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Management of *Thrips tabaci* (Thysanoptera: Thripidae) Through Agronomic Practices in Onion Field Plots

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ABSTRACT

Onion, *Allium cepa* (L.) is very important and highly valuable vegetable crop all over the world. Amongst the insect pests, onion thrips, *Thrips tabaci* Linedman (Thysanoptera: Thripidae) has been proved to be the most important factor for onion yield reduction. In the present study effects of intercropping and plant spacing were recorded in onion field plots as a management tool against *T. tabaci*. For this purpose, four intercrops (chili, tomato, okra and cotton) and five plant spacings (10, 15, 20, 25 and 30 cm) were used in onion field crop. Minimum thrips density per plant was recorded in onion plots intercropped with cotton during the study period of two years. The maximum thrips density was recorded in control plots (26.19±5.67), $F_{4,250}$= 7.79; P< 0.001. Onion plots intercropped with cotton gained the highest bulb weight and yielded maximum onion/plot followed by tomato, chilli and okra, respectively. No difference in mean bulb weight of control and onion plot intercropped with okra was recorded in the current study. However, bulb weight of onion in both of these plots was significantly lower as compared to onion plots intercropped with cotton. Minimum thrips density per plant was recorded in onion plots in which plant to plant space was 30 cm followed by 25 cm, 20 cm, 15 cm and 10 cm plant spacing during both experimental years. The thrips density was increased with the decrease of plant to plant spacing. Further, single bulb weight with 30 cm plant spacing was significantly higher as compared to lowest plant spacing (10 cm). In both years, onion plots with minimum plant spacing (10 cm) produced more yield/plot but with lowest bulb weight and vice versa. Therefore, it was concluded that cotton should be intercropped with onion as a trap crop and medium onion plant spacing should be practiced for reducing thrips infestation and suitable bulb size with optimum yield.

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Authors' Contribution
MA, AMR and MK designed the study. AK, AAK, performed the experiments. HMT analyzed the data. AK and AAK wrote the article, MAA and MIU helped in writing the article.

Key words
Agronomic practices, Eco-friendly, IPM, Onion thrips

INTRODUCTION

Thrips tabaci is an important insect pest of onion (Lorbeer *et al.,* 2002; Nawrocka 2003; Jensen *et al.,* 2003; Waiganjo *et al.,* 2008), during the high infestation period its population may reached to 100 thrips/plant (Ullah *et al.,* 2010). In addition to direct damages it serves as a vector of different diseases and causes economic losses in onion production. The eco-friendly management practices are required to keep pest population below economic damages by assuring safe mode to beneficial (Khaliq *et al.,* 2014). The way of using cultural and agronomic practices are considered important for the management of thrips and to increased crop yield (Cheema *et al.,* 2003; Msuya *et al.,* 2005). Several sustainable practices are being used worldwide in reducing thrips infestation of vegetable crops. These practices are very helpful in reducing the injudicious use of broad spectrum insecticides (Martin *et al.,* 2003; Rueda and Shelton, 2003; Ullah *et al.,* 2007), which cause severe effects on the economy of a country.

Intercropping and plant spacing are very important agronomic techniques that keep thrips population below economic injury level in onion crop (Finckh and Karpenstein-Machan, 2002; Malik *et al.,* 2003). Intercropping has wide range of benefits including suppression of weeds, improvement in soil fertility, conservation of natural predatory fauna and higher production (Trdan *et al.,* 2005, 2006; Blaser *et al.,* 2007; Kabura *et al.,* 2008; Rao *et al.,* 2012). Reasonable plant spacing alters the behavior of insects by reducing appropriate egg laying site and shelter leading to healthy plant growth and lower risks of pest outbreak and diseases (Anyim, 2002; Ferro, 2002).

Intercropping is considered as an important component of crop production system in developing

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countries (Sodiya *et al.,* 2010). Onion and clover (Trifolium) intercropping cause reduction in onion thrips population and higher onion yield (Hildenhagen *et al.,* 1995; Trdan *et al.,* 2006). Chilies intercropped with garlic and onion showed lower pest infestation levels with higher yield (Aswathanarayanareddy *et al*., 2006). A significantly higher population of thrips was observed in the single or mono cropping rather than mixed-cropping (Pankeaw *et al.,* 2011). Up to 15.7% thrips reduction was achieved by intercropping onion crop with spider plants (Gachu *et al.,* 2012).

