Original Research Article

Effect of Different Insecticides against Fall Armyworm, *Spodoptera frugiperda* (J.M. Smith) in Maize at Belaka Municipality, Udayapur, Nepal

ABSTRACT

This research was conducted to evaluate the five selected commercial formulation of insecticides against newly introduced Fall armyworm *spodoptera frugiperda* in the farmer's field at Belaka Municipality of Udayapur district, Nepal. The experiment was laid out in Randomized completely blocked design (RCBD) from 23rd Feb 2021. The prepared field was divided into six treatments and four replications (Imidacloprid 70 % WDG@0.3ml/ltr water, Spinetoram 11.7 % SC@0.3ml/ltr water, Chlorantraniliprol 18.5 % W/W@0.4ml/ltr water, Emamectin Benzoate 5% WDG@0.4ml/ltr, Azadirachtin 0.03% EC @5ml/ltr and control). Total three spray of the insecticides were done at the interval of 7 days after the initial damage symptoms starts to appear. The field experiment showed that all the insecticides were significantly effective in reducing the number of live larvae per plant after 3rd spray whereas fast and foremost reduction in live larvae was seen in the plot sprayed with spinetoram and chlorantraniliprole. There was 89% reduction of live larvae after 1st spray in the plot sprayed with spinetoram and chlorantraniliprole followed by emamectin benzoate, 66%. Similarly, no damage symptoms were seen in the plot sprayed with spinetoram and chlorantraniliprole after 3rd spray. The highest grain yield per plot was also gained from chlorantraniliprole (8.8 ton/ha) and spinetoram (8.5 ton/ha).

Keywords: *Spodoptera frugiperda*, RCBD, Spinetoram, Chlorantraniliprol, Emamectin Benzoate

INTRODUCTION

Maize (*Zea mays*) belongs to the family poaceae is the leading crop in the world in term of production (*FAOSTAT*) [1]. In context of Nepal, it is the second most important crop after rice. It is cultivated in the area of 956447 ha with average production of 2713635 metric ton with an average productivity of 2.84 mt/ha (MoAD, 2020) [2]. Maize is one the major crop grown in Udayapur district in an area covering about 17, 836 ha with average production of 39,846 metric tonn. Since a few years, the maize production has not increased as expected though there is advancement in agricultural technologies and the development of new innovations.The crop has been largely affected by the severe outbreak of dangerous insect and pest among which Fall armyworm is the prime (Bista *et al*., 2020) [3]. Although maize is the way of life for most of the farmers in udayapur district its productivity has been deceased

due to the infestation of fall army worm. The invasive fall armyworm (FAW) is threatening maize production and the livelihoods of smallholder farmers.

Fall armyworm has been reported for the first time in Nepal from gaidakot of Nawalparasi district in May 2019. Since then, insect has been spread into various maize growing agro ecological zones of Nepal. (Bajracharya *et al*., 2019) [4]. It is the most destructive pest in maize cultivation to decline production and productivity.Caterpillars of this Spodoptera species are considerably more voracious than many other noctuid maize pests. Each of its six larval instars feeds extensively on young maize leaves often destroying the vegetation growth point of the plant. As per the unpublished report of National Plant Protection Organization (NPPO) about 20% losses has been reported in the maize field in Chitwan, Nepal. (GC & YD, 2020) [5]. The invasion of pest in Nepal is somehow a new phenomenon and its systematic studies including losses before and after invasion are yet to be quantified.

People are unaware about the IMP packages and proper management practices as it is newly entered pests in Nepal. Due to the improper knowledge about the management practices, farmers in infected areas are spraying various highly toxic insecticides like cocktail formulations of chlorpyriphos 50% and cypermethrin 5% which are readily available in the local market with various trade name (Bajracharya *et al*., 2019) [4]. Farmers are using high dose of various insecticides with frequent application without the knowledge of their efficacy. Various research have been done nationally and internationally against fall armyworm. Various insecticides and pesticides and different management practices are recommended against fall armyworm in different countries, but they are either not registered in Nepal or not easily available in local market. Considering all these factors, this research is focused on evaluating some of the selected insecticides including those with novel mode of action against fall army worm which are easily available in local market to generate baseline data to find the best insecticides for its management.

