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EVALUATION OF BIOPESTICIDES AGAINST DEFOLIATOR INSECT PESTS OF LUCERNE (*MEDICAGO SATIVA* L.)

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SUMMARY

An experiment entitled "Evaluation of biopesticides against defoliator insect pest of lucerne (*Medicago sativa* L.)" was conducted at the All India Co-ordinated Research Projecton Forage Crops, Department of Agril. Botany, Mahatma Phule Krishi Vidyapeeth, Rahuri Dist. Ahmednagar (Maharashtra) during *Rabi* 2022-23. During the course of study, seven biopesticides were evaluated against defoliator insect pest of lucerne *i.e. Helicoverpa armigera* and *Spodoptera litura*. Among the entomopathogenic fungal and viral biopesticides tested against *H. armigera, Metarhizium rileyi* (1×10^8cfu/g) 1.15% WP and *Ha*NPV @ 500 LE/ha found superior and showed less than 1 larva of *H. armigera* at 10 days after spray; whereas among the biopesticides tested against *S. litura*, *Metarhizium rileyi* (1×10^8 cfu/g) 1.15% WP and *Sl*NPV @ 500 LE/ha were equally effective for management of *S. litura*. These treatments were recorded least larval population at 7 and 10 days after application and significantly superior over other treatments.

Key words: Lucerne, *H. armigera*, *S. litura*, biopesticides

Lucerne *(Medicago sativa* L.), often referred to as the 'Queen of forage crops' holds the distinction of being one of the earliest cultivated fodder crops. It is also known as alfalfa, a name derived from the Arabic language, signifying 'best fodder'. While commonly referred to as lucerne in Europe, its origins trace back to South Western Asia. Today, it is cultivated extensively across the globe and has successfully adapted to warm and cooler subtropical regions (Martin and Leonard, 1976). Lucerne goes by various names, including Alfalfa, Snail clover, Purple Mexico, Medic herb, Burgundy hay or clover, Chilen clover and Bourgeons Hoy (Bolton *et al*., 1972). Besides as an excellent fodder crop, it has soil conditioning properties and ability to fix nitrogen, it is valued for the ability to fix nitrogen during drought when other legumes are not nodulated or not actively fixing nitrogen (Johnson and Rumbaugh, 1981). Lucerne contains approximately 20.2% crude protein, 16.2% digestible crude protein, 30.1% crude fiber, 1240 g of calcium per 100 kg of lucerne, 350 g of phosphorus per 100 kg of lucerne, and 2.17 M cal/kg of metabolic energy (Banerjee, 1978). Alfalfa is rich in valuable nutrients including essential amino acids, minerals, vitamins, and dietary fiber (Hadidi *et al*, 2023). *M. sativa* is grown for livestock and poultry, with the area sown continuing to expand and demand higher than current supply. The plant is considered integral to the transformation of traditional agriculture It also provides an important alternative to overgrazing of ecologically sensitive grassland environments (McNeill *et al*., 2022). In India, quantitative losses of about 37.7% have been recorded in lucerne due to insect pests (Ram and Gupta, 1989). In Maharashtra, quantitative losses are approximately 42.28% in green forage due to *Spodoptera litura* Fab. and 41.01% in seed yield due to *Helicoverpa armigera* in lucerne (Tambe, 2009). The crop is close to human diet in food chain. So uses of highly persisted chemical insecticides are not desirable for control of pests of lucerne crop. Insect pests associated with this crop are aphids (Pandey *et. al*., 1995). Microbial insecticides/ biopesticides are suitable for incorporation in Integrated Pest Management system that relies predominantly on preventing pest problems by manipulating relationships between plants, beneficial organism and pests. So there is immense need to develop safer tactics for management of the pests. Therefore, the investigations were undertaken to develop the eco-friendly management system.

MATERIALS AND METHODS

Experimental site

The present investigation entitled, efficacy of microbial and botanical pesticides against *H. armigera* and *S. litura* was carried out during *Rabi* season of 2016-17 to 2019-20 under field condition at the All India Coordinated Research Project on Forage Crops & Utilization at MPKV, Rahuri Dist- Ahmednagar, Maharashtra. The topography of the field was fairly uniform and levelled. The soil of experiment area was medium black with adequate drainage.

