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Bio-efficacy of *Beauveria bassiana* against gram pod borer, *Helicoverpa armigera* Hubner (Noctuidae: Lepidoptera) in chickpea

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Abstract

A field experiments was carried out at Zonal Agricultural Research Station (ZARS), Visveswaraya Canal Farm, Mandya, Karnataka to evaluate the bio-efficacy of *Beauveria bassiana* 1.15WP against gram pod borer, *Helicoverpa armigera* on chickpea. In all three sprays, ten days after the treatment, a significant and lower larval population was recorded in *B. bassiana* 1.15% WP @ 3000g/ha and *B. bassiana* 1.15% WP @ 2500g/ha which recorded larval population of 2.33 and 2.66/10 plants with 80.75 and 78.03 percent reduction in larval population over untreated control and were on par with each other. The next best treatments were *B. bassiana* 1.15% WP @ 2000g/ha and commercial neem formulation @ 5000 ml/ha and quinalphos 25 EC@1000ml/ha which recorded mean larval population of 3.33, 3.99 and 4.33 per 10 plants with 72.50, 67.05 and 64.24 per cent larval population reduction over untreated control, respectively. However, significantly higher larval population was recorded in untreated control (12.11 larvae/10plants) and this was followed by *B. bassiana* 1.15% WP @ 1500g/ha (10.33 larvae/ 10plants). Likewise, the higher yield was recorded in *B. bassiana* 1.15% WP @ 3000g/ha and *B. bassiana* 1.15% WP @ 2500g/ha and these treatments were also registered significant lower pod damage of 8.11 and 8.36 per cent, followed by commercial neem formulation @ 5000 ml/ha (9.87%) with 73.65, 72.83 and 67.93 per cent reduction in pod damage over untreated control, and were on par with each other compared to untreated control which recorded significantly higher pod damage (30.78%). Among the treatments there was no adverse effect of *B. bassiana* on the prevailing population of wasps and other natural enemies except in quinalphos 25EC @ 2.5ml/l.

Keywords: *Beauveria bassiana, Helicoverpa armigera*, bioefficacy, chickpea

Introduction

Gram commonly known as 'chickpea' or Bengal gram is the most important pulse crop in India. Chickpea occupies about 38 per cent of area under pulses and contributes about 50 per cent of the total pulse production of India. It is used for human consumption as well as for feeding to animals. It is eaten both whole fried or boiled and salted or more generally in the form of split pulse which is cooked and eaten. Both husks and bits of the 'dal' are valuable cattle feed. Fresh green leaves are used as vegetable (sag). Straw of Chickpea is an excellent fodder for cattle. The grains are also used as vegetable (chole). Chickpea flour (besan) is used in the preparation of various types of sweets. Chickpea is considered to have medicinal effects and it is used for blood purification. Chickpea contains 21.1 per cent protein, 61.5 per cent carbohydrates, 4.5 per cent fat. It is rich in calcium, iron and niacin. Chickpea has been known in this country for a long time. It is said to be one of the oldest pulses known and cultivated from ancient times both in Asia and in Europe. It's probable place of origin lies in south western Asia, which is in the countries lying to the north-west of India such as Afghanistan and Persia. Pulses are important sources of protein for India's large and growing population. Chickpea (*Cicer arietinum)* is one of the most important pulse crops of India. India is the largest producer with 75% of world acreage and production of gram. India produces 5.3mt of chickpea from 6.67 mha with an average production of 844 kg ha-1 (www.iipr.res.in). The survey conducted from time to time by various agencies in different parts of the country revealed that there are many factors which influence the production of chickpea. Among the insect pests particularly pod borer, *Helicoverpa armiger* is one of the main constraints which limit the production of chickpea. The yield loss in chickpea due to pod borer was 10 – 60 per cent in normal weather conditions (Bhatt and Patel, 2001) [4]. Reports of high level of resistance to the conventional insecticides in *H. armigera* have resulted in renewed interest in the research for exploring the opportunities of using biopesticides. Keeping in view, the present study was undertaken to evaluate the Bio-efficacy of *Beauveria bassiana* 1.15% WP against gram pod borer, *H. armigera* on chickpea.

