INTERNATIONAL JOURNAL OF AGRICULTURE & BIOLOGY
ISSN Print: 1560–8530; ISSN Online: 1814–9596
08–094/SEN/2008/10–5–577–580
http://www.fspublishers.org

Full Length Article

Population Dynamics of Whitefly (*Bemisia tabaci*) on Cultivated Crop Hosts and their Role in Regulating its Carry-over to Cotton

MUHAMMAD RAFIQ[1], ABDUL GHAFFAR AND MUHAMMAD ARSHAD
Central Cotton Research Institute, Old Shujabad Road, Multan, Pakistan
[1]Corresponding author's e-mail: mrafiq_ento@yahoo.com

ABSTRACT

Population dynamics of whitefly (*Bemisia tabaci* Gen.) was studied throughout the year, for 6 years on oilseed, pulses, sugar, fodder and vegetable crops in cotton growing areas of the Punjab, Pakistan. Infestation based on their abundance was found on 17 field and 28 vegetable crops. Of those, 16, 22 and 7 were observed as major, minor and incidental hosts, respectively. During winter months (December to February), the insect was present on 22 hosts. However, *Solanum melongena*, *S. incanum*, *Mentha viridus*, *Ipomoea batatus* and *Ricimus communis* served as main hosts for over wintering whitefly. Spring vegetables like *Citrullus* spp., *Cucumis* spp. *Solanum* spp. and pulse, *Glycine max*, mainly helped in the pre-cotton season build up of whitefly population in addition to early sown cotton. Better and timely management of the pest on these hosts will significantly help to reduce the carry-over of the pest to cotton and other economical crops.

Key Words: Cotton whitefly; *Bemisia tabaci*; Population dynamics; Winter hosts; Carry-over

INTRODUCTION

Cotton whitefly (*Bemisia tabaci* Gen.) was described over 100 years ago as a pest of tobacco in Greece (Anonymous, 1989). Since then, it has become one of the most important sucking pest of world's industrial and food crops like cotton, sunflower, melon, tomato, brinjal etc. Over 500 plant species from Asia, Africa, America, Europe, Russia, Australia and the Pacific Islands confirms its polyphagous nature (Anonymous, 1986; Greathead, 1986). From cotton growing areas of central Punjab, Pakistan, it has been reported from 164 plant species (Attique *et al*., 2003). In 16 out of 27 cotton producing countries, whitefly has been reported as a major pest during mid to late cotton growing season (Ann., 1989). In the Punjab of subcontinent region, American cotton varieties failed completely during 1919 and 1926 and partially in 1921, 1923 and 1927, because of whitefly attack (Hussain & Trehan, 1933).

Heavy infestation may reduce plant vigor and growth, cause chlorosis and uneven ripening of bolls. Its direct feeding induces physiological disorders resulting in shedding of immature fruiting parts. Its nymphs produce honeydew, on which black sooty mold grows, reducing the photosynthetic capabilities of plants. This situation results in stunting of plants and lint contamination. It acts as a sole vector of more than 100 plant viruses, which cause diseases to many commercial crops in different parts of the world (Jones, 2003). It also transmits cotton leaf curl virus disease, a real threat to cotton production in Pakistan.

Role of different crops in the winter survival, population build up and carry-over of whitefly to cotton has been recognized by various workers like Hussain and Trehan (1933) and Hussain *et al.* (1936) from India and Mohyuddin *et al*. (1989) from Pakistan. Similar role of crops and vegetables in the carry-over and population build up of whitefly has also been signified by Butler *et al.* (1986) and Johnson *et al*. (1982) from Southern California, Melamed-Madjar *et al.* (1979) and Gerling (1984) from Israel, Mabbit (1978) and Nachapong and Mabbit (1979) from Thailand. To develop an effective management strategy against this pest, relative density estimates and winter survival on different crop hosts was under taken from 1996 to 1999 and then during 2004-2005 and results are presented here.

