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Research Article

EFFICACY OF COMBINATION OF BIOPESTICIDES AGAINST *SPODOPTERA LITURA* (FABRICIUS) INFESTING LUCERNE, *MEDICAGO SATIVA* (LINNAEUS)

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Abstract: Field trial on 'Efficacy of combination of biopesticides against *Spodoptera litura* (Fabricius) infesting lucerne, *Medicago sativa* (Linnaeus)' was undertaken during 2013-14 and 2014-15 on lucerne crop at All India Co-ordinated Research Project on Forage Crops, MPKV, Rahuri (M. S.).Studies on efficacy of biopesticides against *S. litura* revealed that, SlNPV plus *Nomuraea rileyi* @ 1 ml/lit + 5 g/l was the most promising treatments which recorded least number of survival larval population(2.84 larvae/m row) and maximum green forage yield (118.63 q/ha). It was, however, at par with SlNPV plus *Metarhizium anisopliae* and SlNPV plus *Beauveria bassiana*.

Keywords: *Spodoptera litura, biopesticides, lucerne*

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Introduction

Lucerne or alfalfa (*Medicago sativa* Linnaeus) is an important cosmopolitan forage crop being referred to as 'Queen' of forage crops, and used as fodder for all classes of livestock by Michaud *et al*. [1]. In India, it was introduced in early 1900's and has now been used as perennial forage crop grown under a wide range of soil and climatic conditions. It is well adopted to warm temperature and cooler subtropical regions. Moreover, it has soil conditioning properties and ability of fixing atmospheric nitrogen. For the harvesting of lucerne as a fresh fodder, the first cut should be taken at 55-65 days after sowing and the subsequent cuts may be taken at 21-25 days interval. In general, 13-16 cuts can be taken by the farmers per annum. Being herbaceous in nature, the insect-pests have enormous scope to perpetuate and build up their population on lucerne under favorable climatic conditions. Chari and Patel [2] reported that tobacco caterpillar, *Spodoptera litura* (Fabricius), is one of the important polyphagous crop pests distributed throughout south and eastern world tropics infesting 112 species of plants belonging to 44 families, of which 40 species are known from India. The stock of *S. litura* seems to have developed resistance to some of the common insecticides were observed by Ramakrishnan *et al*. [3]. In order to mitigate the pest problems in lucerne crop, farmers rely heavily on the pesticides. Frequent use of pesticides leads to occurrence of residues in lucerne fodder. Being an important fodder crop for livestock in the region, such residues can have deleterious effects on domestic animals as well as human health and is therefore, cause for public concerned. Moreover, these pesticides have detrimental effects on natural enemies and beneficial like pollinators *viz*., honey bees. Hence, the present investigation was carried out to know the possibility of utilizing these microbial agents in combination were compared with their respective individual components in field experiment. Jaques [4] reported that the efficacy of biological component of mixtures was frequently enhanced by low concentrations of chemical components in the mixtures. However, the information on their use in combination for enhancing the effectiveness, in managing the insect pests is very much meagre. Under these circumstances utilization of natural pathogens such as nuclear polyhedrosis virus (NPV) and mycoinsecticides may prove worthy for control of tobacco caterpillar. Similarly, Coping [5] and Zimmerman [6] reported that myco-insecticides are easy to formulate, less toxic to mammals with no residual toxicity, less chances of resistance development in insect and have great capacity as biocontrol agent. Many biopesticides especially bacteria, virus and recently fungus exploited solely as a component of IPM strategies for the control of *S. litura* in various crop ecosystems.

Material and Methods

Field experiments for evaluating efficacy of biopesticides were conducted in the during on lucerne crop during 2013-14 and 2014-15 at All India Coordinated Research Project on Forage Crops in a Randomized Block Design (RBD) with 8 treatments including untreated control replicated thrice with individual plot size of 15.12 m^2 (4.2m x 3.6 m). All the test biopesticides were applied as foliar sprays. The observations were recorded on surviving larval population of *S. litura* per meter row length at three spots in each treatment plot one day before and at 3, 7 and 10 days after applications. Finally, treatment wise green forage was recorded at each cut/harvesting. The data on survival larval population of *S. litura* were transformed in to square root of n+1 value. The green forage yield data per plot recorded were converted into q/ha. The data were subjected to statistical analysis as per the procedure given by Panse and Sukhatme [7].

