

“Comparative study of chemicals with botanicals against spotted stem borer, *Chilopartellus*(Swinhoe) on Maize (*Zea mays* L.)”

ABSTRACT: *Chilo partellus* is regarded as one of the most significant and prevalent insect pests of maize and the mystic aspect of feeding makes it challenging to control. Current study was conducted to evaluate comparative study of chemicals with botanicals against *Chilo partellus*. Eight treatments were tested under field conditions namely Azadirachtin 10,000ppm, Neem oil 3%, Karanj oil 3%, Neem oil 3% + Imidacloprid 17.5%SL, Karanj oil 3% + Imidacloprid 17.5%SL, Imidacloprid 17.5%SL, Spinosad 45%SC and untreated control in Randomized Block Design with three replications. Among all the treatments lowest larval population of *Chilo partellus* were recorded in Karanj oil 3% + Imidacloprid 17.5%SL (1.99) followed by Karanj oil 3% + Imidacloprid 17.5%SL (2.42), Imidacloprid 17.5%SL (2.71), Spinosad 45%SC (3.17), Neem oil 3% (3.73), Karanj oil 3% (3.95) and Azadirachtin 10,000ppm (4.44) were superior over the T₀ untreated control which recorded (7.24). The highest yield was recorded in Karanj oil 3% + Imidacloprid 17.5%SL with 39.20 q/hectare and most economic treatment was Imidacloprid 17.5%SL with highest cost benefit ratio (1:2.2).

Keywords: *Chilo partellus*, Maize stem borer, Maize, Management, Control, Insecticides, Biopesticides, Efficacy

1. INTRODUCTION: Maize (*Zea mays* L.) is the world's leading crop and is widely cultivated as cereal grain that was domesticated in Central America. It is one of the most versatile emerging crops having wider adaptability. Globally, maize is known as queen of cereals because of its highest genetic yield potential (Directorate of Maize Research, ICAR). It is a crop that used to produce a variety of foods and fodder using diverse plant parts, such as grain, leaves, stalks, tassels, and cobs (Singh *et al.*, 2006). It is an important source of vitamins, minerals, lipids, protein, starch, and fiber. It is also highly nutritious for use in cattle and poultry feed (Prasanna *et al.*, 2001, Farnham *et al.*, 2003). In terms of nutrition, maize grains include 4% oil, 70% carbohydrates, 2-3% crude fiber, and 10% protein in addition to vitamins A and E, riboflavin, and nicotinic acid. Zein is low in calcium and lacking in the necessary acids tryptophan and lysine (Joshi 2015). In Asia, maize consumed as

human food contributes over 20% of food calories (Shiferaw *et al.*, 2011). The global consumption pattern of maize is: feed-61%, food-17% and industry- 22%. It has attained a position of industrial crop globally as 83% of its production in the world is used in feed, starch and bio-fuel industries. Further, using maize directly or indirectly more than 3000 products are being made providing a wide opportunity for value addition. Because of its myriad uses, it is a prime driver of the global agricultural economy. With a yield of 1423 million MT, it is grown on 188 million hectare of land in 170 countries across the globe. Worldwide China has maximum area under maize followed by the USA, both together representing 39% of world maize area. Since 2005, India ranks 4th in terms of area with 9.89 million hectare land under maize. (Indian Institute of Maize Research, ICAR 2024). Production of Maize in the country during 2023-24 is estimated at record 224.82 lakh tones. (PJTSAU, 2024). The insect pest complex that affects maize in India is an area that has not received extensive study. Notable insect pests are *Helicoverpa armigera* (Hubner) and *Mythimna separata* (Walker). *Spodoptera frugiperda*, *Atherigona soccata* (Rondani), *Rhopalosiphum maidis* (Fitch), and *Chilo partellus* (Swinhoe) (Chouradiet *et al.*, 2017). Scientists have undertaken numerous investigations and come to the conclusion that the maize stem borer, *C. partellus* is a significant pest of pearl millet (*Pennisetum typhoideum* (Rich), sorghum (*Sorghum bicolor* L.), and maize (*Zea mays* L.) across Asia and Africa. (Panwar, 2005). Similarly, It was also noticed infesting Rice (*Oryza sativa*), Sugarcane (*Saccharum officinarum*) and several millets, grasses. (Kauma *et al.*, 2008). *Chilo partellus*, a member of the Pyralidae family of insects, is a notable biotic barrier to maize cultivation worldwide. (Pingali, 2000). It is most significant pests in Asia and Africa. (Arabjafari and Jalali, 2007). Approximately 139 distinct insect pest species attack maize; among these, *C. partellus* is a major pest in various agroclimatic zones of India. (Shukla and Kumar, 2005). It is very difficult to control the stalk borer, because of cryptic and nocturnal habits of adult moth (Singh *et al.*, 2014).

