where no fishes were released but *E. crassipes* was there. The observation showed increase of mosquito larvae population in each coming month as shown in Table 1. The other control was set at University gate-4 where only *P. stratiotis* was used, but no fishes. The population mosquito larvae usually *Culex* and *Anopheles* was increasing in each coming month as shown in Table 1. In the experimental place Sukhar Sindh, *E. crassipes* was used with *Tilapia* fishes. The observation showed the increase of *Anopheles, Culex* and *Mansonia* mosquitoes in this breeding place. In the presence of these plants and the fish 99% reduction (control) of the mosquito larvae was achieved, no matter which species of the mosquito was breeding there was controlled in six months period. If this situation remains continue the control will remain continue. Beside *Culex* mosquitoes, the *Anopheles* generally *stephensi* were also found in stagnant polluted sewage water.

DISCUSSION

Stephen and Hornby (1962) reported mosquito control by biological methods, when chemicals failed to control *Culex pippens* & *C. fatigans*. The biological method gave effective control in swamps and sewage ponds at moderate costs by using Gambusia or *Tilapia* fishes in accordance with the ecological requirements of the species selected. In the present case also instead of using chemicals, which not only give side effects but also produce resistance problems, the biological method for controlling mosquito larvae by means of fish *Tilapia* or others may be adopted successfully to control not only the *Culex* but *Anopheles* larvae as well.

Nakagawa (1964) reported “Total control” of *Culex pippens* fatigans and *Aedes vexans nocturnus* was achieved with predatory fishes Gambusia affinis and *Tilapia mossambica*. In the present work the *Pistia stratiotis* was grown in sewage stagnant water. In stagnant sewage water the *Culex* mosquitoes were controlled by *Tilapia* fishes. The *Anopheles* species which came to breed there, were also controlled by *Tilapia mossambicus*. So not only the *Culex* but *Anopheles* larvae were also controlled by the fish.

Buranarek and Camarillo (1968) they reported four species of fishes were tested, namely, *Tilapia, Mollienesia*, Swordtail, and Goldfish as means of controlling the wrigglers of the common house mosquitoes under laboratory and field conditions. *Tilapia* gave the highest percentage of wrigglers consumed with 97.80 percent; followed by *Mollienesia* with 97.33 percent; Swordtail fish with 97.10 percent; and Goldfish gave the lowest number of wrigglers consumed with 69.56 percent. In the field or ponds there had been apparent reduction of the wriggler population in ponds where the fish were released compared with the control pond. In the present work *Tilapia* fish with *Pistia* plant was used in sewage stagnant water which was unavoidable. The plant and fish gave excellent results. Similarly in Pakistan there are various other fishes as well which may be used in ornamental ponds around residential houses and in a community areas, such as *Poecilia reticulata*, *Cyprinus carpio*, Gambusia affinis, *Aphanius dispar*, *Aplocheilus panchax*, *Chanda* (baculis, name, ranga), *Colisa* (chuna, fasciata, laila), *Puntius* (conchonius, sophore, ticto) may also be practiced with accordance to environment and requirement of the city in Pakistan or wherever needed.

Nakagawa and Ikeda (1969) reported the biological control of mosquitoes with larvivorus fish in Hawaii. Among 17 species of exotic fishes the most effective appeared to be (1) Gambusia affinis (2) *Poecilia reticulata* (Peters), (3) *Lima vitata* (Guichenot), and (4) *Tilapia mossambica* (Peters) were effective against *Culex quinquefasciatus* Say. In the present work also one of the above most effective fish *Tilapia mossambicus* proved to the best
larvivore fish here in Karachi, Sindh Pakistan in controlling the *Culex pipiens* and *Culex fatigans* as well as *Anopheles stephensi* and others.

Legner and Medved (1973) reported biological control of *Culex* mosquitoes and Chironomid & midges by means of three species of fish. *T. mossambica* (Peters) *T. zilli* (Gervais) and *Molliesenia* (Poecilia) *latipinna* (Le Sueur). *Molliesenia* in two types of shallow ponds gave significant and sustained predation of high magnitudes. While *Tilapia zilli & T. mossambica* causing more than 80% and 65% reduction of larvae respectively. In 170 days (about six months) experiment the fish population increased *T. zilli* 1060-fold (to 534 fish) while *T. mossambica* increased 519-fold (to 418 fish) from an initial stocking of two to three females each. The fecundity appeared to increase with higher water temperature. In the present investigation the *Tilapia mossambicus* was released randomly @ one fish/m², in accordance to the requirement of the water body. The fish population increased high more than released. The mosquito larvae of *Culex* and *Anopheles* were not found in the places where, there the fishes were released after six months experimental observations. Whereas in control area, abundance of *Culex* larvae remarkable population of *Anopheles* larvae and in some cases *Aedes* larvae were also found. The present work is in line with the previous work and supports the biological method to control the mosquito larvae.

Hauser (1975) reported *Tilapia zilli* and *T. mossambica* as biological control agent for aquatic weeds and noxious aquatic insects including mosquito larvae and Chironomid in California midges. In the present work it was found that *Lemna & Spirodela* can not flourish with *Tilapia* species. This may be the reason that Tilapia feed on aquatic weeds, therefore in present work *Pistia* and *Eichhornia* was used with *Tilapia* fish experiment. *Pistia* plant gave better results as compared to *Eichhornia* plant.

Vešlimirović and Clarke (1975) reported biological control of vector mosquitoes in Maldives Republic by means of *Poecilia reticulata*, *P. sphenops* and *Kuhlia tenuisurus* to control *Anopheles tesselates* Theo and *A. subpictus* Grassi (malaria) and *Culex pipiens fatigans* (filariasis) in wells. Whereas in the present work *Tilapia mossambicus* was used in sewage stagnant water and almost fresh water for the control of *Culex* and *Anopheles*.

Menon and Rajagopalan (1977) reported the habitat, predation rate, and larvivorous potential of 13 species of fishes found in Pondicherry. Even though *Gambusia affinis* and *Tilapia mossambica* are exotic and were introduced into India many years ago, they are well established in many parts of India. *Poecilia reticulata* was also studied for its potential as a larvivore because of its effectiveness in sewage drains with polluted water. Small scale field trials in wells using *Gambusia affinis*, *Poecilia reticulata*, *Aplocheilus blocki*, and *Oryzias melastigma* showed that *Aplocheilus blocki* and *Oryzias melastigma* are more efficient than *Gambusia affinis* in controlling mosquito breeding, as they survived better and showed higher tolerance for pollution, water temperature, etc. The potential for the use of indigenous fishes in controlling the vector of urban malaria, *Anopheles stephensi*. In the present work *Tilapia mossambicus* was used in sewage, stagnant and polluted water. The fishes were released one week after the introduction of *Pistia* & *Eichhornia*. The *Pistia* flourished well and gave excellent results with *Tilapia* in biological mosquito control method.

World Health Organization (1981) this report provides a critical appraisal of status and potential use of fish as a method for vector control. A scheme for evaluation and testing of fish for mosquito control, and a list of known and potential larvivorous fish is given. A priority ranking of the following fishes for mosquito control has been provided: *Gambusia affinis*, *Aphanius dispar*, *Aplocheilus* spp., *Nothobranchius* spp., *Ctenopharyngodon idella*, *Oryzias* spp., *Poecilia reticulata*, and *Tilapia* spp. In the present work *Tilapia mossambicus* has been used in the biological control for vector mosquito larvae.

Yeon & Yu (1990) reported the predation effectiveness of mosquito larvae (*Culex pipiens pallens*) by herbivorous *Tilapia mossambicus niloticus* in the laboratory. The predation of mature *Tilapia* consumed later instar stage of above mosquitoes on average of 1,433.5 larvae/day, followed by intermediate and immature fish consuming 995.2 and 364.5 individual larvae respectively. In a test consuming weeds, mature *Tilapia* consumed on the average of 4.34 gr. Per day, intermediate and immature fish consuming 2.69 and 1.11 gr. Per day, respectively. In the test of weed preference, the most preferred weed by *Tilapia* was *Equisetum* spp. followed by *Lemma* and *Spirodela* spp., but non-preferential foraging behavior was shown on the rice stalk demonstrating that *Tilapia* was not likely to harm the rice plant, when released in natural rice field. The present work was carried on field level by means of *Tilapia mossambicus* accomplished with *Pistia & Eichhornia*, giving 90% to 99% control of *Culex* spp. in stagnant polluted water. Similarly these fishes may also be released in the rice field in Pakistan for the control of *Anopheles* mosquitoes, responsible for malaria in Pakistan and elsewhere.

Qadri et al. (2007) reported biological control of *Aedes aegypti* mosquitoes by *P. reticulata* in fresh water. Whereas in the present work *T. mossambicus* has been used in fresh water at Urdu University, Baitul Mukarram Masjid and Nipa Chorangi while in
sewage water at Metrovil Karachi and Karachi University supporting biological control by fishes in Pakistan.

Tariq et al. (2009) reported the biological control of mosquito larvae by means of two local weeds the *Lemna minor* and *Spirodela* spp., accomplished with rainbow fish, *Poecilia reticulata* in Karachi, Sindh-Pakistan. During this experiment it was also observed that *Lemna* and *Spirodela* do not persists with Tilapia fish because Tilapia fish beside mosquito larvae also feed on weeds (*Lemna*, *Spirodela* & others). Therefore in the present work two local plants *Pistia stratiotis* and *Echhornia crassipes* were used for the control of mosquito larvae, accomplished with *Tilapia mossambicus* which gave good results as biological control in stagnant and dirty water.

**REFERENCES**


Table-1. Showing, place, area in sq.m and monthly observation of mosquito larvae with control percentage in bracket.

<table>
<thead>
<tr>
<th>Ob.</th>
<th>Place</th>
<th>Area sq. m</th>
<th>Pretreatment</th>
<th>1 Month</th>
<th>2 Months</th>
<th>3 Months</th>
<th>4 Months</th>
<th>5 Months</th>
<th>6 Months</th>
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<tbody>
<tr>
<td>1</td>
<td>Karachi Univ.</td>
<td>35x71.5 = 2502</td>
<td>823</td>
<td>741 (9.9)</td>
<td>605 (26.5)</td>
<td>455 (44.7)</td>
<td>182 (77.9)</td>
<td>178 (78.4)</td>
<td>09 (98.9)</td>
</tr>
<tr>
<td>2</td>
<td>Metrovil Karachi</td>
<td>20x100 = 2000</td>
<td>799</td>
<td>780 (2.4)</td>
<td>677 (15.3)</td>
<td>428 (46.5)</td>
<td>201 (74.8)</td>
<td>95 (88.1)</td>
<td>03 (99.6)</td>
</tr>
<tr>
<td>3</td>
<td>Korangi</td>
<td>2x1700 = 3400</td>
<td>900</td>
<td>795 (11.7)</td>
<td>635 (29.5)</td>
<td>499 (44.6)</td>
<td>192 (78.7)</td>
<td>67 (92.6)</td>
<td>06 (99.4)</td>
</tr>
<tr>
<td>4</td>
<td>Urdu University</td>
<td>2x2000 = 4000</td>
<td>612</td>
<td>503 (17.8)</td>
<td>414 (32.4)</td>
<td>380 (367.9)</td>
<td>188 (69.3)</td>
<td>35 (94.3)</td>
<td>02 (99.7)</td>
</tr>
<tr>
<td>5</td>
<td>Baitul Mukarram</td>
<td>2x3000 = 6000</td>
<td>518</td>
<td>401 (22.6)</td>
<td>298 (42.5)</td>
<td>189 (63.5)</td>
<td>103 (80.1)</td>
<td>21 (95.9)</td>
<td>01 (99.8)</td>
</tr>
<tr>
<td>6</td>
<td>Landhi</td>
<td>20x500 = 10000</td>
<td>489</td>
<td>409 (16.4)</td>
<td>300 (38.6)</td>
<td>165 (66.3)</td>
<td>97 (80.1)</td>
<td>31 (93.7)</td>
<td>04 (99.2)</td>
</tr>
<tr>
<td>7</td>
<td>University Gate-4 (Control)</td>
<td>10x1000 = 10000</td>
<td>490</td>
<td>523 (+6.7)</td>
<td>542 (+10.6)</td>
<td>587 (+19.8)</td>
<td>613 (+25.1)</td>
<td>629 (+28.4)</td>
<td>253 (+33.3)</td>
</tr>
<tr>
<td>8</td>
<td>Orangi Town (Control)</td>
<td>4x2000 = 10000</td>
<td>327</td>
<td>382 (+16.8)</td>
<td>407 (+24.5)</td>
<td>430 (+31.5)</td>
<td>491 (+50.1)</td>
<td>516 (+57.8)</td>
<td>569 (+74.0)</td>
</tr>
</tbody>
</table>

Formula to calculate population = \frac{\text{Pretreatment reading} - \text{Monthly observation}}{\text{Pretreatment reading}} \times 100
<table>
<thead>
<tr>
<th>Image</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1.jpg" alt="Image" /></td>
<td><em>Eichhornia crassipes</em> in field</td>
</tr>
<tr>
<td><img src="image2.jpg" alt="Image" /></td>
<td><em>Eichhornia crassipes</em> with flower</td>
</tr>
<tr>
<td><img src="image3.jpg" alt="Image" /></td>
<td>Magnified flower of <em>Eichhornia crassipes</em></td>
</tr>
<tr>
<td><img src="image4.jpg" alt="Image" /></td>
<td><em>Pistia stratiotis</em> initial stage in field</td>
</tr>
<tr>
<td><img src="image5.jpg" alt="Image" /></td>
<td><em>Pistia stratiotis</em> in grown stage in field</td>
</tr>
<tr>
<td><img src="image6.jpg" alt="Image" /></td>
<td><em>Pistia stratiotis</em> showing daughter plants in field</td>
</tr>
<tr>
<td><img src="image7.jpg" alt="Image" /></td>
<td><em>Tilapia mossambicus</em> used as mosquitoes larvivorous fish</td>
</tr>
<tr>
<td><img src="image8.jpg" alt="Image" /></td>
<td><em>Tilapia mossambicus</em> magnified</td>
</tr>
<tr>
<td><img src="image9.jpg" alt="Image" /></td>
<td><em>Mansonia</em> spp. of mosquito</td>
</tr>
<tr>
<td><img src="image10.jpg" alt="Image" /></td>
<td><em>Filariasis</em> vector mosquito <em>Culex</em> spp. (in dirty water)</td>
</tr>
<tr>
<td><img src="image11.jpg" alt="Image" /></td>
<td>Dengue vector mosquito <em>Aedes</em> spp. (in fresh water)</td>
</tr>
<tr>
<td><img src="image12.jpg" alt="Image" /></td>
<td>Malaria vector mosquito <em>Anopheles</em> spp. (in fresh water)</td>
</tr>
</tbody>
</table>

Fig. 1-12. Showing *E. crassipes*, *P. stratiotis*, *T. mossambicus*, *Mansonia* spp., *Culex* spp., *Aedes* spp. & *Anopheles* spp.
VARIETAL RESISTANCE OF ABELMOSCHUS ESCULENTUS AGAINST BEMISIA TABACI AND EARIAS SPP. UNDER FIELD CONDITIONS

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(Received for publication: 13.11.2012)

ABSTRACT

Studies on varietal resistance of okra against whitefly, Bemisia tabaci and fruit borer, Earias spp. were carried out at Entomology Section, ARI, Tandojam. Seeds of six varieties viz: Sabzpari, Super green, Noori-786, Sharmeeli, Pusa sawani, and Ambak were sown on April, 19, 2012 in a randomized complete block design (RCBD) with four replications. Observations on pest infestation were started in second week of May and continued till harvest of the crop. Observations were recorded at weekly intervals from 5 plants selected at random per treatment. The results revealed that the population of whitefly varied significantly (P<0.05) on different dates and on different varieties. Okra variety Sabzpari harboured the minimum pest (3.17 insects / leaf) population, while Noori-786 harboured the maximum (4.46 insects / leaf) population. Therefore, it could be considered comparatively and least the most resistance varieties. Similarly, fruit borer population and percent infestation also varied significantly (P<0.05) on different dates but it was insignificant amongst varieties. The highest pest population (0.82 larvae / plant) and percent infestation (46.4) were recorded on varieties Noori-786 and Pusa Sawani, while the least percent infestation (39.8) was recorded on variety Sabzpari. Therefore, Sabzpari, could be considered as comparatively more resistant okra variety than remaining varieties against whitefly as well as fruit borer infestation.