Results and Discussion

Cumulative efficacy of biopesticides against *S. litura* and green forage yield on Lucerne

The mean of the data for two years [Table-3] revealed that, there was significant difference among the insecticidal treatments. The initial larval population of *S. litura* DBS ranged from 6.29 to 7.08 per m row. Combination of SlNPV and *N. rileyi* @ 1 ml/lit + 5 g/l was found to be the most promising treatment with lowest survival population (2.84 larvae/m row). It was, however, at par with SlNPV + *M. anisopliae* (3.12). This was followed by SlNPV + *B. bassiana*, SlNPV and *N. rileyi* (1 ml + 5 gm/l) with 3.73, 4.02 and 4.59 larvae/m row, respectively. Alone *M. anisopliae* @ 5 g/l and *B. bassiana* @ 5 g/l observed to be comparatively least effective by recording 4.85 and 5.67 larvae/m row, respectively. The maximum population of larvae was recorded in untreated check (6.96 /m row).

Table-1 Field efficacy of biopesticides against *S. litura* on lucerne (2013-14)

S	Treatment	Dose	Number of survival larvae/m row					Green forage	
			Pre count	3 DAS	7 DAS	10 DAS	Mean	Yield (q/ha)	Percent increase over check
1	*SlNPV*(1 x 10^6 POBs/ml)	1 ml/lit	7.13(2.84)	6.37(2.7)	3.3(2.06)	2.77(1.9)	4.14(2.25)	101.68	35.63
2	*Nomuraea rileyi*(1 x 10^8cfu/ml)	5 g/lit	7.27(2.87)	7(2.82)	4.53(2.36)	3.67(2.15)	4.85(2.41)	103.94	38.64
3	*Beauveria. bassiana* (1 x 10^8cfu/ml)	5 g/lit	7.17(2.8)	6.9(2.8)	5.67(2.48)	4.2(2.26)	5.67(2.56)	94.63	26.22
4	*Metarrhizium anisopliae*(1 x 10^8cfu/ml)	5 g/lit	7.27(2.86)	7(2.84)	4.8(2.41)	3.33(2.06)	5.06(2.46)	100	33.39
5	*SlNPV* + *N. rileyi*(1 x 10^6 POBs/ml) + (1 x10^8cfu/ml)	1 ml/lit +5 g/lit	6.2(2.66)	5.37(2.51)	2(1.67)	0.77(1.33)	2.73(1.92)	110.38	47.23
6	*SlNPV* + *B. bassiana*(1 x 10^6 POBs/ml) + (1 x10^8 cfu/ml)	1 ml/lit +5 g/lit	7.5(2.85)	6.5(2.73)	3(1.97)	1.87(1.68)	3.79(2.18)	105.67	40.95
7	*SlNPV* + *M. anisopliae*(1 x 10^6 POBs/ml) +(1 x10^8cfu/ml)	1 ml/lit +5 g/lit	6.27(2.67)	6(2.64)	2.23(1.73	0.9(1.37)	3.04(2)	107.98	44.03
8	Untreated check	-	7.1(2.83)	8.5(3.07)	8.9(3.12)	6.74(2.77)	8.04(3)	74.97	
SE±			0.1	0.06	0.08	0.17	0.09	1.61	
CD @ 5%			NS	0.19	0.25	0.51	0.28	4.85	

Figures in the parenthesis are $\sqrt{(n+1)}$ *transformed values, DAS: Days after spray, NS: Non Significant*

Table-2 Field efficacy of biopesticides against *S. litura* on lucerne (2014-15)

