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Efficacy of Bio-Insecticides and Synthetic Insecticides on the Control of *Helicoverpa armigera* Insect on Tomato Crop

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Abstract. A field study was conducted to investigate the effect of botanical extracts i.e. neem oil emulsified with NIFA adjuvant, turmeric and hinge crude extracts and neem oil in combination with white oil emulsified with NIFA adjuvants and the synthetic insecticides i.e. emamectin and bifenthrin on the control of *Helicoverpa armigera* on tomato crop. It was found that the highest control of *H. armigera* was observed for emamactin and the lowest was recoded for control. Similarly, the highest yield of tomato was recoded for neem-white oil treatment and lowest infestation was recorded for emamactin benzoate. The neem oil and neem oil in combination with white oil emulsified with NIFA adjuvant also showedbetter results than bifenthrin and hinge and turmeric crude extracts in controlling the larvae population of *H. armigera*. On the basis of these findings, neem oil and neem oil combined with white oil is the best management technique for controlling the *H. armigera,* as these agents pose least environmental hazards and are relatively nontoxic to beneficial insects and humans and readily photodegrade.

Keywords: adjuvant, botanical extracts, tomato borer, neem oil, white oil.

Introduction

Tomato is an important vegetable grown throughout the world (Jat and Ameta, 2013). In Pakistan this vegetable is grown in large area (Mari *et al*., 2007). The tomato plant is attacked by various insect pest which cause a great damage to plant and economical loss to the farmers (Meena and Raju, 2014; Chowdary *et al*., 2010). *Helicoverp armigera* or tomato borer is a major pest of tomato crop, responsible for a decrease in tomato production (Wagh *et al*., 2012 and Geiger *et al*., 2010). *Helicoverp armigera* is a polyphagous pest and can infest a large number of crops and lower the market value of vegetable crops (Prasanna *et al*., 2013). The *H. armigera* can cause a mark decrease in the yield of tomato (Gajete *et al*., 2004). Synthetic insecticides are commonly used for the control of this pest, but this insect has developed resistance to a large number of synthetic pesticides (Gandhi *et al*., 2013; Kaur *et al*., 2013). Besides, the synthetic pesticides are toxic to non-target insects and are not easily degraded and their residues may accumulate in the food chain and may be toxic to humans (Damavandian, 2010). So efforts are being made to find the alternate pest management strategies to overcome the harmful effects of the synthetic pesticides. Botanical extracts notably the neem oil and paraffinic, white mineral oilare relatively safe alternative to synthetic insecticides because neem products rapidly degrade and is target specific.

The present study was carried out to see the effect of neem oil and white paraffinic oil emulsified with NIFA developed adjuvant, turmeric and hinge crude extracts and the synthetic pesticides such as emamactin and bifenthrin on tomato crop for the control of *H. armigera.*

Materials and Methods

Design of experiment. The field study was carried out at the tomato field situated in Pabbi station Nowshera. The experiment was carried out in the randomized complete block design, RCBD. The field was divided into seven plots with three replications. The distance between the plants was seventy cm and a row to row distance of one meter was maintained. The size of each plot was sixteen m^2. Shimla variety of the tomato was sown. The plantation was carried out in 3rd week of March 2017.

Treatments. The synthetic insecticides were purchased from the local market in Peshawar. The neem oil was

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extracted by cold press method and emulsified with NIFA adjuvant. The turmeric and hinge extracts were prepared using the procedure of Munir (2006). The neem oil was mixed with white oil in a ratio of 4:6 and the emulsified with NIFA adjuvant and a paste was developed. The following treatments were applied three times during the whole experiment in the field against the *Helicoverpa armigera* (Table 1).

Table 1. Different treatments and their percentage concentration

Treatments	% Concentration
Neem oil emulsified with NIFA adjuvant (3%)	3
Neem-white oil emulsified with NIFA adjuvant	3
Hinge crude extract	3
Turmeric crude extract	5
Emamectin benzoate	2.5
Bifenthrin	2.5
Control (no application)	____

Data collection. The population of larvae of *H. armigera* was recorded on weekly basis. The insecticides were applied at an interval of fifteen days. Ten plants were selected in each plot for the observation of larvae. The percent protection of the fruit over the control was determined using the following formula,

% protection over control = C-T/C

where:

C = % fruits damaged in control; T = % fruits damaged in treatment.