Chilo partellus lay oval-shaped, creamy white eggs having length of around 0.8 mm. (Panchal and Kachole, 2013). It takes 4–8 days for the eggs to develop into larvae. (Panchal and Kachole, 2013) and takes 28–35 days for the larvae to develop into pupa. Larvae in their final instar measure 25–30 mm long, and their bodies have rows of dark spots. Pupae are long, cylindrical and dark brown colored, males are smaller than females. 5-12 days after pupation, adults emerge from pupae. The moths are pale brown colored with an approximate wingspan of 20-30 mm. These moths have 3–8 day lifespan. When they attain maturity, they

mate and lay eggs. The life cycle of *C. partellus* takes 25–50 days to complete (Panchal and Kachole, 2013). Because maize has more sugars and amino acids than other gramineous hosts, it is more vulnerable to harm from stem borer infestation (Souza, 2002). It starts to infest the crop three to four weeks after sowing and continues to do so until the crop reaches maturity. (Sarup *et al.*, 1978) The leaf-eating and stem-tuning activity of the larvae are the most common symptom of *Chilo partellus* damage to maize plants. In a natural field conditions. the first signs of infestation are characteristic leaf lesions and scarification caused by the first and second instars of *C. partellus* (Sithole, 1990). After hatching, stem borer larvae move over the plant, gather in the funnel, and feed on the curled leaves for a few days before approaching the stalk and stem. (Mushore, 2005). When the infestation is severe, the larvae, either in the leaf whorl or in the stem, can cut through the meristematic tissues; the central leaves dry up to produce the ‘dead heart’ symptom (De Groote, 2002). A dead heart is caused by the borers burrowing upward after entering the stem at the surface of the soil. (Kfir *et al.*, 2002). Exit holes and tunnels in the main stem inhibit plant growth and promote bacterial and fungal diseases (Ndiritu 1999, Songa *et al.*, 2001). Dead hearts reduce translocation, ear damage, lodging, initial leaf senescence and in severe cases complete crop failure (Naz *et al.*, 2003, Gupta *et al.*, 2010). The yield losses exhibit significant regional variations, with a range of 25-40% depending on the pest population density and crop phenological stage of infection (Khan *et al.*, 2015).

2. MATERIALS AND METHODS

The study was conducted in *Kharif*, season 2023 at central research farm, SHUATS, Prayagraj India. Experimental design employed was a Randomized Block Design (RBD) consisting of eight different treatments including untreated control, each treatment was replicated thrice. The Plot size was 2m×1m and treatments were assigned randomly. The treatments included Azadirachtin 10,000ppm (1ml/l) Neem oil 3% (30ml/l), Karanj oil 3% (30ml/l), Neem oil 3% + Imidacloprid 17.5%SL (30ml/l+0.25ml/l), Karanj oil 3% + Imidacloprid 17.5%SL (30ml/l+0.25ml/l), Imidacloprid 17.5%SL (0.5ml/l), Spinosad 45%SC (0.5ml/l) and untreated control. Two sprays were carried out at interval of 15 days during the experimentation to assess the effectiveness of chemicals and botanicals on the *chilopartellus* larval population. Five plants were randomly selected in each treatment and observations were taken one day before spraying application and three, seven and fourteen-days after spraying. Chemicals and Botanicals were applied at their recommended doses at economic threshold level (ETL = 10% infestation).

