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Efficacy of different Chemicals and Neem Products against Fall Armyworm, [*Spodoptera frugiperda* (J. E. Smith)] in Maize (*Zea mays* L.)

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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 *Rabi* season of 2022-2023. 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 Chlorantraniliprole 18.5% SC@ 0.4ml/lit, T_2 Emamectin benzoate 5% SG @0.5g/lit, T_3 Spinetoram 11.7% SC @0.9ml/lit, T_4 Flubendiamide 39.35% SC @0.24ml/lit, T_5 Novaluron 10%EC@1.0ml/lit, T_6 Neem oil 2% @ 20ml/lit, T_7 NSKE 5%@50ml/lit, and Control. The results on *Spodoptera frugiperda* larvae population after the first and second spray proved that all of the treatments were significantly superior to the control. Among the all treatments, Spinetoram 11.7% SC (3.77), (2.17) was recorded minimum larval population of *Spodoptera frugiperda* after both sprays followed by, Chlorantraniliprole 18.5% SC (3.95), (2.44), and maximum larval population was recorded in Neem oil @2% (4.86), (3.31), followed by NSKE @ 5% (5.06), (3.51), was found to be least effective but superior over the control. While, the highest yield was obtained from the treatment Spinetoram 11.7%SC (40.10 q/ha) as well as C: B ratio (1:1.83), followed by Chlorantraniliprole 18.5% SC (33.03q/ha), (1:1.74), Emamectin benzoate 5% SG (30.01q/ha), (1:1.73), and Neem oil @ 2% (27.32 q/ha), (1:1.56) respectively, while the lowest grain yield of (26.66 q/ha), (1:1.53) was observed in plot treated with NSKE @5% and the untreated control plot resulted least grain yield (19.49 q/ha), (1:1.16) in comparison to plots treated with different chemicals and neem products. Now a days the fall armyworm was very serious challenging pest in the world.

Keywords: Chemicals, Cost Benefit ratio, Efficacy, Maize, Neem products, *Spodoptera frugiperda*.

INTRODUCTION

Zea mays L. generally known as maize, is a member of the Poaceae family. It is one of the most adaptable growing crops, with greater tolerance to a variety of agro-climatic conditions. Because of its superior genetic output potential among cereals, this crop is known as the "Queen of cereals" around the world. Its significance stems from the fact that it is not only utilised as human food and animal feed, but it is also widely employed in the corn starch business, corn oil manufacturing, and as baby corn in many recipes (Singh, 2014).

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 fibres (2.7%). Unfortunately, maize is deficient in two major amino acids, namely tryptophan and lysine and also minerals like iron and zinc and vitamin B12. Due to a good nutritional profile, a high proportion of maize grains is processed industrially for transforming into value-added products by three basic methods:- wet milling, dry milling and nixtamalization that enhance shelf stability of the product by preventing the hydrolysis of lipids. Potassium is a major nutrient present which has a good significance because an average human diet is deficient in it (Kaushal *et al*., 2023).

Overall, the number of farmers using cover cropping has increased in recent years, owing in part to recent governmental incentives. The overall farmland area planted with cover crops in the United States in 2017 (6.2 million ha) was 50% more than in 2012 (NASS, 2021), and has continued to rise over the last half-decade. However, overall frequency is minimal, at around 5% of planted area in 2017 (Wallander *et al*., 2021).

It is cultivated 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).

The country represents nearly 4% of the global maize area and 2% of global production. The peninsular India represents nearly 40% of the total maize area in the country producing over 52% of production. Madhya Pradesh and Karnataka are the most important maize growing states representing 14.0 and 13.7% of crop acreage respectively, followed by Maharashtra (12.0%), Rajasthan (9.8%), Uttar Pradesh (8.0%), Telangana (6.1%), Bihar (5.4%), Gujarat (4.7%) and Tamil Nadu (3.8%) (Rakshit *et al*., 2022).

Maize borers and shootfly are regular pests that too are occurring in three different growing seasons of the crop. is a *Chilo partellus* regular pest of *Kharif* maize. *Sesamia inferens* is more prevalent in *Rabi* crop but it also occurs in spring maize. *Atherigona* spp. is a regular pest of spring in northern part of India. The loss caused by insect pests in maize crop ranges from 5- 15% (Pradyumn *et al.,* 2012).