The percent reduction in larval population was determined using Abbots formula developed in 1925 and is given as;

% Reduction = C-T/C ×100.

where:

C = larvae population in control; T= larvae population in treatment.

Similarly, the yield of tomato for each plot was determined and increase in yield over control was determined for each treatment.

Data analysis. The results were subjected to one-way ANOVA followed by Dunnett post hoc test.

Results and Discussion

Effects of treatments on larvae population. The results obtained regarding the population of *H. armigera* per plant of tomato after the application of the pesticides in each treatment are shown in Table 2. All the treatments of the insecticides were found superior over control. It is apparent from the table that lowest mean population of larvae 0.96 per plant was observed for emamectin benzoate treatment and the highest population of larvae per plant was recorded for control and was 1.66. The emulsified neem treatment has 1.12, neem-white oil has 1.06, hinge crude extract has 1.33, turmeric crude extract has 1.26, while bifenthrin has 1.28 larvae of *H. armigera* per plant respectively. There was a gradual decrease in larvae population plant after each week. In second week, the lowest larval population was recorded for neem treatment and was 0.81 larvae per plant and the highest larvae were recorded for control. In third week, the number of *H. armigera* further reduced in all the treatment except turmeric crude extract which has a slight increase in larval population and was 1.1 larvae per plant (Fig. 1). The lowest larval population was recorded for emamectin benzoate treatment and was 0.66 larvae per plant. The larvae per plant after third week were 0.75, 0.82, 0.1.05, 0.93 and 1.7 for neem, neem-white oil, hinge crude extract, turmeric crude extract, emamectin benzoate, bifenthrin and control

Table 2. Population of *H. armigera* on tomato plant in each treatment on week basis.

Treatments	1st Weak	2nd Weak	3rd Weak	4th Weak	5th Weak	6th Weak	%larvae reduction
T1	1.12±0.62^{NS}	0.81±0.46^{NS}	0.75±0.36^{NS}	0.55±0.41**	0.41±0.40**	0.20±0.26**	59
T2	1.06±0.58^{NS}	0.93±0.40^{NS}	0.82±0.75^{NS}	0.41±0.18**	0.33±0.30**	0.00±0.00**	62.1
T3	1.33±0.61^{NS}	1.12±0.69^{NS}	1.05±0.47^{NS}	0.96±0.41^{NS}	0.91±0.46^{NS}	0.77±0.25**	34.6
T4	1.26±0.67^{NS}	1.03±0.55^{NS}	1.1±0.46^{NS}	0.88±0.60*	0.81±0.80^{NS}	0.63±0.45**	39.1
T5	0.96±0.55^{NS}	0.89±0.26^{NS}	0.66±0.31^{NS}	0.53±0.50**	0.21±0.20**	0.00±0.0**	65.3
T6	1.28±0.30^{NS}	0.950.45^{NS}	0.93±0.64^{NS}	0.71±0.26**	0.44±0.40**	0.33±0.33**	50.6
T7 (Control)	1.66±0.76	1.83±0.76	1.7±0.61	1.91±0.36	2.10±1.01	1.90±0.36	__

