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EFFICACY OF DIFFERENT PLANT EXTRACTS AND SYNTHETIC INSECTICIDE AGAINST THE *Helicoverpa armigera*

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Abstract

A study was conducted at a farmer's field in Nowshera, Pakistan, in 2024 to investigate the effects of various botanical extracts, including neem seed extract, turmeric extract, heng extract, garlic extract, and the synthetic insecticide emamectin benzoate, on the tomato fruit worm, *Helicoverpa armigera*. The results indicated that the lowest number of larvae per plant (0.38 larvae/plant) was observed with emamectin benzoate, while the highest number (0.95 larvae/plant) was recorded in the control. Emamectin benzoate also yielded the highest tomato production, with 7497 kg/ha, compared to the control plot's lowest yield of 3597.7 kg/ha. The percentage of fruit damage was significantly lower in the emamectin benzoate treatment (8.73%), with the control showing the highest damage (18.32%). Based on these findings, it is concluded and recommended that emamectin benzoate is the most effective treatment for controlling *Helicoverpa armigera*, resulting in the highest yield and the lowest percentage of fruit damage.

Keywords: *Helicoverpa armigera*, plant extracts, synthetic insecticide, tomato

Introduction

Tomato (*Lycopersicon esculentum* Mill) has rapidly become one of the world's most important food crops in less than a century. Despite being botanically classified as a fruit, the tomato is traditionally considered a vegetable (Anonymous, 2000). Like many agricultural crops, tomato is susceptible to infection by many pests, with the fruit borer, *Helicorpa armigera*, being a major threat. The polyphagous larvae of this moth are known to feed on a variety of crops, including corn, tobacco, and cotton, as well as other vegetables. In particular, in tomatoes, larvae can damage the fruit at any developmental stage, rendering it unmarketable (Gajete et al., 2004). Tomato production in Pakistan is very low compared to developed countries. Among the many factors contributing to this low yield, insects represent a major constraint. Although several pests affect the tomato crop, the most destructive is the tomato fruit borer. Despite the widespread use of insecticides to manage this pest, many of the chemicals used fail to provide adequate control. Furthermore, the use of chemical pesticides often leaves toxic residues on the fruit, and over-reliance on these chemicals has led to the development of resistance in pest populations (Natekar et al., 1987). Therefore, the adoption of organic amendments, plant-derived products, and microbial-based pesticides offer promising alternatives for pest management. Natural pesticides offer a viable alternative to synthetic chemicals, as they are environmentally friendly and pose minimal risk to natural enemies, humans and other animals. For example, most botanical pesticides exhibit low to moderate mammalian toxicity (Hasan, 1992). In light of the significant threat posed by *H. armigera*, the present study was conducted to evaluate the effects of botanical insecticides and chemical treatments on yield and quality of tomato crop.

Materials and Method

In 2024, experiments were conducted using a randomized complete block design (RCBD) with six treatments and three replications at a farm field in Nowshera. Experimental plots, each measuring 5 by 1 m, were spaced with 0.60 m between plants and 1 m between rows, with a total field area of 360 m2. Each plot contained 16 plants, and recommended agricultural practices were followed throughout the study. Treatments included crude extracts of neem seed, turmeric, garlic, and henge along with chemical treatment with emamectin benzoate and untreated controls.

Treatment preparation

The insecticide emamectin benzoate was procured from the local market. Crude extracts of neem seeds, turmeric, henge and garlic were prepared following the procedure described by Munir (2006).

Data collection

Data were collected weekly throughout the experiment. The treatment was applied immediately after the first fruit set and reapplied at 15-day intervals until the fruiting stage was completed. Mature tomato fruits were harvested separately from each plot and the weight and number of damaged fruits were recorded for each plot. The total yield of tomatoes was calculated by summing the yield from each pick for each plot.

Yield = Total weight of tomato collected from each plot

Percent fruit loss is determined using the formula:

Percent Fruit Damage = (Number of damaged fruits / Total number of fruits) ×100

Data analysis

Data analysis was performed using the statistical package STATISTIX 8.1. Significance of results was determined using ANOVA at the 5% significance level, as described by Steele and Torrey (1980).