Key words: Different varieties, sucking and chewing insects, abiotic factors and okra.

INTRODUCTION

Okra, Abelmoschus esculentus L. (Malvaceae) is an important vegetable-crop in many parts of the world. It is a native crop of Africa, South East Asia and North Australia to the pacific. It is herbaceous annual plant of the old world tropics and widely cultivated or naturalized in the tropical and sub-tropical counties (Memon et al., 2004). It requires more than 8 irrigations during the Kharif season (Sahito and Kamran, 2012) if there is shortage of water than apply the drip irrigation system which is successful, first time reported by Soomro et al., (2012). Okra lobbed leaves are generally hairy and may reach 11 inches in length. It is often grown as a perennial in many tropical areas. Cultivars vary in plant height, shape and color of the pod. Most cultivars were adapted to high temperatures and wide range of soil types. Average temperature of 68-80 °F is the best for growth, flowering and pod development. This crop is tolerant to wide variation in rain fall (Paul et al., 2000). Okra contains water, calcium, Iron, Protein, Starch and also it is rich source of vitamins, A and B and also contains minerals, phosphorus, iodine and salts which play a significant role in human diet (Khushk et al., 2003). Khambete and Desai, (1996) screened 26 okra, A. esculentus cultivars for resistance to jassid, A. biguttula biguttula and shoot / fruit borer, Earias vittella in naturally infested fields.

Whitefly, Bemisia tabaci (Gennadius) (Hemiptera: Aleyrodidae) stands out as the most important member for its grave impact on tropical and sub tropical agriculture. The whitefly cause direct damage by feeding and produce honey dew and more alarmingly inflicts severe crop losses by transmitting fairly large number of viral diseases (Basu, 1995). It is a worldwide pest, causing yield loss and economic injury in many crop species (Gerling and Mayer, 1996; Oliveira et al., 2001). Bhagabati and Goswami, (1992) found whitefly populations highest in okra that caused yellow vein mosaic virus was highest (100%) in crops sown in May and June. Disease in incidence and populations of Bemisia tabaci were both least in October sown crops. A high positive correlation was observed between disease incidence and the population of B. tabaci. Okra vegetable is attacked by number of insect pests such as aphids, jassids, whitefly, thrips, spotted boll worm and mites from sowing till harvest. Abhishek et al., (1998) conducted field trials to test seven okra varieties for resistance to (Earias vittella Fab.). Varieties: AROH- 2 and Komal showed lowest shoot damage (4 and 5%). Varieties Ankur- 35 and Parbhani Kranti registered significantly higher shoot damage (7.5 and 8.0%). Srinivasa and Sugetha, (2001) evaluated nine okra cultivars for resistance to
major pests including leafhopper, *Amrasca biguttula*, red cotton bug, (*Dysdercus sp.*), fruit and shoot borer, (*Earias* spp.) and spider mite, *Tetranychus macfarlanei*. No any variety was completely free from infestation during the Kharif season. Prasad and Prasad, (2002) investigated the effects of intercropping and insecticide application on the incidence of shoot and fruit borer, *Earias vitella* on okra. Okra, cv. Pusa Sawani was sown with 3 intercrops, i.e. French bean (*Phaseolus vulgaris* cv. S-9). Abro et al., (2004) investigated the effect of growing of cotton (*Gossypium hirsutum* cv. NIAB-78) and okra (cv. Pusa Sawani) as monocrops, mixed crops or poly cultures on percent infestation of *Earias* spp. (*E. vitella* and *E. insulana*) on both crops under field conditions. The highest *Earias* spp. infestation (18.45%) was recorded on okra grown as a mono crop, followed by okra grown as a mixed crop. The percent infestation observed was 10.29, 5.97 and 3.90%, respectively. Pawar et al., (1996) studied the effect of sowing dates on the incidence of leafhopper, *Amrasca devastans* mite, *Tetranychus cinnabarinus* and fruit borer, *Earias vitella* of okra were conducted. The results showed that the crop had a lower incidence of leafhopper (13.3 and 13.7 LH/L) and fruit borer (17.9 and 18.6%), with a good yield of marketable fruits.

The spotted boll worm, *Earias insulana* (Boisdouval) and *Earias vitella* (Fabricius) (Lepidoptera: Noctuidae) are serious polyphagous insect pests on many economic crops widely distributed in North Africa, India, Pakistan and other countries of the world. The *Earias insulana* is distributed in Europe, Asia, USSR and most of Africa, while *Earias vitella* in Asia, Australia, the pacific islands and in Africa (Memon et al., 2004). Kadam and Khaire, (1995) studied the dynamics of *Earias vitella* infesting okra in relation to abiotic factors and an eco-friendly approach to management of the pest. Hashmi, (1994) reported in the pre flowering stage the larvae bore into the top tender portions of the okra plant and tunnel down the stem, which result in withering and drying of attacked portions of the shoots. The fruits and stems were often attacked by fruit borer. Vyas and Patel, (1991) conducted field studies during the Kharif season on the basis of damage caused by *Earias vitella* and the marketable fruit yield, the okra variety, Okra- 1 was considered the most suitable for use under the prevailing climatic conditions. Singh and Brar, (1994) reported that okra as sown on May 15, harboured the highest mean population of *Earias* spp. Crops protected from the insect pests gave a greater fruit yield than the control and the losses in yield varied from 32.06 to 40.84%. Okra is heavily infested by whitefly and *Earias* spp. so much so that farmers usually apply pesticides on every alternate day in some localities where pest pressure is high on okra crop. These heavy uses of highly toxic insecticides cause human health hazards. No more study on the varietal resistance of okra against to whitefly and *Earias* spp. is reported in Pakistan. Therefore, present investigation is under taken to study the extent of damage and varietal resistance of okra varieties available in Sindh - Pakistan against whitefly and *Earias* spp. for the benefit of farmers and consumers communities.

**MATERIALS AND METHODS**

The present studies on varietal resistance of okra against whitefly, *Bemisia tabaci* and fruit borer *Earias* spp. were carried out at Entomology section, Agriculture Research Institute, Tandojam. The plot size for each treatment was about 102 x 70 feet. The row to row distance was 2 ½ feet and plant to plant distance was 1 ½ feet. The seeds of different varieties of okra were obtained from the Entomology Section (ARI), Tandojam. The sowing of different varieties of okra namely Sabzpari, Super Green, Noori-786, Sharmeeli, Pusa Sawani and Ambak were done on April, 19, 2012 in randomized complete block design (RCBD) with four replications. The varieties were sown in parallel lines through a hand drill. The observations on pest infestation were started in 2nd week of May, 2012 and continued till harvest of the crop in the 1st week of August, 2012. The observations were recorded by observing 5 plants selected from each treatment at random. Whiteflies and their nymphs were also recorded at random and 3 leaves were observed thoroughly from every plant. Selected each from bottom, middle and top portion of the plants, nymphs were observed with the help of magnifying glass. In the case of whiteflies, the leaves were touched and turned as gently as possible in order to avoid their fast escape from the leaves, under observation.

Fruit borer infestation was observed carefully from 1st week of June until the completion of the data. The whole infested and un-damaged fruits were recorded at weekly basis like as in whitefly at early in the morning hours 8: AM. The fruits were counted from top, middle and bottom portions of the every plant. For this purpose, 5 plants were kept under observation from each treatment at random. The damaged fruits were picked and brought to the laboratory, at Entomology section ARI, Tandomam and finally all damaged fruits were opened and the larvae of *Earias* spp. were counted and kept in plastic jars for adult emergence. The data collected from the experimental trial / plot was subjected to statistical analysis. The fruit infestation (%) would be estimated by using following formula:

\[
\text{No. of fruits infested by *Earias* spp.} = \frac{\text{Fruit infestation (})}{\text{Total fruits per plant}} \times 100
\]
Table-1. Average per leaf population of whitefly, *B. tabaci* on different varieties of okra (±S.D) in summer season during, 2012

<table>
<thead>
<tr>
<th>Dates</th>
<th>Sabzpari</th>
<th>Super green</th>
<th>Noori-786</th>
</tr>
</thead>
<tbody>
<tr>
<td>10-05-12</td>
<td>3.03±0.45</td>
<td>4.17±1.00</td>
<td>5.11±1.33</td>
</tr>
<tr>
<td>17-05</td>
<td>4.68±1.11</td>
<td>8.39±1.21</td>
<td>9.83±1.41</td>
</tr>
<tr>
<td>24-05</td>
<td>4.36±1.91</td>
<td>6.67±1.31</td>
<td>7.54±1.27</td>
</tr>
<tr>
<td>31-05</td>
<td>3.6±0.88</td>
<td>6.04±1.06</td>
<td>6.08±0.81</td>
</tr>
<tr>
<td>7-06</td>
<td>7.98±1.52</td>
<td>9.99±1.15</td>
<td>9.02±1.67</td>
</tr>
<tr>
<td>14-06</td>
<td>3.47±1.41</td>
<td>4.07±1.03</td>
<td>7.38±1.09</td>
</tr>
<tr>
<td>21-06</td>
<td>5.19±0.97</td>
<td>6.26±1.78</td>
<td>5.79±0.57</td>
</tr>
<tr>
<td>28-06</td>
<td>4.5±1.18</td>
<td>3.28±0.57</td>
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</tr>
<tr>
<td>5-07</td>
<td>0.81±0.21</td>
<td>1.28±1.25</td>
<td>0.77±0.13</td>
</tr>
<tr>
<td>12-07</td>
<td>0.13±0.06</td>
<td>0.06±0.04</td>
<td>0.18±0.09</td>
</tr>
<tr>
<td>19-07</td>
<td>0.21±0.06</td>
<td>0.15±0.06</td>
<td>0.20±0.03</td>
</tr>
<tr>
<td>26-07</td>
<td>0.09±0.03</td>
<td>0.13±0.06</td>
<td>0.14±0.05</td>
</tr>
<tr>
<td>(±S.D).</td>
<td>3.17±2.45 c</td>
<td>4.20±3.36 ab</td>
<td>4.64±3.47 a</td>
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</table>

<table>
<thead>
<tr>
<th>Sharmeeli</th>
<th>Pusa sawni</th>
<th>Ambak.</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.67±0.96</td>
<td>4.57±0.79</td>
<td>4.44±1.03</td>
<td>4.33±0.70 de</td>
</tr>
<tr>
<td>6.01±1.33</td>
<td>5.14±0.53</td>
<td>5.56±1.26</td>
<td>6.60±2.04 b</td>
</tr>
<tr>
<td>7.85±2.29</td>
<td>6.13±2.17</td>
<td>5.65±0.94</td>
<td>6.36±1.28 b</td>
</tr>
<tr>
<td>6.32±2.05</td>
<td>6.49±1.21</td>
<td>4.09±0.74</td>
<td>5.43±1.25 c</td>
</tr>
<tr>
<td>9.31±0.60</td>
<td>11.21±1.01</td>
<td>9.81±1.47</td>
<td>9.55±1.07 a</td>
</tr>
<tr>
<td>3.69±1.21</td>
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<td>3.88±0.85 e</td>
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<tr>
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<td>4.53±1.31</td>
<td>4.4±0.51</td>
<td>4.95±0.99 d</td>
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<tr>
<td>3.94±1.15</td>
<td>4.05±0.60</td>
<td>3.47±0.39</td>
<td>3.96±0.52 e</td>
</tr>
<tr>
<td>0.83±0.13</td>
<td>0.96±0.19</td>
<td>0.86±0.28</td>
<td>0.91±0.18 f</td>
</tr>
<tr>
<td>0.19±0.06</td>
<td>0.21±0.13</td>
<td>0.14±0.5</td>
<td>0.15±0.05 g</td>
</tr>
<tr>
<td>0.36±0.30</td>
<td>0.19±0.06</td>
<td>0.14±0.05</td>
<td>0.20±0.07 g</td>
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<tr>
<td>0.15±0.03</td>
<td>0.14±0.06</td>
<td>0.16±0.07</td>
<td>0.20±0.07 g</td>
</tr>
<tr>
<td>3.90±3.10 b</td>
<td>4.06±3.28 ab</td>
<td>3.44±2.89 c</td>
<td></td>
</tr>
</tbody>
</table>

Cdi for dates = 0.594; cdi for varieties = 0.42. Means followed by same letters in a column are not significantly (P<0.05) different from each other by LSD method.
Table-2. Average per plant larval population of fruit borer, *Earias* spp. on different varieties of okra (±S.D) in summer season during, 2012

<table>
<thead>
<tr>
<th>Dates</th>
<th>Sabzpari</th>
<th>Super green</th>
<th>Noori-786</th>
</tr>
</thead>
<tbody>
<tr>
<td>7-06-12</td>
<td>0.65±0.1</td>
<td>0.80±0.28</td>
<td>0.80±0.16</td>
</tr>
<tr>
<td>14-06</td>
<td>0.80±0.16</td>
<td>0.50±0.2</td>
<td>0.60±0.23</td>
</tr>
<tr>
<td>21-06</td>
<td>0.80±0.28</td>
<td>0.60±0.16</td>
<td>0.75±0.19</td>
</tr>
<tr>
<td>28-06</td>
<td>0.60±0.16</td>
<td>0.55±0.19</td>
<td>0.30±0.11</td>
</tr>
<tr>
<td>05-07</td>
<td>0.65±0.37</td>
<td>0.80±0.43</td>
<td>0.70±0.11</td>
</tr>
<tr>
<td>12-07</td>
<td>0.65±0.19</td>
<td>0.85±0.3</td>
<td>0.65±0.25</td>
</tr>
<tr>
<td>19-07</td>
<td>1.05±0.25</td>
<td>0.90±0.41</td>
<td>1.10±0.47</td>
</tr>
<tr>
<td>26-07</td>
<td>0.55±0.19</td>
<td>0.60±0.28</td>
<td>1.25±0.30</td>
</tr>
<tr>
<td>02-08</td>
<td>0.85±0.34</td>
<td>0.80±0.36</td>
<td>1.25±0.77</td>
</tr>
<tr>
<td>(±S.D)</td>
<td>0.73±0.15</td>
<td>0.71±0.14</td>
<td>0.82±0.31</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sharmeeli</th>
<th>Pusa sawni</th>
<th>Ambak</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.60±0.16</td>
<td>0.75±0.19</td>
<td>0.70±0.25</td>
<td>0.71±0.08 c</td>
</tr>
<tr>
<td>0.75±0.3</td>
<td>0.60±0.16</td>
<td>0.75±0.19</td>
<td>0.66±0.11 c</td>
</tr>
<tr>
<td>0.45±0.19</td>
<td>0.70±0.11</td>
<td>0.75±0.19</td>
<td>0.67±0.12 c</td>
</tr>
<tr>
<td>0.40±0.16</td>
<td>0.40±0.16</td>
<td>0.60±0.23</td>
<td>0.47±0.12 d</td>
</tr>
<tr>
<td>0.55±0.34</td>
<td>0.65±0.19</td>
<td>0.60±0.16</td>
<td>0.65±0.08 c</td>
</tr>
<tr>
<td>0.75±0.19</td>
<td>0.75±0.19</td>
<td>1.00±0.28</td>
<td>0.77±0.13 c</td>
</tr>
<tr>
<td>0.90±0.24</td>
<td>1.00±0.58</td>
<td>0.75±0.34</td>
<td>0.95±0.12 b</td>
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<tr>
<td>1.25±0.25</td>
<td>1.15±0.34</td>
<td>1.10±0.25</td>
<td>0.97±0.31 ab</td>
</tr>
<tr>
<td>1.55±0.66</td>
<td>1.40±0.43</td>
<td>0.90±0.25</td>
<td>1.12±0.31 a</td>
</tr>
<tr>
<td>0.80±0.38</td>
<td>0.82±0.30</td>
<td>0.79±0.17</td>
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</tr>
</tbody>
</table>

