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Validation of different Management Practices Adopted by Farmers against *Spodoptera frugiperda* (J.E. Smith) in Maize

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ABSTRACT: Fall Armyworm (FAW) (*Spodoptera frugiperda*) is a major devastating and gregarious feeding on many crops like maize, sorghum and rice etc. It threatened livelihoods, nutrition, food security and caused major economic losses to farmers. The major emphasis is given on synthetic pesticides for control of this pest which affected human health, natural enemies and the ecosystem negatively. The farmers used local management practices for control of fall armyworm. These practices were safe for human, natural enemies and environment. Therefore, field experiments conducted on evaluation different management practices adopted by farmers against *S. frugiperda* in maize were carried out at maize improvement project, Mahatma Phule Krishi Vidyapeeth, Rahuri during *Kharif* 2021 and *Rabi* 2021. All the treatments were significantly superior over untreated plots. Results of the experiment indicated that standard check chlorantraniliprole 18.5 % SC @ 0.4 ml/l recorded lowest plant damage (24.05%). Among the different farmer's practices, neem seed powder @ 2 g/whorl was the significantly superior to rest of the treatments which recorded plant damage (33.07 %). It was followed by lime @ 5 g/whorl, which showed 45.18 per cent plant damage. The next effective farmer's practices were wood ash @ 5 g/whorl, soil @ 5 g/whorl and sand @ 5 g/whorl which recorded plant damage of 46.31, 47.70 and 48.87 per cent, respectively. The untreated plot showed the highest percentage of plant damage (61.24 %).

Keywords: Maize, *Spodoptera frugiperda*, plant damage, chlorantraniliprole 18.5 % SC.

INTRODUCTION

Farmers have even begun to cultivate more than one crop year in worldwide. Maize is also a common staple crop that is directly related to household food security. Maize is used in a variety of ways, including human consumption, animal and poultry feed and the industrial manufacturing of numerous products (DAMC, 2019). It is grown all over the world and is a significant crop in global agriculture. Due to its many industrial uses, maize is a more flexible crop than wheat and rice; yet, its primary use is for animal feed, which is followed by human nourishment. As a result, it has become a dynamic crop in agri-food systems around the world (Grote *et al*., 2021). Globally, 17 percent of the maize crop is consumed as food, 61 percent is fed to animals and 22 percent is used as a raw resource for industry (FAOSTAT, 2020). Although maize plants have a high genetic production potential, which are susceptible to insect pest infestations (Khatri *et al*., 2020). Fall armyworm caused an annual loss of 8.3 - 20.6 million tons per annum in maize (FAO, 2020). Farmers that use pesticides to prevent fall armyworm are more vulnerable to harmful chemical contamination in the ecosystem, which kills species that are not intended targets and progressively disrupts the ecosystem (Kumela *et al*., 2019). Because of the extensive subsistence farming practices in India, the use of transgenic plants and chemical pesticides is not cost-effective. Moreover, treatment of fodder crops with pesticides is not advised because the crops are directly fed to cattle. However, there are also drawbacks to using chemicals excessively, such as residues in grains and silage, pest recurrence and insect resistance to insecticides. In this experiment, major importance was given on eco-friendly management of *S. frugiperda* in maize.

MATERIALS AND METHODS

The experiment was conducted on the farm of maize improvement project, Mahatma Phule Krishi Vidyapeeth (MPKV), Rahuri during *Kharif* 2021 and *Rabi* 2021. The experiment was laid out in randomized block design (RBD) with ten treatments and three replications, with plot size 4 × 3 m^2 and spacing of 75 x 25 cm^2. Eco-parmeshwar (P-3302) cultivar was used. Maize was grown with all recommended package of practices recommended by MPKV, Rahuri for raising the crop except insect-pest management. The treatments include: T_1: Wood ash @5g/whorl, T_2: Soil @5g/whorl, T_3: Sand @5g/whorl, T_4: - Neem seed powder @ 2g/whorl, T_5: Lime@5g/whorl, T_6: Chilli extract spray 10 %@ 10 ml/l, T_7: Chlorine water 0.03 % @10

ml/whorl, T_8: Chlorantraniliprole - 18.5 % SC @ 0.4ml/l used as standard check, T_9: Detergent water spray@5 g/l and T_{10}: Untreated control. Source: woos ash, soil, sand, lime, chilli, chlorine water were procured from local market. Neem seed powder - Liebigs Agro Chem Pvt. Ltd, Kolkata and chlorantraniliprole 18.5 % SC- FMC India Pvt. Ltd, Bandrakurla complex (E), Mumbai. The first application of treatments were done when incidence of fall armyworm noticed. The observation of plant damage was recorded from each treatment. The observations were recorded one day before application as a pre-count while post-treatment counts were taken at 5, 10 and 14 days after application (DAA). Application of treatments were done at 14 days intervals and observations were recorded at pre and post-sprays per plot. The per cent damage was calculated by the formula given below by Mallapur *et al*. (2018)

$$\text{Per cent damage} = N/T * (100)$$

Where, N = Total Number of damaged plants per plot,
T = Total number of plants per plot