MATERIALS AND METHODS

To study the population dynamics of cotton whitefly, winter survival and carry-over of whitefly (*B. tabaci*) from different crop and vegetable hosts to cotton in the cotton growing areas of the Punjab, all available crop species were examined throughout the year from 1996 to 1999 and then during 2004-2005. Sample size varied from 10-150 leaves depending on the size and nature of plant species. Nymphal/pupal population on leaves was counted under binocular stereo-microscope. The data is presented as population for both adults and nymphs of whitefly per 100 cm^{-2} leaf area. Based on the level of infestation and duration

To cite this paper: Rafiq, M., A. Ghaffar and M. Arshad, 2008. Population dynamics of whitefly (*Bemisia tabaci*) on cultivated crop hosts and their role in regulating its carry-over to cotton. *Int. J. Agri. Biol.*, 10: 577–80

of attack, the hosts were categorized; (a) Major host plants were widely cultivated and all the stages of whitefly were available for more than three months in reasonable numbers; (b) Minor host plants and all the stages of whitefly were available on the host plants from 3-10 months in quite less in numbers and (c) Incidental plants were in very small numbers and negligible population of whitefly feeding stages.

RESULTS

Whitefly infestation was recorded from 45 plant species comprising of four each of fibers, oil, pulses and fodder crops, one sugar and 28 vegetables. Of these, 16 were major (Fig. 1-2), 22 minor (Table I) and 7 incidental hosts, which carry very low numbers of whitefly and do not play any significant role in the whitefly population dynamics.

Population dynamics. From the major host plants, whitefly was present throughout the year, on *Mentha viridis* and *Solanum melongena* with a peak in September and on *Ipomoea batatus* and *Capsicum frutescens* with maximum population in October. It was available on *Gossypium hirsutum* from April to January with peak population in September, from September to May on *Cucurbita pepo* var. *melo pepo* with highest numbers in October and from February to May on *Cucumis sativus* with maximum population in May. From March to November, it was recorded on *C. melo* and *Phaseolus aureus* with the peak in August. On *Abelmoschus esculentus*, it was also found during March to January with maximum numbers in September. It was seen on *Glycine max* from March to May with maximum population in May and on *Citrullus lanatus* from March to October with a peak in July. During April to November it was found on *C. lanatus* var. *fustulosus* and *Corchorus capsularis* with highest population in April and August, respectively and on *C. melo* var. *Phut* from April to October with maximum numbers in October. On *Sesame indicum*, it was present from May to October with highest population in June.

The data given in Table I indicated that from the minor host plants, highest population per 100 cm^{-2} was on *S. incanum* (18.5) in October followed by *Brassica campestris* var. Sarson (15.0), *Sesbania sesban* (12.1) and *Bennincasa hispida* (11.6) in September, on *Ricimus communis* (10.2) in June, on *Raphanus sativus* (8.5) in September, on *C. melo* var. *flexuosus* in May (7.4), on *S. tuberosum* in October (5.5), on *G. arboreum* (4.5) in September and on *Helianthus annus* in April (3.3). The pest population was maximum on *Cyamopsis tetragonoloba* in August (2.4), on *Lycopersicon esculentum* in October (2.0), on *B. oleracea* var. *botrytis* and *Luffa acutangula* both in September (1.9), on *P. mungo* (1.5) and *Hibiscus cannabinus* (1.3) in June on *Momordica charantia* (1.1) in October and on *Spinacea oleracea* in September (0.8), on *C. pepo* in April (0.6) on *Lagenaria siceraria* in October (0.5), on *Colocasia esculenta* in June (0.3) and on *B. rapa* in October (0.2).

Whitefly was occasionally recorded from seven plant species for one or two months only. It was recorded in October and November on *Beta vulgaris* (0.2 & 0.1), on *Pisum sativum* (1.5 & 0.1) and on *Trifolium alexandrinum* (2.9 & 0.4) respectively. On *Daucus carota* it was in September (0.7) and October (0.6), on *Raphanus* sp. in May (0.2) and October (2.5), on *Lens culinaris* in March (0.01) and April (0.02) and on *Medicago sativa* only in October (0.01).