Within a year of the first report, FAW had developed to become a serious pest of maize throughout the country, including the states of the northeast. The rapid expansion of the pest, the high damage it causes and the consequent need for intensive use of pesticides seriously threaten food and nutritional security and the livelihood of millions of resource-poor farmers worldwide (Singh *et al*., 2023).

The **Food and Agriculture Organization (FAO)** of the United Nations has declared *S. frugiperda* as one of the major invasive pests in the world, emphasizing that serious attention needs to be placed on *Spodoptera frugiperda* as it may threaten global food security due to its polyphagous nature (FAO, 2017).

In India, it was first noticed on maize in Karnataka during May, 2018 later, it was spread to Andhra Pradesh, Madhya Pradesh, Maharashtra, Tamil Nadu and Telangana (Kalleshwaraswamy *et al.,* 2018).

In India, fall armyworm (FAW) was firstly reported in the research fields of maize at the University of Agricultural and Horticultural Sciences, Shimoga, Karnataka. In Chhattisgarh the *Spodoptera frugiperda* was first reported at Raipur (Deole and Paul 2018).

The Fall armyworm (FAW) (*Spodoptera frugiperda* J.E. Smith) (Lepidoptera: Noctuidae) is a highly polyphagous and destructive agricultural pest with a wide host range (> 100 plant species that include cereals, legumes, cotton, potato, banana, vegetables, and grasses (Kalyebi *et al.,* 2023).

The pest has spread to over 44 countries in Africa since its first detection in 2016, causing maize yield losses valued at between US$2,531 and US$6,312 million per annum (Nyamutukwa *et al.,* 2022).

Maize yield loss of 20–50% in recent estimates at Africa suggests severe impact on livelihoods of the farmers depended on Maize farming (Early *et al*., 2018).

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 trails was laid out during the *Rabi* season of 2022-2023 in Randomized Block Design(RBD) with three replications, seven treatments and untreated control. The plot had dimensions of $2\times1m^2$. The maize seeds of variety 'Ajeet-Vajra' were sown in plots keeping row to row and plant to plant distances of 60cm×20cm.

All of the chemicals and neem products used in the study were sprayed as foliar application. The eight different treatments were used with dosage consisting of T_1 Chlorantraniliprole 18.5%SC @0.4ml per lit, T_2 Emamectin benzoate 5% SG @ 0.4g per lit, T_3 Spinetoram 11.7% SC @0.9ml per lit, T_4 Flubendiamide 39.35% SC @ 0.24ml per lit, T_5 Novaluron 10%EC @1.0ml per lit, T_6 Neem oil 2% @20ml /lit, T_7 NSKE 5%@50ml/lit and T_8 untreated control. Two sprays were carried out at intervals of 15 days during the experiment to assess the effectiveness of pesticides when the *Spodoptera frugiperda* larval population reached the 4-6 ETL threshold. On five randomly chosen and tagged plants in each plot, pre- and post-treatment observations on the larvae population were made shortly before 24 hours and 3, 7, and 14 days following application, respectively.

Formulae used:

The spray solution of desired concentration was prepared by adoption the following formula:

$$V = \frac{(C \times A)}{\%a.i.}$$

Where,

V= Volume of a formulated pesticide required

C= Concentration required.

A= Volume of total solution to be prepared.

% a. i. = given Percentage strength of a formulated pesticide (Sisay *et al.*, 2019).

Larval population (no.) = Number of larvae/ 5 plants

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

(Thumar *et al.*, 2020).

