WEEDING, A POPULATION SUPPRESSION TOOL FOR *BEMISIA TABACI* (HEMIPTERA: ALEYRODIDAE) ON TOMATO CROP

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ABSTRACT: *Whitefly, Bemisia tabaci remains active and completes its many generations round the year. Some weeds are also serving as intermediate hosts between crops of varying seasons or houses B. tabaci till main crop reaches to preferable stage to be attacked with in agro-ecosystem. The aim of the study was to ascertained weed species as alternative hosts and effect of weed eradication on B. tabaci population in tomato agro-ecosystem. Beside that impact of weeding plus whitefly control on tomato yield was also determined, therefore each weeding practice plot were repeated and sprayed with Confidor 200SL. For this purpose, the seeding of Roma variety was transplanted in July, 2014 in RCBD with 5 replicates. The treatments were: T_1= complete eradication of weeds (CEW), T_2=CEW + Confidor, T_3= Eradication dicotyledonous weed (EDWR), T_4=EDW+Confidor, T_5= Eradication monocotyledonous weeds (EMWR), T_6=EMW+ Confidor, T_7=Weedy check (WC) and T_8=WC+ Confidor. Weekly population of B. tabaci was counted on tomato and weeds as well. The results revealed showed that B. tabaci appeared on tomato plants as well as on plants of different weed species present in tomato field. The highly preferred weed plants to B. tabaci were Portulaca oleracea, Polygonum plebejum and Echinochloa colona; whereas Cyperus rotundus was moderately preferred and Trianthema monogyna, Cynodon dactylon, Digera arvensis and Corchorus antichorus were the least preferred weed plants. The plots with CEW significantly ($P<0.01$) decreased B. tabaci population followed by (EDW), (EMW) whereas maximum per leaf population was recorded in the WC plots. Similarly, the highest tomato yield was recorded in the plots treated with (CEW+Confidor) and the lowest in WC plots. It is concluded that complete weeding reduces the population development of B. tabaci on tomato crop that ultimately enhance the yield of tomato crop.*

Keywords: *Bemisia tabaci,* Population, Dicotyledonous weeds, Monocotyledonous weeds, weeding.

INTRODUCTION

Tomato (*Solanum Lycopersicum* L.) is a vegetable fruit with rich dietary values for human and animals as well, being grown in small scale in home or backyard gardens and cultivated at large scale in the field commercially almost all countries of the world [1, 24]. The fruits contain high nutritional value [27], contain essential nutrients, which fulfils a huge source of energy in humans. Beside that fruits also contain lycopene that prevent human against prostate, stomach and lung cancer [9]. There are several seasons of low yield in Pakistan such as impure seed, diseases, insect invasion. The reduction in tomato production due to insect pests activities has been reported [13]. Numerous insect pests are associated with to tomato crop right from seeding to harvesting. However, the whitefly *Bemesia tabaci* is very noxious [26] in the sense that it reduces the vitality of tomato plant by sucking up the sap of the leaves [15] and the most dangerous one is the transmission of Gemini viruses [8, 29]. The fly has a huge host range including cultivated and non-cultivated plants [10]. Maximum hosts are the plants of Leguminosae, Compositae, Solanaceae, Malvaceae and Euphorbiaceae. The crops cotton, brinjal, sweet potato, alfa alfa, cucurbits, etc.in the northern and western regions of Indo-Pak continent are severely damage by the fly [4]. *B. tabaci* remains active round the year, however, in winter season it develops its active population on different weed plants especially during the gaps between crops. Cheese weed and sow thistle harbor it population from October to March whereas, *Convolvulus arvensis* and *Helianthus annuus* serve as its host in spring [5]. Periodical population shifitting of B. tabaci indicates that 1st adult of the year to appear almost after 3rd week of January, usually on *Convolvulus arvensis* and *Euphorbia spp.,* or cultivated plants such as *Brassica spp.*, [3], and *Echinochloa crus-galli* L, *Amaranthus retroflexus* L, *Solanum nigrum* L. *Chenopodium album* L and Datura *stramonium* L. support *B. tabaci* population in summer season [21]. Enormous weed species support *B. tabaci* as its alternate hosts and it could be the reason that thy fly sustains its population and activities around the year [16]. Consequently, transition of *B. tabaci* population goes as weeds-crop-weed. Eventually, crops are being severely attacked by the fly. Keeping the significance of weeds as alternate host of *B. tabaci*, the present studies were undertaken to find out the facts that weeding influences the population of the fly in tomato agro-ecosystem. The results of the experiment will help the farmers to manage population of B. *tabaci* on tomato crops.