Results and discussion

The results of the study on the larval populations of *Helicoverpa armigera* following the application of various spray treatments, including garlic crude extract (0.90 larvae per plant), heng crude extract (0.82 larvae per plant), turmeric extract (0.81 larvae per plant), neem extract (0.46 larvae per plant), and emamectin benzoate (0.38 larvae per plant), are presented in Table 1. Data collected at weekly intervals reveals significant differences in larval numbers across treatments. On May 9th, the lowest larval count (0.72 larvae per plant) was observed in T5, followed by T1 (0.78 larvae per plant), T2 (1.02 larvae per plant), and T4 (1.12 larvae per plant), all of which were lower than the control (1.22 larvae per plant). The data from May 16th showed that T5 continued to have the lowest larval count (0.58 larvae per plant), while the count in T6 (1.25 larvae per plant) was statistically similar to that in T1, T2, T3, and T4. On May 23rd, the highest larval population was recorded in T2 (1.22 larvae per plant), with T6, T3, and T4 following at 1.18, 1.08, and 0.98 larvae per plant, respectively. T1 and T5 had the lowest counts, at 0.75 and 0.68 larvae per plant, respectively. By May 30th, T5 had the lowest larval count (0.38 larvae per plant), significantly lower than T1 (0.52 larvae per plant), T4 (0.92 larvae per plant), T2 (0.95 larvae per plant), T3 (1.02 larvae per plant), and T6 (1.05 larvae per plant). Data from June 6th indicated the highest larval count in T3 (0.98 larvae per plant), with T2, T4, and T1 following at 0.92, 0.85, and 0.32 larvae per plant, respectively. T5 had the lowest larval count (0.08 larvae per plant), while T6 recorded 1.02 larvae per plant. On June 13th, T5 again showed the lowest larval population (0.08 larvae per plant), followed by T1 (0.15 larvae per plant). Larval counts in T2, T4, T3, and T6 were 0.78, 0.83, 0.92, and 0.92 larvae per plant, respectively. Notably, by June 20th, no larvae were recorded in any treatment. Across the observation period, the highest infestation occurred during the first two weeks (0.99 larvae per plant), with subsequent weeks showing a decline in larval numbers: 0.93, 0.81, 0.72, and 0.61 larvae per plant in the 3rd, 4th, 5th, and 6th weeks, respectively, and no infestation in the final week. The overall mean data conclusively indicated that T5 (emamectin benzoate) resulted in the lowest larval count (0.38 larvae per plant), followed closely by T1 (neem seed extract) with 0.46 larvae per plant. These treatments were significantly more effective than T2, T4, and T3 (0.81, 0.82, and 0.90 larvae per plant, respectively). The control treatment recorded a larval count of 0.95 larvae per plant. These findings, summarized in Table 1, clearly demonstrate that neem seed extract and emamectin benzoate significantly reduced the mean larval population compared to the control and other treatments. Although some reduction in larval populations was observed with these treatments, the differences were not statistically significant. These findings align with Prasad et al. (2006), who reported that emamectin benzoate 5 SG effectively reduced dead hearts and fruit damage in brinjal. Similarly, Udikeri et al. (2004) found emamectin benzoate and spinosad to be the most effective treatments, as they recorded fewer damaged bolls in the cotton ecosystem, corroborating the present results. Supporting evidence also comes from Ganeshan et al. (1995), who documented the mortality rate of *H. armigera* larvae following the application of neem 1% and a combination of neem, annona, and mahua 1% under laboratory conditions. Hegde (2004) observed a minimum number of larvae per plant with the application of NSKE 5% in okra, while Sarode et al. (1995) reported a 63.39% and 53.48% reduction in *H. armigera* larvae 7 and 14 days after applying NSKE 5%. Additionally, Rao et al. (1991) noted that neem oil (3000 ppm) and solvent-based NSKE, EC (1500 ppm) significantly reduced the number of *Helicoverpa* larvae per 10 plants. In the present study, garlic did not show any significant effect on *H. armigera* larvae, suggesting that garlic alone may not be effective against *H. armigera* in the tomato ecosystem. When considering the mean larval count, emamectin benzoate treatment resulted in the lowest larval infestation, followed by neem seed extract. This could be attributed to the rapid action of synthetic pesticides or the quicker degradation of botanical insecticides compared to synthetic ones. Barnby et al. (1989) reported that azadirachtin and its derivatives undergo photodegradation, leading to a significant decrease in their biological activity, which might explain the lesser efficacy of neem-based treatments in this study.

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Table 1: Mean larval population trend of *Helicoverpa armigera* during 2024 under field condition.