Cdi for dates = 0.71 Means followed by same letters in a column are not significantly (P<0.05) different from each other by LSD method.
Table-3. Average % fruit infestation of *Earias* spp. on different varieties of okra (*\pm S.D*) in summer season during, 2012

<table>
<thead>
<tr>
<th>Dates</th>
<th>Sabzpari</th>
<th>Super green</th>
<th>Noori-786</th>
</tr>
</thead>
<tbody>
<tr>
<td>7-06-12</td>
<td>47.37±9.42</td>
<td>46.22±7.14</td>
<td>55.13±7.55</td>
</tr>
<tr>
<td>14-06</td>
<td>35.11±4.41</td>
<td>34.85±9.10</td>
<td>46.31±11.54</td>
</tr>
<tr>
<td>21-06</td>
<td>33.38±21.19</td>
<td>47.25±3.44</td>
<td>54.55±14.19</td>
</tr>
<tr>
<td>28-06</td>
<td>29.13±12.71</td>
<td>27.20±7.92</td>
<td>28.77±8.70</td>
</tr>
<tr>
<td>05-07</td>
<td>43.42±13.90</td>
<td>53.99±19.72</td>
<td>47.56±10.66</td>
</tr>
<tr>
<td>12-07</td>
<td>39.80±12.27</td>
<td>42.79±6.24</td>
<td>22.96±13.17</td>
</tr>
<tr>
<td>19-07</td>
<td>41.54±11.83</td>
<td>47.07±8.69</td>
<td>47.06±9.12</td>
</tr>
<tr>
<td>02-08</td>
<td>39.04±8.11</td>
<td>47.74±18.20</td>
<td>60.82±16.34</td>
</tr>
<tr>
<td>(\pm S.D)</td>
<td>39.84±46.77</td>
<td>43.08±8.07</td>
<td>46.46±12.67</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sharmeeli</th>
<th>Pusa sawni</th>
<th>Ambak</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>51.03±7.08</td>
<td>50.0±11.91</td>
<td>52.25±5.90</td>
<td>50.36±3.20 ab</td>
</tr>
<tr>
<td>44.61±6.81</td>
<td>34.96±2.02</td>
<td>46.19±2.96</td>
<td>40.33±5.90 d</td>
</tr>
<tr>
<td>41.91±15.61</td>
<td>48.24±8.23</td>
<td>49.20±12.69</td>
<td>45.75±7.28 abc</td>
</tr>
<tr>
<td>25.57±7.07</td>
<td>35.29±12.02</td>
<td>36.15±7.15</td>
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</tr>
<tr>
<td>37.32±27.65</td>
<td>43.87±9.26</td>
<td>32.66±8.51</td>
<td>43.15±7.51 bcd</td>
</tr>
<tr>
<td>43.43±9.43</td>
<td>47.91±12.50</td>
<td>51.24±4.97</td>
<td>41.35±9.87 cd</td>
</tr>
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<td>41.07±5.29</td>
<td>45.46±6.75</td>
<td>37.24±7.91</td>
<td>43.34±4.07 cd</td>
</tr>
<tr>
<td>57.63±14.39</td>
<td>53.17±15.43</td>
<td>54.01±8.16</td>
<td>49.89±7.95 ab</td>
</tr>
<tr>
<td>58.97±10.76</td>
<td>58.05±13.73</td>
<td>40.38±9.36</td>
<td>52.5±8.04 a</td>
</tr>
<tr>
<td>44.61±10.33</td>
<td>46.32±7.60</td>
<td>44.36±7.90</td>
<td></td>
</tr>
</tbody>
</table>

Cdi for % infestation = 6.289 Means followed by same letters in a column are not significantly (P<0.05) different from each other by LSD method.
RESULTS

1. **Whitefly, *Bemisia tabaci***

   The results of comparative varietal resistance of okra against whitefly are given in Table-1, which indicated that the pest started its infestation 20 days after sowing of the crop and continued till fourth week of July after that pest disappeared from the crop as crop matured. In all the varieties peak infestation of whitefly was recorded on June 7, 2012. Pest population started declining on subsequent observations. Statistical analysis of mean population of whitefly on different dates showed a significant difference (P<0.05) in dates. ANOVA of population on different varieties of okra indicated that the mean population difference was statistically significant (P<0.05). The lowest population was recorded on Sabzpari (3.17) followed by Ambak. While, the highest mean population (4.65 insect per leaf) was recorded on Noori-786, respectively.

2. **Fruit borer, *Earias* spp.**

   The pest started its infestation on all varieties in the first week of June and continued its activity till first week of August, when crop was harvested. The pest population remained fluctuating and was less than one larva per plant in all varieties (Table-2). The highest pest population was recorded on August 2, 2012, which was significantly (P<0.05) higher than remaining dates of observations. The mean population on different varieties was statistically non significant.

   Percent infestation of okra fruits on different cultivars caused by *Earias* spp. was shown in (Table-3) which indicated that infestation was almost uniformly distributed in all okra varieties. The overall minimum and maximum infestation was recorded on the fourth week of June and first of August, which was 30.35 and 52.50%, respectively. The infestation differences on different dates were significant (P<0.05) and in different varieties insignificant. The lowest infestation (39.84%) was recorded on Sabzpari, while the highest (46.46%) on Noori-786, respectively.

**DISCUSSION**

In present study, whitefly found infesting on all the varieties of okra however, the differences were significant. Okra variety Sabzpari was comparatively more resistance showing minimum pest population than other varieties. Moreover, whitefly population was significantly negatively correlated with minimum temperature and relative humidity ($r = -0.484$ and $r = -0.793$), respectively and positively correlated with maximum temperature ($r = 0.607$). Mazumber *et al.*, (1996) conducted studies on *B. tabaci*, the vector of yellow vein mosaic virus on three cultivars of okra and found lower number of whiteflies on Parbhani kranti and M-31. Gupta *et al.*, (1998); Kumawat *et al.*, (2000) investigated the seasonal incidence of whitefly on okra and its correlation with abiotic factors and found that maximum temperature was significantly correlated with whitefly density.

Studies on varietal resistance of okra against whitefly, *Bemisia tabaci* and fruit borer, *Earias* spp. were carried out at from April to August 2012. Seed of six varieties were sown and the observations were taken from pest appearance till harvest of crop. In all varieties peak infestation of whitefly was recorded on June 7 and the lowest population was recorded on Sabz Pari (3.17) followed by Ambak. While, the highest mean population of whitefly (4.64/leaf) was recorded on Noori-786. Where as, *Earias* spp., started its infestation on all varieties in the first week of June and it continued its activity till first week of August, when the crop was harvested. The highest population was recorded on August, 2012, which was significantly (P<0.05) higher than remaining dates of observation. The lowest infestation (39.84%) was recorded on Sabzpari, while the highest (46.46%) on Noori-786. Fruit borer, *Earias* spp. was a serious pest of okra in Sindh, Pakistan. In present study all varieties behaved almost similarly against pest. There was no significant difference in pest population and infestation amongst different varieties of okra. Correlation studies between weather parameters and pest populations were insignificant. Only pest infestation was significantly ($r = 0.510$) correlated with maximum temperature. The results of the studies are in agreement with Sahito *et al.*, (2012) who correlated the abiotic factors to whitefly in which the regression analysis showed significant negative correlation of whitefly population with temperature °C and relative humidity %. Another study was conducted by (Sahito *et al.*, 2010; Lanjar and Sahito, 2007; 2009; 2010) who described that whitefly found sever infestation on mustard, okra, sunflower crops and its effect on alternate host-plants. Among all sucking complex the *B. tabaci* damaged vigorously.

The six varieties were cultivated and also found damaged by the fruit borer in the summer season on inorganic okra crop. The studies are in agreement with Kumbhar *et al.*, (1991) who screened 40 varieties of okra for resistance to *E. vittella* and found fruit borer resistance correlated with increased fruit hair density. Mote, (1992) found level of oviposition, larval entry and field infestation lowest on varieties with higher hair density and longer hair. Kambete and Desai, (1996) screened 26 okra cultivars for *E. vittella* resistance found wonderful pink cultivar tolerant with 20-30% infestation. Singh and Brar, (1994) also reported losses in yield varied from 32.06 to 40.84% due to infestation of *Earias* spp. While Nath *et al.*, (1992); Abhishek *et al.*,
(1997) observed that infestation of okra fruits started mosaic virus at the beginning of fruiting, increased progressively and reached a peak 41.25% before harvesting and mean maximum temperature was significantly correlated with percent fruit damage. It was concluded from the results which revealed that okra variety Sabzpari was comparatively more resistant showing minimum pest population than other varieties. While, Noori-786 is considered as least resistant variety moreover, whitefly population was significantly negatively correlated with minimum temperature and relative humidity, respectively and positively correlated with maximum temperature. Therefore, it is suggested that, Sabzpari was found comparatively resistant variety that is recommended for cultivation to get better production.

ACKNOWLEDGEMENTS

The financial assistance and provided field from ARI, Tandojam for conducting this study in free pesticides vegetable (inorganic okra) is gratefully acknowledged. We thank: Prof. Dr. G. H. Abro (Chairman) Dept: Entomology, SAU, Tandojam – Sindh for providing assist in conducting these studies and good facilitation by Dr. A. H. Bajoi, (Entomologist) and Vice-Chancellor, LUAWMS, Uthal–Balochistan are highly appreciated by authors (Mastoi and Sahito) PhD, scholars.

REFERENCES


EVALUATION OF DIFFERENT YEASTS IN LARVAL DIET FOR THE ECONOMICAL MASS REARING OF PEACH FRUIT FLY BACTROCERA ZONATA (SAUNDERS)

IMRAN RAUF, NAZIR AHMAD, S.M.M. SHAH RASHDI, M.H. KHAN, M. BUXT, N. KUHRO AND M. ISMAIL
Nuclear Institute of Agriculture, Tandojam-70060
(Received for publication: 19.11.2012)

ABSTRACT

The intention of this work was to develop appropriate and economic diets for mass rearing of Peach fruit fly, Bactrocera zonata (Diptera: Tephritidae). Diets containing three different yeasts viz. eagle instant yeast, brewer yeast and Torula yeast with wheat bran and other ingredients were tested. Diets based on eagle instant yeast have shown promising results regarding pupal recovery, pupal weight and adult emergence.

Key words: Bactrocera zonata, larval diet, brewer’s yeast, Torula yeast, eagle instant yeast.

INTRODUCTION

The Sterile Insect Technique (SIT) is one of the most promising control approaches for the future of fruit fly integrated management (Enkerlin & Munford, 1997; Hendrichs et al., 2002). In addition to SIT, another important step was the development of fruit fly male only strains through the temperature sensitive lethal (TSL) (Caceres, 2002). All these advances in fruit flies mass rearing and releasing programs are highly dependable on efficient larval and adult diets. The essential information on nutritional requirements is still lacking, because of the incapability to rear fruit fly larvae in a complete purified diet (Chang et al., 2000).

Yeast products are the main nutritional component in the diet used to mass-rear the adults and larvae of fruit flies in these programs (Aluja et al. 2001; Rohlfs and Hoffmeister 2005).

Organisms need a variety of nutrients to complete their life-cycle. Amongst these, proteins stand out as being able to influence several different processes such as development, maintenance and reproduction (Chang et al., 2007). Insect diet has a profound effect on the performance of immature and efficiency of sterile adult released on the field (Yuval et al., 2002). The omission of essential amino acids from fruitfly diet inhibited and delayed development and growth. Pupal recovery, adult emergence and flight ability were affected by removing vitamins or cholesterol. Increasing sugar content in a diet did not affect egg production and hatch, but influenced fly survival (Chang et al., 2000, 2001). A diet with an adequate amount of protein is essential for larvae of B. zonata. The absence of essential amino acids resulted in no survivorship. Vitamins improved larval development, pupal recovery, pupal weight, adult emergence and flight ability. Absence of sugar not only delayed larval developmental period, but also reduced the pupal weight (Chang et al., 2001).

Bulking and nutritive components in an insect diet can be very costly and in some countries are difficult to import. The replacement of costly components by cheaper products has been the concern of researchers in many countries that have fruit fly (Diptera: Tephritidae) mass rearing factory. Most of the research has been conducting on the role of proteins on Ceratitis capitata, an important pest of fruits worldwide (Malavasi et al. 2000) as compare to peach fruit fly B. zonata.

A mass rearing system and Sterile Male Technique SIT for B. zonata is underway and will remain a challenge. A technique to mass rear B. zonata is the start point for the development of SIT (Jaldo et al., 2001, Quinlan et al. 2002). In very few places in the world efforts have been focused on its mass rearing technology. It is essential to develop inexpensive diets that are nutritionally suitable for larval development, contain ingredients that are continuously available, are of known quality, and free of any pollutants. Virtually all artificial larval diets used world-wide have common characteristics. They normally include water, microbial inhibitors, sources of protein, carbohydrate and lipid, plus vitamins, salts, minerals and sterols. The two other ingredients usually added to fruit fly larval diets are a bulking agent and an agent for adjusting pH. The objective of the present work was to identify appropriate yeast for suitable larval diet to be used as a platform to develop a protocol for mass rearing the peach fruit fly.
MATERIALS AND METHODS

Insects

Experiment was conducted at fruitfly rearing and management unit, Nuclear Institute of Agriculture, Tandojam. Flies used in this study were obtained from the permanent colony under conditions of 26 ± 2°C and 60-65% R.H. Adult flies fed on a mixture of sugar and protein hydrolysate enzymatic by a ratio of 3:1, respectively. This laboratory colony was reared on a wheat-based artificial diet since 1963 for > 410 generations.

Diet Formulation

A screening of three different yeasts in larval diets (Torula yeast, brewer’s yeast and Eagle instant dry yeast) was performed in order to find suitable and economic diet for mass rearing of peach fruit fly, *Bactrocera zonata*. The main constitutes of three diets were wheat shorts, sugar, antimicrobial agents (sodium benzoate and nipagen), Hcl and water, whereas different yeasts were used in each diet (Table 01).

a) **Torula Yeast:** Torula, in its inactive form (usually labeled as torula yeast), is widely used as a standard source of protein in larval diets. Torula yeast comprise fungi (*candida utilis*) belongs to class saccharomycetes. It is pasteurized and spray-dried to produce a fine, light grayish-brown powder with a slightly yeasty odor and gentle, slightly meaty taste. Torula yeast was imported from IAEA.

b) **Brewer’s Yeast:** Brewer’s yeast is a type of fungus formally known as *Saccharomyces cervisiae*. When used as a dietary supplement, brewer’s yeast can provide the body with a number of essential vitamins and minerals. It was purchased from local market.

c) **Eagle dry instant yeast:** Eagle dry instant yeast consists of light yellow, porous, rod-shaped particles which are fortified with other necessary ingredients. This yeast also derived from fungus *Saccharomyces cervisiae*. It was also available in local market and manufactured by Angel yeast company limited, Hubai, China.

Diet Preparation

The diet mixture was formulated by weighing all the above-mentioned ingredients into a metal container (with lid) and shaken it vigorously by hand to mix homogeneously. All diets had the pH adjusted to a value between 3.8 to 4.0. Quality control test were run followed the protocols specified on the International Fruit Fly Quality Control Manual (FAO/IAEA/USDA 1998). Then, 400 grams of each diet were poured in three Petri dishes with 15cm of diameter and 2.0cm depth (100g diet per replication).