MATERIALS AND METHODS

To determine the influence of weeding on population of the whitefly on tomato crop, the experiment was conducted at agricultural experimental field of institute of Plant Protection, Sindh Agriculture University, Tandojam-Pakistan during summer 2015. The seedlings of Roma variety were transplanted on the both sides of 1.5 meter wide beds with a distance of 60 cm between the beds on July 10 in a randomized complete block design having eight treatments and five replications. The sub-plot size was maintained 6x9 meters. The plant to plant distance was maintained as 22.5 cm. To determine the real impact of whitefly population on the yield of tomato crop, the crop was sprayed with confidor 200SL along with weeding practices. The spaying was done after each 10-day interval till the end of crop harvest. The details of treatments are as under:

1. Complete eradication of weeds (CEW).
2. Complete eradication weeds (CEW) + Confidor 200SL.
3. Eradication dicotyledonous weeds (EDW).

4. Eradication dicotyledonous weeds (EDW). +Confidor 200SL
5. Eradication monocotyledonous weeds (EMW).
6. Eradication monocotyledonous weeds (EMW) +Confidor 200SL.
7. Weedy check (WC).
8. Weedy check (WC) +Confidor 200SL.

Eradication of weeds was carried out manually on alternate day. Other recommended cultural practices for tomato crop were exercised uniformly for all sub-plots as and when required.

Suppression of other insects on tomato:

In our environment, *Helicoverpa armigera* Hb. and *Amrasca biguttula biguttula* Dist. are also voracious on tomato crop. To determent the sole impact of *B. tabaci* population on tomato yield, the populations of both of these pests were kept under control by installing light traps in experimental area. The lights of the traps were kept on from dusk to late night, after that the containers of the traps were brought in the laboratory. The adults of *H. armigera* and *A. bigutella bigutella* were collected and preserved. With this practice the population of both the insects was kept under control on the trail crop.

***B. tabaci* Population on weeds**

The data on *B. tabaci* population on each weed species was recorded once a week on 10 randomly selected plants per sub- plot. The selection of plant was made by cross movement in the plots. Each weed plant (monocotyledon) was thoroughly examined for *B. tabaci* population, while population on Dicotyledonous was counted by examining 5 leaves per plant.

***B. tabaci* population on tomato crop**

The population of *B. tabaci* was recorded once a week after transplanting to final picking of the fruits. The population of *B. tabaci* was recorded by examining 25 leaves, which were randomly selected (one leaf per plant) from different nodes of tomato plants (node 2-5) from each sub-plot. The leaves were selected by carrying out cross movement (moving from one corner to the apposite corner) in each sub plot. The population of *B. tabaci* (nymphs plus adults) was counted on each leaf separately.

Yield of tomato

The yield of tomato was recorded from each sub-plot. Weighing of tomato was carried at each picking. Finally, the overall fruit weight was calculated for each sub-plot. The total weight of each treatment was calculated in ton per hectare. The data were statistically analyzed through analysis of variance among the treatments and the comparison of means by LSD test.

RESULTS

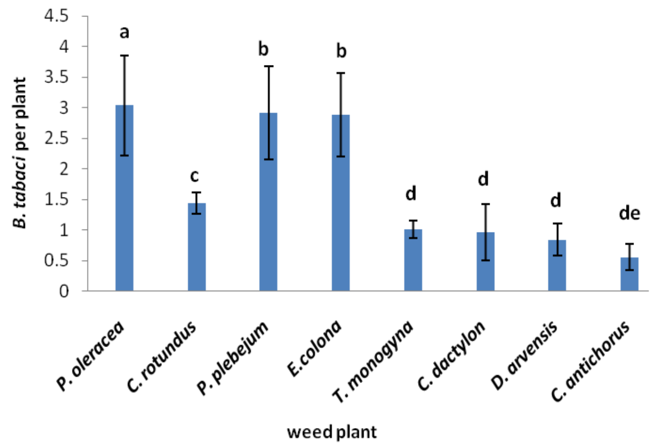
During the studies different weed species were seen grown in the field of tomato crop. The weed species and their taxonomic position are given in the table 01.