Treatments	May				June			Mean
	9th	16th	23rd	30th	6th	13th	20th	
Neem extract (T1)	0.78j	0.72 kl	0.75 jk	0.52 n	0.32	0.15 r	0.00 t	0.46 e
Turmeric crude extracts (T2)	1.02ef	1.08 cd	1.22 ab	0.95 gh	0.92 h	0.78 j	0.00 t	0.81 d
Garlic crude extracts (T3)	1.12c	1.22 ab	1.08 cd	1.02 ef	0.98 fg	0.92 h	0.00 t	0.90 b
Heng crude extracts (T4)	1.08 cd	1.12 c	0.98 fg	0.92 h	0.85 i	0.83 s	0.00 t	0.82 c
Emamectin benzoate (T5)	0.72 xl	0.58 m	0.68 l	0.38 o	0.08 s	0.08 s	0.00 t	0.38 f
Control (T6)	1.22 ab	1.25 a	1.18 b	1.05 de	1.02 ef	0.92 h	0.00 t	0.95 a
Mean	0.99 a	0.99 a	0.93 b	0.81 c	0.72 d	0.61 e	0.00 f	-

Mean in columns followed by the same letters are non-significant 5 % level of probability

LSD $_{(0.05)}$ for Treatments= 0.01

LSD $_{(0.05)}$ for Intervals= 0.01

LSD $_{(0.05)}$ for Treatments x Intervals = 0.04

Yield (kg/ha) and fruit damage (%)

In term of total yield (kg ha^{-1}), the highest yield was recorded in emamectin benzoate (7259 kg ha^{-1}) as followed by neem extract (7497 kg ha^{-1}), turmeric crude extracts (5992 kg ha^{-1}) and heng crude extracts (5857.3 kg ha^{-1}) while lowest yield was recorded in garlic crude extracts 4758.7 kg ha^{-1}) as compared with control treatment (3597.7 kg ha^{-1}). Similarly, in case of fruit damage (%), lowest percent fruit damage was recorded in emamectin benzoate (8.73%) as followed by neem extract (10.03%), heng crude extracts (13.23%), and turmeric crude extracts (14.03 %) while highest fruit damage (%) was recorded in garlic crude extracts (15.91%) as compared with control treatment (18.32%). In this study, heng and turmeric were tested for the first time against *Helicoverpa armigera* in the tomato ecosystem. The results, however, were not promising and indicate a need for further investigation. These findings are consistent with those of Sardana and

Kumar (1989), who observed that neem oil at 2% not only increased yield but was also as effective as monocrotophos at 0.05%. Similarly, Phadke et al. (1988) reported that Neemark, an herbal neem extract, at 0.5% provided the highest yield in treated cotton plots, attributing the protection to the antifeedant properties of neem oil and neem seed extract. Mahadevan (1998) found that 'econeem' at 10 ppm (3.3%) was particularly effective in controlling *H. armigera* on tomatoes, resulting in high yields during both summer and winter seasons. In the present experiment, neem treatments were found to be as effective as the synthetic insecticide emamectin benzoate in reducing crop losses. This is in line with the findings of Srivastava et al. (1984), who reported that an 8% neem seed kernel extract significantly reduced damage by *H. armigera* on red gram, yielding results comparable to treatments with Fenvalerate and Quinalphos. Overall, all treatments had a significant impact in reducing fruit damage, demonstrating that neem seed extract was as effective as emamectin in controlling *H. armigera* and preventing significant crop damage. Kumar and Sangappa (1984) also noted that neem oil at 3% or 5% resulted in the lowest pod damage when applied against *H. armigera* on gram, outperforming synthetic insecticides. Although turmeric extract, garlic extracts, and heng treatments did not reduce the fruit borer population in this study, there was a significant difference between the control and treated plots, likely due to the antifeedant activity of these treatments as reported by Vijayalakshmi et al. (1996).

Table 2: Yield (kg/ha) and fruit damage (%) in tomato crop during 2024.

Treatments	Total yield (kg ha^{-1})	% fruit damage
Neem extract (T1)	7259.0 b	10.03 e
Turmeric crude extracts (T2)	5992.0 c	14.03 c
Garlic crude extracts (T3)	4758.7 e	15.91 b
Heng crude extracts (T4)	5857.3 d	13.23 d
Emamectin benzoate (T5)	7497.0 a	8.73 f
Control (T6)	3597.7 f	18.32 a
LSD (0.05)	4.34	0.22

Mean in columns followed by the same letters are non-significant 5 % level of probability

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Conclusions and recommendations

It is concluded from the results that among the treatments, emamectin benzoate showed highest effectiveness against the pest and in term of yield and % fruit damage emamectin benzoate was recorded as best treatment in the experimental area. Emamectin benzoate is recommended for the control of *Helicoverpa armigera* in tomato crop.