The data of field experiments were analyzed in randomized block design (RBD). The per cent data was transformed into arc sine values. Transformed data were subjected to design to get ANNOVA for the comparison within the treatments.

RESULTS AND DISCUSSION

A. Plant damage (Kharif 2021)

The data (Table 1) indicated that the impact of various treatments on the percentage of plants damaged by *S. frugiperda*. The findings indicate that the percentage of plant damage before to the application of treatments, between 58.33 to 64.58 per cent and it was statistically non-significant, indicating uniform plant damage of maize due to *S. frugiperda*. The plant damage in the untreated plots ranged between 60.42 to 63.54 per cent at 5 DAA and 14 DAA. The treatment with the least plant damage (39.58%) at 5 DAA after the first application of treatments was chlorantraniliprole @ 0.4 ml/l. Neem seed powder @ 2 g/whorl following it and recording 49.48 percent plant damage. At 10 DAA, lowest plant damage (25.52 %) was recorded by chlorantraniliprole @ 0.4ml/l. This was followed by neem seed powder @ 2 g/whorl which recorded 33.85 per cent plant damage. Even after 14 DAA, chlorantraniliprole @ 0.4 ml/l demonstrated superiority by registering the lowest plant damage (13.54 %). The second best treatment, neem seed powder @ 2 g/whorl, resulted in 38.02 percent plant damage. The plant damage in the untreated plots was 59.38 percent and it increased to 63.54 percent after the first application of treatments at 14 DAA. After second application of treatments, at 5 DAA chlorantraniliprole @ 0.4ml/l recorded lowest (22.92 %) per cent of plant damage and it was followed by neem seed powder @ 2 g/whorl (33.33 %). Almost a similar trend was observed in the efficacy of treatments even at 10 DAA. At 14 DAA, chlorantraniliprole @ 0.4 ml/l was significantly superior over rest of the treatments by recording 13.54 per cent plant damage. The standard check chlorantraniliprole @ 0.4 ml/l which continued to outperform the other treatments. This was followed by neem seed powder @ 2g/whorl and lime @ 5g/whorl.

B. Plant damage (Rabi 2021)

Uniform plant damage was observed in maize ranged from 51.21 to 55.21 percent prior to the application of treatments but was statistically non-significant (Table 2). The percentage of plant damage in the untreated plots varied from 52.60 to 61.46 percent. Chlorantraniliprole @ 0.4 ml/l showed to be significantly superior to the other treatments after the first application at 5 DAS by recording the least plant damage (40.63 %). Neem seed powder @ 2 g/whorl was next effective treatment with 47.92 percent plant damage. Chlorantraniliprole @ 0.4 ml/l showed the lowest plant damage (26.04 %) at 10 DAA. In terms of reducing plant damage, neem seed powder was the second best treatment (34.90 %), followed by wood ash @ 5 g/whorl (43.23 %) and lime@5g/whorl (43.75 %). Whereas plant damage was highest (57.29 %) in the untreated plots. The lowest percentage of plant damage (27.60 %) was seen even at 14 DAA with chlorantraniliprole @ 0.4 ml/l. Next in terms of reducing plant damage (36.46 %) was neem seed powder @ 2g/whorl. However, untreated plots recorded the highest (58.33 %) plant damage. After the second application of treatments, among the farmers practices neem seed powder @ 2g/whorl (22.40 %) was the most effective followed by lime@5g/whorl (40.63 %) in reducing the plant damage in maize. Chlorantraniliprole @ 0.4 ml/l (14.06 %) continued to be the most effective treatment after the second application of treatments at 14 DAA.

C. Pooled data of plant damage

Pooled data (Table 3) indicate that every treatment was noticeably better than the untreated control. Throughout the two years, chlorantraniliprole @ 0.4 ml/l remained best treatment because it caused the least plant damage (24.05 %). Among the farmer's practices, neem seed powder @ 2 g/whorl consistently showed the lowest percentage (33.07 %). This was followed by lime @ 5 g/whorl which showed 45.18 per cent plant damage but it was at par with wood ash @ 5 g/whorl, soil @ 5 g/whorl and sand @ 5 g/whorl which recorded plant damage of 46.31, 47.70 and 48.87 per cent, respectively. The untreated plot showed the highest percentage of plant damage (61.24 %).