Experimental Procedure

The rearing room with photoperiod of 10:14 h (L:D) was maintained com fluorescent lights. Three replicates of 200 eggs each (bubbled for 48 hours) were seeded onto a fine strip blotting paper placed on top of diet. After the eggs were applied to the diets they were held at 28 ± 2°C and 80% relative humidity. After 2 days, strip blotting papers were removed from Petri dishes and checked for egg hatching. After 8 days, Petri dishes were removed to other room with temperature of 23 ± 3°C and 75% of relative humidity until larval development was complete. After 10 days individual Petri dish was put in plastic box with saw dust for pupation. Pupae were recorded and transferred to individual box for adult emergence.

The efficacy of the diets of Table 1 was determined by evaluating egg hatching, pupal recovering, pupa weight, sex ratio, emergence %, deformity, half emergence and flier %. Data were presented as mean values ± SE (standard errors), differences among diets were determined by analysis of variance (ANOVA) and means were separated using a Tukey’s test at α=0.05.

RESULTS AND DISCUSSION

The eventual goal of a fruit fly mass rearing production is a reliable result of healthy and competitive adults. This success is very dependable of high control quality of all laboratory procedures and specially a suitable and economic diet. Keeping in mind the quality production of *Bactrocera zonata* for SIT, three different yeasts were evaluated. According to recorded data represented in table 2 the maximum and significantly high pupae were recovered from diet III (168.33) followed by diet I (130.67) and diet II (110.67) respectively. Whereas, pupal weight was significantly high (0.041g) in Diet III which comprise eagle dry instant yeast, instead of diet I (Brewer’s yeast) and diet II (Torula yeast) which were non-significant to each other. The adult emergence (%) of *B. zonata* flies was significantly higher (88.66) in diet III followed by diet II (78.67) and diet I (64.67) respectively. Out of emerged flies, male and female ratio was non-significantly different within all three treatments.

Table 02 represented the egg hatchability, partially emerged, deformity and flier % of emerged adult flies. Overall data showed that egg hatchability was same in diet I and diet III as compared to diet II which manifested significantly lower egg hatchability. Deformity was another parameter studied. According to data, diet III represented minimum deformity, whereas the same was maximum in diet I which was found statistically at par with diet II. Flier % was significantly higher in Diet II and III compared to diet
I. Results also demonstrated that either no any diet was free from partially emerged flies.

To determine the most cost effective diet, three yeasts were evaluated i.e. eagle instant yeast, Torula yeast and brewer’s yeast. The larval diet having eagle instant yeast proved to be the best diet as maximum pupal recovery was obtained from it followed by diet having brewer’s yeast and Torula yeast. It was observed that the diet having instant yeast showed higher fermentation as compared to other diets having brewers and torula yeast. Due to this fermentation the diet was well perforated and that is the main reason that the diet having instant yeast recovered more pupae having maximum weight.

The adults emerged from diet having eagle instant yeast were healthier showing less deformity which will be helpful for SIT programme. The diet having brewer’s yeast showed better results than the diet having torula yeast. These results confirmed as by Sikumbang et al., 2000 that brewer’s yeast is best substitute of other yeasts for Bactrocera carambolae. Unlike our results Bargas et al., 1994 revealed PCC + Torula yeast containing diet is best for rearing of Mediterranean fruit fly. As the eagle instant yeast was used for the first time in larval diets of fruit fly, so, no relevant literature have been found.

Table-1. Ingredients of three larval diets for Bactrocera zonata.

<table>
<thead>
<tr>
<th>Diet Ingredients</th>
<th>Diet 1</th>
<th>Diet 2</th>
<th>Diet 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>% G</td>
<td>% G</td>
<td>% G</td>
<td>% G</td>
</tr>
<tr>
<td>Wheat Shorts</td>
<td>25</td>
<td>100</td>
<td>25</td>
</tr>
<tr>
<td>Sugar</td>
<td>12.5</td>
<td>50</td>
<td>12.5</td>
</tr>
<tr>
<td>Brewer’s Yeast</td>
<td>3.25</td>
<td>-</td>
<td>3.25</td>
</tr>
<tr>
<td>Torula Yeast</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Eagle Yeast</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Nipagen</td>
<td>0.125</td>
<td>0.5</td>
<td>0.125</td>
</tr>
<tr>
<td>Sodium Benzoate</td>
<td>0.19</td>
<td>0.75</td>
<td>0.19</td>
</tr>
<tr>
<td>Hcl</td>
<td>0.125</td>
<td>0.5 ml</td>
<td>0.125</td>
</tr>
<tr>
<td>Water</td>
<td>58.81</td>
<td>235 ml</td>
<td>58.81</td>
</tr>
</tbody>
</table>

Table-2. Pupal recovery, pupal weight, sex ratio and emergence % of Bactrocera zonata on different larval diets.

<table>
<thead>
<tr>
<th>Treat</th>
<th>pupal recovery</th>
<th>pupal wt (g)</th>
<th>Male</th>
<th>female</th>
<th>emerge %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diet 1</td>
<td>130.67 ± 2.1 b</td>
<td>0.033 ± 0.12 b</td>
<td>18.66 ± 1.07 a</td>
<td>20.33 ± 3.5 a</td>
<td>78.67 ± 8.5 b</td>
</tr>
<tr>
<td>Diet 2</td>
<td>110.67 ± 3.11 c</td>
<td>0.033 ± 0.11 b</td>
<td>18.33 ± 2.08 a</td>
<td>21.00 ± 2.00 a</td>
<td>64.67 ± 1.33 c</td>
</tr>
<tr>
<td>Diet 3</td>
<td>168.33 ± 1.12 a</td>
<td>0.041 ± 0.04 a</td>
<td>15.00 ± 0.33 a</td>
<td>24.00 ± 2.08 a</td>
<td>88.66 ± 3.71 a</td>
</tr>
</tbody>
</table>

Table # 03 Egg hatching %, Deformity, Half emergence and flier % of Bactrocera zonata on different larval diets.

<table>
<thead>
<tr>
<th>Treats</th>
<th>Egg hatch %</th>
<th>Deformity</th>
<th>partially emerged</th>
<th>flier %</th>
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<tr>
<td>Diet 1</td>
<td>71.01 ± 2.1 a</td>
<td>2.43 ± 0.88 a</td>
<td>2.00 ± 0.57 a</td>
<td>68.66 ± 1.45 b</td>
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<tr>
<td>Diet 2</td>
<td>63.32 ± 3.2 b</td>
<td>2.33 ± 0.33 a</td>
<td>2.00 ± 1.52 a</td>
<td>87.67 ± 0.88 a</td>
</tr>
<tr>
<td>Diet 3</td>
<td>75.16 ± 1.35 a</td>
<td>1.00 ± 0.57 b</td>
<td>1.67 ± 0.88 a</td>
<td>92.66 ± 1.76 a</td>
</tr>
</tbody>
</table>

Data followed by the same letter, in the same column, do not differ significantly according to Turkey’s HSD test (P>0.05).
Fig. 1-12. Pictorial view showing of fruit rearing cages, fruit fly eggs, enlarged egg, pupae, enlarged pupa, adult male fly, adult female fly, diet 1, diet 2, diet 3 during experiment of *Bactrocera zonata*
RECOMMENDATIONS

This study has shown that the peach fruit fly (Bactrocera zonata) can be economically mass reared on diet based on eagle instant yeast. The eagle instant yeast shows excellent fermentation which help larvae mobility within diet to feed and air well. The significant performance of larval diet open discussion for future researches on improvement of rearing techniques required for the establishment of sterile insect technique (SIT) program focused on the B. zonata and other fruit fly specie.

ACKNOWLEDGEMENT

The authors would like to thank Mr. Muhammad Sarwar and Mr. Shafqat ullah Niazi for their laboratory assistance.

REFERENCES


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MONITORING OF INSECT PESTS ON BRINJAL, SOLANUM MELONGENA (L.) THROUGH LIGHT TRAPS

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(Received for publication: 26.10.2012)

ABSTRACT

An experiment for monitoring of insect pests on brinjal through torch and battery lights as an IPM strategy for pest control was carried out at Latif Farm, Sindh Agriculture University, Tandojam in 2011. Two light traps were used torch light (1.2 watt) and battery light (25 Watt). The results revealed that seven different insect pests of brinjal i.e., Shoot and fruit borer, Leucinodes orbonalis (Guenee), Jassid, Amrasca biguttula biguttula (Ishida), Epilachna beetle, Henosepilachna vigintioctopunctata (Navodita Maurice), Leaf roller, Eublemma olivacea (walker), Blister beetle, Epicauta spp. (De Geer), Aah weevil, Myliocerus subfasciatus (Guerin-Menever) and Brown leafhopper, Orosius orientalis (Matsumura) were attracted to torch light and battery light. Besides insect pests, some predators like green lace wing, Chrysoperla carnea (Stephens), hoverfly, Toxomerus geminatus (Say) and spider, Hippasa ageleoides were also attracted to light traps in negligible numbers. Torch light attracted maximum number of pests in comparison to battery light. The results showed that overall maximum mean number of jassid (5.46 ± 1.96, 4.46 ± 1.76) per trap was attracted to torch and battery light traps followed by tiger moth (4.16 ± 1.57, 3.45 ± 1.77), bark beetle (2.34 ± 1.94, 2.14 ± 2.06), cotton grey weevil (1.62 ± 1.34, 1.04 ± 1.26), pea leaf weevil (1.25 ± 1.29, 0.90 ± 1.26), white leafhopper (0.97 ± 1.12, 0.89 ± 1.22) and red cotton bug with overall maximum mean number of jassid (5.46 ± 1.96, 4.46 ± 1.76) per trap was attracted to torch and battery light traps.

Key words: Pests, predators, brinjal, torch and batteries.

INTRODUCTION

Brinjal (egg plant) Solanum melongena L., also called Aubergine is one of the most important vegetable crops; widely consumed by all population classes and is relatively inexpensive and is available throughout the year. The brinjal belongs to the same family (Solanacae) as the potato, tomato and peppers. It bears a fruit of the same name, commonly used as a vegetable in cooking. It is closely related to the tomato and potato and is native to India and Sri Lanka (Wikipedia, 2010). The plant flourishes in hot climates, but cannot tolerate drought. Brinjal crop is sensitive to cold weather and are damaged easily by frost. Brinjal does extremely well in soil with high humus content and the optimum soil pH ranges between 6.5 and 7.5, while water pH may be between 5.5 and 7.0 (Fuchsia, 2006). The production of eggplant is highly concentrated with 93 percent of output coming from seven countries. China is the top producer (55% of world output) and India is second (28%); Egypt, Turkey, and Japan round out the top producing nations. United States is the 20th largest producer. More than 4 million acres (16,000 km²) are devoted to the cultivation of eggplant in the world (USDA, 2007). It is an important nourishing summer vegetable and is a rich source of iron. Eggplant is one of the most important vegetables in South and South-East Asia. It is grown on over 678,000 ha, which is about 37% of the world eggplant area, with a production of 10.50 million tons (FAO, 2007). The crop seedlings are normally transplanted in March to April and remain on fruiting till October. Due to long cropping season the crop is exposed to the attack of a large number of insect pests, which inflict considerable losses in crop vigor and yield. A horde of insect pests attack this crop due to cultivation throughout the year, out of which brinjal shoot and fruit borer (Leucinodes orbonalis Guenee, Pyralidae: Lepidoptera) is most serious (Sardana et al., 2004). Brinjal contains 92.7% water, 1.1% Protein and 0.02% Carbohydrate. The fuel of calories is 13016 and it rich from vitamin A and B also (Shanmugavelu, 1989).

Though brinjal is a summer crop, it is being grown throughout the year under irrigated condition. Hence, it is subjected to attack by number of insect pests right from nursery stage till harvesting (Regupathy et al., 1997). Crops infested by many insect pests and suffer economic loss to the marketable yield. Among the insect pests infesting brinjal, the major ones are brinjal shoot and fruit borer, Leucinodes orbonalis (Guen.), whitefly, Bemica tabaci (Genn.), leafhopper, Amrasca biguttula biguttula (Ishida), Epilachna beetle,
Henosepilachna vigintioctopunctata (Fab.). And non insect pest, red spider mite, Tetranychus macfurlanei (Baker and Pritchard) is reported from all brinjal growing areas of the world (Eswara and Srinivasa, 2001). The yield loss due to the pest is to the extent of 70-92 percent (Eswara and Srinivasa, 2004; Khuhro et al., 2011). It is very difficult to control the pest because of its burrowing nature. Organic pesticides are widely used to control BSFB, which may adversely affect human health and environmentally safe, effective and eco-friendly strategies to control insect pests (McGaughey et al., 1998). The yearly increase in the cost of pesticides has gone out of the reach of common farmer. Therefore there is a need to develop alternates for handling such economically important pests approach.

As an alternate approach insect traps are used to monitor or directly reduce insect populations. They typically use food, visual lures, chemical attractants and pheromones as bait and are installed so that they do not injure other animals or humans or result in residues in foods or feeds. Visual lures use light, bright colors and shapes to attract pests. Insect traps are sometimes used in pest management programs instead of pesticides but are more often used to look at seasonal and distributional patterns of pest occurrence (Weinzier et al., 1991). Therefore, traps are usually more effective in catching adult insects. When traps are used for monitoring, this is often done to predict outbreaks of a pest species and to assist the farmer in making decisions. When traps are used as a tool to control pests, it should be understood that trap efficiency is related to population density. Some common traps that are often used to catch insects are: sticky traps, light traps and pheromone traps (Campbell et al., 1992). Light traps attract certain insects; however, designs differ according to the behavior of the insects being studied. For effective control of Jassid through light traps, one light trap (200W mercury vapor lamp) was installed per hectare to catch the adults of some nocturnal pests such as Jassid. Farrow’s light trap has a large base so that it captures insects that may otherwise fly away from regular light traps (Kronkright, 1991). The trap consists of three components: a clear plastic trap top to admit light for adult orientation into the trap, a deflector plate to reduce the escape of trapped adults, and a yellow colored trap base with an opening for adult entrance. The light traps (1 light trap/5 acre) would be suggestive to know the range of pest incidence as well as to kill the Jassid population (Chu and Henneberry, 1998). In the present study four (4) light traps each of two different intensities such as torch (1.2 watt) and T 2> batteries with bulb of (25 watt) were installed 3ft above ground level, each at a distance of ten feet, were installed from 6.30 to 10.30 pm. Below light traps plastic tubs containing water were placed 2 ft. above ground level. Sticky matter (Grease) around water tubs was applied before installment of light traps. The observations were recorded twice/week and number of pests and predators appeared were examined carefully. The data was square root transformed and converted on weekly basis for analysis of data. The number of adult insect pests, Shoot and fruit borer, Leucinodes orbonalis (Guenee), Jassid, Amrasca biguttulla biguttula (Ishida), Epilachna beetle, Henosepilachna vigintioctopunctata (Navodita Maurice), Leaf roller, Eublemma olivacea (walker), Blister beetle, Epicauta spp. (De Geer), Ash weevil, Myllocerus subfuscatus (Guerin-Meneville) and Brown leafhopper, Orosius orientalis (Matsumura) and three predators, Green lace wing, Chrysoperla carnea (Stephens), hoverfly, Toxomerus geminatus (Say) and spider, Hippasa agelenoides were attracted and identified in each observation. Populations of insect pests and predators were counted separately and mean populations of each species were calculated weekly. The species of insect pests and predators were identified by comparing the specimens with insects present in museum of Department of Entomology, Sindh Agriculture University, Tandojam. Finally, the data were statistically analyzed through paired T-test and correlation of insect pests and predators with abiotic factors were determined.