MATERIALS AND METHODS

An experimental plot of 221-meter square (length 13m and breadth 17m) was selected at Belaka municipality of Udayapur district which is located 44.3 km east of Gaighat, the district headquarter of Udayapur in inner terai region of Nepal. The geographical coordinations of the site was 26º42ˈ09" N 86º55ˈ29" E latitude and 26º55ˈ38" N 87º10ˈ06" E longitude . Its elevation was approximately 136.2 m from the sea level. It has subtropical climate with temperature ranges from 20ºc to 25ºc . Average annual rainfall in this area was about 110 to 300 cm. The soil on experiment site was loamy with neutral pH. Field experiment was laid out on Randomized completely blocked design (RCBD). The prepared field was divided into four

replications with six treatment (5 insecticides + 1 control/water spray) in each. The gap between two replication was 0.5m and the gap between each treatment in a replication was 0.4m. Each treatment plot size was (4*2.5) meter square. Fertilizer dose was 2.75 kg urea, 2.22 kg DAP and 1.11 kg MOP as per general recommendation (100:60:40 kg NPK /ha). Half dose of Urea and full dose of DAP and MOP was applied as basal dose during field preparation. Remaining half dose of nitrogen was applied twice, one after 25 days of sowing and next after 45 days, as side dressing. A hybrid variety of maize, Tx Hybrid were line shown on 23rd of Feb 2021 maintaining spacing of 60 cm row to row and 25 cm plant to plant. Plants were thinned and one plant per hill was maintained after three weeks of sowing. First weeding was done 30 days after showing and second weeding and earthing up were done 45-50 days after showing. The duration of the research was four months (Feb 23- Jun 16,2021)

Table 1: List of the treatments used in field experiment.

Treatments	Chemical name	Formulation	Doses	Trade name
T1	Imidacloprid	70 % WDG	0.3ml/later	Allmire
T2	Spinetoram	11.7 % SC	0.3ml/ltr	Largo
T3	Chlorantraniliprole	18.5 % W/W	0.4ml/ltr	Cover
T4	Emamectin Benzoate	5% WDG	0.4ml/ltr	Cobra
T5	Control	.....	water	Water
T6	Azadirachtin	0.03% EC	5ml/ltr	Multineem

After the initial symptoms starts to appear, the first data was recorded. After that the treatments were applied as a foliar spray in research field. The data was recorded from 10 randomly tagged plants per plot based on scoring scale (0-5). The data were recorded thrice at an interval of 7 days. The plant was observed on the presence and absent of live larvae, the presence and absent of foliar damage on the upper four leaves and whorl, height of the plant and later yield data were collected.

Data of different parameters were collected in data sheet at the time of data collection. The recorded data were then entered and tabulated in Microsoft-excel worksheet. The tabulated data were then analyzed by using GenStat software (15th edition). All the data were subjected to analysis of variance (ANNOVA) and separation of mean was done by using Duncan's Multiple Range Test (DMRT)

Scoring scale for Foliar damage by FAW:

Table 1. Scoring scale (0-5) for assessment of foliar damage due to fall armyworm (Davis and Williams 1992).

Score	Damage symptoms / description
0	No visible feeding symptoms on upper leaves and whorl
1	Papery window damage symptoms on upper leaves and whorl
2	Few small holes on upper leaves and whorl
3	Ragged holes on upper leaves and partially whorl damage
4	whorl and upper leaves extensively damaged
5	Whorl destroyed and plant dying due to extreme defoliation

The percentage (%) reduction in the no. of live larvae was calculated by using modified Abbotts Formula (Flemings and Ratnakaran ,1985):

- Reduction of live larvae (%) $= \frac{X2-X1}{X2} * 100$

where ,

X1=Mean no. of live larvae in treatment plot after spray.

X2=Mean no. of live larvae in treatment plot before spray.

RESULTS AND DISCUSSIONS

Effect of insecticides in the reduction of live larvae Reduction in live larvae

Reduction of live larvae (%) after spraying different insecticides are given in the table 1. All the insecticides were found significantly effective in reducing fall armyworm infestation after 3rd spray. Spinetoram and chlorantraniliprole were found consistently superior in reducing the live larvae of FAW as compared to others insecticides.There was 89% reduction of the live larvae after 1st spray in the plot sprayed with spinetoram and chlorantraniliprole, followed by emamectin benzoate (66%). Which was then reduced to 100% after 2nd and 3rd spray. Similar result was reported by (Bharadwaj *et al*., 2020) [6] where Spinetoram 11.7 SC and chlorantraniliprole 18.5 WW was found most effective treatment in reducing the population of S. frugiperda followed by Emamectin benzoate 5 WG. After 7 days of 1st spray, significantly least number of larvae was recorded with spinetoram (0.08 larvae per plant) , chlorantraniliprole (0.1 larvae per plant), emamectin benzoate (0.23 larvae per plant), This finding is supported by (Deshmukh *et al*., 2020a) [7] where after 7 days of first spray, the lowest number of larvae per plant was recorded with spinetoram (0.13 larvae per plant), plant, chlorantraniliprole (0.13 larvae per plant), emamectin benzoate (0.17 larva per plant), Live larvae were not found in maize plant after second spray in the plot sprayed with Spinetoram, Chlorantraniliprol and emamectin benzoate. Similar result was reported in a study conducted by (Bajracharya *et al*., 2019) [4]where the Spinetoram, chlorantraniliprole and emamectin benzoate was found promising for live larvae reduction.