S	Treatment	Dose	Number of survival larvae/m row					Green forage	
			Pre count	3 DAS	7 DAS	10 DAS	Mean	Yield (q/ha)	% increase over check
1	*SlNPV* (1 x 10^6 POBs/ml)	1 ml/lit	6.57(2.74)	6.00(2.64)	3.67(2.16)	2.00(1.73)	3.89(2.21)	112.65	57.91
2	*Nomuraea rileyi* (1 x 10^8cfu/ml)	5 g/lit	6.33(2.71)	6.10(2.66)	4.10(2.26)	2.77(1.94)	4.33(2.31)	110.12	54.36
3	*Beauveria. bassiana* (1 x 10^8cfu/ml)	5 g/lit	7.00(2.82)	6.77(2.78)	5.90(2.62)	4.67(2.38)	5.78(2.60)	98.23	37.69
4	*Metarhizium anisopliae* (1 x 10^8cfu/ml)	5 g/lit	6.77(2.78)	6.43(2.73)	4.43(2.33)	3.00(2.00)	4.63(2.37)	107.47	50.64
5	*SlNPV* + *N. rileyi* (1 x 10^6 POBs/ml) + (1 x 10^8cfu/ml)	1 ml/lit +5 g/lit	6.67(2.77)	5.20(2.49)	2.90(1.97)	0.77(1.33)	2.96(1.99)	126.88	77.85
6	*SlNPV* + *B. bassiana* (1 x 10^6 POBs/ml) + (1 x10^8 cfu/ml)	1 ml/lit +5 g/lit	6.33(2.70)	6.00(2.64)	3.33(2.08)	1.67(1.63)	3.67(2.16)	120.59	69.04
7	*SlNPV* + *M. anisopliae* (1 x 10^6 POBs/ml) + (1 x10^8cfu/ml)	1 ml/lit +5 g/lit	6.33(2.71)	5.67(2.58)	3.00(2.00)	0.90(1.37)	3.19(2.04)	121.19	69.88
8	Untreated check	-	5.57(2.56)	6.67(2.77)	6.90(2.81)	4.10(2.26)	5.89(2.62)	71.34	
SE±			0.14	0.05	0.06	0.1	0.07	2.17	
CD @ 5%			NS	0.16	0.18	0.3	0.21	6.53	

Figures in the parenthesis are $\sqrt{(n+1)}$ *transformed values, DAS: Days after spray, NS: Non Significant*

Table-3 Cumulative efficacy of biopesticides against *S. litura* and green forage yield of lucerne (Pooled mean of 2013-14 and 2014-15)

SN	Treatment	Dose	Number of survival larvae/m row					Green forage	
			Pre count	3 DAS	7 DAS	10 DAS	Mean	Yield (q/ha)	Percent increase over check
1	*SlNPV* (1 x 106 POBs/ml)	1 ml/lit	6.84(2.80)	6.19(2.68)	3.49(2.12)	2.38(1.83)	4.02(2.24)	107.17	49.21
2	*Nomuraea rileyi* (1 x 108cfu/ml)	5 g/lit	6.80(2.79)	6.54(2.74)	4.33(2.31)	2.89(1.97)	4.59(2.36)	107.03	46.3
3	*Beauveria. Bassiana* (1 x 108cfu/ml)	5 g/lit	7.08(2.83)	6.83(2.80)	5.77(2.59)	4.43 (2.32)	5.67(2.58)	96.43	31.81
4	*Metarhizium anisopliae* (1 x 108cfu/ml)	5 g/lit	7.02(2.82)	6.74(2.78)	4.62(2.37)	3.18(2.04)	4.85(2.42)	103.74	41.8
5	*SlNPV* + *N. rileyi* (1 x 106 POBs/ml) + (1 x 108cfu/ml)	1 ml/lit +5 g/lit	6.43(2.72)	5.30(2.50)	2.47(1.85)	0.77(1.33)	2.84(1.96)	118.63	62.15
6	*SlNPV* + *B. bassiana* (1 x 106 POBs/ml) + (1 x 108 cfu/ml)	1 ml/lit +5 g/lit	6.91(2.80)	6.24(2.69)	3.17(2.03)	1.77(1.66)	3.73(2.17)	113.13	51.91
7	*SlNPV* + *M. anisopliae* (1 x 106 POBs/ml) + (1 x108cfu/ml)	1 ml/lit +5 g/lit	6.29(2.69)	5.84(2.61)	2.62(1.89)	0.89(1.37)	3.12(2.03)	114.59	56.62
8	Untreated check	-	6.33(2.70)	7.58(2.93)	7.89(2.98)	5.42(2.53)	6.96(2.82)	73.16	
SE±			0.16	0.04	0.07	0.09	0.07	1.87	
CD @ 5%			NS	0.14	0.22	0.29	0.21	5.64	

Figures in the parenthesis are $\sqrt{(n+1)}$ *transformed values, DAS: Days after spray, NS: Non Significant*

Table-4 Influence of *S .litura* on green forage yield and cost economics in respect of biopesticides