The Larval population observation of the maize stem borer was calculated according to the following equation:

$$\text{Larval Population} = \frac{\text{Number of Larvae}}{\text{Total number of Plants}}$$

The healthy marketable yield from different treatments were collected separately and weighed. There were two sprays throughout the research period and the treatment cost and common cost of cultivation per hectare was calculated. Total income was realized by multiplying the total yield per hectare by the prevailing market price; while the net benefit was obtained by subtracting the total cost of plant protection from total income. The C:B was calculated by following formula.

$$\text{Cost Benefit Ratio} = \frac{\text{Gross return}}{\text{Total cost of cultivation}}$$

3. RESULTS AND DISCUSSION

3.1 Comparative efficacy of chemicals with botanicals against spotted stem borer, *Chiloptellus* (Swinhoe) after first spray:

The data on the larval population of spotted stem borer on mean (3rd, 7th and 14th DAS) days after first spray revealed that all the treatments were significantly superior over control. Among all the treatments lowest larval population of spotted stem borer was recorded in T₅ Karanj oil 3% + Imidacloprid 17.5%SL (2.48) followed by T₄ Neem oil 3% + Imidacloprid 17.5%SL (2.91), T₆ Imidacloprid 17.5%SL (3.13), T₇ Spinosad 45%SC (3.66), T₂ Neem oil 3% (4.20), T₃ Karanj oil 3% (4.44) and T₁ Azadirachtin 10,000ppm (5.00) is found to be least effective then all the treatments and is significantly superior over the control (6.93). Among all the treatments (T₅ Karanj oil + Imidacloprid, T₄ Neem oil + Imidacloprid, T₆ Imidacloprid), (T₆ Imidacloprid, T₇ Spinosad), (T₇ Spinosad, T₂ Neem oil), (T₂ Neem oil, T₃ Karanj oil) and (T₃ Karanj oil, T₁ Azadirachtin) were found statistically significant at par with each other.

3.2 Comparative efficacy of chemicals with botanicals against spotted stem borer, *Chiloptellus* (Swinhoe) after second spray:

The data on the larval population of spotted stem borer on mean (3rd, 7th and 14th DAS) days after spray revealed that all the treatments were significantly superior over control. Among all the treatments lowest larval population of spotted stem borer was recorded in T₅ Karanj oil 3% + Imidacloprid 17.5%SL (1.50) followed by T₄ Neem oil 3% + Imidacloprid 17.5%SL (1.93), T₆ Imidacloprid 17.5%SL (2.30), T₇ Spinosad 45%SC (2.68), T₂ Neem oil 3% (3.26), T₃ Karanj oil 3% (3.46) and T₁ Azadirachtin 10,000ppm (3.88) is found to be least effective then all the treatments and is significantly superior over the control (7.55). Among all the treatments (T₂ Neem oil, T₃ Karanj oil) were found statistically significant at par with each other.

3.3 Comparative efficacy of chemicals with botanicals against spotted stem borer, *Chilopartellus*(Swinhoe) after first and second spray (Overall mean).

The data on the larval population of spotted stem borer on mean (3rd, 7th and 14th DAS) days after first and second spray revealed that all the treatments were significantly superior over control. Among all the treatments lowest larval population of spotted stem borer was recorded in T₅ Karanj oil 3% + Imidacloprid 17.5%SL (1.99) followed by T₄ Neem oil 3% + Imidacloprid 17.5%SL (2.42), T₆ Imidacloprid 17.5%SL (2.71), T₇ Spinosad 45%SC (3.17), T₂ Neem oil 3% (3.73), T₃ Karanj oil 3% (3.95) and T₁ Azadirachtin 10,000ppm (4.44) is found to be least effective then all the treatments and is significantly superior over the control (7.24). Among all the treatments (T₅ Karanj oil + Imidacloprid, T₄ Neem oil + Imidacloprid, T₆ Imidacloprid), (T₄ Neem oil + Imidacloprid, T₆ Imidacloprid, T₇ Spinosad), (T₇ Spinosad, T₂ Neem oil, T₃ Karanj oil) and (T₂ Neem oil, T₃ Karanj oil T₁ Azadirachtin) were found statistically significant at par with each other.