RESULTS

The present work on monitoring of insect pests on brinjal through light traps was carried out at the experimental area of Latif Farm, Sindh Agriculture University, Tandojam in 2011. Brinjal “Round Fruit” variety was grown in a Randomized Complete Block Design (RCBD) on ½ acre of area during June, 2011. Two light traps, with two different intensities such as T 1> torch (1.2 watt) and T 2> batteries with bulb of (25 watt) were installed 3ft above ground level, each at a distance of ten feet, were installed from 6.30 to 10.30 pm. Below light traps plastic tubs containing water were placed 2 ft. above ground level. Sticky matter (Grease) around water tubs was applied before installment of light traps. The observations were recorded twice/week and number of pests and predators appeared were examined carefully. The data was square root transformed and converted on weekly basis for analysis of data. The number of adult insect pests, Shoot and fruit borer, Leucinodes orbonalis (Guenee), Jassid, Amrasca biguttulla biguttula (Ishida), Epilachna beetle, Henosepilachna vigintioctopunctata (Navodita Maurice), Leaf roller, Eublemma olivacea (walker), Blister beetle, Epicauta spp. (De Geer), Ash weevil, Myllocerus subfuscatus (Guerin-Meneville) and Brown leafhopper, Orosius orientalis (Matsumura) and three predators, Green lace wing, Chrysoperla carnea (Stephens), hoverfly, Toxomerus geminatus (Say) and spider, Hippasa agelenoides were attracted and identified in each observation. Populations of insect pests and predators were counted separately and mean populations of each species were calculated weekly. The species of insect pests and predators were identified by comparing the specimens with insects present in museum of Department of Entomology, Sindh Agriculture University, Tandojam. Finally, the data were statistically analyzed through paired T-test and correlation of insect pests and predators with abiotic factors were determined.

MATERIALS AND METHODS

The present research work on monitoring of insect pests on brinjal through light traps was carried out at the experimental area of Latif Farm, Sindh Agriculture University, Tandojam in 2011. Brinjal “Round Fruit” variety was grown in a Randomized Complete Block Design (RCBD) on ½ acre of area during June, 2011. Two light traps, with two different intensities such as T 1> torch (1.2 watt) and T 2> batteries with bulb of (25 watt) were installed 3ft above ground level, each at a distance of ten feet, were installed from 6.30 to 10.30 pm. Below light traps plastic tubs containing water were placed 2 ft. above ground level. Sticky matter (Grease) around water tubs was applied before installment of light traps. The observations were recorded twice/week and number of pests and predators appeared were examined carefully. The data was square root transformed and converted on weekly basis for analysis of data. The number of adult insect pests, Shoot and fruit borer, Leucinodes orbonalis (Guenee), Jassid, Amrasca biguttulla biguttula (Ishida), Epilachna beetle, Henosepilachna vigintioctopunctata (Navodita Maurice), Leaf roller, Eublemma olivacea (walker), Blister beetle, Epicauta spp. (De Geer), Ash weevil, Myllocerus subfuscatus (Guerin-Meneville) and Brown leafhopper, Orosius orientalis (Matsumura) and three predators, Green lace wing, Chrysoperla carnea (Stephens), hoverfly, Toxomerus geminatus (Say) and spider, Hippasa agelenoides were attracted and identified in each observation. Populations of insect pests and predators were counted separately and mean populations of each species were calculated weekly. The species of insect pests and predators were identified by comparing the specimens with insects present in museum of Department of Entomology, Sindh Agriculture University, Tandojam. Finally, the data were statistically analyzed through paired T-test and correlation of insect pests and predators with abiotic factors were determined.

RESULTS

The present research work on monitoring of insect pests on brinjal through light traps was carried out at the experimental area of Latif Farm, Sindh Agriculture University, Tandojam in 2011. Brinjal “Round Fruit” variety was grown in a Randomized Complete Block Design (RCBD) on ½ acre of area during June, 2011. Two light traps, with two different intensities such as T 1> torch (1.2 watt) and T 2> batteries with bulb of (25 watt) were installed 3ft above ground level, each at a distance of ten feet, were installed from 6.30 to 10.30 pm. Below light traps plastic tubs containing water were placed 2 ft. above ground level. Sticky matter (Grease) around water tubs was applied before installment of light traps. The observations were recorded twice/week and number of pests and predators appeared were examined carefully. The data was square root transformed and converted on weekly basis for analysis of data. The number of adult insect pests, Shoot and fruit borer, Leucinodes orbonalis (Guenee), Jassid, Amrasca biguttulla biguttula (Ishida), Epilachna beetle, Henosepilachna vigintioctopunctata (Navodita Maurice), Leaf roller, Eublemma olivacea (walker), Blister beetle, Epicauta spp. (De Geer), Ash weevil, Myllocerus subfuscatus (Guerin-Meneville) and Brown leafhopper, Orosius orientalis (Matsumura) and three predators, Green lace wing, Chrysoperla carnea (Stephens), hoverfly, Toxomerus geminatus (Say) and spider, Hippasa agelenoides were attracted and identified in each observation. Populations of insect pests and predators were counted separately and mean populations of each species were calculated weekly. The species of insect pests and predators were identified by comparing the specimens with insects present in museum of Department of Entomology, Sindh Agriculture University, Tandojam. Finally, the data were statistically analyzed through paired T-test and correlation of insect pests and predators with abiotic factors were determined.
(Say) and spider, Hippasa agelenoides were captured through light traps and compared for identification with insect pests and predators available in the museum of Department of Entomology, Sindh Agriculture University, Tandojam.

**Shoot and fruit borer, Leucinodes orbonalis** (Guenée):

The data in Table-1 depicted that torch light trap attracted maximum mean population (5.44) adults of Shoot and fruit borer than battery light trap with maximum mean population of (4.94). The data further showed that maximum tiger moth population ranged between (3.90 – 5.44) per trap in torch light trap, whereas, the battery light attracted less number of Shoot and fruit borer from (3.15 – 4.94) per trap from 2nd week of August up to 4th week of October. The population thereafter declined gradually and ended up with crop harvested on 26th November, 2011. The overall mean Shoot and fruit borer population was (4.16 ± 1.57) per trap/week in torch light than battery light (3.45 ± 1.77) per trap/week. The statistical data of means were significantly different at (P = 0.05) level.

**Jassid, Amrasca biguttula biguttula** (Ishida):

The data in Table-1 showed that torch light trap attracted maximum mean population (8.53) of Jassid than battery light trap with maximum mean population of (6.30). The data further showed that maximum Jassid population ranged between (3.83 – 8.53) per trap in torch light trap, whereas, the battery light attracted from (3.03 – 6.30) per trap from 2nd week of August up to 2nd week of November. The population therefore declined gradually and ended up with crop harvested on 26th November, 2011. The overall mean Jassid population was (5.46 ± 1.96) per trap/week in torch light than in battery light trap (4.46 ± 1.76) per trap/week. The statistical data of means were significantly different at (P = 0.05) level.

**Epilachna beetle, Henosepilachna vigintioctopunctata** (Navodita Maurice):

The data in Table-1 indicated that torch light trap attracted maximum Epilachna beetle population varied from (3.20 – 4.01) per trap from 2nd week of Aug up to 3rd week of September with maximum mean population of (4.01) per trap and the battery light trap attracted Epilachna beetle population with a range of (2.76 – 3.68) per trap from 2nd week of Aug up to 3rd week of September with maximum mean population of (3.68) per trap. The population thereafter declined gradually and ended up with crop harvested on 26th November, 2011. The overall mean Epilachna beetle population attracted was (2.34 ± 1.94) per trap/week in torch light and (2.14 ± 2.06) per trap/week in battery light trap. The statistical analysis of data of means were non-significant at (P = 0.05) level.

**Leaf roller, Eublemma olivacea** (walker):

The data in Table-1 indicated that the adults of Leaf roller were attracted in negligible number with maximum mean population of (1.05) per trap in 2nd week of August in torch light trap while (1.05) per trap in battery light trap in 4th week of August. The overall mean Leaf roller population was (0.85 ± 1.22) per trap/week in torch light and (0.83 ± 1.10) per trap/week in battery light trap. The statistical analysis of data of means were non-significant at (P = 0.05) level.

**Blister beetle, Epicauta spp.** (De Geer):

Blister beetle was attracted to both torch and battery light traps throughout the study period. The data in Table-1 indicated that maximum mean population of Blister beetle (2.21) per trap was recorded in 4th week of August in torch light trap, whereas, (1.48) per trap was attracted to battery light. The overall mean Blister beetle population was (1.62 ± 1.34) per trap/week in torch light and (1.04 ± 1.62) per trap/week in battery light. The statistical analysis of data of means were non-significant at (P = 0.05) level.

**Ash weevil, Myllocerus subfasciatus** (Guerin-Meneville):

The data in Table-1 indicated that Ash weevil was attracted to both light sources. The population varied throughout the study period with maximum mean population (1.51) per trap of Ash weevil in torch light trap in 2nd week of August than battery light trap with maximum mean population of (1.19) per trap in 1st week of September. The data further showed that overall mean Ash weevil population was (1.25 ± 1.29) per trap/week in torch light and (0.90 ± 1.26) per trap/week in battery light trap. The statistical data of means were significantly different at (P = 0.05) level.

**Brown leafhopper, Orosius orientalis** (Matsumura):

The data in Table-1 indicated that the adults of Brown leafhopper were attracted to both light sources. The population varied throughout the study period with maximum mean population of (1.19) per trap in 4th week of August in torch light trap while (1.19) per trap in battery light trap in 3rd week of September. The overall mean population of Brown leafhopper was (0.97 ± 1.12) per trap/week in torch light and (0.89 ± 1.22) per trap/week in battery light trap. The statistical analysis of data of means were non-significant at (P = 0.05) level. During the study period three predators i.e., Green lace wing, Chrysoperla carnea (Stephens), hoverfly, Toxomerus geminates (Say) and spider, Hippasa agelenoides were also attracted to both light sources i.e., torch light and battery light traps in negligible numbers as shown in Table-1.
The data in Table-2 revealed that means of all insect species attracted to both light sources were computed and correlation with temperature and R.H% were determined. The correlation between means of all insect species with mean temperature revealed non-significant correlation with $r^2 = 0.0001$ value (Fig. 1). Similarly, the correlation of all insect species with R.H% showed positive correlation with $r^2 = 0.6183$ value (Fig. 2).

DISCUSSION

The present study on monitoring of insect pests on brinjal through torch and battery traps was carried out at Latif Farm, Sindh Agriculture University, Tandojam. The results revealed that seven different insect pests and three predators were trapped through light traps. Biodiversity of insects was recorded on brinjal crop through both light trap sources during the period of study. The insect pests belong to orders Lepidoptera (Shoot and fruit borer and Leaf roller), Homoptera (Jassid), Coleoptera (Epilachna beetle, Blister beetle and Ash weevil), and Hemiptera (Brown leafhopper), while predators belong to orders Neuroptera (Green lace wing), and Hemiptera (Brown leafhopper), while predators belong to orders Neuroptera (Green lace wing), and Hemiptera (Brown leafhopper). Both light traps i.e., torch light and battery light traps attracted maximum numbers of insect species than battery light trap. Both insect pests and predators were attracted to both light sources from 2nd week of August up to 4th week of November, 2011. It seems that maximum pest populations were attracted to light traps during vegetative period of brinjal crop for feeding on host. The results about the light traps are agreed with Penrat et al., (1985) who designed and built electric light trap was suitable in size and form, easy to install, durable and highly efficient to trap other moths. The estimation of consumed electricity is 0.5-0.7 unit per trap per night. The electric light trap is efficient to be a repellent rather than an attractant, therefore, it is not suitable to trap the fruit-piercing moth. Meierrose et al., (1996) suggested that in South Portugal, light trapping has revealed to be more efficient and reliable for pest noctuid monitoring than pheromone trapping. Fields were in big size and traps attract not only an important number and diversity of insects. Results from two light trap designs working simultaneously in a tomato producing region, as to the pest noctuids Heliothis armigera, Trichoplusia orichalcea and Chrysodeixes calcites.

In brinjal crop seven different insect species were attracted and identified through both light sources i.e., torch and battery light traps. The predators like green lace wing, hoverfly and spiders were also attracted in negligible numbers. The most advantage of this study is attraction of Jassid and adult moths, which are really causing tremendous loss to agricultural crops of Pakistan including brinjal. In this study, maximum number of Jassid was attracted. The results of present study agreed with those of Hudson, (1985) who trapped insects at night through white, yellow and orange lamps to attract Hylesia moths and other insects. The insects were trapped at night in bowls of water containing detergent placed below the pair of lamps being tested. The adults attracted were Saturnids (Lepidoptera), Coleoptera, Diptera, Hymenoptera and Hemiptera. The yellow and orange lamps caught fewer insects than white ones, but none of the lamps were completely unattractive. The results of present study also agree with those of Anonymous, (1981) who installed light traps that attracted several kinds of insects for example rice moth, flour beetle, saw toothed beetle, rice weevil and lesser grain weevil.

The results of present study also agree with those of Husaeni et al., (1997) who determined that Xytorcrea festiva is the most important inner bark beetle and wood boring insect pest of sengon (Paraserianthes falcataria) plantations in Indonesia especially in Java and Sumatra. They further reported that new control approaches are urgently needed, one of them is light trapping of the beetles. The results of present study are partially related to Pisamai, (1990) reduced the population of jasmine flower borer (Hendecasis duplifascialis Hampson) in plantings of jasmine with the help of light traps in Thailand. Adult jasmine flower borers commenced to become active between 8-9 p.m. with the population reaching a peak between 2-4 a.m. The present study showed that all the insect pests were trapped through light traps; however, Jassid and adult moths were more attracted towards light traps. This shows that this study can be exploited for pest control in different crops, fruits and vegetables as well as stored products in storages. Attraction of insects through light may be included in IPM of pests so that adverse effects on pesticides may be excluded for the coming generations. As another study was conducted on mosquitoes by Vavra et al., (1974) that monitored the numbers of mosquitoes caught in CDC light-traps fitted with a standard incandescent lamp and 6 other types were compared in field tests in the Panama Canal Zone. Service et al., (1984) monitored a simple light trap for catching mosquito larvae and other aquatic organisms. Chemical lights ("Cyalume") were used to attract larvae into a funnel-ended trap. The trap proved successful in catching both Aedes species in England and Aedes and Culex species in Ghana. The chemical lights resulted in greater catches of mosquito larvae than the (less bright) betalights, which in turn produced greater catches than unlit traps. Ali et al., (1990; 1994) applied six New Jersey light traps at the northwest shore of Florida, during the summer to assess attractiveness of 6 incandescent light sources of different colors and wattages (intensities). White, yellow, orange, blue, green, and red lamps were used. Seventeen species of mosquitoes were...
collected in 3 separate rate tests using lamps of different intensity and color combinations.

The results further revealed that means of all insect species attracted to both light sources were computed and correlation with temperature and R.H% were determined. The correlation between means of all insect species with mean temperature revealed non-significant correlation with \( r^2 = 0.0001 \) value. Similarly, the correlation of all insect species with R.H% showed positive correlation with \( r^2 = 0.6183 \) value. Besides, Baca, (1995) screened out the flight monitoring of the European corn borer on light trap in Yugoslavia has been performed continuously in the Maize. The results obtained are used for the determination of value to attacked plants in the field which depended to a large extent on the weather conditions, temperature and moisture during the growing season that was not always in accordance with the number of the moths registered on the light trap. More work on light traps of different intensities and colors can be carried out on different crops, vegetables, fruits and stored products such as rice and wheat godowns.