Climatic conditions

Geographically, the central campus of Mahatma Phule Krishi Vidyapeeth is situated between $19^0$47' and $19^0$57' North latitude and between $74^0$32' and $74^0$19' East longitude. The altitude varies from 495 to 569 meters above the sea level. Climatically, this area falls in semi-arid tropics with annual rainfall varying from 307 to 619 mm. Meteorological Observations are graphically depicted in Fig. 1 showing climatic condition during the period of present investigation. During year 2022-23 the maximum temperature was ranged between 28 to 39^0C, minimum temperature was ranged between11 to 27^0C, morning relative humidity was 62 to 88%, evening relative humidity was and total rainfall was 19 to 48 mm respectively.

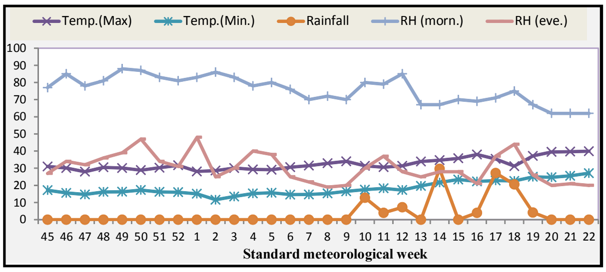

Fig. 1. Meteorological data recorded during the experimentalperiod.

Experimental details

Lucerne variety RL-88 was sown with recommended agronomic practices in at 30 cm spacing as line sowing in 3 m × 4 m plot size with. For the defoliator insect pest management, a trial was laid out in the randomized block design with eight treatments (Table 1) and three replications.

Observation recorded

Treatments of biopesticides sprayed upon the detection of *H. armigera* and *S. litura* infestation in crop. Two applications were applied with at ten days of interval during evening. precount at one day before spray and post treatment count of larval population on the 3rd, 7th and 10th days after spray were taken.

TABLE 1
Treatment details

Tr. No.	Treatment	Application dose
T_1	Azadirachtin (3000ppm)	2ml/lit.
T_2	*Beauveriabassiana* (1×10^{8}cfu/g) 1.15% WP	5g/lit.
T_3	*Metarhiziumanisoplia* (1×10^{8}cfu/g) 1.15% WP	5g/lit.
T_4	*Metarhiziumrileyi (Nomuriya)* (1×10^{8}cfu/g) 1.15% WP	5g/lit.
T_5	*Ha*NPV@ 500 LE/ha	1ml/lit.
T_6	*Sl*NPV@ 500 LE/ha	1ml/lit.
T_7	*Bacillus thuringiensis* (Bt)	2g/lit.
T_8	Untreated control	-

Data analysis

The data on observations of pests were subjected to statistical analysis. The different treatment means were separated using least significant difference test at p=0.5. The percentage data subjected to population as square root transformation whenever needed.

RESULTS AND DISCUSSION

1. Field efficacy of biopesticides against *Helicoverpaarmigera*

The initial larval population of *H. armigera*/ m^2 before spraying was non-significant and ranged from 7.12 to 7.47 in different treatments (Table 2).

Cumulative effect of twospray

At 3 days after spray the range of average population of *H. armigera* was 3.55 to 8.10 larvae/ m^2. The data indicated that all the insecticidal treatments were significantly superior over untreated control in reducing *H. armigera* population. The treatment with azadirachtin (3000 ppm) was the most promising treatment with least number of larval population (3.55). It was, however, at par with *B. thuringiensis (Bt)* 54% DF (4.30). Next promising treatments in order of their merit were *M. rileyi*(1×10^{8}cfu/g) 1.15% WP (4.50), *M. anisopliae* (1×10^{8}cfu/g) 1.15% WP (4.83) and *B. bassiana* (1×10^{8}cfu/g) 1.15% WP (4.90) which were at par with each other. Untreated check (8.10) recorded maximum larval population.

The effect of insecticides on *H. armigera* larvae at 7 days after spraying revealed that again *M. rileyi*1.15% WP proved its superiority against *H. armigera* larvae (2.83 larva/m^2). It was significantly superior to the remaining treatments. Nevertheless, *M. anisopliae*(1×10^8cfu/g) 1.15% WP (3.03) and *Ha*NPV @ 500 LE/ha (3.18) were at par with it. Next effective treatments in order of their effectiveness were Azadirachtin (3000 ppm) (3.44), *B. bassiana* 1.15% WP (3.68) and *B. Thuringiensis* (*Bt*)54 % DF (3.76) which were at par with each other.

At 10 days after spray the treatment with *M. Rileyi* (1×10^8cfu/g) 1.15% WP was significantly superior over rest of the treatments by recording 2.15 larvae/m^2 as against 8.61/m^2 in untreated control. However, it was at par with *Ha*NPV @500 LE/ha (2.32)and *M. anisopliae* (1×10^8cfu/g) 1.15% WP (2.43). Next promising treatments in order of their effectiveness were *B.bassiana*1.15% WP (2.75) and *B. thuringiensis* (*Bt*) 54 %DF (2.98) which were at par with each other followed by Azadirachtin (3000 ppm) (5.10).