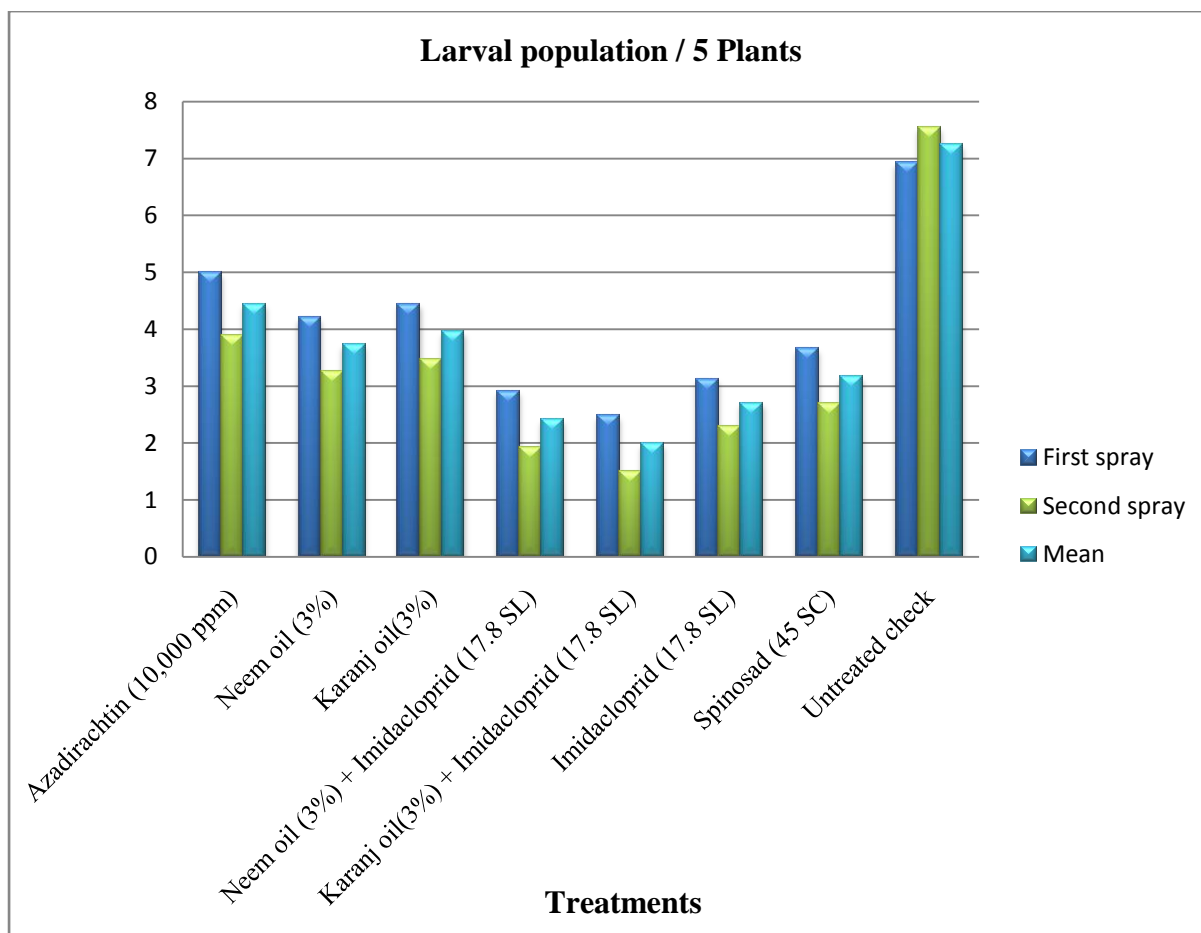


Figure :Comparative efficacy of chemicals with botanicals against spotted stem borer, *Chiloptellus*(Swinhoe) after first and second spray

The yields among all the treatments were significant. The highest yield was recorded in T₅ Karanj oil 3% + Imidacloprid 17.5%SL with 39.20 q/hac followed by T₄ Neem oil 3% + Imidacloprid 17.5%SL with 36.50 q/hac, T₆ Imidacloprid 17.5%SL with 34.40 q/hac, T₇ Spinosad 45%SC with 32.50 q/hac, T₂ Neem oil 3% with 30.70 q/hac, T₃ Karanj oil 3% with 29.85 q/hac, T₁ Azadirachtin 10,000ppm with 27.40 q/hac and T₀ untreated control 19.35 q/hac were recorded which was least yield.

Among all the treatments studied, the best and most economic treatment was T₆ Imidacloprid 17.5%SL (1:2.2), followed by T₅ Karanj oil 3% + Imidacloprid 17.5%SL (1:2.0), T₇ Spinosad 45%SC (1:1.9), T₄ Neem oil 3% + Imidacloprid 17.5%SL (1:1.7), T₁ Azadirachtin 10,000ppm (1:1.7), T₃ Karanj oil 3% (1:1.6), T₂ Neem oil 3% (1:1.5) and T₀ untreated control (1:1.4).

Table:Comparative efficacy of chemicals with botanicals against spotted stem borer, *Chilopartellus*(Swinhoe) on Maize (*Zea mays* L.)”