REFERENCES


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Taxonomic position of insect pests captured through light traps on brinjal having common kingdom Animalia, Phylum, Arthropoda and Class, Insecta

<table>
<thead>
<tr>
<th>Order</th>
<th>Family</th>
<th>Genus</th>
<th>Species</th>
<th>Local Name</th>
<th>T. Name</th>
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<td>Jassid</td>
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03. Order: Coleoptera
Family: Coccinellidae
Genus: Henosepilachna
Species: vigintioctopunctata
Local Name: Hadda beetle/ Epilachna beetle
Technical Name: Henosepilachna vigintioctopunctata Navodita (Maurice)

04. Order: Lepidoptera
Family: Noctuidae
Genus: Dysdercus
Species: Cingulatus
Local Name: Leaf roller
T. Name: Eublemma olivacea (walker)

05. Order: Coleoptera
Family: Meloidae
Genus: Epicausta
Species: spp.
L. Name: Blister beetle
T. Name: Epicausta spp. (De Geer)

06. Order: Lepidoptera
Family: Cucurioniidae
Genus: Myllocerus
Species: subfasciatus
L. Name: Ash weevil
T. Name: Myllocerus subfasciatus (Guerin-Meneville)

07. Order: Hemiptera
Family: Cicadellidae
Genus: Orosius
Species: Orientalis
L. Name: Brown leafhopper
T. Name: Orosius orientalis (Matsumura)

08. Order: Neuroptera
Family: Chrysopidae
Genus: Chrysoperla
Species: Carnea
L. Name: Green lace wing
T. Name: Chrysoperla carnea (Stephens)

09. Order: Diptera
Family: Syrphidae
Genus: Toxomerus
Species: Geminates
L. Name: Hover Fly
T. Name: Toxomerus geminates (Say)

10. Order: Araneae
Family: Lycosidae
Genus: Hippasa
Species: agelenoides
L. Name: Spider
T. Name: Hippasa agelenoides
Pictorial representation of insect pests captured through light traps on brinjal
Figure-1. Regression analysis between mean insect populations trapped through both light traps and mean temperature.

Figure-2. Regression analysis between mean insect populations trapped through both light traps and mean relative humidity.
Table-1. Weekly mean population of insect pests and predators trapped through torch and batteries.

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<tr>
<th>Wks</th>
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<td>3.46 ± 1.96</td>
<td>4.46 ± 1.76</td>
<td>2.34 ± 1.94</td>
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<td>1.62 ± 1.34</td>
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Table-2. Effect of abiotic factors on weekly mean population of insect pests/predators.

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BIODIVERSITY OF SUCKING INSECTS OF COTTON IN THREE LOCALITIES OF DISTRICT MULTAN, PUNJAB-Pakistan

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(Received for publication: 10.10.2012)

ABSTRACT

Studies were carried out in three localities (Riazabad, Budhla Santh and Purana Shujabad) of district Multan, Punjab province, Pakistan, on farmers’ field from June to November during 2003. In each locality a plot of 10 acres was selected and the data was recorded randomly from 2 acres in each locality on fortnightly basis by using hand net, light trap, sucker, jerking, camel hairbrush and berlese funnel and were analyzed statistically using Shannon-Weiner index of diversity. A total of 6001 sucking insects belonging to 39 species, 20 families and 6 orders were captured in three localities. The value of Shannon-Weiner diversity index for diversity, maximum diversity, evenness and dominance were 0.679, 1.591, 0.835, and 0.165 respectively. The evenness value showed that sucking insects were 83.5% evenly distributed with only the dominance of few species namely Thrips tabaci, Thrips palmi, Scirtothrips dorsalis, Bemisia tabaci, Amrasca devastans and Isotomas sp.

Key words: Biodiversity, insect, cotton, Shannon-Weiner diversity index, species richness and evenness.

INTRODUCTION

Cotton is the major cash crop of our country and is an important source of foreign exchange. During its growth period, the crop is handicapped by 150 insect and mite pests (Attique and Rashid, 1983) due to recorded feeding on cotton in Pakistan. Cotton insect pests attacks are estimated to be responsible for 39-50% cotton crop losses every year (Naqvi, 1976).

From sucking insects, only jassid in case of heavy infestation causes up to 35% loss of cotton yield (Atwal, 1986). Whitefly (Bemisia tabaci Genn.) has gained the status of most serious pest of cotton during last few years and is involved in the spread of CLCV (Ali et al., 1995). Some biotypes of whitefly, such as the A and B have already been identified in some advanced countries of the world (Bedford et al., 1992). Honey dews produced by whitefly and aphids accumulate on leaves and exposed cotton lint fiber of open bolls, affect the quality, cause the development of sooty mould and interfere with photosynthesis.

Biodiversity is the variability among living organisms from all sources including terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, and of ecosystems. Species diversity is used to describe the variety of species, whether wild or domesticated, within a geographical area. Ecosystem diversity refers to the enormous variety of plant; animal and microorganism communities and the ecological processes that make them function (Anonymous, 2000). Biodiversity in crops can be summarized with two of its components, species richness and evenness. The richness indicates the number of species present in a designated area whereas evenness stands for the relative abundance of each species (Vanclay, 1992). Species richness provides an extremely useful measure of diversity when a complete catalogue of species in the community is obtained (Magurran, 1988).

Million years of interaction between adaptation and speciation is reported as reason of biodiversity, so knowledge of the adaptive diversity of insects to microhabitats becomes an essential component (Hawkesworth, 1995). Classification of species into functional groups highlights species effects on ecological diversity and the effects of such changes on species interactions (Ananthakrishnan, 1997). Ecosystem diversity is regulated through functionally different type of organisms. Interactions among species within a functional group as well as the relative importance of these groups are essential components in the study of biodiversity; a change in the abundance of a functional group can directly affect the ecosystem and community processes (Walker, 1992). The formal treatment of biodiversity and its measurement is complex. Despite
considerable interest in this subject, the use and application of measurement indices is heterogeneous (Hawksworth, 1995).

It is not easy to record, describe or even count the number of extent species. Life forms are so diverse that many years of specialized training are required to be able to recognize and describe them and even then, such training will provide knowledge of just one small group of living organisms (Agarwal et al., 1996). However, Sequeira and Naranjo, (2008) recommended that minimum sample of 20 leaves at nodes 3, 4 or 5 below the terminal as the most parsimonious and practical sampling protocol for cotton fields. The simplest measure of species diversity is a species count. Simple species count remains the most popular approach to evaluate species diversity and to compare habitats or species assemblages (Humphries et al., 1996).

Studying diversity of insect pests looks a fascinating one but in fact it is laborious and great commitment demanding field of research. As previously no work has been done on the biodiversity of sucking insects in the cotton growing area of Multan district, which occupies a unique place as far as cotton production/protection activities, therefore, the present research project was planned to collect, identify and compare the insect faunal biodiversity in cotton fields. The work presented here highlights different sucking insect pest species present on cotton crop and this work will help in the development of comprehensive control programme against sucking insects.

MATERIALS AND METHODS

The study was conducted at three localities of district Multan i.e. Riazabad, Budhla Santh and Purana Shujabad, of Punjab province, Pakistan. In each locality a plot of 10 acres was selected. For comprehensive biodiversity, the data was recorded randomly from 2 acres in each locality on fortnight basis.

Insects either immature or adults, harmful or beneficial, either on the ground or in the soil, on the plants or in the air were collected by different techniques such as; by aspirator, netting, hand picking, leaf beating and light trapping on random basis. A light trap with electric bulb emitting white light at a height of four feet from ground level was put up once a fortnight, in an open place near the cotton field. The light trap was operated from dusk to dawn. Net sweeping with hand nets was done for insects present in the canopy of crop for an hour time from each area to collect the data. Net sweeping was done randomly throughout the experimental sites without dividing the area or selecting any sub area. Aspirator with small 16 volts battery was used to collect adults of whitefly from different plants of cotton. Aphids and thrips were collected either by removing them directly from infested surfaces with a fine moistened camel-hair brush or by jarring the plants on white paper sheet placed beneath them. The berlese funnel was used to extract small insects from soil. The material was placed on a coarse screen platform, which had been inserted into a large funnel. The tip of the funnel extended into a jar of 70% alcohol. Heat from a light bulb suspended above the funnel slowly dried the debris after several hours to a day and drives the insects downward into the alcohol.

Collection was done for three consecutive days in each locality respectively. The specimens for each and every collection day were treated separately. The collected mature specimens were killed in a cyanide killing bottle, pinned, set, labeled and mounted in collection boxes or preserved in paper envelopes. Naphthalene balls mounted on pins were kept in collection boxes for the safety of collected specimens. The collected immature and soft bodied specimens were put into vials containing 70% alcohol for biodiversity count. Each collection made on fortnight intervals was labeled accordingly containing the date of collection, locality name, common name, technical name of specimens. For microscopic studies, permanent slides of thrips, whitefly and collembolans were prepared.

The collected specimens were identified up to species level with the help of available, related taxonomic material in the “Insect Biodiversity and Biosystematics Lab” Department of Agri. Entomology, University of Agriculture Faisalabad. Some of the specimens were identified by comparison against the collection present in the museum of Department of Agri. Entomology, University of Agriculture Faisalabad.

Diversity index

The biodiversity count was made by using Shannon-Weiner index (Shannon, 1948) to estimate species richness, species evenness and species diversity (Kikkawa, 1996).

Shannon-Weiner diversity index:

\[ H' = \sum (pi - \ln (pi)) \]

or

\[ H' = \frac{n \log n - \sum_{i} f_i \log f_i}{n} \]

\[ H'_{\text{max}} = \log k \]

\[ J' = \frac{H'}{H'_{\text{max}}} \]

\[ D = 1 - J' \]

K is the total number of species, \( f_i \) is the proportion of \( i \)th species in a total number of all the species, \( n \) is the total number of specimens caught during entire collection, \( H' \) is the diversity of sucking insects, \( H'_{\text{max}} \) is the maximum diversity, \( J' \) is the evenness and \( D \) is the dominance.
RESULTS AND DISCUSSIONS

Interesting results were observed as a result of these studies. A total of 39 species were collected belonging to 20 families and 6 orders (Table 1). A total of 6001 sucking insects were captured corresponding to insect orders Collembola, Hemiptera, Homoptera, Thysanoptera, Diptera and Hymenoptera. The order Hemiptera was the more diverse with 7 families followed by orders Homoptera, Diptera, Collembola, Thysanoptera and Hymenoptera with 5, 4, 2, 1 and 1 family, respectively. Among all families, thripidae, pyrrhocoridae, syrphidae and apidae, had more species as compared to other families having 8, 4, 4, and 4 species, respectively.

The value of Shannon-Weiner diversity index for diversity, maximum diversity, evenness and dominance were 0.679, 1.591, 0.835, and 0.165, respectively (Table 2 and Fig.1). The evenness value showed that sucking insects were 83.5% evenly distributed with only the dominance of few species namely Thrips tabaci, Thrips palmi, Scirtothrips dorsalis, Bemisia tabaci, Amrasca devastans and Isotomas spp.

During the fortnightly collection Collembola had 593 individuals distributed in two species; Podorus sp. with 254 individuals and Isotomas sp. with 339 specimens. The value of Shannon-Weiner diversity index for diversity, maximum diversity, evenness and dominance were 0.29, 0.301, 0.985, and 0.15 respectively (Fig.2). The evenness value shows that 98.5% evenly distribution, with a dominance value of 1.5% with the increase in number of species; species richness. There is an increase in species diversity.

Ten species of sucking insects in 7 families of order Hemiptera were collected with a total of 631 specimens during the entire period. Family Pyrrhocoridae was the dominant with 4 species and all other families Coreidae, Reduviidae, Anthocoridae, Lygaeidae, Pentatomidae and Tingidae with only one species each. The value of Shannon-Weiner diversity index for diversity, maximum diversity, evenness and dominance were 0.244, 1.00, 0.902, and 0.98 respectively. The results revealed that there was 90.2% evenly distribution of this order. The dominance value 0.98 showed that 9.8% of 10 species is one; so one species Dysdercus koenigii was dominating on other species. The pattern of distribution of these ten species, species richness and species diversity are shown in (Fig. 3).

A total of 1466 insects of order Homoptera were collected during entire collection representing 5 families and 7 species. Family Aleyrodidae were dominant with 2 species; Bemisia tabaci and B-biotype which were elevated to an independent species Bemisia argentifolii (Bellows et al., 1994) were captured. Whitefly spent much time during cooler days to complete its life cycle (Lanjar and Sahito, 2005). Bemisia tabaci was the predominant species (Baloch et al., 1994). Total collected insects of this family were 934 and maximum individuals of Bemisia tabaci 752 as compared to all sucking species, Bemisia argentifolii with 182 individuals. Other families of this order were Membracidae, Delphacidae, Cicadellidae and Aphididae with 2, 1, 1 and 1 species respectively. Family Membracidae with single species Otinotus oneratus were reported and total individuals of this species were 25. A single Perkinsiella sp. of family Delphacidae were captured and total individuals of this species were 24. Another important family recorded was Cicadellidae with 2 species Amrasca devastans and Amrasca biguttula. Amrasca devastans was dominant with 294 individuals and in case of heavy infestation causes up to 35% loss of cotton yield (Atwal, 1986). Aphis gossypii of family Aphididae was not collected during all collection dates but only 71 individuals were captured in the month of November.

The value of Shannon-Weiner diversity index for diversity index for diversity, maximum diversity, evenness and dominance were 0.612, 0.845, 0.724, and 0.276 respectively. The results reveal that 72.4% evenly distribution. The value of dominance (0.276) indicates 27.6% dominance, and 2 species Bemisia tabaci and Amrasca devastans were dominant in cotton crop area. Species richness and species diversity of 7-species are shown in Fig. 4.

In all orders, Thysanoptera had maximum species richness with 2781 individuals distributed in one family and eight species. Thrips tabaci had maximum 898 individuals, followed by Thrips palmi, Scirtothrips dorsalis, Thrips flavus, Florithrips taegardhi, Frankliniella schultzei, Rhipiphorothrips cruentatus, Scolothrips indicus with 541, 484, 204, 248, 167, 97 and 62 individuals respectively. Sharma and Sandeep, (1992) recorded 70% average population of Thrips tabaci on cotton in Punjab. Tunc et al., (1999) reported that Thrips tabaci and Frankliniella intonsa were the most frequent and abundant species on cotton. These results are not fully in agreement with the present study as it was disclosed that Thrips tabaci, Thrips palmi and Scirtothrips dorsalis are the most frequent and abundant species found on cotton in Multan district. The value of Shannon-Weiner diversity index for diversity index for diversity, maximum diversity, evenness and dominance were 0.784, 0.903, 0.869 0.131 respectively. The values show that 86.9% evenness and 13.1% dominance. Only single species Thrips tabaci was dominating. Species richness and species diversity of these species are shown in Fig. 5.

Among the order Diptera, 386 sucking insects belonging to 4 families and 8 species were trapped from cotton field. The value of Shannon-Weiner diversity index for diversity index for diversity, maximum diversity, evenness and dominance were 0.160, 0.903, 0.926, and 0.74, respectively. Pattern of distribution, species richness and species diversity of 8 species of Diptera are shown in Fig. 6.

Total of 144 specimens of order Hymenoptera were captured. All of these collected, 4 species belonged to a single family Apidae. The diversity index results showed the diversity was 0.598, and maximum diversity was 0.602. Evenness and dominance were 0.993 and 0.07 respectively. The abundance of all of these 4
species was almost equal to one another. Distribution pattern, species richness and species diversity of 4 species of Hymenoptera are shown in Fig. 7.

There are more than 5000 insect species found in Pakistan (Anonymous, 2000, Khan et al., 2007) and the maximum numbers of insects were of small size (Nee and Lawton, 1996). In cotton mostly the body size of sucking insect pests are small so they have more diversity and richness. Cotton pests were active when the crop was 3-4 weeks old and remained active until the crop was removed (Zala et al., 1999). In agriculture, biodiversity is directly related with ecological conditions (Dueli et al., 1999). Species richness does not indicate how the diversity of the population is disturbed or organized among those particular species (Vulinec, 2000). Disturbance in any discrete event in time that disrupts ecosystem, community or population structure and changes resources, substrate availability, or the physical environment (White and Pickett, personal communication). He proposed that intermediate levels of disturbance should favor higher levels of diversity. The disturbance in the cotton crop in the form of Agricultural practices, and the use of chemicals causes a decrease in the diversity (Perfecto and Snelling, 1995). Mehesar et al. (2011) reported that the population of sucking insect pests of cotton is reduced because of application of plant growth regulators (PGRs) and micronutrients.

