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Evaluation of *Beauveria bassiana* against chickpea pod borer, *Helicoverpa armigera* and its safety to natural enemies

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ABSTRACT

The chickpea pod borer, *Helicoverpa armigera* (Hubner), a serious insect pest of pulses, has developed resistance to many groups of insecticides all over the world. The entomopathogenic fungi, *Beauveria bassiana* (Buls.- Criv.) safe to predators and parasites, recommended for using in rotation with insecticides to mitigate the resistance to chemical insecticides, was evaluated for its efficacy against *H. armigera* in chickpea and its safety to natural enemies at research farm, Institute of Pesticide Formulation Technology in Gurgaon, Haryana during two seasons 2012-13 and 2013-14. The three spray were made on 15 days intervals starting from appearance of pest, i.e. (07.02.2013, 22.02.2013 and 09.03.2013 during 2012-13) and (16.02.2014, 03.03.2014 and 18.03.2014 during 2013-14) cropping season of different doses of *Beauveria bassiana* 1.15% WP (1×10^8 cfu/g) were carried out with knapsack sprayer @500 litres of water per hectare. The results revealed that *B. bassiana* 1.15% WP @ 3 000 g/ha and 2 500 g/ha were highly effectual in controlling pod borer populations after two sprays of both the seasons, quinalphos 25%EC @ 1 000g/ha being a chemical pesticide was sprayed at pod formation stage and also effective against pod borer populations on both the seasons.

Key words: *Beauveria bassiana,* Efficacy, *Helicoverpa armigera,* Quinalphos, Safety

A known number of chemical pesticides used to control pests have resulted in resistance and environmental pollution there by arousing effect on natural enemies and human beings. To mitigate the use of chemical pesticides and to boost the natural enemy populations, it is more desirable to go for biopesticides. The entomopathogenic fungi, *Beauveria bassiana* (Buls. - Criv.), well known as a potential insect biological control agent has a wide host range and have been exploited for use against many crop pests such as stem borers, beetles, aphids, mites, termites, white flies, mealy bugs, thrips, etc. (Shah and Pell 2003). These entomopathogenic hyphomycetes fungi have great potential as biological control agents against insects and is an important component within integrated pest management systems .They are being developed worldwide for the control of many pests of agricultural importance (Thungrabea and Tongma 2007).

Helicoverpa armigera (Hubner) (Lepidoptera: Noctuidae) is a serious pest on several crops and is widely distributed worldwide (Lawo *et al.* 2008). It has now assumed the status of national pest in India as it feeds on several economically important crops (Ramlee *et al.* 1996). It causes severe damage and loss to a wide range of food, fiber, oil, fodder, horticultural, ornamental, aromatic and medicinal plants. Losses solely due to this pest of up to ₹ 10 000 million have been reported in various crops (Yadav and Rao 2006). It is known to develop resistance to almost all the insecticides used for its control (Kranti *et al.* 2002 and Bajya *et al.* 2010). Reports on high level of resistance to the conventional insecticides in *H. armigera* have resulted renewed interest in the research for exploring the opportunities of using biopesticides. Biopesticides such as *Bacillus thuringiensis* (Berliner) (*Bt*), *B. bassiana,* NSKE 5% etc. can provide an alternative, more environment friendly option to control these insect pests (Jeyarani and Karuppuchamy 2010). Keeping in this view, the present study was undertaken to evaluate the efficacy of *B. bassiana* against the pod borer and to incur its safety to natural enemies in chickpea ecosystem.

MATERIALS AND METHODS

The present study was carried out in research farm at Institute of Pesticide Formulation Technology, Gurgaon, Haryana during two seasons, i.e. 2012-13 and 2013-14. The field was laid in randomized block design with seven treatments replicated thrice including the untreated check. Chickpea variety Pusa 547 was sown during third week of October 2012 (I season) and during third week of October 2013 (II season) in plots of 6×5 m^2 with a spacing of 40 cm × 10 cm. The crop was raised adopting standard agronomic practices and the biopesticide, viz. *Beauveria bassiana* 1.15 % WP (1×10^8 cfu/g) supplied by Yash

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Krishi Takniki Evam Vigyan Kendra, Allahabad at five doses, viz. 1 000, 1 500, 2 000, 2 500 and 3 000 g/ha were compared with neem oil based EC containing Azadirachtin 0.03% along with recommended chemical pesticide quinalphos 25 EC and the untreated check. The treatments were imposed when the pod borer population crossed the Economic Threshold Level. Three sprays were given using a high volume sprayer at fifteen days interval with a spray fluid of 500 l/ha. The pod borer larval population was recorded one day before first spray and 7, 10 and 14 days after first and second spray on 5 randomly selected plants per replication. The larval population/5 plants were transformed to square root values for statistical analysis. The observations on pod damage by pod borer larvae were recorded by randomly selecting 100 pods from 5 plants per replication at 7 and 14 days after third spray and at harvest. Based on the data recorded per cent pod damage by pod borer larvae was calculated and the percentage was transformed to angular values for statistical analysis and the grain yield per replication was recorded separately and converted to q/ha. To confirm the cause of death of gram pod borer larvae in field due to *B. bassiana* application, the dead larvae were randomly collected from the *B. bassiana* treated and other plots as well. The larvae were observed in the laboratory up to 10 days to see the growth of whitish mycelium growth on the insect surface. Effect on natural enemies: Observations on spiders, Coccinellids and *Chrysoperla* were recorded one day prior to initiation of spray. The post treatment observations were recorded on 7th day of each spray.