It could be also seen from Fig. 1 chlorantraniliprole @ 0.4ml/l was the most effective and excelled over all other treatments in suppressing plant damage caused by *S. frugiperda* population. This was followed by neem seed powder @ 2 g/whorl, lime @ 5 g/whorl, wood ash @ 5 g/whorl, soil @ 5 g/whorl and sand @ 5 g/whorl.

The experiment's findings, which showed that chlorantraniliprole @ 0.4 ml/l was the most successful treatment against *S. frugiperda*, are consistent with the findings of a number of previous researchers. According to Chekuri and Tayde (2023), chlorantraniliprole 18.5% SC was effective in reducing the larval population of *S. frugiperda* in maize. Ramesh

and Tayde (2022), reported that chlorantraniliprole 18.5% SC (6.24%) was most effective treatment for lowering the percentage of maize fall armyworm. The present study observations about the effectiveness of neem seed powder at 2g/l are consistent with the findings of Stevenson *et al*. (2017), who stated that small-scale African farmers typically utilized neem leaves or seeds to make botanical pesticides to control *S. frugiperda*. According to Adeye *et al.* (2018), using 4.5 litres per hectare of neem oil decreased both the frequency and severity of insect attacks on plants. The results of this study support the effectiveness of lime at 5g/whorl, as reported by Hruska (2019), who stated that lime is a locally accessible material that is utilised by many smallholder farmers worldwide to manage FAW. Smallholder farmers use a technique known as "sand mixed with lime" to kill FAW larvae by placing it inside the whorl of affected maize, as reported by CABI (2017). The findings on effectiveness of wood ash are consistent with Tambo *et al*. (2020) reported that 17.7 per cent of farmers across five African nations use ash on the maize crop whorl, with a 48–77 per cent efficacy compared to a 92–97 per cent for synthetic pesticides. Similarly, Abrahams *et al*. (2017) demonstrated that ash placed in the whorls decreased the yield losses caused by the fall armyworm in maize.

Table 1: Evaluation of farmer's practices on plant damage of *S. frugiperda* in maize during *Kharif* 2021.

TN	Treatments	Dose /whorl or l	Per cent plant damage						
			Pre-count	First Application			Second Application		
				5 DAA	10 DAA	14 DAA	5 DAA	10 DAA	14 DAA
T_1	Wood ash	5 g/whorl	64.58 (53.49)	54.69 (47.70)	44.79 (41.99)	51.56 (45.90)	52.60 (46.50)	34.90 (35.99)	47.92 (43.78)
T_2	Soil	5 g/whorl	63.02 (52.58)	55.73 (48.30)	45.31 (42.30)	52.60 (46.50)	53.13 (46.82)	35.94 (36.76)	48.96 (44.40)
T_3	Sand	5 g/whorl	58.33 (49.82)	56.77 (48.90)	47.40 (43.51)	53.13 (46.79)	51.56 (45.90)	38.02 (38.04)	51.04 (45.60)
T_4	Neem seed powder	2 g/whorl	60.94 (51.34)	49.48 (44.68)	33.85 (35.55)	38.02 (38.06)	33.33 (35.25)	22.40 (28.22)	25.00 (29.95)
T_5	Lime	5 g/whorl	61.46 (51.65)	52.08 (46.20)	43.23 (41.11)	50.52 (45.30)	51.04 (45.62)	33.85 (35.58)	46.88 (43.21)
T_6	Chilli extract spray 10%	10 ml/l	62.50 (52.27)	58.85 (50.13)	49.48 (44.70)	57.29 (49.22)	59.90 (50.72)	40.10 (39.29)	53.65 (47.15)
T_7	Chlorine water 0.03%	10 ml/whorl	60.94 (51.33)	57.81 (49.51)	47.92 (43.80)	58.33 (49.85)	59.90 (50.73)	41.15 (39.88)	52.60 (46.52)
T_8	Chlorantraniliprole 18.5 % SC	0.4 ml/l	60.94 (51.37)	39.58 (38.97)	25.52 (30.33)	27.60 (31.68)	22.92 (28.57)	12.50 (20.68)	13.54 (21.54)
T_9	Detergent water spray	5 g/l	61.46 (51.63)	59.90 (50.72)	56.25 (48.63)	60.42 (51.09)	63.54 (52.87)	62.50 (52.30)	64.58 (53.52)
T_{10}	Untreated control	—	59.38 (50.43)	60.42 (51.03)	62.50 (52.26)	63.54 (52.86)	66.15 (54.45)	66.67 (54.77)	67.19 (55.09)
	SE(m)±		1.85	1.91	1.51	1.85	2.13	2.17	2.41
	CD @ 5%		NS	5.67	4.50	5.51	6.33	6.46	7.15
	CV		6.20	7.36	7.08	8.02	8.06	9.87	9.68

