International Journal of Advanced Biochemistry Research 2024; SP-8(5): 01-04

International Journal of Advanced Biochemistry Research

ISSN Print: 2617-4693
ISSN Online: 2617-4707
IJABR 2024; SP-8(5): 01-04
www.biochemjournal.com
Received: 01-02-2024
Accepted: 04-03-2024

Ayush Jain
M.Sc. Scholar, Department of Entomology, SHUATS, Prayagraj, Uttar Pradesh, India

Ashwani Kumar
Associate Professor and Head, Department of Entomology, SHUATS, Prayagraj, Uttar Pradesh, India

Corresponding Author:
Ayush Jain
M.Sc. Scholar, Department of Entomology, SHUATS, Prayagraj, Uttar Pradesh, India

Comparative efficacy and economics of selected chemicals and *Metarhizium anisopliae* against fall armyworm, *Spodoptera frugiperda* (J.E. Smith) on maize (*Zea mays* L.) at Prayagraj, Uttar Pradesh

Ayush Jain and Ashwani Kumar

DOI: https://doi.org/10.33545/26174693.2024.v8.i5Sa.1083

Abstract
The experiment was conducted at the research plot of the Department of Entomology at Central Research Farm, Sam Higginbottom University of Agriculture Technology and Sciences, Prayagraj during the *Kharif* season of 2023. The experiment was laid out in a Randomized Block Design (RBD) with three replication, Seven treatments, and untreated control were evaluated against, *Spodoptera frugiperda* i.e. T_1 Thiamethoxam 12.6% + Lambda Cyhalothrin 9.5% ZC, T_2 Chlorantraniliprole 18.5% SC, T_3 Lambda Cyhalothrin 5% EC, T_4 Chlorantraniliprole 9.3% + Lambda Cyhalothrin 9.5% ZC, T_5 *Metarhizium anisopliae,* T_6 Thiamethoxam 25% WG, T_7 Spinosad 45% SC, and T_8 Control. The results on *the Spodoptera frugiperda* larval population after both sprays proved that all of the treatments were significantly superior to the control. Among the all treatments lowest larval population of *Spodoptera frugiperda* was recorded after both sprays in Chlorantraniliprole 18.5% SC (0.93). Spinosad 45% SC (1.06), was found to be the next best treatment followed by Chlorantraniliprole 9.3% + Lambda Cyhalothrin 9.5% ZC (1.22), Lambda Cyhalothrin 5% EC (1.37), Thiamethoxam 12.6% + Lambda Cyhalothrin 9.5% ZC (1.48), Thiamethoxam 25% WG (1.75) whereas, *Metarhizium anisopliae* (1× 108 CFU/ml) (1.95) was found to be least effective but superior over the control. While, the highest yield was obtained from the treatment Chlorantraniliprole 18.5% SC (42.40 q/ha) as well as B: C ratio (1:2.58), followed by Spinosad 45% SC (39.62 q/ha), (1:2.49), Chlorantraniliprole 9.3% + Lambda Cyhalothrin 9.5% ZC (36.24 q/ha), (1:2.27), Lambda Cyhalothrin 5% EC (33.50 q/ha), (1:2.13), Thiamethoxam 12.6% + Lambda Cyhalothrin 9.5% ZC (29.32q/ha), (1:1.90) and Thiamethoxam 25% WG (26.12 q/ha), (1:1.69) respectively, while the lowest grain yield of (24.63 q/ha), (1:1.48) was observed in plot treated with *Metarhizium anisopliae* and the untreated control plot resulted least grain yield (18.24 q/ha), (1:1.25).

Keywords: Biopesticides, chemical insecticides, maize, *Spodoptera frugiperda*

Introduction

Maize belongs to the tribe Maydeae of the grass family Poaceae. "Zea"' was derived from an old Greek name for a food grass. The genus Zea consists of four species of which *Zea mays* L. is economically important. The number of chromosomes in *Zea mays* is 2n =20 (Murdia *et al*., 2016) [23]. Globally, Maize (*Zea mays* L.) is known as the "queen of cereals" because it has the highest genetic yield potential among the cereals. In India, maize is the third most important food crop after rice and wheat (Suthar *et al*., 2020) [26].