Materials and Methods

The field experiments was carried out at Zonal Agricultural Research Station (ZARS), Visveswaraya Canal Farm, Mandya, Karnataka to evaluate the bio-efficacy of *Beauveria bassiana* 1.15% WP against gram pod borer, *Helicoverpa armigera* on chickpea. The trials were laid out in RBD with seven treatments including an untreated control (water spray) and three replications. The popular and leading chickpea variety Annigeri – 1 was sown in the second fort-night of November with a distance of 30 cm (R x R) and 15 cm (P x P) in a plot measuring 20.25m^2 (4.5 x 4.5 m^2).

All the recommended cultural and agronomical practices were followed to raise healthy crop as per the package of University of Agricultural Sciences, Bangalore. The first spraying of respective treatments were done at ETL (1 larva/5 plants, Atwal and Dhaliwal, 1997) [1] in the first fortnight of February, second and third sprays were taken at 15 days intervals during second and first fortnights of February and March, respectively by using pneumatic knapsack sprayer with a spray fluid of 500 liters/ha. The observations on the larval population of *H. armigera* and pod damage were recorded on ten tagged plants in each replication, a day before and ten days after in each spray. The data on larval population in each replication were subjected to $\sqrt{x+0.5}$ transformations, simultaneous the percent pod damage by *H. armigera* in each replication were subjected to arc sin $\sqrt{\%}$ transformation.

Further, the data on larval population and per cent pod damage by *H. armigera* were subjected for ANOVA (Gomez and Gomez, 1984; Hosmand, 1988) [5, 6] and means were separated by Tukey’s Honesty Significant Difference Test (HSD) (Tukey, 1953) [13]. The percentage reduction in larval population and pod damage over untreated control was calculated. The harvest was done at physiological maturity. The grain yield was recorded treatment wise and the data thus collected were subjected for ANOVA (Gomez and Gomez, 1984; Hosmand, 1988) [5, 6] and means were separated by Tukey’s Honesty Significant Difference Test (HSD) (Tukey, 1953) [13].

Results and Discussion

Bio-efficacy of *B. bassiana* 1.15 WP on larval population

A day before spray, there were no significant difference among the treatments with respect to the larval populations. Each treatment differs significantly on 10th day of spray. The lower larval population (4.66/10 plants) was observed in commercial neem formulation @ 5000 ml/ha and differs significantly with rest of the treatments. The next best treatment was *B. bassiana* 1.15% WP @ 3000 g/ha which recorded 5.33 larvae/10 plants and was on par with *B. bassiana* 1.15% WP @ 2500 g/ha and quinalphos 25 EC @ 1000 ml/ha (5.00 larvae/10 plants) and were on par with each-other. The maximum larval populations were observed in untreated control and *B. bassiana* 1.15% WP @ 1500 g/ha which recorded 9.66 and 7.00 larvae/10 plants, respectively and differs significantly.

Similar trend was observed a day before second spray. On the 10th day of second spray, significantly the lower larval population was observed in *B. bassiana* 1.15% WP @ 2500 g/ha which recorded 3.33 larvae/10 plants. This treatment was followed by *B. bassiana* 1.15% WP @ 3000 g/ha and commercial neem formulation @ 5000 ml/ha and quinalphos 25 EC @ 1000 ml/ha which recorded 3.66, 4.33 and 4.66 larvae/10 plants, respectively and were at par with each other. These treatments were followed by *B. bassiana* 1.15% WP @ 2000 g/ha and *B.bassiana*1.15% WP @ 1500 g/ha which recorded 5.33 and 8.00 larvae/10 plants, respectively, and differs significantly. Among the treatments, significant and higher larval population (10.33/10 plants) was observed in untreated control.