RESULTS AND DISCUSSION

The mean population prior to insecticidal application varied between 6 to 9.33 larvae/five plants during first season and varied from 7 to 10.33 during second season. *B. bassiana* 1.15% WP @ 3 000 g/ha recorded mean population of 0.67 and 0.33 larvae/5 plants during first season and second season respectively which was statistically on par with *B. bassiana* 1.15% WP @ 2 500 g/ha which resulted in 0.67 larvae/5 plants during both the seasons (Table 1). A total reduction in larval population was observed in plots sprayed with quinalphos 25% EC @ 1 000 ml/ha. which proved very effective among the treatments, whereas neem oil based EC containing azadirachtin 0.03% EC resulted in a mean population of 3.3 laravae/5 plants during first season and 3.00 larvae/5 plants during second season which was only next to the lower doses of *B. bassiana* 1.15% WP @ 1 500 g/ha and 2 000 g/ha. Earlier reports on the efficacy of *B. bassiana* against gram pod borer (Rijal *et al.* 2008, Ritu *et al.* 2012) fall in line with the present study.

As affirmed from Table 2 the per cent pod damage by gram pod borer ranged from 12.33 to 17.67 during first season and 11.33 to 17.33 day before spraying. Highest per cent reduction resulted from the plots treated with quinalphos

Table 1 Evaluation of *Beauveria bassiana* 1.15% WP against gram pod borer larvae on chickpea during 2012-13 and 2013-14 cropping season

Treatment	Dosage (g/ml/ha)	Mean population of gram pod borer larvae/ 5 plants during 2012-13*							Mean population of gram pod borer larvae/5 plants- during 2013-14*						
		PTC	Days after first spray			Days after second spray			PTC	Days after first spray			Days after second spray		
			7	10	14	7	10	14		7	10	14	7	10	14
B. bassiana 1.15% WP	1500.00	8.33 (2.96)	5.67 (2.48)	3.33 (1.95)	6.00 (2.54)	4.00 (2.11)	3.67 (2.04)	3.00 (1.86)	8.67 (3.02)	5.33 (2.41)	2.67 (1.77)	5.33 (2.40)	3.67 (2.04)	3.33 (1.94)	2.33 (1.64)
B. bassiana 1.15% WP	2000.00	6.00 (2.54)	4.67 (2.27)	2.33 (1.68)	6.33 (2.60)	3.67 (2.04)	2.67 (1.77)	2.00 (1.56)	7.00 (2.73)	4.33 (2.18)	1.67 (1.46)	5.67 (2.48)	3.33 (1.94)	2.33 (1.68)	1.67 (1.47)
B. bassiana 1.15% WP	2500.00	7.67 (2.82)	4.33 (2.20)	2.00 (1.56)	3.00 (1.86)	2.00 (1.56)	1.33 (1.34)	0.67 (1.00)	8.33 (2.94)	4.00 (2.11)	1.33 (1.29)	2.67 (1.77)	1.67 (1.39)	1.00 (1.17)	0.67 (1.07)
B. bassiana 1.15% WP	3000.00	7.67 (2.85)	4.33 (2.34)	1.67 (1.46)	3.33 (1.95)	2.33 (1.66)	1.00 (1.17)	0.67 (1.05)	8.33 (2.96)	3.67 (2.02)	1.00 (1.17)	2.33 (1.64)	2.00 (1.48)	0.67 (1.05)	0.33 (0.89)
Neem oil based EC containing Azadirachtin 0.03% EC	5000.00	9.33 (3.13)	5.00 (0.88)	3.67 (2.04)	7.00 (2.73)	4.33 (2.20)	4.67 (2.27)	3.33 (1.95)	10.33 (3.28)	5.33 (2.41)	3.00 (1.87)	6.33 (2.59)	4.00 (2.12)	4.00 (2.11)	3.00 (1.89)
Quinalphos 25% EC	1000.00	7.33 (2.79)	0.33 (3.29)	0.00 (0.71)	0.67 (1.05)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	8.00 (2.90)	0.67 (1.05)	0.33 (0.88)	1.00 (1.22)	0.33 (0.88)	0.00 (0.71)	0.33 (0.89)
Untreated control		9.00 (3.08)	10.33	11.33 (3.44)	14.00 (3.81)	16.33 (4.10)	18.33 (4.34)	15.67 (4.02)	10.00 (3.22)	11.33 (3.44)	12.33 (3.57)	15.00 (3.93)	16.67 (4.14)	19.00 (4.41)	17.00 (4.17)
SEm+		0.20	0.10	0.12	0.15	0.13	0.15	0.14	0.25	0.15	0.21	0.23	0.26	0.18	0.19
CD (P=0.05)		0.62	0.30	0.37	0.46	0.40	0.45	0.42	0.78	0.46	0.65	0.70	0.80	0.57	0.57