It has various traditional uses and is useful for various diseases like Analgesic, Astringent, Anti- allergic, Emollient, skin rashes, stored throat, Anti angina, Anti-hypertensive, biliousness, Anti- lithiasis, Anti-diarrheal Urinary disorders including dysuria, cystitis, urethritis, nocturnal enuresis, Anti-prostatitis, Anti-tumor, Anti dysentery, Diuresis etc. (Thuma *et al*., 2019) [27]. Another major categorization is based on the size and composition of the endosperm containing an appreciable amount of carbohydrates (66.2%), lipids (3.6%), proteins (11.1%), and vitamins and minerals (3.6%) along with fibers (2.7%). Unfortunately, maize is deficient in two major amino acids, namely tryptophan and lysine, and also minerals like iron zinc, and vitamin B12.

Maize is cultivated on nearly 190 m ha in about 165 countries having a wider diversity of soil, climate, biodiversity, and management practices that contribute 39% to the global grain production. The United States of America (USA) is the largest producer of maize contributing nearly 36% of the total production in the world (APEDA, 2015) [3]. India ranks sixth in global maize production and fifteenth position in its productivity in the world, contributing to 2.4 percent of world production with almost a 5 percent share in world harvested area (Sangle *et al.*, 2020) [25].

The predominant maize-growing states that contribute more than 80 percent of the total maize production are Andhra Pradesh (20.9%), Karnataka (16.5%), Rajasthan (9.9%), Maharashtra (9.1%), Bihar (8.9%), Uttar Pradesh (6.1%), Madhya Pradesh (5.7%), Himachal Pradesh (4.4%). Apart from these states' maize is also grown in Jammu and Kashmir and North-Eastern states (Murdia *et al.*, 2016) [23].

It has been reported that demand for national maize is steadily increasing year after year; for instance, in 2018, demand was 14.37 million tons, rising to 23 million tons in 2021 and 23.1 million tons in May 2022, and it is predicted that in 2025 it will reach 33.13 million tons. South Sulawesi is designated as a national maize production hub. The average cultivated area exceeds 300 thousand ha, contributing to an annual production of more than 1.5 million tons (Bahtira *et al.*, 2023) [5].

Maize is affected by as many as 141 insect pests. Among these, only a few are considered major pests in India *viz*., shoot fly, stem borers, armyworm (*Mythimna separata*), and *Helicoverpa armigera.* However, the recent invasion of the fall armyworm, *Spodoptera frugiperda* (Noctuidae: Lepidoptera) has become a great threat to maize cultivation (Mallapur *et al.,* 2019) [22]. Damage due to this pest attack can reduce corn grain yield by up to 34 percent in Brazil, 20 to 50 percent in Africa (Thumar *et al.*, 2020) [27] and 40% in Honduras and 72% in Argentina (Early *et al.*, 2018) [13] in Africa has the potential to cause maize yield losses in a range from 8.3 to 20.6m tonnes per annum, in the absence of any control methods (Day *et al.*, 2017) [10] In Brazil, reduction in maize grain yield that amounts to annual loss of US$ 400 million and causes annual crop losses of over US$ 500 million throughout the south-east United States and the Atlantic coast. Yield losses in maize due to fall armyworm damage reach up to 32% in the United States and 45-60% in Nicaragua (Dileep and Murali, 2020) [12]. In Nigeria FAW caused yield losses in a range of 8.3 to 20.6 million tonnes per annum, destroying 21%-53% of the annual production of maize averaged over three years in these countries (Igyuve *et al.*, 2018) [18].

Materials and Methods

The experiment was conducted at SHUATS, Central Research Farm (CRF), Sam Higginbottom University of Agriculture, Technology and Sciences, Naini, Prayagraj. The research trail was laid out during the kharif season of 2023 in Randomized Block Design (RBD) with three replications, seven treatments, and an untreated control. The plot had dimensions of 2×1m2. The maize seeds of variety 'Deccan-115' were sown in plots keeping row-to-row and plant-to-plant distances of 45cm×30cm. Larval Population observation was recorded by observing the number of larvae present per 5 randomly selected plants in an area of 48 m2. From each treatment for the presence of egg masses and larvae one day before insecticide application and on 3^{rd}, 7^{th} and 14^{th} days after each application. The percent infestation over control against fall armyworm was calculated by considering the mean of three observations recorded on the 3rd, 7th, and 14th days after the first and second spraying. The mean population was calculated by following the formula.