Similar trend in larval population was observed among the treatments a day before the third spray indicating cumulative effect of each treatment. On the 10th day of third spray, Significant and lower larval population were recorded in *B. bassiana* 1.15% WP @ 3000 g/ha and *B. bassiana* 1.15% WP @ 2500 g/ha which recorded larval population of 2.33 and 2.66/10 plants with 80.75 and 78.03 percent reduction in larval population over untreated control and were on par with each-other. The next best treatments were *B. bassiana* 1.15% WP @ 2000 g/ha and commercial neem formulation @ 5000 ml/ha and quinalphos 25 EC @ 1000 ml/ha which recorded 3.33, 3.99 and 4.33 larvae/10 plants with 72.50, 67.05 and 64.24 per cent reduction over untreated control, respectively. However, significantly higher larval population was recorded in untreated control (12.11 larvae/10 plants) and this was followed by *B. bassiana* 1.15% WP @ 1500g/ha (10.33 larvae/ 10 plants) (Table 1).

Earlier reports on the efficacy of *B. bassiana* against gram pod borer (Rijal *et al*. 2008; Ritu *et al*. 2012 [12]; Bajya *et al.* 2015) [9, 10, 2] fall in line with the present study.

Bio-efficacy of *B. bassiana* 1.15 WP on pod damage

A day before first spray, there were no significant difference among the treatments with respect to the pod damage caused by *H. armigera*, and the pod damage in these treatments varied between 23.34 to 25.18 percent. Ten days after the first spray each treatment differs significantly. The lower pod damage was observed in commercial neem formulation @ 5000 ml/ha (13.77%) and *B. bassiana* 1.15% WP @ 3000 g/ha (13.86) and these treatments were at par with *B. bassiana* 1.15% WP @ 3000 g/ha which recorded 14.36 per cent pod damage. However, significantly higher pod damage was noticed in untreated control (24.38%). Similar trend in pod damage by *H. armigera* was observed among the treatments a day before second and third spray and 10th day after second spray.

On the 10th day after third spray, each treatment differs significantly. The treatments *B. bassiana* 1.15% WP @ 3000 g/ha and *B. bassiana* 1.15% WP @ 2500 g/ha registered significant and lower pod damage of 8.11 and 8.36 per cent, followed by commercial neem formulation @ 5000 ml/ha (9.87%) with 73.65, 72.83 and 67.93 per cent reduction in pod damage over untreated control, and were on par with each other. These treatments were followed by quinalphos 25 EC @ 1000 ml/ha, *B. bassiana* 1.15% WP @ 2000 g/ha and *B. bassiana* 1.15% WP @ 1500 g/ha which recorded 11.28, 16.16 and 29.26 per cent pod damage with 63.35, 47.49 and 4.93 per cent reduction in pod damage over untreated control, respectively. Whereas, the untreated control recorded significantly higher (30.78%) pod damage (Table 2).

The results are in closer proximity with the studies conducted by Srikanth and Seshamahalakshmi (2012) [12], Prasad and Purohit (2013) [8] and Bajya *et al.* (2015) [2] which proved efficacy of B. bassiana against *H. armigera.*

Effect of *B. bassiana* 1.15 WP on natural enemies

Populations of natural enemies prevailing in the experimental plots were recorded before first spray and after 7 days of each spray. The data recorded revealed that there was negligible population of natural enemies in the plots at the time of first application of treatments hence; the details are not presented in the report. The observations recorded after 7 days of each spray showed low and scattered population of coccinellids and spiders, whereas, sufficient population of wasps carrying larvae of pod borers was recorded in various plots. The treatments with B. *bassiana* 1.15% WP at various concentrations recorded significantly higher number of wasps (Vespidae: Hymenoptera) compare to other treatments. The results presented in Table 3 revealed that there was no adverse effect of treatments on the prevailing population of wasps except in case of quinalphos 25% EC. Hence *B. bassiana* 1.15% WP was found safer to natural enemies associated with chickpea agro ecosystem. The present result on the safety of B. bassiana to natural enemies is in close agreement with the findings of Nguyen *et al.* 2010 [7] and Bajya *et al*. 2015 [2]. This finding is in line with the previous study reported by Bayu and Prayogo (2018) [3], that the entomopathogenic fungi did not affect the survival rate of natural enemies.