Table I. Mean number of nymphs and pupae of *Bemisia tabaci* per 100 cm^{-2} on various minor crops

Family	Host	Jan.	Feb.	Mar.	Apr.	May	June	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Araceae	*Colocasia esculenta*	0.02	-	-	-	0.0	0.1	0.03	0.02	0.3	0.1	0.0	0.0
Asteraceae	*Helianthus annus*	-	0.0	1.0	3.3	1.4	0.0	-	-	-	-	-	-
Brassicaceae	*Brassica campestris var.sarson*	0.02	0.02	0.03	0.04	0.05	-	-	0.2	15.0	2.0	0.4	0.2
	B. oleracea var. botrytis	0.0	0.0	0.0	-	-	0.02	0.02	0.2	1.9	0.3	0.01	0.0
	B. rapa	0.01	0.0	0.0	-	-	-	-	0.0	0.1	0.2	0.1	0.2
	Raphanus sativus	0.01	0.02	0.0	0.0	0.0	-	-	0.4	8.5	0.7	0.3	0.2
Cucurbitaceae	*Bemincasa hispida*	-	-	0.04	0.4	0.7	0.5	0.2	0.1	11.6	2.0	1.4	0.8
	Cucurbita pepo	-	-	0.2	0.6	0.1	0.1	0.0	0.2	0.5	0.0	0.0	-
	Cucumis melo var. flexuosus	-	-	0.2	4.5	7.4	-	-	-	-	-	-	-
	Lagenaria siceraria	0.0	0.0	0.1	0.3	0.1	0.1	0.04	0.01	0.2	0.5	0.1	0.1
	Luffa acutangula	0.01	0.0	0.02	0.6	0.5	0.9	0.6	0.1	1.9	1.3	0.1	0.03
	Momordica charantia	-	-	0.0	0.1	0.3	0.1	0.3	0.1	0.7	1.1	0.2	0.1
Chinopodiaceae	*Spinacea oleraceae*	0.0	0.05	0.01	0.0	-	-	0.04	0.1	0.8	0.5	0.4	0.0
Malvaceae	*Gossypium arboreum*	-	-	-	0.5	2.9	3.0	2.7	3.6	4.5	3.2	0.6	0.2
	Hibiscus canabinus	-	-	-	-	0.8	1.3	0.6	0.8	1.1	0.3	-	-
Meliaceae	*Ricimus communis*	0.7	0.0	0.0	0.4	2.0	10.2	5.7	1.1	0.5	1.1	0.1	0.8
Papilionaceae	*Cyamopsis tetragonoloba*	-	-	-	-	0.0	0.1	0.6	2.4	1.2	0.5	0.3	-
	Phaseolus mungo	-	-	0.0	0.1	0.4	1.5	0.4	0.2	0.3	0.3	0.0	-
	Sesbania sesban	0.2	0.0	0.0	0.0	4.4	0.0	0.6	0.0	12.1	0.7	0.6	0.0
Solanaceae	*Lycopersicum esculentum*	0.2	0.2	0.1	0.2	0.3	0.3	0.2	-	0.4	2.0	0.7	0.5
	Solanum incanum	1.0	0.6	0.5	2.9	6.6	5.4	5.7	8.2	14.1	18.5	10.0	6.3
	S. tuberosum	0.1	0.1	0.8	0.2	0.3	0.0	-	-	0.0	5.5	0.6	0.3

0.0 = Whitefly absent;
- = Host plant absent

Fig. 1. Population trends of *Bemisia tabaci* on different crops based on mean number of nymphs and pupae 100 cm^{-2} leaf area