Table 3. Reduction of FAW larval count in different observations after pesticides spray

S.N.	Treatments	Reduction in larval count in second observation	Reduction in larval count in third observation	Reduction in larval count in fourth observation
1	Imidacloprid	65^{bc}	86^{b}	100^{b}
2	Spinetoram	89^{bc}	100^{b}	100^{b}
3	Chlorantraniliprol	89^{c}	100^{b}	100^{b}

4	Emamectin Benzoate	66[c]	100[b]	100[b]
5	Control	-58[a]	-75[a]	-85[a]
6	Neem	45[b]	78[b]	100[b]
	CV %	54.3	52.5	60.6 t
	LSD	40.42	51.4	63.10
	Prob	**	**	**
	s.e.d.	19	24.11	29.60

Note: NS- Non-Significant; *- Significant at 5% level of significance and **-Significant at 1% level of significance, CV-Coefficient of variance, LSD-Least Significant Difference, s.e.d-standard error of differences of mean

Effect of different insecticides on the foliar and upper parts of leaves

On the basis of damage symptoms on whorl and upper four leaves chlorantraniliprole and spinetoram were found superior compared to all other treatments. Chlorantraniliprole and spinetoram were effective in reducing foliar damage of maize as compared to untreated control in green house experiment (Sisay *et al*., 2019) [8]. Emamectin benzoate was found second most effective insecticides on the basic of damage symptoms. Emamectin is effective insecticides against lepidopteran insect pest (Argentine *et al*., 2002) [9] and it was found very effective against S. frugiperda in laboratory condition when treated with pesticide treated cotton leaves and flowers. Similarly (Hardke *et al*., 2011) [10] reported that chlorantraniliprole is highly effective in bioassay against *S. frugiperdain* laboratory as well as effective in controlling the pest in field sorghum.

Table 4. Evaluation of various insecticides against FAWdamage on whorl and upper leaves in maize

S.N.	Treatments	Pest Damage score before spray	Pest Damage score after 1st spray	Pest Damage score after 2nd spray	Pest Damage score after 3rd spray	Damage reduction before spray and after 3rd spray

1	Imidacloprid	2.75^{ab}	1.25^{a}	0.75^{ab}	0.50^{a}	83.3
2	Spinetoram	3.75^{b}	1.25^{a}	0.75^{ab}	0.00^{a}	100
3	Chlorantraniliprol	3.00^{ab}	1.25^{a}	0.50^{a}	0.00^{a}	100
4	Emamectin Benzoate	3.00^{ab}	1.75^{ab}	1.00^{ab}	0.25	88
5	Control	2.75^{ab}	3.00^{b}	3.25^{c}	3.50^{b}	-33.3
6	Neem	2.50^{a}	1.75^{ab}	1.50^{bc}	1.75^{b}	29.2
	CV %	22.7	44.3	45.3	47.1^{c}	32.4
	LSD	1.014	1.143	0.881	0.71	30
	Prob	NS (0.21)	* (0.036)	** (0.001)	** (<.001)	** (<.001)
	s.e.d.	0.476	0.536	0.413	0.33	14

Note: NS- Non-Significant; *- Significant at 5% level of significance and **-Significant at 1% level of significance, CV-Coefficient of variance, LSD-Least Significant Difference, s.e.d-standard error of differences of mean.

Effect of different insecticides on the yield of maize

Of the tested insecticides, the highest grain yield was recorded in the treatment of chlorantraniliprole 18.5 SC (8.82 ton/ha) followed by spinetoram 11.7 SC (8.59 ton /ha) and emamectin benzoate 5 SG (7.47 ton/ha). Similar result was reported by (Deshmukh *et al*., 2020) [7] in the field efficacy of insecticides for management of invasive fall armyworm where Chlorantraniliprole recorded the higher grain yield, followed by spinetoram and emamectin benzoate. In the present experiment lowest reduction in damage (29.2%) and lowest yield (6.35 ton/ha) were observed from azadirachtin after control (water sprayed) plot. Pesticides have no significant effect on plant height. Similar result was reported by (Sisay *et al*., 2019) [8]. There was no significant difference in the height of the plant after chemical spray.