Appropriate row spacing reduces insect pest infestation (Asiwe *et al.,* 2005; Ihejirika *et al.,* 2008; Sarwar, 2008; Akinkunmi *et al.,* 2012). Row to row distance of 30 cm and plant to plant distance of 20 cm distance has been reported to be most suitable to suppress the thrips population and better yield (Malik *et al.,* 2003). More plant spacing help in bulb expression and also minimize competition for nutrient and light (Saud *et al.,* 2013). The present study was designed to evaluate the impact of some intercrops and different plant spacing on the management of thrips population in onion fields.

MATERIALS AND METHODS

Effect of intercropping

The study was conducted at the University College of Agriculture, University of Sargodha, Sargodha, Punjab, Pakistan during 2010-2012. The onion was intercropped with chili (*Capsicum annum* L.), tomato (*Lycopersicon esculentum* L.), okra (*Abelmoschus esculentus* L.) and cotton (*Gossypium hersutum* L.). Fifteen plots [three for each treatment and three controls plots with only onion and no intercropped] were used for each experiment. Each plot was 800 cm long and 180 cm wide. Six alternate rows including intercrops and onion were planted in each plot, which counts 50 onion plants and 25 plants of intercrops in each row. The row to row distance between plants was 30 cm while plant to plant distance between onion and intercrop was 15 cm and 30 cm, respectively. A distance of 90 cm was maintained between each experimental plot. Randomized Complete Block Design (RCBD) was used. Plots were irrigated using canal water on weekly basis during early three irrigations, while the duration was prolonged to 10-14 days afterward. The fertilizers in granular form were applied in three split doses (i) at sowing, (ii) seedling transplantation and (iii) onion bulb formation time. The recommended fertilizers doses (kg/ha) of Nitrogen, Phosphorus and Potassium at a ratio of 35:35:25 were applied.

Data collection

Fifteen plants were randomly selected (5 plants/row) from each experimental field plot for thrips population estimation. The adults and larval thrips population per leaf was visually counted on weekly basis by using magnifying hand lens of 4X power. The weight of single bulb (g), yield/ plot (kg), and overall yield/hectare (tons) from control and treated plots was also recorded.

Effect of onion plant spacing

Onion seedlings of 10 weeks' old were shifted from nursery to experimental field plots during mid of January. Impact of five plant spacing's (*i.e.*, 10cm, 15cm, 20cm, 25cm, and 30cm) was observed on onion thrips density. In total, 15 experimental plots [three for each of four treatments and three untreated controls] were utilized for each experiment. The distance between each experimental plot was 90 meters. In each plot, there were three rows of onion seedlings. In 1st row there were 75 plants and plant to plant space was 10m. In the 2nd, 3rd, 4th and 5th row the numbers of plants were 50, 38, 30, 25 cm and plant to plant distance was 15, 20, 25 and 30 cm, respectively. In all treatment plots row to row distance was 30 cm. A distance of 9 meter was maintained between experimental plots. The design used was Randomized Complete Block Design (RCBD). Irrigation and fertilizer application patterns were same as described in the intercropping experiment.

Statistical analyses

Before the analysis of data, the normality was assessed using Kolmogrorov-Smirnov normality test. Parametric tests were performed on normal data. Analysis of variance (ANOVA) followed by Tukey's test was used to compare the treatments. Pearson correlation was performed to find out the relationship of thrips density and plant spacing. Results were considered significant if P-value was less than 0.05. All statistical analyses were performed using SPSS (version 16) and Minitab (version 14.1)

RESULTS

Intercropping

Non-significant difference was found between two years (2011 and 2012) however minimum thrips density was recorded in the onion plots which were intercropped with cotton followed by tomato, chilli and okra, respectively (Table I). The maximum thrips density was recorded in control plots (*i.e*., 26.19±5.67). Statistically significant difference was found in the thrips densities among treatments ($F_{4,250}$= 7.79; P< 0.001 for 2011 and $F_{4,250}$= 9.77; P< 0.001for 2012). Onion plots intercropped with cotton yielded highest bulb weight followed by

Table I.- **Impact of intercropping on thrips population, onion bulb weight, yield/plot and yield/hectare in onion field plots.**