References

Anonymous. 2000. Tomato integrated pest management an ecological guide training resource text on crop Dev., major agronomic practices, diseases and insect ecology, insect pests, natural enemies and diseases of tomato FAO intercountry programme for the Dev. and application of integrated pest management in vegetable growing in South and South-East Asia. Lao People's Democrat. Repub. 2nd ed. 209p.

Barnby, M.A., R.B. Yamaski and J.A. Klocke. 1983. Biological activity of *azadirachtin*, three derivatives and their unltravoilet radiation degradation products against tobacco budworm (Lepidoptera: Noctuidae) larvae. J. Econ. Entomol. 82: 58-63.

Gajete, T.D., L.B. Gajete, J.R. Irabagon and E.B. Tiburcio. 2004. Technoguide for tomato production. In: Technoguides for Agric. Production and Livelihood Projects. CLSU Res. Office, RET, Science City of Muñoz, Nueva Ecija. pp.58-65. Ganeshan, S., K. Raman and B.N. Vyas. 1995.

Effect of certain plant extracts on growth and development of three important Noctuidae pests. Pestol. 19 (10): 18-23.

Hassan, S.A. 1992. Guideline of the side-effect of plant protection product on *Trichogramma chilonis*. In: Guideline for Testing the Effect of Pesticides on Beneficial Organism, (ED) Hassan, S.A. IOBC/ WPRS Bullet. 15 (3): , 19-39.

Hegde, K.K., 2004. Ecofriendly approaches in the management of okra fruits borers. M.Sc (Hons.) Thesis, Univ. of Agric. Sci. Dharwad. 82p.

Kumar, A.R.V. and H.K. Sangappa. 1984. A note on the performance of plant product in the control of gram caterpillar in bengalgram. Curr. Res. 13: 38-40.

Mahadevan, N.R. 1998. *Azadirachtin* to control tomato fruit borer. Insect Environ. 3(4): 10-14.

Munir, K. 2006. Efficacy of different plant crude extracts for the control of insect pests of okra. M.Sc (Hons.) Thesis, The Univ. Agric. Peshawar, Pakistan.

Natekar, M.G., S. Rai and N.P. Agnihotri. 1987. Bioefficacy of synthetic pyrethroids and their residues in brinjal fruit. Pestol. 11(1): 18-22.

Phadke, A.D., V.S. Khandal and S.R. Rahalkar. 1988. Use of neem [*Azadriachta indica*] product in insecticide resistance management (IRM) in cotton. Pest. Bomby. 22(4): 236-238.

Rao, B.S.T., G.P.V. Reddy, M.M.K. Murthy and V.D. Prasad. 1991. Efficacy of neem products in the control of bhendi pest complex. Indian J. Pl. Prot. 19:49-52.

Sardana, H.R. and N.K. Kumar. 1989. Effectiveness of plant oils against leaf hopper, shoot and fruit borer on okra. Indian J. Entomol. 51(2): 167- 171.

Sarode, S.V., Y.S. Jumde, R.O. Deotale and H.S. Thakre. 1995. Evaluation for neem seed kernel extract at different concentration of management of *Helicoverpa armigera*. Indian J. Entomol. 57: 385-388.

Srivastava, K.P., N.P Agnihorti, V.T Gajdhiye and H.K Jain. 1984. Relative efficacy of fenvalerate, quinalphos and neem kernel extracts for the control of pod fly, *Melanagromyza obtusa* (Malloch) and pod borer, *Heliothis armigera* Hubner infesting red gram, *Canjanus cajan* (L) Millsp. together with their residue. J. Entomol. Res. 8(1): 1-4.

Steel, R.G.D and J.H. Torrie. 1980. Principles and procedures of statistics: a biological approach. 2nd Ed. Mcgraw Hill Book, New York, USA. pp.39-40.

Udikeri, S.S., S.B. Patil, V. Rachappa and B.M. Khadi. 2004. Emamectin benzoate 5 SG: A safe and promising bio-rational against cotton bollworms. Pestology, 6: 24-27.

Vijayalaksmhi, K., B. Subhashini and V.K. Shivani. 1996. Plant in pest control – garlic and onion. Centre for Indian Knowledge System, Chennai.120p