Grain yield and cost benefit ratio

Each treatment differs statistically with respect to grain yield at harvest. However, Significant and higher grain yield was observed in *B. bassiana* 1.15% WP @ 3000 g/ha which recorded 17.50 q/ha, with 84.21 per cent increase in yield over untreated control. This treatment was followed by *B. bassiana* 1.15% WP @ 2500 g/ha, Quinalphos 25 EC @ 1000 ml/ha, commercial neem formulation @ 5000 ml/ha, *B. bassiana* 1.15% WP @ 2000 g/ha and *B. bassiana* 1.15% WP @ 1500 g/ha which recorded grain yield of 17.18, 16.56, 15.62, 15.31 and 9.68 q/ha with 80.92, 74.34, 64.47, 61.18 and 1.97 per cent increase in grain yield over untreated control, respectively. However, significantly lower seed yield (9.50 q/ha) was recorded in untreated control (Table 4).The highest cost benefit ratio (1:4.90) was recorded in *B. bassiana* 1.15% WP @ 3000 g/ha. This was followed by *B. bassiana* 1.15% WP @ 2500 g/ha, quinalphos 25 EC @ 1000 ml/ha, *B. bassiana* 1.15% WP @ 2000 g/ha, commercial neem formulation @ 5000 ml/h and *B. bassiana* 1.15% WP @ 1500 g/ha which recorded C:B ratio of 1:484, 1:451, 1:425, 1:3.75 and 1:2.32, respectively. Whereas, untreated control recorded least C:B ratio (1:2.35) compared to rest of the treatments.

The use of B. bassiana is safe to the predators and effectively increased the yield as compared with the application of chemical insecticide and without any treatments (Bayu and Prayogo, 2018) [3]. However the present result was contradictory to result found by Bajya *et al.* 2015 [2], this may be due to strainal variations and treatment dosage.

Table 1: Bio-efficacy of *B. bassiana* 1.15WP against gram pod borer, *H. armigera* on chickpea

Sl. No.	Treatments	Dose/ha	I Spray Larvae/10 Plants		II Spray Larvae/10 Plants		III Spray Larvae/10 Plants		Per cent reduction over control
			1 DBFS	10 DAFS	1 DBSS	10 DASS	1 DBTS	10 DATS	
1	*B. bassiana*1.15 WP	1500g	7.33(2.79)	7.00(2.73)c	8.66(3.02)d	8.00(2.91)d	9.66(3.18)c	10.33(3.29)d	14.69
2	*B. bassiana*1.15 WP	2000g	7.66(2.85)	6.33(2.61)bc	6.00(2.54)bc	5.33(2.41)c	4.33(2.19)ab	3.33(1.95)b	72.50
3	*B.bassiana*1.15 WP	2500g	8.00(2.91)	5.33(2.41)ab	5.33(2.41)ab	3.33(1.95)a	3.99(2.11)ab	2.66(1.77)a	78.03
4	*B. bassiana*1.15 WP	3000g	7.00(2.73)	5.00(2.34)b	5.33(2.41)ab	3.66(2.03)b	3.66(2.03)a	2.33(1.68)a	80.75
5	Azadirachtin 0.03%	5000ml	8.33(2.97)	4.66(2.27)a	5.00(2.34)a	4.33(2.19)b	4.00(2.12)ab	3.99(2.11)bc	67.05
6	Quinalphos 25 EC	1000ml	7.66(2.85)	5.33(2.41)ab	6.66(2.67)c	4.66(2.27)b	4.66(2.27)b	4.33(2.19)c	64.24
7	Untreated control	-	8.33(2.97)	9.66(3.18)d	7.66(2.85)d	10.33(3.29)e	11.66(3.48)d	12.11(3.55)e	-
SE m±			NS	0.02	0.05	0.03	0.09	0.10	-
CV%				22.5	18.85	24.5	21.2	15.9	
CD @ p=0.05				0.07	0.19	0.10	0.27	0.32	

DBFS- day before first spray; DAFS- days after first spray; DBSS- day before second spray; DASS- day after second spray; DBTS- day before third spray; DATS- Day after third spray; Figures in the parentheses indicate √ 0+0.5 transformed values; Values in the column followed by common letters are non-significant at p=0.05 as per Tukey's HSD (Tukey, 1953) [13].