RESULTS AND DISCUSSION

The data revealed on population of *Spodoptera frugiperda* over control on mean (3,7 and 14 DAS) after first spray revealed that all the treatments were significantly superior over control (6.31). Among all the treatments minimum larvae population was recorded in Spinetoram 11.7% SC (3.77) followed by Chlorantraniliprole 18.5 %SC (3.95), Emamectin benzoate 5% SG (4.17), Flubendiamide 39.35% SC (4.37), Novaluron 10 %EC (4.57), Neem oil @2%(4.86) and NSKE @5% (5.06). In this the maximum larvae population was recorded in NSKE @5% (5.06) was found to be least effective but superior over the control. After second spray revealed that all the treatments were significantly superior over control (7.02). Among all the treatments minimum larvae population was recorded in Spinetoram 11.7% SC (2.17) followed by Chlorantraniliprole 18.5% SC (2.44), Emamectin benzoate 5% SG (2.66), Flubendiamide 39.35% SC (2.86), Novaluron 10% EC

(3.06), Neem oil @2% (3.31). In this the maximum larvae population was recorded in NSKE @5% (3.51) was found to be least effective but superior over the control.

The result of present investigations that, all the treatments showed best in yield over control. The highest yield of grain was recorded in the plot, treated with Spinetoram 11.7% SC (40.10 q/ha), which was followed by Chlorantraniliprole 18.5% SC (33.03 q/ha), Emamectin benzoate 5% SG (30.01 q/ha), Flubendiamide 39.35% SC (29.90 q/ha), Novaluron @1.0% EC (28.03 q/ha) and Neem oil @2% (27.32 q/ha), respectively, while the lowest grain yield (26.66 q/ha) was observed in plot treated with NSKE @5% and the untreated plot resulted least grain yield (19.49 q/ha).

Among the treatments studied, the best and most economical treatment was T_3- Spinetoram 11.7%SC (1:1.83), which was followed by T_1- Chlorantraniliprole 18.5%SC (1:1.74), T_2- Emamectin benzoate 5%SG (1:1.73), T_4- Flubendiamide 39.35% SC (1:1.61), T_5- Novaluron 1.0% EC (1:1.57) and T_6- Neem oil @2% (1:1.56), T_7- NSKE @5% (1:1.53) as compared to control (1:1.16).

The overall mean population revealed that all the treatments except untreated control are effective and at par. Among all the treatments lowest larvae population of maize fall armyworm was recorded in spinetoram 11.7% SC (2.97). Similar findings made by Dileep *et al.* (2020); Bharadwaj *et al.* (2020) followed by Chlorantraniliprole 18.5% SC(3.20) and the similar findings were given by Sangle *et al*. (2020); Jeyarajan *et al.* (2021); Thumar *et al.* (2020). Emamectin benzoate 5%SG (3.42) was found to be the next best effective treatment which in line with the findings of Mallapur *et al.* (2019); Sangle *et al*. (2020).

When yield and cost benefit ratio was worked out, interesting result was achieved. Among the treatments the best and most economical treatment was Spinetoram 11.7% SC (40.10), (1:1.83), Similar findings to Srujana *et al*. (2021); Thumar *et al.* (2020); Birhanu *et al.* (2019), which was followed by Chlorantraniliprole 18.5% SC(33.03), (1:1.74), with is similar to findings of Srujana *et al*. (2021); Deshmukh *et al.* (2020); Kalleshwaraswamy *et al.* (2018), Emamectin benzoate 5% SG(30.01), (1:1.73) which is in line with findings of Sangle *et al.* (2020); Dileep *et al*. (2020).

Table 1: Effect of different chemicals and botanicals against larval population of *Spodoptera frugiperda* in maize (1st and 2nd spray):