NS= Non-significant, *=Significant; at á < 0.05; ** = Significant at á < 0.01

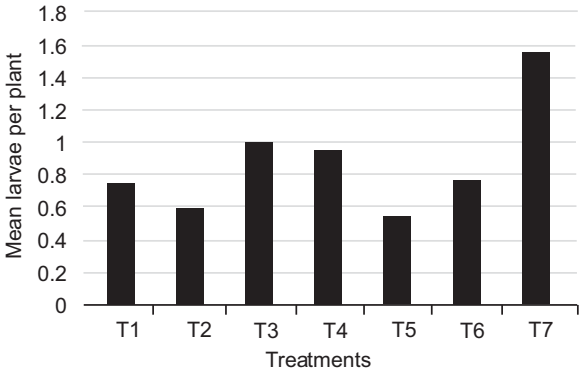

Fig. 1. Mean larvae per plant

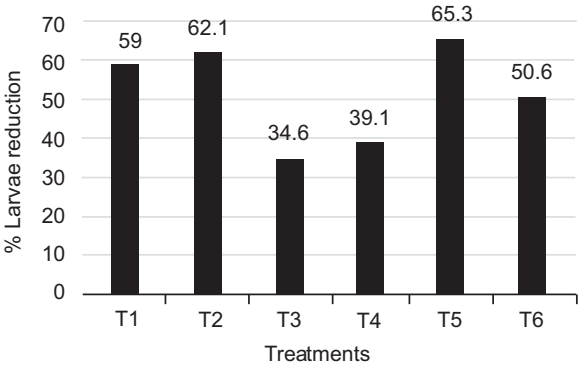

Fig. 2. Percent larvae reduction over control

treatments respectively. Data collected after fourth week indicates that neem-white oil has lower larvae population per plant as compared to all other treatments and was found to be 0.41 larvae per plant shown in Fig. 2. All the treatments have lower larvae population of *H. armigera* than those recorded after the third week. The highest larvae were recorded for control and was 1.91. Neem oil and emamectin benzoate have almost the same number of larvae per plant and were 0.55 and 0.53 respectively. The larvae per plant were 0.96 and 0.88 respectively for hinge and turmeric crude extract treatments. After fifth week the number of larvae further reduced in all the treatments and the reduction in larval population was more pronounced in case emamectin benzoate treatment, where the number of *H. armigera* was 0.21 per plant and control has the highest larvae population per plant and was found to be 0.91. The sixth week data shows that larvae population were significantly lowered by the insecticides and all the treatments have the lowest larval population than the previously recorded data and no larvae were found in case of neem-white and emamectin benzoate treatments and neem oil treatment has a larvae population of 0.2 per plant. The highest number of *H. armigera* per plant was 0.77 per plant recorded for bifenthrin treatment. The lowest mean larvae population was recorded for emamectin treatment and was 0.54 and the highest mean value was recorded for hinge treatment and was 1.02. neem-white oil treatment showed next best results after emamectin benzoate and next to this treatment was neem oil treatment having mean values of 0.59 and 0.64 respectively. The percent larvae reduction over control was the highest for emamectin treatment and was 65.3 and lowest was recorded for hinge crude extract treatment and was 34.6 (Fig. 2).

Fruit infestation and yield parameters. The highest yield of tomato was recorded for neem-white oil treatment and was 583 kg (Fig. 3). Neem oil and emamectin benzoate have almost the same total yield and was 560 and 570 kg respectively. Amongst the six treatment, the lowest yield was recorded for hinge crude extract treatment and was 525 kg. The yield of tomato for control was 463 kg. Similarly, the lowest infestation in tomato fruits were recorded for emamectin benzoate and was 4.2 percent and the highest damage was observed control and was 17.33 percent, shown in Table 3 and Fig. 3.

The present findings are in close agreement with the data taken by Shah *et al*. (2013) who reported that neem extract has nearly the same action as that of emamectin benzoate in controlling the *H. armigera* on tomato. They found that mean number of *H. armigera* per plant were 0.40 and 0.46 for emamactin and neem treatments respectively. They also found that highest yield of tomato (7540 kg) was recorded for neem treatment and

Table 3. Damaged fruits and overall yield of tomato for each treatment.