2. Field efficacy of biopesticides against *Spodopteralitura*

The pre-treatment observations in the experimental field were recorded 1 day before first spray. Larval population of *S. litura* ranged from 6.07 to 6.80 larvae/m^2. The larval population in various treatment plots did not differ significantly (Table 3).

Cumulative effect of two spray

At 3 days after spray all the insecticidal treatments demonstrated significant effectiveness in reducing the larval population of *S. litura* when compared to untreated plots, where the larval population was 7.20 larvae per square meter (Table 3). Among the various treatments, Azadirachtin (3000 ppm) (2.95 larvae/m^2) proved to be the most effective treatment and was at par with *B. thuringiensis* (*Bt*) 54 % DF(3.18larvae/m^2). Next superior treatment was *M. rileyi* (1×10^8cfu/g) 1.15% WP (3.44 larvae/m^2), which was at par with *M. anisopliae* (1×10^8cfu/g) 1.15% WP (3.68 larvae/m^2). Additionally, the application of *Sl*NPV @500LE/ha showed promising results in reducing the incidence of *S. litura.*

At 7 days after spray all the insecticidal treatments were determined to be significantly effective in reducing the larval population of *S. litura* when compared to untreated plots, which had an average of 7.66 larvae per square meter. Among the various treatments, *M. rileyi* exhibited the highest effectiveness, with only 1.97 larvae per square meter and at par with *M. anisopliae* (1.63 larvae/m^2) and *Sl*NPV @ 500 LE/ha (2.27 larvae/m^2). The next best treatments included Azadirachtin (3000 ppm) (2.45),

TABLE 2

Cumulative effect of two spray on larval population of *H. armigera*

Tr. No.	Treatments	Survival larval population/m^2			
		Pre count	3 DAS	7 DAS	10 DAS
T_1	*Azadirachtin* (3000 ppm)	7.46 (2.82)	3.55 (2.09)	3.44 (1.98)	3.33 (1.96)
T_2	*Beauveria bassiana* (1×10^8 cfu/g) 1.15% WP	7.25 (2.78)	4.90 (2.31)	3.68 (2.04)	2.75 (1.80)
T_3	*Metarhizium anisopliae* (1×10^8 cfu/g) 1.15% WP	7.23 (2.78)	4.83 (2.35)	3.03 (1.88)	2.43 (1.71)
T_4	*Metarhizium rileyi* (*Nomuraea*) (1×10^8 cfu/g) 1.15% WP	7.33 (2.80)	4.50 (2.23)	2.83 (1.82)	2.15 (1.63)
T_5	*Ha*NPV@ 500 LE/ha	7.47 (2.82)	5.20 (2.39)	3.18 (1.92)	2.32 (1.68)
T_6	*Sl*NPV @ 500 LE/ha	7.13 (2.76)	7.75 (2.90)	8.18 (2.95)	8.47 (2.99)
T_7	*Bacillus thuringiensis* (Bt)	7.27 (2.78)	4.30 (2.17)	3.76 (2.06)	2.98 (1.87)
T_8	Untreated control	7.12 (2.79)	8.10 (2.98)	8.28 (2.96)	8.61 (3.01)
	SEm+-	0.28	0.04	0.04	0.03
	CD 5%	NS	0.13	0.11	0.09
	CV %	6.73	6.22	6.97	6.77

*Figures in parentheses are transformed values **DAS- Days after spray.

TABLE 3
Cumulative effect of two sprayon survival larval population of S. litura

Tr. No.	Treatments	Survival larval population/m^2 days			
		Pre count	3 DAS	7 DAS	10 DAS
T_1	*Azadirachtin* (3000 ppm)	6.23 (2.59)	2.95 (1.99)	2.45 (1.71)	2.75 (1.80)
T_2	*Beauveria bassiana* (1×10^8 cfu/g) 1.15% WP	6.80 (2.70)	3.85 (2.18)	2.60 (1.76)	2.25 (1.66)
T_3	*Metarhizium anisopliae* (1×10^8 cfu/g) 1.15% WP	6.25 (2.60)	3.68 (2.07)	2.16 (1.63)	1.70 (1.48)
T_4	*Metarhizium rileyi* (*Nomuraea*) (1×10^8 cfu/g) 1.15% WP	6.50 (2.65)	3.44 (2.05)	1.97 (1.57)	1.42 (1.37)
T_5	*Ha*NPV @ 500 LE/ha	6.16 (2.58)	7.10 (2.88)	7.57 (2.84)	8.00 (2.91)
T_6	*Sl*NPV @ 500 LE/ha	6.30 (2.61)	4.30 (2.30)	2.27 (1.66)	1.52 (1.42)
T_7	*Bacillus thuringiensis* (Bt)	6.07 (2.56)	3.18 (2.00)	2.75 (1.80)	2.47 (1.72)
T_8	Untreated control	6.21 (2.59)	7.20 (2.85)	7.66 (2.85)	8.23 (2.95)
	SEm ±	0.32	0.03	0.03	0.05
	CD at 5%	NS	0.10	0.11	0.16
	CV (%)	8.80	5.33	6.78	6.53