Biodiversity and biomass (insect density) increased gradually during the season (Colignon et al., 2001). The collected individuals of sucking insect pests increased as the season progressed and peaked when the cotton leaf area was maximum in the month of August (Bishnoi et al., 1996). These results were matching with the present study as in present study maximum individuals 1070 of sucking insects were captured during second fortnight of August and minimum individuals 64 during second fortnight of November.

Table 2. Results of Insects Collection Data using Shannon-Weiner Diversity Index

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<th>Biodiversity components</th>
<th>Values</th>
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<td>Maximum Diversity (H' max)</td>
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<td>Evenness (J')</td>
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<td>Dominance (D)</td>
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REFERENCES


Biodiversity of sucking insects of cotton in three localities of district Multan, Punjab-Pakistan


**Shannon-Weiner Diversity Index**

**Fig. 1.**
Fig. 2.

Fig. 3.

Fig. 4.
Fig. 5.

Fig. 6.

Fig. 7.

DIVERSITY AND RICHNESS OF ORDER HYMENOPTERA DURING 2003
## Table 1. Cumulative Population of Cotton Sucking Insects in 3 Localities at District Multan during 2003

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<th>JULY</th>
<th>AUG</th>
<th>SEP</th>
<th>OCT</th>
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RESPONSE OF SUCKING INSECT COMPLEX TO VARIOUS COLORS OF STICKY TRAPS IN OKRA CROP

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(Received for publication: 25.05.2012)

ABSTRACT

The present research investigations were carried out to see the response of sucking insect complex to various colors of sticky traps in okra crop at Latif farm, Sindh Agriculture University, Tandojam from 01-08-2011 to 14-11-2011. The purpose of study was to develop IPM strategy against sucking complex pests of okra through various colors of sticky traps. For this purpose, yellow, green, blue, maroon and white colored sticky traps were tested for attraction of pests of okra. Results revealed that among all colors, yellow sticky traps attracted maximum mean number of jassids 1.22, 1.21 and 1.16 per trap installed at 1, 2 and 3 feet levels above the ground level followed by green color traps 0.92, 0.86 and 0.89. Similarly, mean number of thrips 0.94, 1.07 and 1.12 were maximum on yellow color trap followed by green color traps 0.88, 1.01 and 0.96 per trap. As such, maximum mean number of whiteflies 1.44, 1.17 and 0.94 per trap were attracted on yellow color traps followed by green 1.05, 0.86 and 0.83 per trap. White colored sticky traps attracted the least number of pests. The result further showed that maximum mean number of jassid (0.90) captured comparatively was higher on 1ft level above the ground as compared to 2 and 3 ft. heights of colored sticky traps; however they were statistically non-significant. Thrips captured on different heights of traps indicated that maximum mean number of thrips (0.95) was recorded on 2 and 3ft as compared to 1 ft above ground level and were statistically different at (P= < 0.05). The results further showed that the maximum mean numbers of whiteflies were recorded at 1ft (0.94) than (0.87 and 0.82) per traps installed at 2 and 3ft level. The rain occurred from August 28 to Sept 18, 2011 which drastically reduced whitefly and thrip population, but the jassid population was not affected due to rain up to end.

Key words: Colors, Sticky Traps, sucking insects, heights, okra.

INTRODUCTION

Okra, *Abelmoschus esculentus* L. (Family: Malvaceae.) is a warm-season annual and main Kharif vegetable of Pakistan. The people eat it with great interest. The origin of this vegetable is considered from Africa and Asia. Okra is a good source of vitamins, minerals, salts and has good calories values. The edible portion contains 89.8, 0.8 0.2, 7.4 and 1.8 percent water, protein, fat, carbohydrate and ash, respectively. It has 175 calories per pound. It is one of the cash crops of Sindh (Khoso, 1992). Okra is attacked by many insect pests right from germination to harvest (Jagtab et al., 2007). Sucking pests in the early stage and the fruit borers in the later stage cause extensive damage to okra fruits and the yield losses have been reported up to 69 percent (Mani et al., 2005). Among sucking insect pests i.e. whitefly, aphid, jassid and thrip are the major pests of okra while fruit borers (spotted boll worm, American boll worm) cause damage in the later stage of okra (Zoebisch et al., 1993). The magnitude of infestation and the nature of extent of injury vary with plant variety, seasons and localities (Heinz and Cheney, 1995). Sticky traps have been widely used to monitor flying insects in many agro-ecosystems and a more preferable method for sucking insects in the management systems. They have been also used against some insect pests in ornamental plants, tomato and potato in both fields and greenhouses. The use of yellow sticky traps to monitor populations of flying pests has been widely used for monitoring whitefly thrips and leafhooper. (Steiner et al., 1999; Vernon and Gilliespie, 1995; Mensah, 1996). Height and size of traps were more important for catching of some adult flying insects (Rao et al., 1991). The sticky traps of different colors for monitoring population of *B. tabaci* on cotton found that 30 cm above the ground level attracted more adult of *B. tabaci* than traps placed at heights of 60, 90 and 120 cm above ground level on cotton, mentioning that yellow sticky trap for leafhopper should be placed at heights between 25 and 75 cm above ground level in cotton (Uthamasamy et al., 1990; Nandihalli et al., 1993).

Color attraction is an innate characteristic of insects. It is well known that yellow is attractive to sucking complex, fruit flies, western yellow-jacket, and whitefly parasitoids, *Eretmocerus* spp. (Hoelmer et al., 1998). Thrips, in contrast, showed a greater photo tactic response to bright blue sticky traps with
a peak reflectance at 460 nm. Blackmer et al. (1995) reported that 76 percent of Bemisia tabaci adults responded to a visual wave length stimulus at 550 nm in a flight chamber. Numerous other reports also indicate that thrips are attracted to blue as well as to white (Brodsgaard, 1993). The present study was carried out to investigate the response of sucking insect complex to various colored sticky traps in okra crop.

MATERIALS AND METHODS

For conducting experiment on response of sucking insect complex of okra crop to various colors sticky traps such as yellow, green, maroon and white. Okra crop (Sabzpari) was sown on 1st June, 2011 at Latif experimental Farm, Sindh Agriculture University, Tandojam. The size of plot was 106x66sqft. Five colored plastic sticky traps i-e yellow, green, blue, maroon, and white were installed at 1, 2 and 3ft levels above ground level. Light yellow Grease was applied on each plastic sheet measuring 1×1ft and observation was recorded two days after application of grease. The observations were recorded at weekly intervals. As such observations were recorded for 13 weeks. After each observation, the plastic sheets were cleaned with rough cloth and fresh grease was applied for each observation. The experiment was replicated four times.

The statistical analysis was performed using the Statistix 8.1; software. The data were subjected to factorial analysis of variance (ANOVA) to determine the significance of individual factors and their interactions

RESULTS

For conducting experiment on response of sucking insect complex of okra crop to various colors sticky traps such as yellow, green, maroon and white. Okra crop (Sabzpari) was sown on 1st June, 2011 at Latif experimental Farm, Sindh Agriculture University, Tandojam.

JASSID, Amrasca bigutella bigutella (Ishida):

The results of the effect of various Sticky color traps on attraction of jassid shown in (Table 1) indicated that the yellow sticky traps attracted maximum mean number of jassids 1.22, 1.21 and 1.16 at 1, 2 and 3, feet height of traps, respectively followed by green (0.92, 0.86, 0.89), blue (0.80, 0.81, 0.83), maroon (0.84, 0.75, 0.80) color traps. Whereas, white color traps captured the least number of jassid among all the color traps. The statistical ANOVA results (Table 4) showed the there was significant (F=94.17, DF= 4, 96, P<0.001) effect of colors on attraction of jassid. However, there was no effect of height of traps on attraction of pest.

BROWN THRIP, Scirtothrips dorsalis (Hood):

The results of effect of various sticky color traps on attraction of the thrips shown in (Table 2) that the maximum mean numbers (0.94,1.07,1.12 ) per trap were captured by yellow color traps at different heights followed by (0.88,1.01, and0.96),(0.77,0.89 and 0.94),(0.80,0.94 and 0.84) on green, blue and white color traps, respectively whereas, maroon color attracted least number of thrips than other color traps. The statistical ANOVA results (Table 4) indicated that there was significant (F=13.56, DF=4, 96; P<0.001) effect of trap colors on attraction to capture of white flies on sticky traps. There was significant effect of height of color traps on attraction of traps. Maximum mean of thrips (0.95) was attracted at 2 and 3 feet above ground level. However, the least mean number (0.83) of thrips was attracted on color traps installed 1 feet above ground level. The ANOVA results showed significant difference at (P<0.001) level.

WHITE FLY, Bemisia tabaci (Genn):

The results of effect of various sticky color traps on attraction of white fly (Table 3) indicate that maximum mean number of (1.14,1.17 and 0.94) white flies was attracted to yellow colors traps at different heights ( 1, 2 and 3 ft., respectively) followed by green(1.05, 0.86 and 0.83) maroon (0.95,0.75 and0.73) blue (0.84, 0.77 and 0.79) and white color traps (0.73, 0.80 and 0.82). The ANOVA results showed that treatments (colors) were statistically different at (P<0.001) level. There was significant (F=9.15, DF=4, 96; P<0.001) effect of trap color on attraction to capture of white flies to sticky traps. Similarly, there was also significant effect (F=3.60; DF=2, 96; P<0.031) of trap height on capture of whiteflies. The highest numbers of whiteflies were attracted to sticky traps installed at 1 feet level above ground this captured more whiteflies compared with other trap heights.

DISCUSSION

Different colored sticky traps have been used for attraction of pest populations in agro ecosystem for estimating the level of infestation and integrated pest management decisions. This is one of the reliable methods of population estimation and comparatively less labor intensive methods. In present study, various colored sticky traps (yellow, green, blue, maroon and white) were tested for the management of pest population of okra crop first time in Sindh, Pakistan. The results revealed that yellow color sticky traps captured /attracted maximum number of jassid, thrips and whitefly followed by green sticky traps than blue, maroon and white color traps .The results further showed that there was no effect of height of trap on attraction of jassid and the number of jassids captured on all heights was almost similar. However, no effect of height of traps on attraction of jassid was noticed and all the color traps received similar numbers. There was no significant
Response of sucking pests complex to various colours of sticky traps in okra crop

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effect of rain on the jassid population which was attracted to color traps even in rainy days which occurred continuously for the 3 weeks (4th week of August to 3rd week of September). The results also agree with those of Mochizuki et al. (1993) who reported that yellow sticky traps were found to be most suitable for catching adult tea green leafhopper. Empoasca onukii Matsuda among five kinds of colored (blue, green, yellow and white) sticky traps. The green sticky color traps were significantly attractive for leafhopper species in 2007, while they were not attractive in previous trials. The results also partially agree with those of Keichiro et al. (2011) who collected plant hoppers on maize using yellow and blue sticky traps and found that greater numbers of insects were trapped in yellow traps relative to blue traps. Traps located at a lower height (40cm) above the ground level attracted larger number of hoppers cicadulina bipunctata Melichar. In present study, lower traps at (30cm) height received comparative increased number of jassids, however, statistically non significant. Thothong and Kienmeesuke (2000) showed that bright blue, yellow, white and blue sticky traps caught significantly more adult traps than transparent. Mark et al. (2002) tested yellow white and blue sticky cards in avocado orchard for their attractiveness to Scirtothrips perseae, Frankliniella occidentalis and Frankliniorthrips orizabensis. The result revealed that yellow was most attractive to S. perseae and white cards captured mostly F. orizabensis and F. occidentalis. Blue cards attracted less number of thrips throughout period under study. The results of present study agree with the study of Macintyre et al. (2006) that the number of thrips was higher at 2 and 3 ft level. This shows that thrips fly at higher above ground level. As results of present study also showed that in case of thrips maximum attraction was at 2 an 3 feet height than 1 foot height above the ground level. The present study also depicted that maximum numbers of whitefly were attracted at 1 ft above ground level indicating that whitefly flies at low level, whereas, thrips fly maximum at 2 and 3ft above ground level. However the present studies were carried out on okra in the month of August to November 2011. The population of sucking pests particularly whitefly and thrips disappeared due to continuous rain from August 28 to Sept 18, 2011.

CONCLUSIONS

➢ Yellow and green color traps attracted maximum population of whitefly, thrip and jassid.

➢ White color trap attracted the least number of sucking complex.

➢ Attraction of pests at different heights 1, 2 and 3ft above ground level indicated that jassid were present on all heights statically non significant.

➢ Thrips were attracted maximum on 2 and 3 ft level and above ground the color traps installed at 1ft above ground.

➢ More number of Whiteflies was attracted on traps installed at 1 ft level than 2 and 3ft level.

REFERENCES


Fig. 1. Photographs showing different colored sticky traps in okra crop at 1, 2 and 3 feet heights at Latif Farm during 1st August to 14th November, 2011. Fig. 2. Sticky trap is being pasted with grease. Fig. 3. Observation of pests using magnifying glass; Fig. 4. Recording the pest numbers by visual method.
Table-1. Weekly mean population of jassid, attracted to various colored traps at different heights above ground level

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Table-2. Weekly mean populations of brown thirps, attracted to various colored traps at different heights above ground level.

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Table-3. Weekly mean population of white fly, attracted to various colored traps at different heights above ground level.

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<tr>
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<td>0.70</td>
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</tr>
<tr>
<td>MEAN</td>
<td></td>
<td>1.14</td>
<td>1.17</td>
<td>0.94</td>
<td>1.05</td>
<td>0.86</td>
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Table-4. Effect of height of color traps on attraction of insect pests of okra.

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<tr>
<th>Insect</th>
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<th>Yellow</th>
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<th>Blue</th>
<th>Maroon</th>
<th>White</th>
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<td>1.21</td>
<td>0.92</td>
<td>0.84</td>
<td>0.86</td>
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<tr>
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<td>1.20</td>
<td>0.85</td>
<td>0.75</td>
<td>0.80</td>
<td>0.74</td>
</tr>
<tr>
<td></td>
<td>3ft</td>
<td>1.15</td>
<td>0.88</td>
<td>0.80</td>
<td>0.83</td>
<td>0.70</td>
</tr>
<tr>
<td>Mean</td>
<td></td>
<td>1.19 a</td>
<td>0.88 b</td>
<td>0.79 c</td>
<td>0.81 c</td>
<td>0.74 d</td>
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</tbody>
</table>

<table>
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<th>Green</th>
<th>Blue</th>
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<td>Thrips</td>
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<td>0.77</td>
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<td>0.91</td>
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<tr>
<td>Mean</td>
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<td>0.85 c</td>
<td>0.85 c</td>
<td>0.86 c</td>
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<table>
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<td>1.14</td>
<td>1.05</td>
<td>0.84</td>
<td>0.95</td>
<td>0.73</td>
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<td>0.74</td>
<td>0.80</td>
</tr>
<tr>
<td></td>
<td>3ft</td>
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<td>0.83</td>
<td>0.78</td>
<td>0.72</td>
<td>0.81</td>
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<tr>
<td>Mean</td>
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<td>1.08 a</td>
<td>0.91 b</td>
<td>0.79 c</td>
<td>0.81 bc</td>
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THE DENSITY OF DENGUE FEVER VIRUS-VECTOR MOSQUITOES,
(AEDES AEGYPTI L.) AT DIFFERENT PLACES IN TOWNS OF KARACHI,
DURING SUMMER AND WINTER, 2009-2011

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(Received for publication: 05.06.2012)

ABSTRACT

The dengue season in Karachi Division, the dengue Zone of Sindh province usually starts with the start of raining season in Sindh. Generally July to November are the month for dengue infection. In December, January & February, the density remain under control due to Natural Thermal Control, but from March to June its population starts to grow slowly due to increase of temperature and in raining season their population shoot rapidly just after one week of the 1st sufficient rain, whose water could persist even after evaporation for seven days. In the present paper, the density of dengue fever virus (DFV) -vector mosquitoes (DFV-VM) have been recorded continuously from December 2009 – May 2011 (Total 18 Months) to observe the presence (prevalence) throughout the year, during all seasons. Each breeding site of the town was visited weekly i.e. 4 times a month. These 4 observations were added to get the average monthly data and the average monthly data of six months was subjected to calculate the average density in six months. The Towns were ranked in decreasing sequence from high to low density. Liaquatabad Town showed the highest rank i.e. # 1 due highest density (2382.87/six month) and Keamari Town showed the lowest density (17.50/6 month). All town areas of Karachi Division were positive for DFV-VM that is why it was termed as Dengue Zone of Sindh province, for Ae. aegypti L., whereas the Dengue Zone of Punjab province is Lahore, not only for Ae. aegypti L. but also Ae. albopictus Skuse.