Sr. No.	Treatments	Dose	Number of larvae population of *Spodoptera frugiperda*/ 5 plants								Yield (q/ha)	C:B Ratio
			First spray				Second Spray			Overall mean		
			1DBS	3DAS	7DAS	14DAS	3DAS	7DAS	14DAS			
T_1	Chlorantraniliprole 18.5% SC	0.4ml/lit	5.60	4.46^{g}	3.53^{g}	3.86^{g}	3.06^{g}	2.00^{g}	2.26^{g}	3.20^{b}	33.03	1:1.74
T_2	Emamectin benzoate 5% SG	0.4g/lit	5.66	4.73^{f}	3.73^{f}	4.06^{f}	3.26^{f}	2.26^{f}	2.46^{f}	3.42^{b}	30.01	1:1.73
T_3	Spinetoram 11.7%SC	0.9 ml/lit	5.86	4.40^{g}	3.26^{h}	3.66^{h}	2.86^{h}	1.66^{h}	2.00^{h}	2.97^{b}	40.10	1:1.83
T_4	Flubendiamide 39.35% SC	0.24 ml/lit	5.66	4.93^{e}	3.93^{e}	4.26^{e}	3.46^{e}	2.46^{e}	2.66^{e}	3.62^{b}	29.90	1:1.61
T_5	Novaluron 10%EC	1.0ml/lit	5.73	5.13^{d}	4.13^{d}	4.46^{d}	3.66^{d}	2.66^{d}	2.86^{d}	3.82^{b}	28.03	1:1.57
T_6	Neem oil @ 2%	20ml/lit	5.60	5.46^{c}	4.40^{c}	4.73^{c}	3.86^{c}	3.00^{c}	3.06^{c}	4.08^{b}	27.32	1:1.56
T_7	NSKE@ 5%	50ml/lit	5.66	5.66^{b}	4.60^{b}	4.93^{b}	4.06^{b}	3.20^{b}	3.26^{b}	4.28^{b}	26.66	1:1.53
T_8	Control	---	5.46	6.00^{d}	6.20^{a}	6.73^{a}	6.73^{a}	7.00^{a}	7.33^{a}	6.66^{a}	19.49	1:1.16
	F-test			NS	S	S	S	S	S	S	---	---
	S.Em (±)		0.11	0.07	0.05	0.05	0.06	0.07	0.04	0.56	---	---
	CD @ 0.05 %		--	0.15	0.11	0.12	0.14	0.16	0.09	1.32	---	---

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

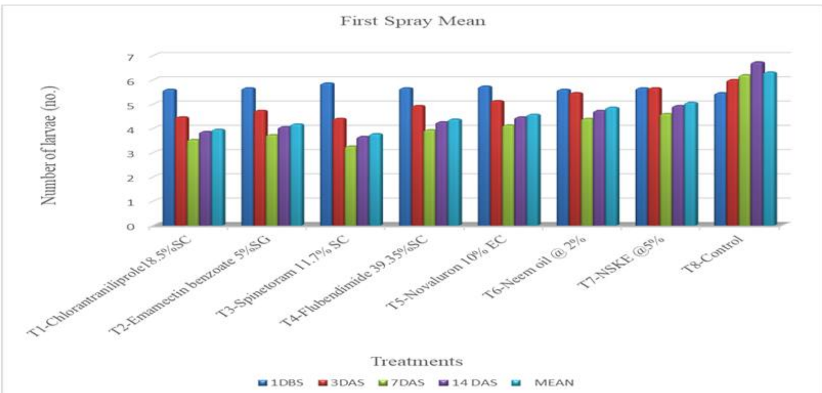

Fig. 1. Effect of different chemicals and botanicals against fall army worm in maize (*Zea mays* L.) after first spray.

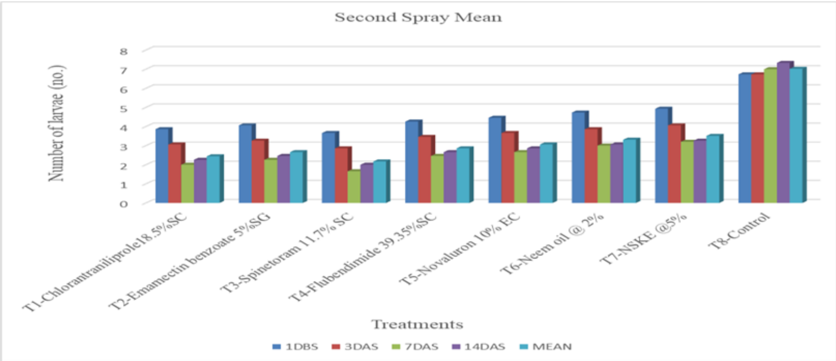

Fig. 2. Effect of different chemicals and botanicals against fall army worm in maize (*Zea mays* L.) after second spray.