Treatments	Mean% Damaged fruits	%Protection over control	Yield (kg)	%Increase over control
T1	5.1±1.01**	70.5	560±8.71**	18.76
T2	4.66±2.20**	71.74	583±11.79**	22
T3	7.8±2.25**	55	525±13.23**	13.33
T4	4.9±1.01**	71.7	538±9.84**	15.4
T5	4.2±1.05**	75.7	570±13.23**	20.1
T6	4.8±1.05**	72.3	553±9.85**	17.72
T7	17.33±3.05	__	455±4.36	___

NS= Non-Significant; **=Significant at $\propto < 0.01$

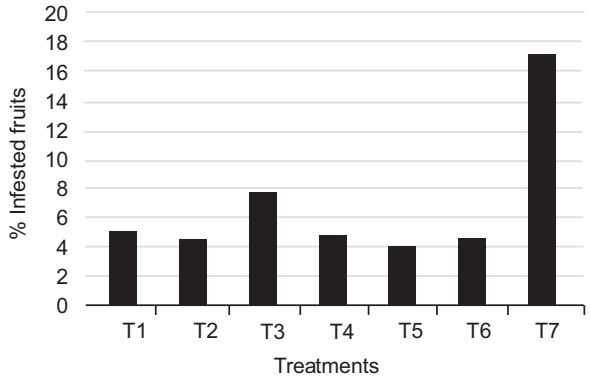

Fig. 3. Percent infested tomato fruits

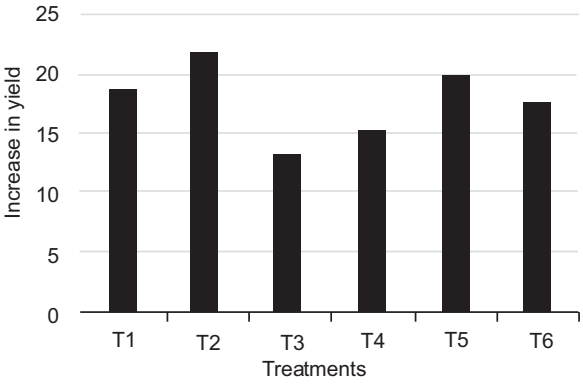

Fig. 5. Increase in yield over control

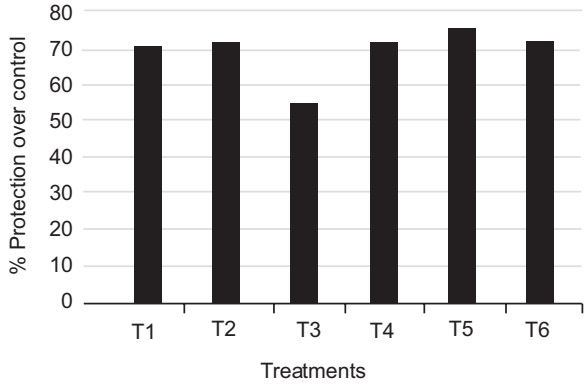

Fig. 4. Percent protection over control

the next high yield was recorded for emamactin benzoate (7300 kg). Packiam *et al*. (2012) found that Pon neem showed high oviposition deterrent property. Phukon *et al*. (2014) reported that neem oil was as much effective as cypermethrin in controlling the fruit damage by *H. armigera* and noted 92.20 percent reduction in fruit damage for cypermethrin and 91.12% reduction for neem treatments respectively. They also noted that neem oil was the next superior treatment after cypermethrin in increasing the yield of tomato over the control treatment which is shown in Fig. 4.

Rijal *et al*. (2008) reported that neem oil yielded second highest production of chick pea after cypermethrin. Elshafie and Abdelraheem (2012) reported that neem treatment has a significant effect in the yield of tomato over control. shown in Fig. 5. Hedge (2004) applied 5% neem seed kernel extracts (NSKE) on okra plants and observed the lowest number of larvae of pod borer per plant.

Udikeri *et al*. (2004) noticed that emamectin was a better agent to control the cotton bollworms and their finding confirms the present study.

Conclusion

The present study reveals that the neem oil and its combination with white oil showed good results for the control of *H. armigera* on tomato crop. These bio-pesticides are the excellent alternatives of the synthetic peticides and can be effectively applied as IPM strategy in order to lower the inputs of toxic synthetic chemical pesticides. Further study is recommended on these bio-pesticides on other crops for the control of other insect pests.

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Conflict of Interest. The authors declare no conflict of interest

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