SN	Treatment	Dose	Total green forage yield (q/ha)	Increased GFY over check (q/ha)	Increased income over check (Rs./ ha)	Plant protection cost (Rs./ ha)	Net profit (Rs./ha)	ICBR
1	*SlNPV*	1 ml/lit	218.32	72.01	14,042/-	1,900/-	12,142/-	1 : 6.39
2	*N. rileyi*	5 g/lit	214.06	67.75	13,211/-	1,550/-	11,661/-	1 : 7.52
3	*B.bassiana*	5 g/lit	192.86	46.55	9,077/-	1,550/-	7,527/-	1 : 4.86
4	*M. anisopliae*	5 g/lit	207.47	61.16	11,926/-	1,550/-	10,376/-	1 : 6.69
5	*SlNPV* + *N. rileyi*	1 ml/lit +5 g/lit	237.26	90.95	17,735/-	2,650/-	15,085/-	1 : 5.69
6	*SlNPV* + *B. bassiana*	1 ml/lit +5 g/lit	222.27	75.96	14,812/-	2,650/-	12,162/-	1 : 4.59
7	*SlNPV* + *M. anisopliae*	1 ml/lit +5 g/lit	229.17	82.86	16,158/-	2,650/-	13,508/-	1 : 5.10
8	Untreated check	-	146.31	-	-	-	-	--

Green forage yield

The differential control of *S. litura* was reflected in terms of green forage yield of lucerne. It revealed that SlNPV+ *N. rileyi* @ 1 ml/l + 5 g/l registered higher green forage yield of 118.63 q/ha with maximum per cent (62.15) increase in yield over untreated check. It was, however, at par with SlNPV+ *M. anisopliae* @ 1 ml/l + 5 g/l (114.58 q/ha) and SlNPV+ *B. bassiana* @ 1 ml/l + 5 g/l (111.14 q/ha) which recorded 56.62 and 51.91 per cent increase in yield, respectively. This was followed by alone SlNPV @ 1 ml/l (109.16 q/ha), *N. rileyi* @ 5 g/l (107.03 q/ha) and *M. anisopliae* @ 5 g/l (103.74) with 49.21, 46.30 and 41.80 per cent increase in yield, respectively which were statistically in similar range.

Table-5 Influence of *S .litura* on green forage yield and cost economics in respect of biopesticides

SN	Cost of insecticides	Cost of biopesticides (Rs./ lit/kg)	Quantity/spray (l/kg/ha.)	Qty. used (ml/g/ ha) for 2 sprays	Cost (Rs./ha)	Labour charges (Rs./ha)	Total cost (Rs./ha)
1	*Sl*NPV	1100/-	0.5	1.0	1,100/-	800/-	1,900/-
2	*N. rileyi*	150/-	2.5	5.0	750/-	800/-	1,550/-
3	*B.bassiana*	150/-	2.5	5.0	750/	800/-	1,550/-
4	*M. anisopliae*	150/-	2.5	5.0	750/	800/-	1,550/-
5	*Sl*NPV + *N. rileyi*	1100/- +150/-	0.5 + 2.5	1.0 + 5.0	1,850/-	800/-	2,650/-
6	*Sl*NPV + *B. bassiana*	1100/- +150/-	0.5 + 2.5	1.0 + 5.0	1,850/-	800/-	2,650/-
7	*Sl*NPV + *M. anisopliae*	1100/- +150/-	0.5 + 2.5	1.0 + 5.0	1,850/-	800/-	2,650/-