Table 1. Weed species and their taxonomic position.

Monocotyledon	Family	Vernacular name
Cyperus rotundus (L.)	Cyperaceae	Kabbah
Cynodon dactylon (L.)	Poaceae	Chhabbar
Echinochloa colona (L.)	Poaceae	Jangli Swank
Dicotyledon		
Trianthema monogyna (L.)	Aizoaceae	Waho
Portulaca oleracea (L.)	Portulacaceae	Leh
Digeria arvensis (Forsk)	Amaranthaceae	Lulur
Corchorus antichorus (L.)	Titiaceae	Bhauphali
Polygonum plebejum (R.)	Polygonaceae	Kheirola

***B. tabaci* on weeds**

Some of the above weeds were appeared immediately in the following week of transplanting of tomato crop and rest of them1 or 2 weeks later. The data presented in Fig.-1 revealed that *B. tabaci* appeared on the on all weeds from their emergence in the field till maturity. Fluctuating population of the whitefly were recorded on all weeds, hence, maximum activities were recorded twice in 1st week and 4th week of august, 2014, respectively. The overall population mean showed that *P. oleracea* harbored significantly (P<0.01) maximum *B. tabaci* per plant followed by, *P. plebejum* , *E.colona*, *C. rotundus* *T. monogyna* , *C. dactylon* , *D. arvensis* and *C. antichorus* . LSD test revealed that *B .tabaci* appeared non-significantly (P<0.05) on *P. plebejum* and *E. colona*; and on *D. arvensis*, *C. dactylon* and *T. monogyna*, respectively.



LSD: Means followed by the same letters are not statistically different at (P>0.05)

Fig. 1. Population (Mean± S.E) of *B. tabaci* per plant on weeds

B. tabaci on tomato

Figure. 2-5 revealed the occurrence of *B. tabaci* population on tomato crop. It started its activities on tomato plants in all treatments right from transplanting till last picking of tomatoes. During study period the peaks in population i.e. 1^{st} and 2^{nd} peaks were recorded in 1^{st} and 4^{th} weeks of August, respectively. At 1^{st} weak the population was recorded as 12.48±1.42 in sub plots of eradication of monocotyledonous weeds (EMW) followed by eradication dicotyledonous weeds (EDW) 10.32±1.36, complete eradication weeds (CEW) 7.28±1.03 and Weedy check (WC) 15.46± 2.46. The fly showed similar population trend during 4the week of August. The highest population (12.46±2.18) per leaf was recorded WC plots followed by EMW (9.47± 1.42), EDW (10.26±0.88) and CEW (6.48±0.62). Significant differences ($P<0.01$) in the population of *B. tabaci* appeared in all treatments. LSD at ($P < 0.05$) endorsed the same variation in the population of the fly appeared in all treatments.