Treatments (intercrops)	Mean thrip density (MTD)		Bulb weight (g)		Yield/plot (kg)		Yield (T.ha)	
	2011	2012	2011	2012	2011	2012	2011	2012
Control	26.19±5.67^{c}	33.15±6.73^{d}	45.18±2.2^{a}	40.98±2.2^{a}	6.77±0.32^{a}	6.14±0.52^{a}	9.72±0.47^{a}	8.82±0.51^{a}
Chili	19.42±4.26^{b}	23.03±4.4^{b}	50.82±2.9^{ab}	48.51±2.1^{b}	7.62±0.43^{ab}	7.27±0.47^{ab}	10.15±0.62^{ab}	10.44±0.86^{ab}
Tomato	18.01±3.97^{b}	20.75±3.98^{b}	51.38±3.04^{ab}	49.73± 2.64^{b}	7.70±0.45^{ab}	7.46±0.39^{ab}	11.06±0.68^{ab}	10.70±0.55^{ab}
Okra	23.68±5.1^{c}	29.25±5.96^{c}	46.66±3.25^{a}	43.71±3.03^{a}	7.0±0.48^{ab}	6.55±0.43^{ab}	10.04±0.69^{ab}	9.41±0.78^{ab}
Cotton	8.21±1.6^{a}	10.72±1.94^{a}	55.45±3.64^{b}	53.51±2.41^{c}	8.31±0.54^{b}	8.02±0.59^{b}	11.93±0.78^{b}	11.52±0.73^{b}

Note: values in the column having different superscripts are significantly different.

Table II.- **Impact of plant spacing on thrips population, onion bulb weight, yield/plot and yield/hectare in onion field plots.**

Treatments (intercrops)	Mean thrip density (MTD)		Bulb weight (g)		Yield/plot (kg)		Yield (T.ha)	
	2011	2012	2011	2012	2011	2012	2011	2012
Control (15cm)	22.68±4.76^{c}	27.66±6.21^{c}	59.66±2.5^{ab}	45.25±2.3^{ab}	5.96±0.33^{b}	6.78±0.31^{b}	12.84±0.48^{ab}	9.74±0.56^{ab}
10 cm	24.31±5.07^{c}	30.56±6.78^{c}	50.81±2.97^{a}	37.86±2.67^{a}	7.62±0.57^{b}	8.22±0.63^{b}	16.40±0.82^{b}	12.22±0.72^{b}
20 cm	19.64±4.15^{b}	24.31±5.50^{b}	66.46±3.04^{b}	51.07±2.84^{ab}	4.98±0.34^{a}	5.71±0.31^{a}	10.73±0.49^{a}	8.21±0.44^{a}
25 cm	17.28±3.67^{b}	21.82±4.95^{b}	71.57±2.14^{b}	58.68±2.11^{b}	4.29±0.27^{a}	5.28±0.24^{a}	9.24±2.55^{a}	7.52±2.16^{a}
30 cm	14.85±3.16^{a}	19.55±4.6^{a}	73.29±2.55^{b}	59.93±2.35^{b}	3.66±0.19^{a}	4.49±0.16^{a}	7.89±0.27^{a}	6.45±0.24^{a}

Note: values in the column having different superscripts are significantly different.

tomato, chilli and okra, respectively. No difference in mean bulb weight of control and onion plot intercropped with okra was recorded. However, bulb weight of onion in both of these plots was significantly lower compared to the onion plots intercropped with cotton (Table I)

When the onion yield (tons/hectare) was compared among treatments, no difference in the onion plots intercropped with chilli, okra and tomato was found. However, yield of control plots (without intercropping) was significantly less compared to the onion crop intercropped with cotton. Over all, there was significant difference among treatments for bulb weight ($F_{4,14}$= 5.19; P< 0.01), yield/plot ($F_{4,14}$= 5.15; P< 0.01), and onion yield tons/hectare ($F_{4,14}$= 5.17; P<0.01).

Plant spacing

Minimum thrips density was recorded in the onion plots where plant to plant space was 30cm followed by 25cm, 20cm, 15cm and 10cm plant spacing, respectively (Table II). Thrips density was increased with the decrease of plant to plant space (Table II). Statistically non-significant difference was recorded in the thrips densities between plots with 10cm and15cm plant spacing. Similarly, there was no difference in thrips densities between the plots in which plant to plant spacing was 20cm and 25cm. However, the thrips density in the plots with 30cm plant spacing was significantly lower compared to the all other treatment plots ($F_{4,50}$= 2.62; P= 0.036 during 2011 and $F_{4,50}$= 1.88; P= 0.11 was observed during 2012). There was a significant negative correlation between plant spacing and thrips density (Pearson correlation= -0.997; P< 0.001). Similarly, onion plots with 30cm plant spacing yielded highest bulb weight but a non-significant difference in mean bulb weight of onion plots with 20cm, 25cm and 30cm plant spacing was observed. However, these plots differed significantly from the plots with 10cm plant spacing (Table II). Maximum onion yield tons/hectare was found in plot with 10cm plant spacing followed by control plots with 15cm plant spacing. However, no significant difference was observed in yield tons/hectare among treatments with plant spacing 20cm, 25cm and 30cm. Over all, there was a significant difference among treatments for bulb weight ($F_{4,14}$= 6.55; P= 0.007), yield/plot ($F_{4,14}$= 9.19; P= 0.002) and onion yield tons/hectare ($F_{4,14}$= 9.2; P= 0.002).