Cost economics

Data presented in [Table-4] revealed that SlNPV+ *N. rileyi* @ 1 ml/l + 5 g/l recorded maximum net profit of Rs. 1,50,85.00/ha. It was followed by SlNPV+ *M. anisopliae* @ 1 ml/l + 5 g/l and SlNPV+ *B. bassiana* @ 1 ml/l + 5 g/l obtained Rs. 13508.00 and Rs.12162.00 per hectare, respectively. The maximum ICBR ratio was recorded in *N. rileyi* @ 5 g/l (1:7.52), followed by *M. anisopliae* @ 5 g/l (1:6.69), SlNPV (1:6.39), SlNPV+ *N. rileyi* (1:5.69) and SlNPV+ *M. anisopliae* @ 1 ml/l + 5 g/l (1:5.10). In the present investigation, the combination of SlNPV with entomopathogenic fungus gave excellent control against *S. litura*. These findings are in agreement with Malakar *et al*. [8]. Further, Malakar *et al*. [9] reported that respective fungal sporulation and virus occlusion bodies exhibited almost similar pattern of pest mortality. It appears that combined effect of entomopathogenic fungus and SlNPV complements each other and /or act synergistically, could offer an attractive biorational strategy. Due to lack of literature on joint action of entomopathogenic fungus and Nuclear Polyhedrosis Virus (NPV) specifically in respect of lepidopteran pests infesting lucerne, the results could not be compared. Lecuona and Alves [10], Glare [11], Timper and Brodie [12] and Inglis *et al*. [13] pointed out that combined application of two or more entomopathogenic fungi with other pathogens adds synergistic efficacy. In the present studies, SlNPV alone was observed to be next promising treatment against *S. litura* which is in corroboration with Pal [14] on lucerne, Bhutia *et al*. [15] on cabbage, Kulkarni and Lingappa [16] on soybean and potato and Patil and Abhilash [17] on groundnut. Similarly, effectiveness of *N. rileyi* as evidenced in the present studies is in agreement with the observations made on lucerne against *S. litura* and on groundnut Patil and Abhilash [17]. *B. bassiana* was found to be least effective against *S. litura*. These findings are in conformity with Tambe [18] and Pal [14] on lucerne. Studies carried out under laboratory condition by Malarvannan *et al*. [19] also evidenced inferior performance of *B. bassiana* [20,21].

Conclusion

This investigation was revealed that combination of SlNPV and *N. rileyi* was the most promising treatments against *Spodoptera litura* infesting lucerne recorded least number of survival larval population and maximum green forage yield.

Application of research: In the present studies, SlNPV alone was observed to be next promising treatment against *S. litura*

Research Category: Agriculture Entomology

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References

[1] Michaud R., Lehmen W. F. and Rumbaugh M. D. (1988) *American Society Agronomy, Madison, WI.,* 25-91.
[2] Chari M.S. and Patel N.G. (1983) *Cotton Development* 13, 465-482.
[3] Ramakrishnan N., Saxena -V.S. and Dhingra S. (1983) *Pesticides*, 18, 23-27.
[4] Jaques R.P. (1988) *Can. Ent.* 120, 575-580.
[5] Copping L. G. (2004) *British Crop Protection Council, UK*,107.
[6] Zimmermann G. (2007) *Bicont. Sci. Technol*., 17, 553-596.
[7] Panse V. G. and Sukhatme P. V. (1967) *ICAR. New Delhi*, 145.
[8] Malakar R., Joseph S. E., Ann E. H. and John P. B. (1999a) *J. Invert. Path*., 73, 91-100.
[9] Malakar R., Elkinton J. S., Carrol S. D. and D'Amico V. (1999b) *Biol. Cont.,* 16, 189-198.
[10] Lecuona R. E. and Alves S. B. (1988) *J. Applied Entomol*., 105, 223-228.
[11] Glare T. R. (1994) *Biocont. Sci. and Tech*., 4, 321-329.
[12] Timper P. and Brodie B. B. (1995) *Biol. Cont*., 5, 629-635.
[13] Inglis D. G., Goettel S. M., Butt M. T. and Strasser H. (2001) *CAB Int*., 23-69.
[14] Pal S. (2014) *M. Sc. Thesis submitted to Mahatma Phule Krishi Vidyapeeth, Rahuri, Maharashtra, India*, 71.
[15] Bhutia K.S., Chakrvathy A.K., Dodabasappa B., Narabenchi G.B. and Lingraj V.K. (2012) *Bulletin of Insectology*, 65(2), 247-256.
[16] Kulkarni N. S. and Lingappa S. (2002) *J. Agric. Sci*., 15(1), 47-55.
[17] Patil R.H. and Abhilash C. (2014) *Int. Confe. on Biol., Civil and Environ. Engg., March 17-18, 2014, Dubai, UAE*, 131-133.
[18] Tambe A. B. (2009) *Ph. D. Thesis submitted to Mahatma Phule Krishi Vidyapeeth, Rahuri, Maharashtra, India*, 209.
[19] Malarvannan S., Murali P. D., Shanthakumar P., Prabavarthy V. R. and Nair S. (2010) *J. Biopestici., 3(1 Special issue),* 126-131.
[20] Inglis D. G., Johnson D. L., Cheng K. J., Goettel M. S. (1997) *Biol. Cont*., 8, 143-152.
[21] Inglis D. G., Duke G. M., Kawchuk L. M. and Goettel M. S. (1999) *Biol. Cont*., 14, 111-120.