$$\text{Mean Larval Population} = \frac{\text{Number of larvae}}{\text{5 plants}}$$

(Alam *et al*., 2022) [2]

Cost Benefit Ratio of Treatments

Gross returns were calculated by multiplying the total yield with the market price of the produce. The cost of cultivation and cost of treatments were deducted from the gross returns, to find out the returns and cost-benefit ratio by following the formula

$$\text{Cost Benefit Ratio} = \frac{\text{Gross Returns}}{\text{Total Cost of Cultivation}}$$

(Thumar *et al*., 2020) [27]

Results and Discussion

The data revealed on the population of *Spodoptera frugiperda* over control on the mean (3, 7 and 14 DAS) after the first spray revealed that all the treatments were significantly superior over control. Among all the treatments the lowest percent of the larval population was observed in the T_2 Chlorantraniliprole 18.5% SC (1.64) followed by T_7 Spinosad 45% SC (1.73), T4 Chlorantraniliprole 9.3% + Lambda-cyhalothrin 9.5% ZC (1.95), T_3 Lambda-cyhalothrin 5% EC (2.04), T_1 Thiamethoxam 12.6 + Lambda-cyhalothrin 9.5% ZC (2.20). In this T_6 Thiamethoxam, 25% WG (2.40) and T_5 *Metarhizium anisopliae* (1 x 108 cfu/ml) (2.60) is found to be the highest larval population than all treatments and significantly superior over the control T_8 (3.19).

The data revealed on the population of *Spodoptera frugiperda* over control on the mean (3,7 and 14 DAS) after the second spray revealed that all the treatments were significantly superior over control. Among all the treatments the lowest percent of the larval population was observed in the T_2 Chlorantraniliprole 18.5% SC (0.93) followed by T_7 Spinosad 45% SC (1.06), T4 Chlorantraniliprole 9.3% + Lambda-cyhalothrin 9.5% ZC (1.22), T_3 Lambda-cyhalothrin 5% EC (1.37), T_1 Thiamethoxam 12.6 + Lambda-cyhalothrin 9.5% ZC (1.48). In this T_6 Thiamethoxam, 25% WG (1.75) and T_5 *Metarhizium anisopliae* (1 x 108 cfu/ml) (1.95) is found to be the highest larval population than all treatments and significantly superior over the control T_8 (3.75).

The data on the population of *Spodoptera frugiperda* on the first spray, second spray, and overall mean revealed that all the treatments were significantly superior to the control. Among all the treatments, the lowest population was recorded in Chlorantraniliprole 18.5% EC (1.28). Similar findings were reported by Deshmukh *et al.* (2020) [11], Hardke *et al*. (2011) [16], and Beuzelin *et al.* (2022) [7] who reported that Chlorantraniliprole @ 18.5% EC was the most effective treatment indicating recorded lowest population of fall armyworm (*Spodoptera frugiperda*). Spinosad 45% SC (1.39) was found to be the next best treatment which is in line with the findings of Ahir *et al*. (2021) [1], Idrees *et al*. (2022) [17], Bajracharya *et al*. (2020) [6] who reported that Spinosad 45% SC was the most effective treatment indicating recorded lowest population of fall armyworm (*Spodoptera frugiperda*). Chlorantraniliprole 9.3% + Lambda Cyhalothrin 9.5% ZC (1.58) was found to be the next best treatment which is in line with the findings of Bharadwaj *et al*. (2020) [8], Gouthami *et al*. (2022) [15], Applanaidu and Kumar (2022) [4]. Lambda Cyhalothrin 5% EC (1.70), was found to be the next best treatment which is in line with the findings of Charitha and Kumar (2023) [9], Patidar *et al*. (2022) [24], Khairul *et al*. (2022) [20]. Thiamethoxam 12.6% + Lambda Cyhalothrin 9.5% ZC (1.84) was found to be the next best treatment which is in line with the findings of Sangle *et al*. (2020) [25], Kumari *et al*. (2020) [21]. Thiamethoxam 25% WG (2.078) was found to be the next best treatment which is in line with the findings of Mallapur *et al*. (2019) [22], and Ingavale (2021). The result of *Metarhizium anisopliae* (1× 108 CFU/ml) (2.27) was found to be least effective but comparatively superior over the control, these findings are supported by Ekshinge and Kumar (2022) [14].