Figures in the parantheses are arc sin transformed figures, NS: Non-significant, DAA= Days after application

Table 2: Evaluation of farmer's practices on plant damage of *S. frugiperda* in maize during *Rabi* 2021.

TN	Treatments	Dose /whorl or l	Per cent plant damage						
			Pre-count	First Application			Second Application		
				5 DAA	10 DAA	14 DAA	5 DAA	10 DAA	14 DAA
T_1	Wood ash	5 g/whorl	54.17 (47.41)	51.56 (45.90)	43.23 (41.10)	47.92 (43.80)	50.00 (45.00)	34.90 (36.19)	41.67 (40.19)
T_2	Soil	5 g/whorl	53.13 (46.80)	52.08 (46.20)	43.75 (41.40)	49.48 (44.70)	52.08 (46.20)	35.94 (36.78)	43.75 (41.38)
T_3	Sand	5 g/whorl	54.17 (47.39)	52.60 (46.49)	45.83 (42.61)	50.52 (45.30)	53.65 (47.09)	38.02 (38.05)	47.92 (43.80)
T_4	Neem seed powder	2 g/whorl	55.21 (48.01)	47.92 (43.78)	34.90 (36.08)	36.46 (37.12)	31.77 (34.26)	21.35 (27.46)	22.40 (28.22)
T_5	Lime	5 g/whorl	51.04 (45.60)	51.04 (45.60)	43.75 (41.40)	45.83 (42.61)	49.48 (44.70)	33.85 (35.55)	40.63 (39.59)
T_6	Chilli extract spray 10 %	10 ml/l	52.08 (46.20)	53.13 (46.81)	45.31 (42.30)	52.60 (46.51)	55.21 (48.00)	41.15 (39.89)	48.44 (44.10)
T_7	Chlorine water 0.03%	10 ml/whorl	51.04 45.60)	52.60 (46.50)	46.88 (43.21)	53.13 (46.79)	54.69 (47.70)	39.06 (38.66)	47.92 (43.80)
T_8	Chlorantraniliprole 18.5 % SC	0.4 ml/l	55.21 (48.00)	40.63 (39.58)	26.04 (30.62)	27.60 (31.68)	24.48 (29.62)	14.06 (22.00)	14.06 (21.94)
T_9	Detergent water spray	5 g/l	54.17 (47.39)	53.13 (46.80)	51.04 (45.60)	55.21 (48.00)	58.85 (50.10)	52.08 (46.20)	55.21 (48.01)
T_{10}	Untreated control	—	52.60 (46.50)	53.65 (47.09)	57.29 (49.21)	58.33 (49.81)	61.46 (51.63)	59.38 (50.41)	58.33 (49.80)
	SE(m)±		1.55	1.42	1.59	1.70	1.32	1.37	2.03
	CD @ 5%		NS	4.21	4.72	5.05	3.92	4.08	6.02
	CV		5.73	6.40	6.65	7.17	6.15	7.41	8.76

Figures in the parantheses are arc sin transformed figures, NS: Non-significant, DAA= Days after application

Table 3: Evaluation of farmer's practices on plant damage of *S. frugiperda* in maize (*Kharif* and *Rabi*2021-Pooled).