DISCUSSION

Cultural practices such as intercropping are very important component of eco-friendly management of many economic pests. In the present study, thrips population reduction in year 2011 was observed as 68.6%, 31.2%, 25.8% and 9.6% when onion was intercropped with cotton, tomato, chili and okra, respectively as compared to control. Almost similar trend was observed in 2012. These findings are in agreement with Gachu *et al*. (2012) who observed up to 45.2% and 21.6%, reduction of onion thrips density when onion crop was intercropped with spider plant and carrot, respectively. Present results are also in accordance with Afifi *et al*. (1990) as they reported 80% reduction in onion thrips infestation by intercropping of onions and garlic with tomato in Egypt and in England, Uvah and Coaker (1984) observed 50% decreased in onion thrips population with mixed planting of carrot and onion.

When onion was intercropped with cotton, the thrips population moved towards cotton seedlings. Faircloth *et al*. (2002) also reported that cotton seedlings are more susceptible to thrips attack. So cotton can be used as trap crop in onion and when thrips populations reached to a certain level, the trap crop should be sprayed with insecticide (Alston and Drost, 2008).

In addition to reducing thrips population, the intercropping also showed positive effects on onion yield (Table I). Trdan *et al.* (2006) also obtained similar results of thrips suppression and higher onion bulb yield when onion intercropped with white clover, but *Lacy phacelia* intercropped in onion reduced onion yield. The reason behind the reduction in onion bulb yield could be competition between intercrops for nutrients, light, and water (Trdan *et al*., 2006). Similarly, Kabura *et al.* (2008) revealed that onion and pepper intercropping did not affect bulb size. They also recorded higher total and marketable onion yield in monocrop onion than intercrop. Gombac and Trdan (2014) also found least thrips damage to leek plants when intercropped with birdsfoot trefoil (*Lotus corniculatus* L.) but significantly lower yield was obtained as the intercrop remained pretty competitive with leek plants.

In present study inverse relation between plant spacing and thrips population in onion field crop was noted. Present study showed 13.40% reduction in thrips infestation and 11.39 % increase in onion bulb weight when plant to plant distance was increased from 15 cm (control) to 20 cm in year 2011 and same trend was observed in 2012. Similar results were obtained by Malik *et al*. (2003) and they recommended 30 cm row to row and 20 cm plant to plant distance, most suitable thrips suppression and also produce better yield. Abdel-Rahman and Hamid (2013) suggested that onion seedlings transplanted on ridges at 10 cm distance ensure better onion bulb size and ultimately produce better yield.

The increase in bulb weigh with increase in plant spacing in current study is an agreement with the results of Saud *et al*. (2013) who noted significant increase in average bulb weight with more plant spacing (Table II). The same result was observed by Farrag (1995) who mentioned that single onion bulb weight increase with higher plant spacing. Increase plant spacing provide more space to bulb for expression and reduce competition for nutrient and light Saud *et al.* (2013), affect food searching and egg laying behavior of insect pests (Ferro, 2002) and reduced pest damage with increase in plant spacing Anyim (2002).

The lower plant spacing produces more yield per plot and enhance total yield because of more number of plants. Stoffella (1996) and Kahsay *et al.* (2013) found that onion yield increased with higher plant density but at the expense of smaller bulb size. Asaduzzaman *et al.* (2012) recommended wider plant spacing for quality onion seed production. Khan *et al.* (2003) reported that wider plant spacing gave larger onion bulb size which was not better for storage purpose and for consumer demand while closer spacing produces small bulb size which was not suitable for consumer choice. Therefore, medium bulb size with optimum plant spacing is recommended in onion to minimize the thrips density, maintain the bulb size and with better ultimate yield.

CONCLUSIONS

The current investigations revealed that if cotton is intercropped with onion as a trap crop and are planted with spacing of 20-25 cm thrips infestation is reduced. Moreover the bulb size as well as the yield is also increased.

Statement of conflict of interest

Authors have declared no conflict of interest.

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