Tables 1: Effect of selected chemicals and Metarhizium anisopliae against larval population of *Spodoptera frugiperdain* in maize (1st and 2nd spray)

Sr. No.	Treatments	Dose	Number of Larvae (*Spodoptera frugiperda*)/five plants								Yield (q/ha)	C: B Ratio
			1 DBS	3 DAS	7 DAS	14 DAS	3 DAS	7 DAS	14 DAS	Overall mean		
T_1	Thiamethoxam 12.6% + Lambda Cyhalothrin 9.5% ZC	0.125 ml/lit	2.73	2.40	2.00	2.20	2.00	1.06	1.40	1.84	29.32	1:1.90
T_2	Chlorantraniliprole 18.5% SC	0.4 ml/lit	2.73	1.86	1.40	1.66	1.33	0.60	0.86	1.28	42.40	1:2.58
T_3	Lambda Cyhalothrin 5% EC	0.64 ml/lit	2.80	2.26	1.80	2.06	1.80	1.06	1.26	1.70	33.50	1:2.13
T_4	Chlorantraniliprole 9.3% + Lambda Cyhalothrin 9.5% ZC	0.50 ml/lit	2.86	2.20	1.66	2.00	1.66	0.93	1.06	1.58	36.24	1:2.27
T_5	*Metarhizium anisopliae* (1× 108 CFU/ml)	2.5 ml/lit	3.00	2.80	2.40	2.60	2.33	1.66	1.86	2.27	24.63	1:1.48
T_6	Thiamethoxam 25% WG	0.25 g/L	2.86	2.60	2.20	2.40	2.13	1.46	1.66	2.07	26.12	1:1.69
T_7	Spinosad 45% SC	0.25 ml/lit	2.73	1.93	1.53	1.73	1.46	0.73	1.00	1.39	39.62	1:2.49
T_8	Control	-	3.06	3.06	3.13	3.40	3.53	3.73	4.00	3.47	18.24	1:1.25
	F - test		NS	S	S	S	S	S	S	S	--	---
	S.Ed. (±)		-----	0.070	0.081	0.086	0.075	0.063	0.065	0.310	--	--
	C.D.at 0.05%		-----	0.150	0.173	0.185	0.185	0.160	0.135	0.738	--	--

DBS= Day Before Spray, DAS= Day After Spray, NS= Non- Significant, S= Significant

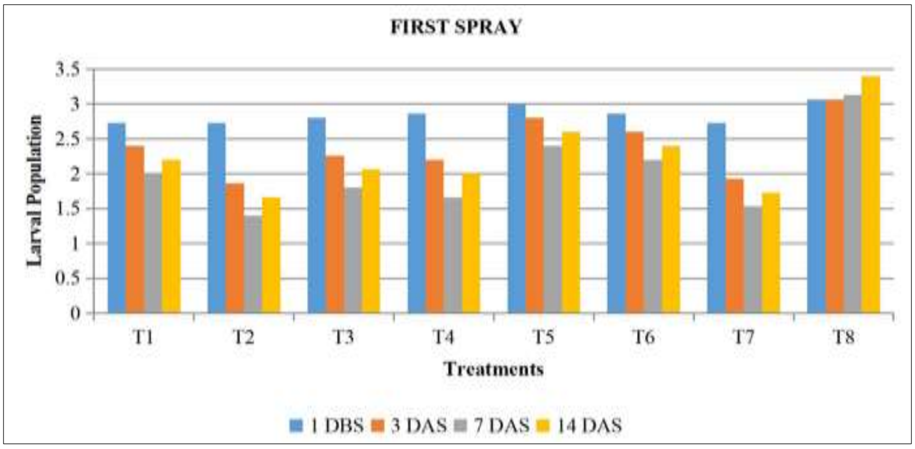

Fig 1: Efficacy of selected chemicals and *Metarhizium anisopliae* against larval population of fall armyworm (*Spodoptera frugiperda*) on maize (*Zea mays*) (First spray)