TN	Treatments	Dose /whorl or l	Percent plant damage							Pooled Mean
			Pre-count	First Application			Second Application			
				5 DAA	10 DAA	14 DAA	5 DAA	10 DAA	14 DAA	
T_1	Wood ash	5 g/whorl	59.38 (50.41)	53.13 (46.80)	44.01 (41.56)	49.74 (44.85)	51.30 (45.75)	34.90 (36.13)	44.79 (41.99)	46.31 (42.87)
T_2	Soil	5 g/whorl	58.07 (49.65)	53.91 (47.24)	44.53 (41.86)	51.04 (45.60)	52.60 (46.50)	35.94 (36.79)	46.35 (42.90)	47.40 (43.50)
T_3	Sand	5 g/whorl	56.25 (48.60)	54.69 (47.69)	46.61 (43.06)	51.82 (46.05)	52.60 (46.49)	38.02 (38.06)	49.48 (44.70)	48.87 (44.35)
T_4	Neem seed powder	2 g/whorl	58.07 (49.67)	48.70 (44.25)	34.38 (35.82)	37.24 (37.59)	32.55 (34.79)	21.88 (27.87)	23.70 (29.13)	33.07 (35.04)
T_5	Lime	5 g/whorl	56.25 (48.60)	51.56 (45.90)	43.49 (41.25)	48.18 (43.95)	50.26 (45.15)	33.85 (35.58)	43.75 (41.41)	45.18 (42.22)
T_6	Chilli extract spray 10 %	10 ml/l	57.29 (49.21)	55.99 (48.46)	47.40 (43.51)	54.95 (47.86)	57.55 (49.34)	40.63 (39.59)	51.04 (45.60)	51.26 (45.72)
T_7	Chlorine water 0.03%	10 ml/whorl	55.99 (48.45)	55.21 (48.00)	47.40 (43.51)	55.73 (48.29)	57.29 (49.21)	40.10 (39.28)	50.26 (45.16)	51.00 (45.57)
T_8	Chlorantraniliprole 18.5 % SC	0.4 ml/l	58.07 (49.67)	40.10 (39.29)	25.78 (30.48)	27.60 (31.68)	23.70 (29.12)	13.28 (21.36)	13.80 (21.75)	24.05 (29.23)
T_9	Detergent water spray	5 g/l	57.81 (49.50)	56.51 (48.75)	53.65 (47.09)	57.81 (49.50)	61.20 (51.48)	57.29 (49.20)	59.90 (50.74)	57.73 (49.45)
T_{10}	Untreated control	-	55.99 (48.45)	57.03 (49.05)	59.90 (50.72)	60.94 (51.33)	63.80 (53.01)	63.02 (52.56)	62.76 (52.41)	61.24 (51.50)
	SE(m)±		1.41	1.29	1.14	1.22	1.21	1.43	1.87	1.01
	CD @ 5%		NS	3.83	3.39	3.63	3.59	4.25	5.55	3.00
	CV		4.97	7.02	6.13	6.92	6.63	7.58	8.78	5.62

Figures in the parantheses are arc sin transformed figures, NS: Non-significant, DAA= Days after application

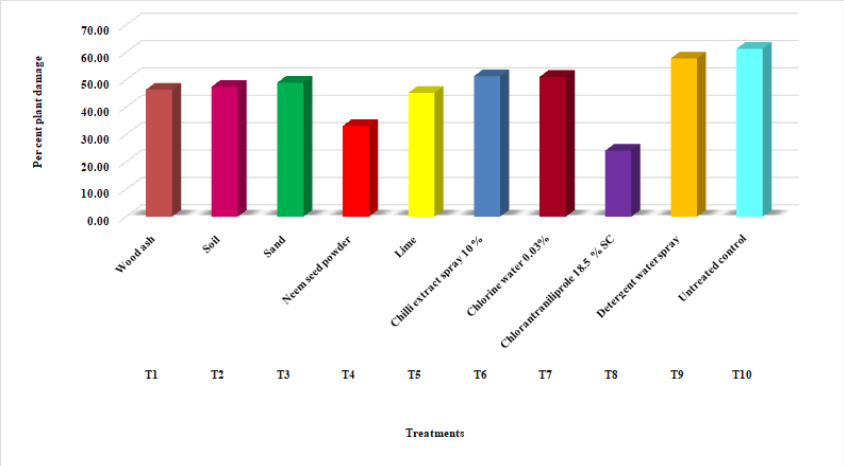

Fig. 1. Effect of different farmer's practice on plant damage of *S. frugiperda* in maize (Pooled).

CONCLUSIONS

On the basis of results of current investigation, it can be concluded that for management of fall armyworm, *S. frugiperda* the insecticide chlorantriniliprole 18.5 % SC (Standard check) shown most effective in reducing plant damage by fall armyworm. Among the farmer's practices, neem seed powder @ 2 g/ whorl, lime @5g/whorl and wood ash @ 5g/whorl of water found effective for the management of fall armyworm, *S. frugiperda* infesting maize. The importance of farmer's practices in fall armyworm control lies in promoting sustainable agricultural practices. These farmers' practices can be used in ecofriendly management of fall armyworm in small land holding farmers.

FUTURE SCOPE

Identification of effective farmer's practices and which will be used as an one of the component in integrated management of fall armyworm for ecofriendly and sustainable approach.

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Conflict of Interest. None.

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