S. No.	Treatments	Dosage	Larval Population of <i>Chilopartellus</i>									Yield (q/ha)	C:B Ratio	
			First spray					Second spray						Overall mean
			1DBS	3DAS	7DAS	14DAS	Mean	3DAS	7DAS	14DAS	Mean			
T ₁	Azadirachtin (10,000 ppm)	1 ml/lit	5.80	5.60 ^b	4.40 ^b	5.00 ^b	5.00 ^b	4.13 ^b	3.60 ^b	3.93 ^b	3.88 ^b	4.44 ^b	27.40	1:1.7
T ₂	Neem oil (3%)	30 ml/lit	5.93	5.06 ^c	3.26 ^d	4.26 ^c	4.20 ^{cd}	3.40 ^d	3.13 ^c	3.26 ^c	3.26 ^c	3.73 ^{bc}	30.70	1:1.5
T ₃	Karanj oil (3%)	30 ml/lit	5.60	5.33 ^{bc}	3.66 ^c	4.33 ^c	4.44 ^{bc}	3.73 ^c	3.26 ^{bc}	3.40 ^c	3.46 ^c	3.95 ^{bc}	29.85	1:1.6
T ₄	Neem oil (3%) + Imidacloprid (17.8SL)	30ml/lit + 0.25 ml/lit	5.80	3.86 ^e	2.13 ^e	2.73 ^e	2.91 ^f	2.20 ^f	1.66 ^e	1.93 ^f	1.93 ^f	2.42 ^{de}	36.50	1:1.7
T ₅	Karanj oil (3%) + Imidacloprid (17.8SL)	30ml/lit + 0.25 ml/lit	6.06	3.40 ^f	1.73 ^f	2.33 ^f	2.48 ^f	1.66 ^g	1.33 ^e	1.53 ^g	1.50 ^g	1.99 ^e	39.20	1:2.0
T ₆	Imidacloprid (17.8SL)	0.5 ml/lit	5.73	4.06 ^e	2.33 ^c	3.00 ^e	3.13 ^{ct}	2.46 ^f	2.13 ^d	2.33 ^e	2.30 ^e	2.71 ^{de}	34.40	1:2.2
T ₇	Spinosad (45 SC)	0.5 ml/lit	5.73	4.46 ^d	3.00 ^d	3.53 ^d	3.66 ^{de}	2.86 ^e	2.46 ^d	2.73 ^d	2.68 ^d	3.17 ^{cd}	32.50	1:1.9
T ₈	Control		6.06	6.60 ^a	6.93 ^a	7.26 ^a	6.93 ^a	7.40 ^a	7.60 ^a	7.66 ^a	7.55 ^a	7.24 ^a	19.35	1:1.4
F-Test			NS	S	S	S	S	S	S	S	S	S		
S.Ed.(±)			NS	0.15	0.18	0.13	0.32	0.13	0.13	0.16	0.13	0.81		
CD (0.05)			NS	0.32	0.38	0.28	0.67	0.28	0.28	0.33	0.28	0.95		

DBS-Day before Spraying, DAS-Day after Spraying, NS- Nonsignificant, S-Significant

4. CONCLUSION : *Chilo partellus*, a lepidopteran stem borer, damages the worldwide maize ecosystem economically. Due of its cryptic nature of feeding, it is challenging to control with chemical Insecticides. The excessive use of chemical insecticides and its associated detrimental effects have been widely criticized. Insects quickly develop resistance to chemical insecticides when they are frequently exposed to them but botanical insecticides contain a variety of naturally occurring active ingredients with unique modes of actions, such as antifeedant, repellent, oviposition deterrent, and synergistic effects, making resistance difficult to develop. Therefore, when chemical and botanical insecticides are used together, they have substantially greater efficacy than when they are applied separately because of their synergistic and complimentary effects. Keeping in the view present research was conducted and results shows that combinations of chemicals with botanical insecticides, Karanj oil 3% + Imidacloprid 17.5%SL followed by Neem oil 3% + Imidacloprid 17.5%SL shows highest efficacy with highest yield 39.20 and 36.50 q/hacare respectively against spotted stem borer but economically best treatment was Imidacloprid (17.8SL) which shows highest cost benefit ratio (1:2.2). Combinations of chemicals with botanicals have lower cost benefit ratio to some extent compared to chemicals because of the high dosages and expense of botanicals but it considered as a feasible alternative of chemicals and reduces adverse acute and chronic effects in environment along with bioaccumulation and biomagnifications.

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