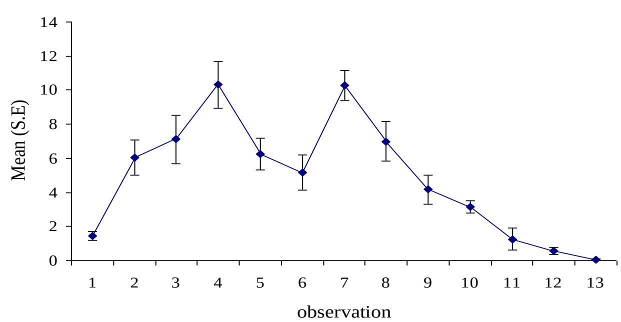


Fig.2. Population of *B. tabaci* on tomato in the plot treated EMWR

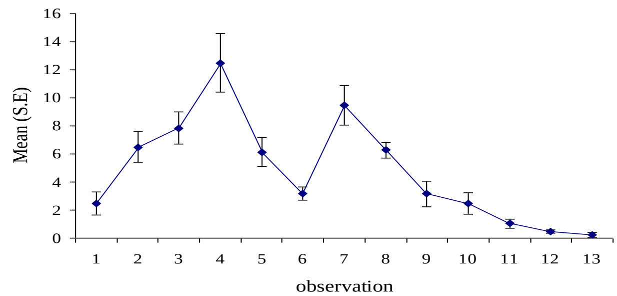


Fig.3. Population of *B. tabaci* on tomato in the plot treated EMWR

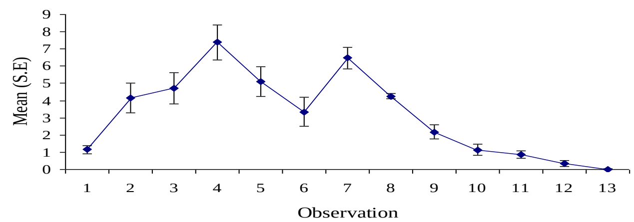


Fig.4. Population of *B. tabaci* on tomato in the plot treated CEW.

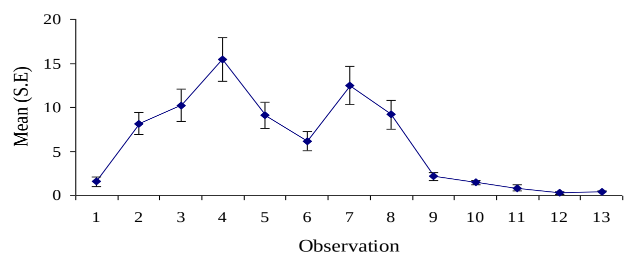


Fig.5. Population of *B. tabaci* on tomato in the control plot (CW).

Tomato Yield

The effect of weeding and whitefly population on tomato plants was determined through crop yield. The data in figure 6 showed the yield of tomato, the plots of CEW performed well and produced significantly maximum tomatoes (at $P<0.01$). However, the plots of EMW and EDW produced tomatoes non-significantly (LDS at $P<0.05$). The lowest yield was obtained in the plots of weedy check (WC). The data in Table 2 reveals the losses of tomato yield due to the activities of *B. tabaci*. Minimum yield loss was observed in the plots of CEW followed by DWR, MWR and WC. It was also estimate from yield data that in the plots of CEW, the fly could cause only 3.35% yield loss as compared to the yield of the plots treated as CEW+ Confidor, whereas monocotyledon weed species supported *B. tabaci* to enhance the yield losses to 8.95%. Due to the presence dicotyledon weeds species the fly further enhanced it activities and caused 13.24% losses to tomato yield, which is 2.05% more as compared to monocotyledon weed species. It is further revealed that both types of weed species well supported the fly activity, in presence of them the losses to tomato crop due to *B. tabaci* reached to 13.24%. It is concluded that the presence of weeds boosted up the activities of the fly as a result it caused 9.88% more loss to tomato yield as compared to clean cultured tomato crop. Yield loss to tomato crop due to the competition of weeds was also estimate as (12.12%), (1082%) and (26.67%) due to emergence of monocotyledon, dicotyledon and monocotyledon + dicotyledon weed species, respective ely.

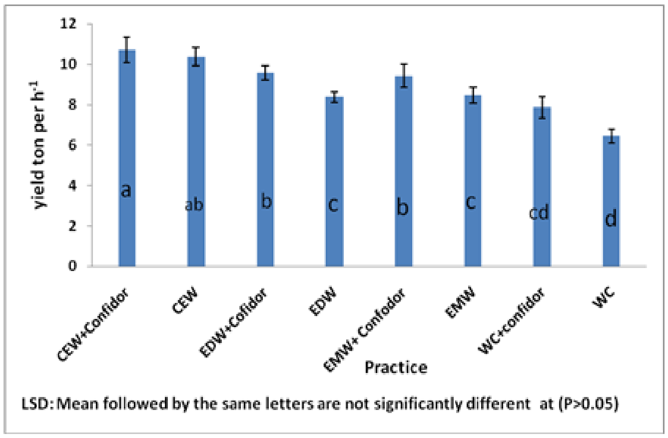


Fig. 6. Yield of tomato crop influenced by different weeding practices.