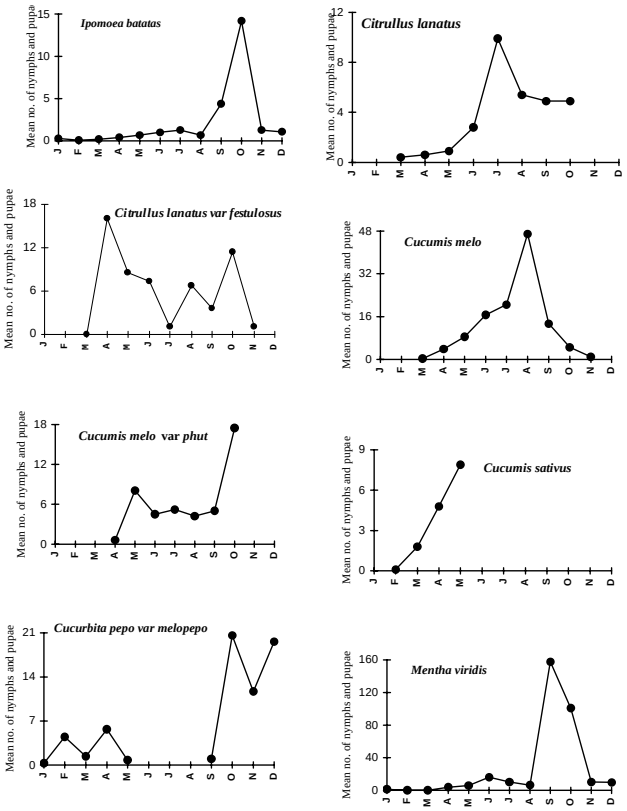
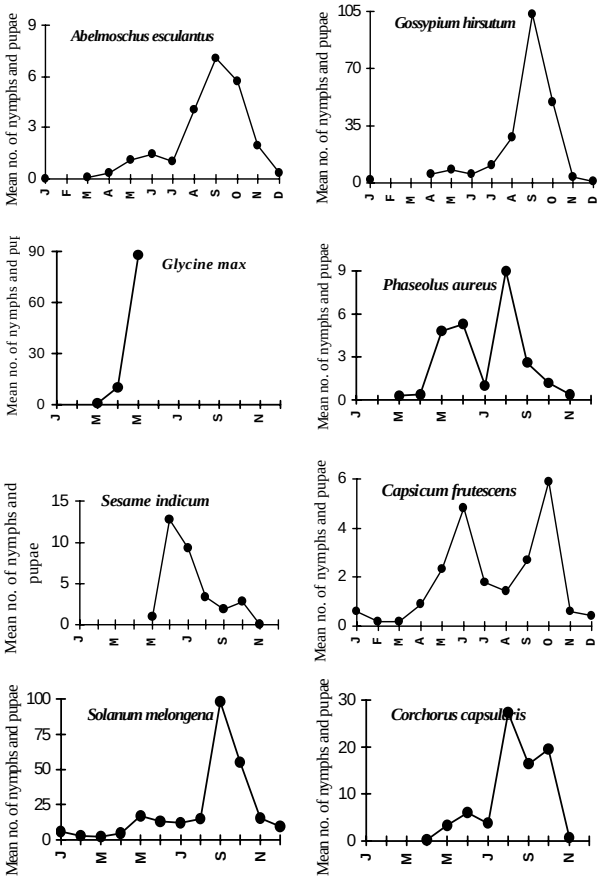


Fig. 2. Population trends of *Bemisia tabaci* on different crops based on mean number of nymphs and pupae 100 cm^{-2} leaf area



Winter survival. From the crop hosts, whitefly was noted on *B. compestris* var. *sarson, G. hirsutum, G. arboreum, P. aureus, S. sesban, R. communis* and *S. incanum* during winter months (December to February). The role of *R. communis and G. arboreum* may be very limited in the winter survival of the pest, in spite of high population levels, because of very limited distribution of these crops in the cotton growing areas of the Punjab. It seemed that ratoon left over cotton ratoon plays important role in the winter survival of the pest along with limited contribution of *B. compestris* var. *sarson, P. aureus* and *S. sesban*.

Among the vegetables, *C. frutescens, C. pepo* var. *melo pepo L. esculentum, M. viridis, S. melongena* and *S. tuberosum* played critical role in the winter survival of the pest. Other winter vegetables recorded as hosts of whitefly either carried negligible population of the pest or cultivated on very limited scales.

DISCUSSION

During winter, cotton whitefly continues to breed on 6 field crops and 18 vegetables at a slow rate. Its maximum population was recorded on *B. compestris* var. *sarson, G. hirsutum, P. aureus* and *S sesban* among crops and *C. frutescens, C. pepo* var. *melo pepo, L. esculentum. M. viridis, S. melongena* and *S. tuberosum* among vegetables carried majority of the pests populations during this period and play pivotal role in the carry-over of the pest Contribution of these hosts in the over wintering of whitefly was argued by Hussain and Trehan (1933), Hussain *et al*. (1936) and Mohyuddin *et al.* (1989) from cotton growing areas of the Punjab, Pakistan.

After winter, from March onwards, increase in temperature results in the rapid multiplication of whitefly on almost all the available hosts. Among the crops and vegetables, *P. aureus, L. culinaris, P. mungo, G. max, H. annus, S. melongena, C. pepo* var. *melo pepo, C. melo* etc., play major role in the multiplication of the pest and its carry-over to cotton crop.