Table 2: Bio-efficacy of *B. bassiana* 1.15WP against pod damage by *H. armigera* on chickpea

Sl. No.	Treatments	Dose/ha	I Spray % pod damage/10 Plants		II Spray % pod damage/10 Plants		III Spray % pod damage/10 Plants		Per cent reduction over control
			1 DBFS	10 DAFS	1 DBSS	10 DASS	1 DBTS	10 DATS	
1	*B. bassiana*1.15 WP	1500g	24.26(29.47)	25.18(29.53)c	23.81(29.20)c	24.76(29.87)d	26.26(30.79)d	29.26(32.77)d	4.93
2	*B. bassiana*1.15 WP	2000g	23.34(28.86)	15.24(23.03)b	16.26(23.81)b	19.18(25.99)c	20.18(26.71)c	16.16(23.73)c	47.49
3	*B. bassiana*1.15 WP	2500g	23.87(29.27)	14.36(22.30)ab	12.16(20.44)a	11.38(19.73)a	10.32(18.72)a	8.36(16.85)a	72.83
4	*B. bassiana*1.15 WP	3000g	24.28(29.47)	13.86(21.89)a	11.78(20.09)a	10.23(18.63)a	9.46(17.95)a	8.11(16.54)a	73.65
5	Azadirachtin 0.03%	5000ml	23.46(29.00)	13.77(21.81)a	12.17(20.44)a	12.16(20.44)a	10.77(19.19)a	9.87(18.34)ab	67.93
6	Quinalphos 25 EC	1000ml	24.81(29.87)	15.16(22.87)ab	15.86(23.50)b	16.16(23.73)b	13.34(21.39)b	11.28(19.64)b	63.35
7	Untreated control	-	25.18(30.13)	24.38(29.53)c	24.22(29.47)c	26.83(31.18)d	28.96(32.58)d	30.78(33.71)d	-
SE m±			NS	0.36	1.24	1.68	1.16	1.03	-
CV%				22.6	19.8	20.1	18.3	15.8	
CD @ p=0.05				1.14	3.87	4.56	3.11	3.18	

DBFS- day before first spray; DAFS- days after first spray; DBSS- day before second spray; DASS- day after second spray; DBTS- day before third spray; DATS- Day after third spray; Figures in the parentheses indicate arc sin√% transformed values; Values in the column followed by common letters are non-significant at p=0.05 as per Tukey's HSD (Tukey, 1953) [13].

Table 3: Bio-efficacy of *B. bassiana* 1.15 WP against natural enemy complex in chickpea

Sl. No.	Treatments	Dose/ha	Natural enemies/10 plants (7 days after I spray)			Natural enemies/10 plants (7 days after II spray)			Natural enemies/10 plants (7 days after III spray)		
			Coccinellids	Spiders	Wasps	Coccinellids	Spiders	Wasps	Coccinellids	Spiders	Wasps
1	*B. bassiana* 1.15 WP	1500g	0.33	0.00	2.33^{b}	1.11	0.00	3.33^{d}	0.00	0.00	5.11^{b}
2	*B. bassiana* 1.15 WP	2000g	0.33	0.33	1.99^{c}	0.00	0.66	5.33^{b}	0.00	1.33	3.33^{d}
3	*B. bassiana* 1.15 WP	2500g	0.00	0.00	4.99^{a}	0.00	0.00	6.99^{a}	0.00	0.00	6.99^{a}
4	*B. bassiana*1.15 WP	3000g	1.33	0.00	1.66^{d}	0.33	0.00	5.66^{b}	0.33	0.00	4.66^{c}
5	Azadirachtin 0.03%	5000ml	0.00	0.00	1.66^{d}	0.00	0.00	2.33^{e}	0.00	0.00	2.66^{d}
6	Quinalphos 25 EC	1000ml	0.00	0.00	0.00^{e}	0.00	0.33	0.00^{e}	0.00	0.00	0.00^{e}
7	Untreated control	-	0.00	0.00	4.66^{a}	0.33	0.00	4.33^{c}	0.00	0.00	5.33^{b}

Activities of natural enemies observed per plot (16 mt^2); Values in the column followed by common letters are non-significant at p=0.05 as per Tukey's HSD (Tukey, 1953) [13].