Figures in parentheses are transformed values, DAS: Days after spray.

B. bassiana (2.60 larvae/m^2) and *B. thuringiensis* (*Bt*) 54 % DF (2.75 larvae/m^2) which were at par with each other.

At 10 days after spray *M. rileyi SlNPV* @500LE/ha recorded significantly lower population (1.42), which was at par with *Sl*NPV @ 500 LE/ha (1.52), *M. anisopliae* (1.70). Next effective treatments in order of efficacy were *B. bassiana* (2.25), *B. thuringiensis* (*Bt*) 54 % DF (2.47) and Azadirachtin (3000 ppm) (2.75) which are at par with each other.

Overall results indicated that *M. rileyi* (*Nomuraea*) (1×10^8cfu/g) 1.15% WP was most effective treatment against both *H. armigera* and *S. litura*. Next to*M. rileyi* (1×10^8cfu/g) 1.15% WP, viral biopesticides *Ha*NPV @ 500 LE/ha and *S*lNPV @ 500 LE/ha proved to be effective against *H. armigera* and *S. litura*. Lucerne crop is irrigated crop with high population density, it helps in maintaining humidity which favours for fast multiplication of entomopathogenic fungus in field and hence it gave excellent results. *Ha*NPV and *Sl*NPV plays an important role for the control of *H. armigera* and *S. litura*. It enters in to larval body through feeding of flowers and pods of lucerne and get infection and multiplies into the nucleus of host and get occluded in polyhedral inclusion bodies. Integument of larva becomes fragile and on slight rupture, a whitish fluid comes out from the integument and hanging death of larva is observed.

In the present investigation, entomopathogenic fungus *i.e. M. rileyi* (*Nomuraea*) (1×10^8cfu/g) 1.15% WP gave excellent control against *H. armigera* and *S.litura*. These findings are in agreement with Tambe (2009) that showed effectiveness of different biopesticides against *H. armigera*on lucerne and it did not affect the activities of honey bees on lucerne seed crop. Also several research workers showed the effectiveness of *Metarhizium rileyi* against *H. armigera* and *S. litura* (Devi *et al.* 2003; Manjula and Krishna Murthy, 2005; Navi *et al*., 2006; Padanad and Krishnaraj, 2009; Tamboli, 2016; Hazarika *et al*, 2016) and combinations of fungal and viral microbial insecticides (Elanchezhyan, 2006). Wang *et al* (2023) reported that *Metarhizium rileyi* impairs and evades cellular immunity in the lepidopteran insect pest. *Metarhizium rileyi* recorded the highest enzymatic activity and exhibited the maximum mortality rate against instar larvae of *S. litura*, suggesting the possible role of these enzymes in the pathogenicity of the fungus (Grewal *et al*., 2021). *Metarhizium rileyi* is one of the most promising entomopathogenic fungi for controlling lepidopteran pest because of its specificity to lepidopteran larvae (Gebreslasie *et al.*, 2023).

CONCLUSION

Metarhizium rileyi (*Nomuraea*)(1×10^8cfu/g) 1.15% WP was most effective treatment for management of both *H. armigera* and *S. litura. Ha*NPV @ 500 LE/ha and *Sl*NPV@ 500 LE/ha were next alternative treatment for the control of *H. Armigera* and *S. litura* respectively. Overall results indicated that all entomopathogenic fungi showed their pathogenicity on defoliator pest due to the thick plant population of lucerne, it maintained micro climate which help to fungi for fast multiplication on target pests. Incorporation of bioinsecticides *viz., Sl*NPV@ 500 LE/ha and *Ha*NPV@ 500 LE/ha in addition with *Metarhizium rileyi* in IPM programme would be effective and eco-friendly for management *H. armigera* and *S. litura* respectively.

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