Butler et al. (1986) also recognize the role of spring crops and vegetables as major source of infestation of whitefly to summer crops especially from the U.S.A. Similar contribution of these hosts in the carry-over of whitefly has also been identified by Johnson *et al*. (1982) from Southern California, Melamed-Madjar et al. (1979) and Gerling (1984) from Israel, Nachapong and Mabbit (1979) and Mabbit (1978) from Thailand and Mohyuddin *et al.* (1989) from Pakistan.

These studies improved our understanding on host and time-related population dynamics of whitefly. Better management of this pest on winter and spring crop hosts like squash, okra, brinjal, tomato, sunflower etc. can reduce its survival/carryover to cotton. This will result in reduction of pesticide use on cotton.

REFERENCES

Anonymous, 1986. *Bemisia tabaci (Gennadius), Distribution Maps of Pests' Series A No. 284 (Revised)*. Commonwealth Institute of Entomology, London

Anonymous, 1989. *Management of Whitefly, Bemisia tabaci G. on Cotton*, p: 50. Andhra Predesh Agriculture University, Rajendranagar, Hyderabad

Attique, M.R., M. Rafiq, A. Ghaffar, Z. Ahmad and A.I. Mohyuddin, 2003. Hosts of *Bemisia tabaci* (Gen.) (Homoptera; Aleyrodidae) in cotton areas of Punjab, Pakistan. *Crop Protect.*, 22: 715–20

Butler, J.R., G.D. Jr., T.J. Hennebeery and W.D. Hutchinson, 1986. Biology, sampling and population dynamics of *Bemisia tabaci*. In*:* Russell, G.E. *(ed.), Agricultural Zoology Reviews*, Vol. 1, Intercept, pp: 167–95

Gerling, D., 1984. The overwintering mode of *Bemisia tabaci* and its natural enemies in Israel. *Phytoparasitica*, 12: 109–18

Greathead, A.H., 1986. Host plants. *In*: Cock, (ed.), *Bemisia tabaci, A Literature Survey on the Cotton Whitefly with an Annotated Bibliography*, pp: 17–26. CAB International UK

Hussain, M.A. and K.N. Trehan, 1933. Observations on the life-history, bionomics and control of the whitefly of cotton (*Bemisia gossypiperda* M. & L.). *Indian J. Agric. Sci*., 3: 701–53

Hussain, M.A., K.N. Trehan and P.M. Verma, 1936. Studies on *Bemisia gossypiperda* M. and L. No. 3 Seasonal activities of *Bemisia gossypiperda* M. and L. (The whitefly of cotton) in the Punjab. *Indian J. Agric. Sci*., 6: 893–903

Johnson, M.W., N.C. Toscano, H.T. Reynolds, E.S. Sylvester, K. Kido and E.T. Natwick, 1982. Whiteflies cause problems of southern California growers. *California Agric*., 36: 24–6

Jones, D.R., 2003. Plant viruses transmitted by whiteflies. *European J. Plant Pathol*., 109: 195–219

Mabbit, T.H., 1978. A review of the economic insect pests of cotton in Thailand. Description, infestation and control. 1. Cotton whitefly (*Bemisia tabaci* Gennadius). *In*: *Cotton Pest Management Project, Department of Agriculture Bangkok Report No. 13*, pp: 1–12

Melamed-Madjar, V., S. Cohen, M. Chen, S. Tam and D. Rosilio, 1979. Observations on populations of *Bemisia tabaci* Gennadius (Homoptera: Aleyrodidae) on cotton adjacent to sunflower and potato on Israel. *Israel J. Ento*., 13: 71–8

Mohyuddin, A.I. A.G. Khan and A.A. Goraya, 1989. Population dynamics of cotton whitefly, *Bemisia tabaci* (Gennadius) (Homoptera: Aleyrodidae) and its natural enemies in Pakistan. *J. Zool*., 21: 273–88

Nachapong, M. and T. Mabbit, 1979. A survey of some wild hosts of *Bemisia tabaci* Genn. around cotton fields in Thailand. *Thailand J. Agric. Sci*., 12: 217–22

(Received 07 April 2008; Accepted 23 June 2008)