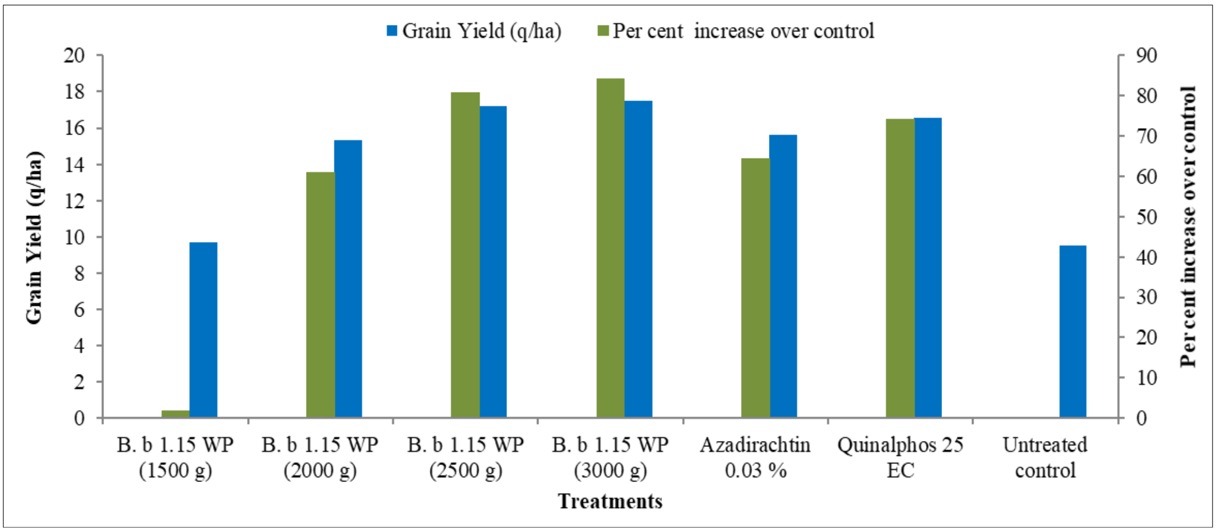

Fig 1: Bio-efficacy of *B. bassiana* 1.15% WP against pod damage by *H. armigera* on chickpea