CONCLUSIONS

From the present investigation, it could be concluded that, among the all treatments Spinetoram 11.7% SC shown most effective in controlling larval population of fall armyworm. Followed by Chlorantraniliprole 18.5% SC and the both insecticides showed best results controlling larval population, followed by Emamectin benzoate 5% SG, Flubendiamide 39.35% SC, Novaluron 10% EC, Neem oil @2% and NSKE @5%. Among the treatments studied Spinetoram 11.7% SC gave the highest yield and cost benefit ratio(40.10 q/ha), (1:1.83), which was followed by Chlorantraniliprole @18.5% SC (33.03 q/ha), (1:1.74), Emamectin benzoate@5% SG (30.01 q/ha), (1:1.73), Flubendiamide @ 39.35% SC (29.90 q/ha),(1:1.61), Novaluron @ 1.0% EC (28.03 q/ha), (1:1.57), and Neem oil @2% (27.32 q/ha), (1:1.56), NSKE @5% (26.66 q/ha), (1:1.53) in field conditions. Respectively as such more trails are required in future to validate the finding.

FUTURE SCOPE

Conventionally farmers are using various types of synthetic chemicals to control fall armyworm. A new devastating insect pest known as the fall armyworm is a big issue for the production of agricultural crops, particularly maize in India. This results from its capacity to. It is exceedingly challenging to control due to its quick reproduction, migration, and feeding on a variety of host plants. However, there are a number of approaches to pest management that have been reported in other areas of the world that may be modified, verified, and applied in India. Therefore, using chemicals to control this pest is best avoided to prevent the development of resistance and to reduce pest population. In order to avoid indiscriminate use of pesticides.

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REFERENCES

Bahtira, R., Arsyad, M., Salman, D., Azrai, M., Tenrirawe, A., Yasin, M. and Ochieng, P. J. (2023). Promoting the New Superior Variety of National Hybrid Maize:Improve Farmer Satisfaction to Enhance Production. *Agriculture*, *13*(1), 174.

Bharadwaj, G. S., Mutkule D. S., Thakre B. A. and Jadhav A. S. (2020). Bio-efficacy of different insecticides against fall armyworm, *Spodoptera frugiperda* (J. E. Smith) on Maize. *Journal of Pharmacognosy and Phytochemistry*, *9*(5), 603-607.

Birhanu, S., Tadele T., Mulati W., Gashivbeza A. and Esays M. (2019). The efficiency of selected synthetic insecticides and botanicals against fall armyworm, *Spodoptera frugiperda*, in maize. *Journal of Insect*, *8*(4), 174-179.

Deole, S. and Paul N. (2018). First report of fall armyworm, *Spodoptera frugiperda* (J. E. Smith) their nature of damage and biology on Maize crop at Raipur, Chhattisgarh, *Journal of Entomology and Zoological Studies*, *6*, 219-221.

Deshmukh, Sharanabasappa, Pavithr A. H. B., Kalleshwaraswamy C. M., Shivanna B. K. and Maruth M. S. (2020). Field Efficacy of insecticides for management of invasive fall armyworm, *Spodoptera frugiperda* (J. E. Smith) (Lepidoptera: Noctuidae) on maize in India. *Florida Entomological Society*, *103*(2), 221-227.

Dileep, N. T., Murali K., Prabhu C., Ganiger and Mahesh H. M. (2020). Safe and cost effective management of the fall armyworm, *Spodoptera frugiperda* (Lepidoptera: Noctuidae) using green insecticide baits. *International Journal of Chemical Studies*, *8*(5), 106-110.

Early, R., Moreno, P. G., Murphy, S. T. and Day, R. (2018). Forecasting the global extent of invasion of the cereal pest *Spodoptera frugiperda* the fall armyworm. *Journal of Entomology and Zoology Studies*, *1*(40), 25-50.

FAO (2017). FAO advisory note on fall army worm (*S. frugiperda*) in Africa. (2017). (assessed 30 May 2020)fao.org/faostat/en .

Jeyarajan, S., Elango K. and Malathi P. (2021). Bioefficacy of chlorantraniliprole 18.5% w/w SC against fall armyworm, *Spodoptera frugiperda* (J. E. Smith) (Lepidoptera: Noctuidae) in maize. Department of Agricultural Entomology, *Centre for Plant Protection Studies*, *7*, 86-87.