Table 5. Yield analysis of maize.

S.N.	Treatments	500 grain weight(gm)	Yield t/ha	Cobs per plot	Initial plant stand	Final plant stand	Plant height
1	Imidacloprid	147.6	7.2^{ab}	49.0^{b}	52	40	266^{ab}
2	Spinetoram	148.5	8.5^{c}	53.5^{b}	53	44	267.5^{ab}
3	Chlorantraniliprol	151.2	8.8^{c}	53.5^{b}	50	40	275^{c}
4	Emamectin Benzoate	148.0	7.4^{b}	49.75^{b}	51	40	264.4^{ab}
5	Control	143.6	6.2^{a}	42.0^{a}	52	39	255^{a}
6	Neem	144.4	6.3^{ab}	43.5^{a}	47	35	259^{ab}
	CV %	5.54	9.9	5.8	11.1	10	2.3
	LSD	11.8	1.115	4.221	8.5	6	8.97
	Prob	NS (0.759)	** (<.001)	** (<.001)	NS (0.717)	NS (0.086)	** (0.005)
	s.e.d.	5.3	0.523	1.98	4	3	4.21

Note: NS- Non-Significant; *- Significant at 5% level of significance and **-Significant at 1% level of significance, CV-Coefficient of variance, LSD-Least Significant Difference, s.e.d-standard error of differences of mean.

This figure below shows that there was 100% reduction in the number of live larvae and damage symptoms after third spray in the plot sprayed with chlorantraniliprole and spinetoram.The highest grain yield was from the plot sprayed with cholorantraniliprole followed by spinetoram .Similarly lowest grain yield and lowest reduction in live larvae and damage symptoms was from the neem sprayed plot.

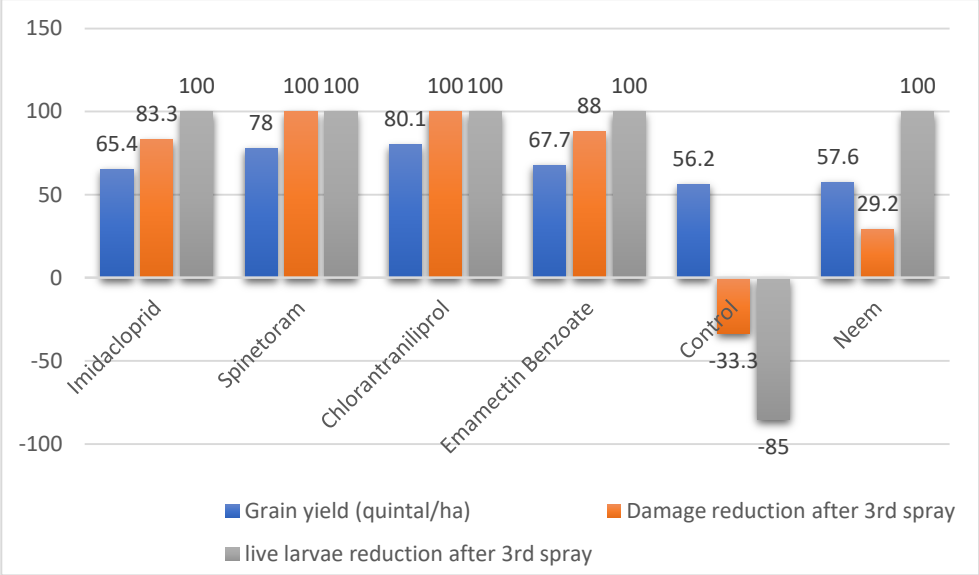

Figure 1: Effect of treatments on reduction of live larvae, foliar damage and yield.

CONCLUSION

From the research findings it was concluded that out of the five different insecticides used, all played an important role in the reduction of live larvae after3rd spray. However, the insecticides chlorantarniliprole and spinetoram shows faster and effective result in the reduction of FAW. These two insecticides showed effective result in the reduction of live larvae as well as foliar damages as compared to other insecticides and also the yield of grain was more in the plot sprayed with these two insecticides. Hence two of the insecticides spinetoram and cholrantraniliprole followed by emamectin can be used effectively to reduce the infestation of FAW in maize.

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