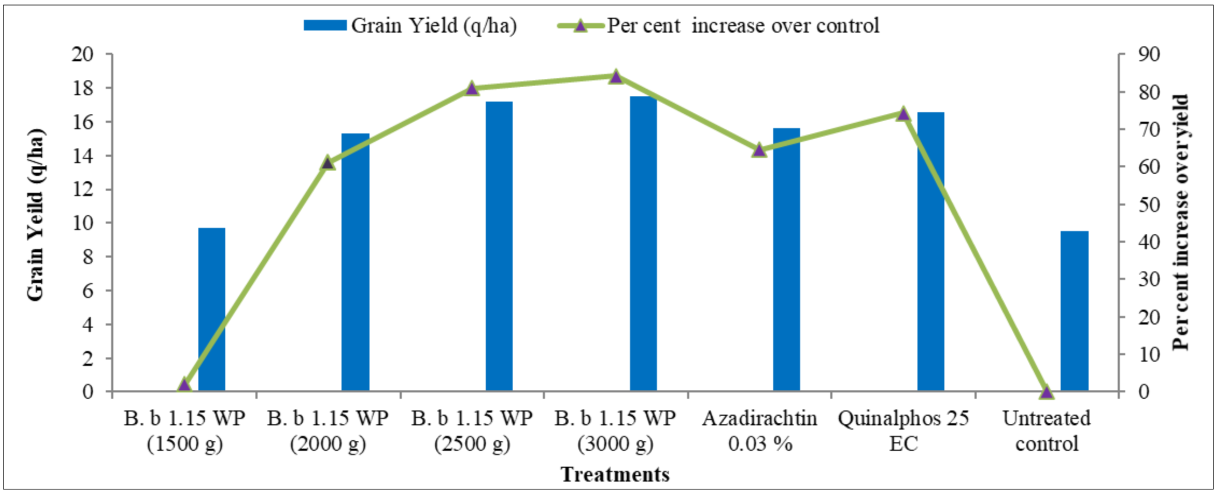

Fig 2: Show the grain yield and per cent increase over control

Conclusion

B. bassiana is one of the important entomo-pathogenic fungi and a component in integrated pest management (IPM) against majority of the crop pest belongs to insect order Lepidoptera. Since foliar spray of *B. bassiana* 1.15% WP @ 2500 g/ha and @ 3000 g/ha have recorded significantly lower larval population, lower pod damage and higher population of natural enemies and higher grain yields in chickpea, this formulation of eco-friendly entomo-pathogenic fungi can be used as bio-insecticide as a component in IPM.

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References

1. Atwal AS, Dhaliwal GS. Pests of pulse crop. In: Agricultural Pests of South Asia and their management, Kalyani Publishers, New Delhi, 1997, 202-208.
2. Bajya DR, Ranjith M, Raza SK. Evaluation of *Beauveria bassiana* against chickpea pod borer, Helicoverpa armigera and its safety to natural enemies. Indian J Agric. Sci. 2015;85:3.

3. Bayu MSYI, Prayogo Y. Field efficacy of entomopathogenic fungi *Beauveria bassiana* (Balsamo.) for the management of mungbean insect pests. IOP Conf. Ser.: Earth Environ. Sci, 2018, 102.
4. Bhatt NJ, Patel RK. Screening of chickpea cultivars for their resistance to gram pod borer, Helicoverpa armigera. Indian Journal of Entomology. 2001;63(3):277-280.
5. Gomez KA, Gomez AA. Statistical procedures for agricultural research. John wiley & sons; 1984; Feb 17.
6. Hosmand RA. Statistical Methods for Agricultural Sciences. Timber press, Portland, Oregon, USA, 1988, 405.
7. Nguyen TL, Chi VTB, Nhan NT, Hong TTB. Exploitation of *Beauveria bassiana* and *Metarhizium anisopliae* as potential biocontrol agents in integrated pest management (IPM) on citrus. Omonrice. 2010;17:152–63.
8. Prasad A, Purohit S. Field Study for the bioefficacy and economics of herbal- Lantana camara (L.) and fungal *Beauveria bassiana* (Balsamo), biopesticides against *Helicoverpa armigera* (Hubner) in south Rajasthan (India). Int. J. sci. eng. 2013;4(6):157-61.
9. Rijal JP, Y DGC, Thapa RB. Kafle LN. Efficacy of Metarhizium anisopliae and Beauveria bassiana against Helicoverpa armigera in chickpea, under field conditions in Nepal. Formosan Entomology. 2008;28:249-58
10. Ritu A. Anjali C. Nidhi T. Sheetal P. Deepak B. Biopesticidal formulation of *Beauveria bassiana* effective against larvae of Helicoverpa armigera. J. biofertil. biopestic. 2013;3:3.
11. Sadasivam S, Manickam A. Biochemical methods, Second edition, New Age International, New Delhi, 1996, 256.
12. Sreekanth M. Seshamahalakshmi M. Studies on relative toxicity of biopesticides to Helicoverpa armigera (Hubner) and Maruca vitrata (Geyer) on pigeonpea (Cajanus cajan L.). J. biopestic. 2012;5(2):191-5.
13. Tukey JW. The technical tools of statistics. American Statistician. 1965;19:23-28.