Kalleshwaraswamy, C. M., Asokan R., Swamy M. H. M., Maruthi M. S., Pavithra H. B., Hedge K., Navi S., Prabhu S. T. and Goergen G. (2018). First report of the fall armyworm, *Spodoptera frugiperda* (J. E. Smith) (Lepidoptera: Noctuidae), an alien invasive pest on maize in India. *Pest Management in Horticultural Ecosystems*, *24*(1), 23-29.

Kalyebi, A., Otim, M. H., Walsh, T. and Tay, W. T. (2023). Farmer perception of impacts of fall armyworm (*Spodoptera frugiperda* J. E. Smith) and transferability of its management practices in Uganda. *CABI Agriculture and Bioscience*, *4*(1), 1-14.

Kaushal, M., Sharma, R., Vaidya, D., Gupta, A., Saini, H. K., Anand, A. and K. C. D. (2023). Maize: an underexploited golden cereal crop. *Cereal Research Communications*, *51*(1), 3-14.

Mallapur, C. P., Naik A. K. S., Hagari T., Praveen and Naik M. (2019). Laboratory and field evaluation of new insecticide molecules against fall armyworm, *Spodoptera frugiperda* (J. E. Smith) on maize. *Journal of Entomology and Zoology Studies*, *7*(5), 729-733.

NASS (2021). *Quick stats API*. https://quickstats.nass.usda.gov/api

Nyamutukwa, S., Mvumi, B. M. and Chinwada, P. (2022). Sustainable management of fall armyworm, *Spodoptera frugiperda* (J. E. Smith): challenges and proposed solutions from an African perspective. *International Journal of Pest Management*, 1-19.

Pradyumn, K., Pamidi L., Javaji S. C., Chikkappa S. G., Karjagi and Dharam P. (2016). Evaluation of biophysical, anatomical and biochemical traits of resistance to *Sitophilus oryzae* L. (Coleoptera: Curculionidae) in stored maize. *Indian Institute of Maize Research*, *1* ,1-8.

Rakshit, S., Sekhar, J. C. and Soujanya, L. P. (2022). Fall Armyworm (FAW) *Spodoptera frugiperda* (J. E. Smith)-the status, challenges and experiences in India. *Fall Armyworm (FAW) Spodoptera frugiperda (J. E. Smith)-the status, challenges and experiences among the SAARC Member States. SAARC Agriculture Centre, SAARC, Dhaka, Bangladesh*, *130*, 29.

Sangle, S. V., Jayewar, N. E. and Kadam, D. R. (2020). Efficacy of insecticides on larval population of fall armyworm, *Spodoptera frugiperda* on maize. *Journal of Entomology and Zoology Studies,* 8(6), 1831-1834.

Singh, A. D. (2014). Maize in India. India Maize Summit, *2*.

Singh, S., Raghuraman, M., Keerthi, M. C., Das, A., Kar, S. K., Das, B. and Acharya, G. C. (2023). Occurrence, Distribution, Damage Potential, and Farmers' Perception on fall armyworm, *Spodoptera frugiperda* (J. E. Smith): Evidence from the Eastern Himalayan Region. *Sustainability*, *15*(7), 5681.

Sisay, B., Tadele T., Mulatu W. and Gashawbeza A., (2019). The efficacy of selected synthetic insecticides and botanicals against fall armyworm, *Spodoptera frugiperda* in maize. *Journal of Insects*, *10*(2), 45.

Srujana,Y., Kamakshi, N. and Krishna, M. T. (2021). Insecticidal activity of diverse chemicals for managing the destructive alien pest fall armyworm *Spodoptera frugiperda* (J. E. Smith) on Maize crop in India *International Journal of Tropical Insect science,* 1-10.

Thumar, R. K., Zala, M. B., Varma, H. S., Dhobi, C .B., Patel, B. N., Patel, M. B. and Borad, P. K. (2020). Evaluation of insecticides against fall armyworm, *Spodoptera frugiperdan* (J. E. Smith) infesting maize. *International Journal of Chemical Studies*, *8*(4), 100-104.

Wallander, S., Smith, D., Bowman, M. and Claassen, R. (2021). Cover crop trends, programs, and practices in the United States. *U.S. Department of Agriculture, Economic Research Service*, EIB 222.

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