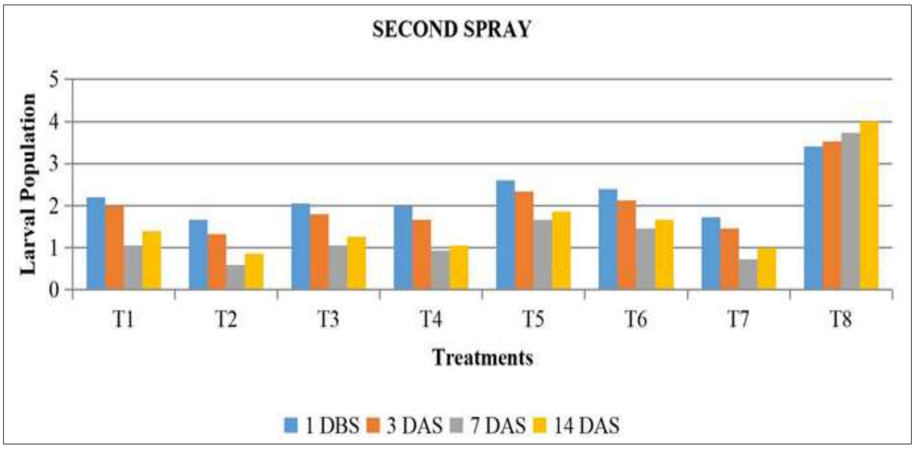

Fig 2: Efficacy of selected chemicals and *Metarhizium anisopliae* against larval population of fall armyworm (*Spodoptera frugiperda*) on maize (*Zea mays*) (Second spray)

Conclusion

Based on the current findings, it is evident that the application of Chlorantraniliprole 18.5% EC resulted in the lowest larval population of fall armyworm in maize plants. Additionally, the highest cost-benefit ratio was recorded for Chlorantraniliprole 18.5% EC. This indicates that Chlorantraniliprole 18.5% EC exhibits superior efficacy in controlling the population of fall armyworm in maize.