Key words: Dengue Fever Virus-Vector Mosquito (DFV-VM), Density, Towns of Karachi, Sindh, Pakistan.

INTRODUCTION

Dengue fever virus-vector mosquitoes (DFV-VM) of the genus Aedes with species Ae. aegypti and Ae. albopictus by transmitting four different kinds of Flavivirus (i.e. Den 1-4) create epidemic havoc almost every year regularly from 2006 in Pakistan and only this year in Punjab more than 50 thousand patients suspected with dengue were brought to hospitals with death toll of nearly 300 patients. In Sindh, where fortunately only Ae. aegypti is involved due to which the situation of this epidemic, this year, has not really flared up but with about 700 confirmed cases of DFV in Sindh mostly in Karachi with 13 fatalities again mostly in Karachi. Every other day more cases with suspicion of DFV are being brought in above said provinces of Pakistan with death toll not significantly decreasing at least in Punjab.

In Punjab synthetic adulticides are also being sprayed against the vector mosquitoes, almost regularly which in addition to kill many predators (beneficial) species and wild organisms, pollute human environment, also create vector resistance against toxic chemicals. There is neither any treatment of DFV or its severe life threatening forms i.e. Dengue hemorrhagic fever (DHF) or dengue shock syndrome (DSS) to date no vaccine of this infectious disease is available worldwide and there is no treatment of this fatal disease, the only mode of its prevention is therefore to manage and maintain dengue vector mosquito under control.Tariq & Qadri (2008), Tariq et al. (2009).

In fact dengue vector mosquito is a house dwelling species and has limited flying ability not more than a few hundred yards. The female Ae. aegypti when bites the dengue patients, gets infected and becomes the source of further transmission. The dengue patient is therefore key person especially his residence where or in the vicinity the female lays eggs in small utensils or discarded plastic containers, buckets, overhead tanks. AC water drainage pots, flower pots, tyre puncture repair shop with water tank, tree holes in lawns etc. (Ritchie et al. 2004, 2010, Gratz, 2004, Qadri, 2006, Qadri et al., 2007, Qadri & Ahmad, 2010, Ahmad and Qadri, 2011). Ae. aegypti female...
could lay eggs in a few ml of water. Unless these breeding sanctuaries are destroyed, the patients are separated from vector mosquitoes, and other uninfected persons in that residence and finally the residence and the vicinity are sprayed through effective but relatively human friendly adulticides. The prevention would long to be a dream.

The dengue vector mosquito is a day time biting mosquito, as reported by Suleman & Shafaqat (1993), Akram et al. (2009). The Aedes sp. is not only found in all provinces of Pakistan presently, Suleman et al. (1993, 1996), but also it was found in Pakistani areas previously called & known as Indo-Pak., since 1914 as reported by Mhasher (1914).

Now it is a risk not only for developing countries but also it is a risk for developed countries as reported by Monath (1994), Pinheiro & Corber (1997). Therefore now this problem is called as a global problem as reported by Gubler (1998). The problem of Dengue is not only found in the jungle areas, rural areas but it is also found in the urban areas, as the situation may be as reported by Hayes et al. (1996).

MATERIALS AND METHODS

The town areas were visited on separate days; one town was visited in one day. The town Orangi, Baldia, Site, Liaquatabad, G.I., Korangi and Shah Faisal was visited on Sunday-Saturday respectively 4 times in a month during Dec. 2009 to May, 2010. The town Keamari, Saddar, N. Nazimabad, Gulberg, Layari and Bin Qasim was visited on Monday-Saturday, respectively 4 times in a month during June 2010 – Nov. 2010. Similarly the town Jamshed, New Karachi, Landhi, Malir and Gadap was visited on Wed-Sunday respectively during Dec. 2010 – May, 2011. Totally 18 months were covered during Dec. 2009 – May, 2011. During the visit all larvae of Aedes spp. from a targeted breeding site were collected and counted weekly. These 4 observations were averaged for monthly observation and six monthly observations were subjected to calculate the final average value per six months.

RESULTS

All areas of Karachi city have been found positive. The density of vector mosquitoes in Liaquatabad area has been found the highest one (2382.83/sm) and therefore this area has been ranked # 1, whereas the lowest density was found in the area of Keamari (17.5/sm) therefore it was ranked as #18. The decreasing sequence of all the areas (Towns) with respect to the density of DFV-vector mosquito in the concern area may be given as follows:


DISCUSSION

Sindh province consists of five divisions, Karachi, Hyderabad, Sukkur, Mirpur and Larkana. In 1934 when these areas were included in Indo-Pak, the Karachi & Larkana were reported as Yellow fever positive (Dengue Zone) by Barraud (1934). During 1986 only Karachi division was reported as yellow fever positive (Dengue Zone) by Kamimura et al. (1986)

In 1989, WHO, recorded yellow fever mosquito (DFV-vector-mosquito) only from Karachi division. Chan et al. (1995) recered the outbreak of dengue Hemorrhagic fever (DHF) in Karachi for the 1st time. Tariq & Zafar (2000) reported the reason of increasing the DFV-vector mosquitoes in Karachi Sindh. Jawad et al. (2001) reported DHF in Karachi Sindh for the 2nd time. Tariq (2001) reported the different types of breeding sites of Aedes, Culex and Anopheles spp. in different areas of Karachi. In the year 2007-2009, only Karachi and Hyderabad division were reported dengue zone by Tariq & Azmi (2010) after surveying the all five divisions of Sindh Province, by seven different methods in three years.

Now in the present report all areas of Karachi division have been surveyed to observe the density of DFV-vector mosquitoes in the main Dengue Zone of Sindh Province during 2009 - 2011.

Therefore it is very clear from the previous and present reports that Karachi and Larkana were positive in 1934 but in the report of 2010 by Tariq & Azmi Karachi and Hyderabad were found dengue positive during 2007 -2009, both reports are parallel to each other, in the sense of two dengue positive divisions of Sindh province. On the other hand, in the report of WHO. (1989), only Karachi division was recorded as dengue positive and now also according to the present & current reports such as Ahmad et al. (2009), Tariq et al. (2010), Tariq et al. (2011a) and Ahmad et al. (2011) only the city of Karachi has been reported as Dengue Zone.

The present work completed in 18 months (including both seasons summer and winter) also proves by the continuous collection that the dengue vector mosquitoes persists round the year in dengue zone area, weather there is winter season or summer season, as also reported by Naqvi et al. (1997), Tariq et al. (2011b) last year. In low temperature the larval stage of these mosquitoes...
prolongs but persists in the winter season as well. The density of the vector mosquitoes shoot up in the raining season due to the availability of more water, more breeding points, more chances of egg laying, more chances of hatching, more humidity to live soundly, more chances of meal, the blood from human and moderate temperature to breed. So to control the density of these mosquitoes, winter season is more effective because the density of these mosquitoes is very low in this season. If this low density is destroyed then the chances of shoot up of these mosquitoes in the raining season will decrease surely. The dengue infection in this way may be controlled in the months of August, September, October & November.

RECOMMENDATIONS

It is obvious from the previous and present reports that since 1934 to date (2011) only Karachi division among the five divisions of Sindh province has been found dengue positive, therefore is a great need to control the dengue vector mosquitoes in Dengue Zone, from where the spread of these mosquitoes may take place and this will be the ultimate control of all divisions of Sindh province. The present work not only proves the whole city of Karachi as the dengue zone but also proves the winter season as an effective duration because the density of these vector mosquitoes in this season is very low and if this low density of these mosquitoes is destroyed then the chances of shoot up of these mosquitoes in the raining season will decrease surely. The dengue infection in this way may be controlled in the months of August, September, October & November.

ACKNOWLEDGEMENTS

The authors are thankful to Pakistan Academy of Sciences for providing the funds for this project entitled: “The Survey, Distribution, Population Dynamics and Biological Control of Mosquitoes Causing Dengue Fever in Karachi” (Ref. No. 5-9/PAS/3392, dated 13-5-2009) to control the Dengue vector mosquitoes in Karachi, after identifying the main localities and areas, positive for dengue vector mosquitoes. We are also thankful to Govt. of Sindh for providing help in survey and control, during 2011. We are also thank full to Prof. Dr. Nasira Khatoon Kazmi, the Director of M.A.H.Q, Biological Research Centre, University of Karachi, Karachi, Pakistan.

REFERENCES


Table-1. Showing all Towns of Karachi Division in decreasing sequence rank with their average density per six months (d/sm).

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<tr>
<th>S #</th>
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<th>Average density</th>
<th>S #</th>
<th>Name of town</th>
<th>Average density</th>
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<td>Liyari</td>
<td>28</td>
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<td>Baldia</td>
<td>212</td>
<td>12.</td>
<td>SITE</td>
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<tr>
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<td>15.</td>
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<tr>
<td>08.</td>
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<td>32</td>
<td>17.</td>
<td>Landhi</td>
<td>18</td>
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</table>

vastness of controlling power boundaries of these levels. Pak. j. entomol. Karachi. 23 (1&2): 61-62.


Density of dengue fever virus-vector mosquito (DFV-VM) in Karachi division since 2009-2011

Table 2. Showing Towns Areas of Karachi Division with breeding site, average monthly density % & average of 6 months of Dengue mosquitoes (Aedes aegypti L.) with ranking of Town

<table>
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<tr>
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</thead>
<tbody>
<tr>
<td>1.</td>
<td>Orangi</td>
<td>M. Nagar UC-4</td>
<td>326/4</td>
<td>81.5%</td>
<td>347/4</td>
<td>86.75%</td>
<td>396/4</td>
<td>89.0%</td>
<td>235/4</td>
<td>58.75%</td>
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<td>2.</td>
<td>Baldia</td>
<td>Faqeer Colony UC-6</td>
<td>836/4</td>
<td>209.0%</td>
<td>1274/4</td>
<td>318.5%</td>
<td>994/4</td>
<td>248.5%</td>
<td>791/4</td>
<td>197.75%</td>
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<tr>
<td>3.</td>
<td>SITE</td>
<td>Pak Colony UC-4</td>
<td>124/4</td>
<td>31.0%</td>
<td>82/4</td>
<td>20.5%</td>
<td>88/4</td>
<td>22.0%</td>
<td>122/4</td>
<td>30.5%</td>
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<td>4.</td>
<td>Liaquat-Abad</td>
<td>Dak Khana UC-4</td>
<td>9475/4</td>
<td>2368.7%</td>
<td>9720/4</td>
<td>2430.0%</td>
<td>9979/4</td>
<td>2494.75%</td>
<td>9402/4</td>
<td>2350.5%</td>
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<td>Gulshan-e-Iqbal</td>
<td>U.O.K. UC-4</td>
<td>231/4</td>
<td>57.75%</td>
<td>290/4</td>
<td>72.5%</td>
<td>255/4</td>
<td>63.75%</td>
<td>211/4</td>
<td>52.75%</td>
</tr>
<tr>
<td>6.</td>
<td>Korangi</td>
<td>Korangi UC-7</td>
<td>96/4</td>
<td>24.0%</td>
<td>124/4</td>
<td>31.0%</td>
<td>123/4</td>
<td>30.75%</td>
<td>92/4</td>
<td>23.0%</td>
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<tr>
<td>7.</td>
<td>Shah Faisal</td>
<td>Al-Falah Society UC-7</td>
<td>1084/4</td>
<td>271.0%</td>
<td>1180/4</td>
<td>295.0%</td>
<td>1440/4</td>
<td>360.0%</td>
<td>1136/4</td>
<td>284.0%</td>
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<td>8.</td>
<td>Keamari</td>
<td>Machar Colony</td>
<td>84/4</td>
<td>21.0%</td>
<td>48/4</td>
<td>12.0%</td>
<td>93/4</td>
<td>23.25%</td>
<td>83/4</td>
<td>20.75%</td>
</tr>
<tr>
<td>9.</td>
<td>Saddar</td>
<td>Garden UC-2</td>
<td>56/4</td>
<td>14.0%</td>
<td>60/4</td>
<td>15.0%</td>
<td>69/4</td>
<td>17.25%</td>
<td>83/4</td>
<td>20.75%</td>
</tr>
<tr>
<td>10.</td>
<td>N. Nazim-Abad</td>
<td>Pahar Ganj Block-P</td>
<td>79/4</td>
<td>19.75%</td>
<td>96/4</td>
<td>24.0%</td>
<td>124/4</td>
<td>31.0%</td>
<td>149/4</td>
<td>37.25%</td>
</tr>
<tr>
<td>11.</td>
<td>Gulberg</td>
<td>Ayesha Manzil UC-3</td>
<td>124/4</td>
<td>31.0%</td>
<td>191/4</td>
<td>47.75%</td>
<td>199/4</td>
<td>49.75%</td>
<td>196/4</td>
<td>49.0%</td>
</tr>
<tr>
<td>12.</td>
<td>Layari</td>
<td>Baghddai UC-5</td>
<td>52/4</td>
<td>13.0%</td>
<td>66/4</td>
<td>16.5%</td>
<td>72/4</td>
<td>18.0%</td>
<td>108/4</td>
<td>27.0%</td>
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<tr>
<td>13.</td>
<td>Bin Qasim</td>
<td>G. Hadeed UC-6</td>
<td>187/4</td>
<td>46.75%</td>
<td>219/4</td>
<td>54.75%</td>
<td>271/4</td>
<td>67.75%</td>
<td>279/4</td>
<td>69.75%</td>
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<tr>
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<td>Soldier Bazar UC-12</td>
<td>50/4</td>
<td>12.5%</td>
<td>57/4</td>
<td>14.25%</td>
<td>99/4</td>
<td>24.75%</td>
<td>107/4</td>
<td>27.75%</td>
</tr>
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<td>15.</td>
<td>New Karachi</td>
<td>Madina Colony UC-7</td>
<td>109/4</td>
<td>27.25%</td>
<td>100/4</td>
<td>25.0%</td>
<td>112/4</td>
<td>28.0%</td>
<td>120/4</td>
<td>30.0%</td>
</tr>
<tr>
<td>16.</td>
<td>Landhi</td>
<td>Dawood Chowarangi UC-3</td>
<td>10/4</td>
<td>2.5%</td>
<td>41/4</td>
<td>10.25%</td>
<td>70/4</td>
<td>17.5%</td>
<td>91/4</td>
<td>22.5%</td>
</tr>
<tr>
<td>17.</td>
<td>Malir</td>
<td>Model Colony UC-1</td>
<td>30/4</td>
<td>7.5%</td>
<td>47/4</td>
<td>11.75%</td>
<td>62/4</td>
<td>15.5%</td>
<td>93/4</td>
<td>23.25%</td>
</tr>
<tr>
<td>18.</td>
<td>Gadap</td>
<td>Z.H. Res. Station-1</td>
<td>62/4</td>
<td>15.5%</td>
<td>78/4</td>
<td>19.5%</td>
<td>100/4</td>
<td>25.0%</td>
<td>129/4</td>
<td>32.25%</td>
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27(2), July-December, 2012

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<th>Place &amp; Country</th>
<th>E-mail Address</th>
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<tbody>
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