Table 2.: Yield Losses (ton h^{1}) of tomato crop due to weed species and *B. tabaci*.

Plots	Yield Losses (ton h^{1})		Total loss (ton h^{1})
	Weeds	*B. tabaci*	
CW	0	0.36	0.36
DWR	1.30	0.96	2.26
MWR	1.16	1.18	2.34
WC	2.86	1.42	4.28

DISCUSSION

The results of the experiment revealed that a fluctuating population of the whitefly was recorded on tomato in all treatments from transplanting till last picking of the tomatoes. The result is in agreement with those of El-Khayat *et al.*, 1994 they reported that among summer host, tomato is one of the most preferred crop of the fly [7]. Hugh *et al.*, 2014) mentioned some species of weeds as alternate hosts of *B. tabaci* [14], Silva *et al.*, 2010 reported that weed species serve as alternate host for whitefly, which transmits viral disease to tomato plant [28]. Patel *et al.*, 2014 reported that almost all weeds of present study are seen germinating in tomato crop [23]. However, El-Khayat *et al.*, 1994 mentioned that *T. monogyna, D. arvensis, C. rotundus, P. oleracea, C. dactylon, P. plebejum, C. antichorus and C. arvensis* were found harboring whitefly population [7]. Attique *et al.*,2003 found maximum population of *B. tabaci* on *T. monogyna, D. arvensis, C. dactylon and P. plebejum*, when analyzed 46 weed species as host of whitefly in winter and spring. In present studies, the fly appeared with higher density on *P. oleracea* followed by *C. rotundus* and lowest on *C. antichorus* [2]. The work of Sampedro- Romero *et al.*, 2002 and Othman *et al.*, 2002 also endorses the weeds *Portulaca oleracea* and *Cyperus rotundus* as preferred host of the fly [22, 25]. The results further showed that weeds played an important role as alternate host of whitefly in tomato crop. Their presence in the field enhanced the activity of *B. tabaci*, consequently more of its population was recorded in the plots of WC. Marten *et al.*, 2004 reported shifting of *B. tabaci* from vegetable crops to ornamentals and then to some weeds in green house and open field as well in summer [17]. Zhang *et al.*, 2013 reported that weeds play important role as alternate and intermediate hosts for *B. tabaci* before invading to cultivated crop [30]. Complete Eradication of weeds (CEW) discouraged the fly to carry their activities up to that extend as recorded in WC plot. The same situation is denoted by Monsef and Kashkooli, 1978 they observed 10-11of *B. tabaci* generations a year. After passing winter, it emerges as adults finds weeds, later shifted to cotton [19]. Hilje, 2000 and Hilje *et al.*, 2001 suggested weeding as one of the potential IPM practices to control *B. tabaci* and to enhance crop yield [11, 12]. Lanjar and Sahito, 2007 who reported that complete eradication of weed in okra crop reduced the activity of *B. tabaci* in okra field [16]. Medina- Balderas *et al.*, 2002 disagree with our results, they reported that weeds favored the presence of parasitoids, which reduced the population density of *B. tabaci* and ultimately the incidence of viral diseases. During present investigation the yield losses due to *B. tabaci* were ascertained. It was observed that in the plots where population of *B. tabaci* was the highest, yield losses was also the highest [18]. The Report of EFSA Panel on Plant Health, 2013 also mentioned that *B. tabaci* poses a substantial threat to both field and protected agricultural crops and ornamental plants. It invades the plants by the direct feeding that influences the vigor, growth and yield of infected plants [6]. Mourad, 1996 reported that due to the fly infestation yield of cotton was seriously reduced i.e., decreased number of bolls and decline in weight of seed and lint per boll [20].

CONCLUSIONS

It is concluded that the weeds emerged in tomato crop harbored *B. tabaci* as its alternate hosts. The population of whitefly found fluctuating on weeds as on the main crop. Presence of weeds and *B. tabaci* drastically reduced tomato crop yield. Weeding in tomato field discourages the population buildup of whitefly on tomato crop. Hence, weeding in tomato crop is recommended right from crop germination to it maturity to suppress the activities of *B. tabaci* thus reduces the yield losses of tomato crop.

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