References

1. Ahir KC, Mahla MK, Sharma K, Babu SR, Kumar A. Bio-efficacy of insecticides against fall armyworm. Indian Journal of Agricultural Sciences. 2021;91(12):1796-1800.
2. Alam T, Shivakumara MN, Prasad R, Narayan A. Studies on the population dynamics of fall armyworm, *Spodoptera frugiperda* (J.E. Smith) on maize about weather parameters. The pharma innovation journal. 2022;SP-11(10):971-975.
3. APEDA-Agricultural and Processed Food Products Export Development Authority; c2015. [Accessed: Insert Date]. Available from: https://apeda.gov.in
4. Appalanaidu B, Kumar A. Comparative efficacy of selected chemicals and biopesticides against fall armyworm [*Spodoptera frugiperda* (J. E. Smith)] on maize (*Zea mays* L.) at Prayagraj (U.P). The Pharma Innovation Journal. 2022;11(5):1472-1476.
5. Bahtira R, Arsyad M, Salman D, Azrai M, Tenrirawe A, Yasin M, *et al*. Promoting the New Superior Variety of National Hybrid Maize: Improve Farmer Satisfaction to Enhance Production. Agriculture. 2023;13(1):174.
6. Bajracharya ASR, Bhat B, Sharma P. Field Efficacy of Selected Insecticides against Fall Armyworm, *Spodoptera frugiperda* (JE Smith) in Maize. Journal of the Plant Protection Society. 2020;6:127-133.
7. Beuzelin JM, Larsen DJ, Roldán EL, Schwan Resende E. Susceptibility to chlorantraniliprole in fall armyworm (Lepidoptera: Noctuidae) populations infesting sweet corn in southern Florida. Journal of Economic Entomology. 2022;115(1):224-232.
8. Bharadwaj GS, Mutkule DS, Thakre BS, Jadhav AS. Bio- efficacy of different insecticides against fall armyworm, *Spodoptera frugiperda* (J.E. Smith) on Maize. Journal of Pharmacognosy and Phytochemistry. 2020;Sp 9(5):603-607.
9. Charitha K, Kumar A. Field Efficacy of Selected Insecticides against Fall Armyworm, *Spodoptera frugiperda* (J. E. Smith) On Maize (*Zea mays* L.) At Prayagraj. Journal of Experimental Zooology India. 2023;26(2):2221-2224.
10. Day R, Abrahams P, Bateman M, Beale T, Clottey V, Cock M, Witt A. Fall armyworm: impacts and implications for Africa. Outlooks on Pest Management. 2017;28(5):196-201.
11. Deshmukh S, Pavithra HB, Kalleshwaraswamy CM, Shivanna BK, Maruthi MS, David Mota-Sanchez. Field efficacy of insecticides for management of invasive fall armyworm, *Spodoptera frugiperda* (J. E. Smith) (Lepidoptera: Noctuidae) on maize in India. Florida Entomologist. 2020;103(2):221-27.
12. Dileep NT, Murali K, Prabhu C, Ganiger, Mahesh HM. Safe and cost-effective management of the fall armyworm, *Spodoptera frugiperda* (Lepidoptera: Noctuidae) using green insecticide baits. International Journal of Chemical Studies. 2020;8(5):106-110.
13. Early R, González-Moreno P, Murphy ST, Day R. Forecasting the global extent of invasion of the cereal pest *Spodoptera frugiperda*, the fall armyworm. NeoBiota. 2018;40:25-50.
14. Ekshinge SN, Kumar A. Efficacy of selected insecticides against fall armyworm [*Spodoptera frugiperda* (J. E. Smith)] on maize (*Zea mays* L.). The Pharma Innovation Journal. 2023;12(5):4470-4473.
15. Gouthami BD, Seetha RP, Dhljrtja S, Suresh M. Field Evaluation of Insecticides Against Fall Army Worm *Spodoptera frugiperda* (J.E Smith) in Sweet Corn. IndianJournals.com. 2021;83(2):219-222.
16. Hardke JT, Temple JH, Leonard BR, Jackson RE. Laboratory toxicity and field efficacy of selected insecticides against fall armyworm (Lepidoptera: Noctuidae). Florida Entomologist. 2011;272-278.
17. Idrees A, Qadir ZA, Afzal A, Ranran Q, Li J. Laboratory efficacy of selected synthetic insecticides against second instar invasive fall armyworm, *Spodoptera frugiperda* (Lepidoptera: Noctuidae) larvae. Plos one. 2022;17(5).
18. Igvuve TM, Ojo GOS, Ugbaa MS, Ochigbo AE. Fall armyworm (*Spodoptera frugiperda*); its biology, impact, and control on maize production in Nigeria. Nigerian journal of crop science. 2018;5(1):70-79.
19. Ingavale D. Control of Fall Armyworm (*Spodoptera frugiperda*) by Using Some Selective Chemical Insecticides. International Journal of Innovative Science and Research Technology. 2021;6(2):2456-2165.
20. Khairul MD, Rahman MDM, Ara E, Hossain MDS, Amin MDR. Field efficacy of selected insecticides and botanicals against fall armyworm in maize. Journal of Entomology and Zoology Studies. 2022;10(6):33-38.
21. Kumari M, Deole S, Tiwari S. Field efficacy of selected insecticides against fall armyworm on maize crop. International Journal of Chemical Studies. 2020;8(6):255-259.
22. Mallapur CP, Naik AK, Hagari S, Praveen T, Naik M. Laboratory and field evaluation of new insecticide molecules against fall armyworm, *Spodoptera frugiperda* (JE Smith) on maize. Journal of Entomology and Zoology Studies. 2019;7(5):729-733.
23. Murdia LK, Wadhwani R, Wadhawan N, Bajpai P, Shekhawat S. Maize utilization in India: an overview. American Journal of Food and Nutrition. 2016;4(6):169-176.
24. Patidar S, Das SB, Vishwakarma R, Kumari P, Mohanta S, Paradkar VK. Field evaluation of insecticides against fall armyworm infesting maize. The Pharma Innovation Journal. 2022;SP-11(4):892-895.
25. Sangle SV, Jayewar NE, Kadam DR. Efficacy of insecticides on larval Population of fall armyworm, *Spodoptera frugiperda* on maize. Journal of Entomology and Zoology Studies. 2020;8(6):1831-1834.
26. Suthar M, Zala MB, Varma HS, Lunagariya M, Patel MB, Borad BP. Bioefficacy of granular insecticides against fall armyworm, *Spodoptera frugiperda* (J E Smith) in maize. International Journal of Chemical Studies. 2020;SP-8(4):174-179.
27. Thumar RK, Zala MB, Varma HS, Dhobi CB, Patel BN, Patel MB, Borad PK. Evaluation of insecticides against fall armyworm, *Spodoptera frugiperda* (J. E. Smith) infesting maize. International Journal of Chemical Studies. 2020;8(4):100-104.