*Mean of three replications, PTC- Pre treatment count, NS - Non significant, Figures in parentheses are square root transformed values (x + 0.5)

Table 2 Per cent pod damage and yield of chickpea during 2012-13 and 2013-14 cropping season

Treatment	Dosage (g/ml/ha)	Per cent pod damage by gram pod borer larvae (2012-13)				Per cent reduction in pod damage over control (2012-13)			Yield at harvest (q/ha)	Per cent pod damage by gram pod borer larvae (2013-14)				Per cent reduction in pod damage over control (2013-14)			Yield at harvest (q/ha)
		1	Days after third spray			Days after third spray				1	Days after third spray			Days after third spray			
		(DBS)	7	14	At harvest	7	14	At harvest		(DBS)	7	14	At harvest	7	14	At harvest	
B. bassiana 1.15% WP	1500.00	12.33	6.33	7.33	10.33	61.23	69.45	63.96	15.85	11.33	5.67	5.33	9.33	66.64	71.45	61.65	16.14
B. bassiana 1.15% WP	2000.00	15.67	5.33	5.67	9.00	67.36	76.37	68.60	16.92	14.67	5.00	4.33	8.33	70.58	76.80	65.76	17.37
B. bassiana 1.15% WP	2500.00	15.00	4.33	3.67	4.67	73.48	84.70	83.71	17.70	14.33	4.00	3.00	4.00	76.47	83.93	83.55	18.45
B. bassiana 1.15% WP	3000.00	16.33	3.67	3.33	4.33	77.52	86.12	84.89	18.25	15.67	3.00	2.33	3.00	82.35	87.52	87.66	18.94
Neem oil based EC containing Azad-irachtin 0.03% EC	5000.00	17.67	7.00	8.00	8.67	57.13	66.66	69.75	16.57	17.33	6.33	6.67	8.00	62.76	64.27	67.11	16.96
Quinalphos 25% EC	1000.00	15.33	1.67	1.00	1.67	89.77	95.83	94.17	21.00	16.00	1.00	0.67	1.33	94.10	96.41	94.53	21.64
Untreated control		15.00	16.33	24.0	28.67				13.29	15.33	17.00	18.67	24.33				14.05
SEm+		1.86	0.85	066	0.69				0.80	1.72	1.01	1.15	1.09				0.64
CD (P=0.05)		5.73	2.62	2.03	2.12				2.46	5.31	3.11	3.56	3.36				1.98

DBS, Days before spray; Mean of three replications

Table 3 Effect of *Beauveria bassiana* 1.15% WP on natural enemies in chickpea crop during 2012-13 and 2013-14

Treatment	Dose (g/ml/ha)	Mean number of natural enemies after 7 days of spray for two seasons (2012-13 & 2013-14)											
		Spider/plant*				*Coccinellids*/plant*				*Chrysoperla* /plant*			
		1DBA	1st Spray	2nd spray	3rd spray	1DBA	1st Spray	2nd spray	3rd spray	1DBA	1st Spray	2nd spray	3rd spray
*B. bassiana*1.15% WP	1500.0	1.03 (1.22)	1.10 (1.26)	1.20 (1.28)	0.67 (1.08)	1.37 (1.35)	1.23 (1.31)	1.13 (1.26)	0.67 (1.08)	1.00 (1.22)	0.93 (1.19)	0.82 (1.13)	0.67 (1.08)
B.bassiana 1.15% WP	2000.0	0.97 (1.21)	1.00 (1.22)	1.38 (1.36)	1.00 (1.22)	1.40 (1.36)	1.38 (1.36)	1.16 (1.27)	0.33 (0.91)	0.98 (1.21)	0.92 (1.19)	0.81 (1.14)	0.33 (0.91)
B. bassiana 1.15% WP	2500.0	0.97 (1.20)	0.99 (1.21)	1.17 (1.27)	0.33 (0.91)	1.43 (1.32)	1.40 (1.37)	1.05 (1.23)	0.33 (0.91)	0.99 (1.21)	0.87 (1.16)	0.68 (1.08)	0.83 (1.15)
B. bassiana 1.15% WP	3000.0	0.90 (1.18)	0.90 (1.18)	1.23 (1.30)	0.67 (1.08)	1.22 (1.25)	1.10 (1.26)	1.23 (1.30)	0.67 (1.08)	0.93 (1.19)	0.83 (1.15)	0.73 (1.11)	0.33 (0.91)
Neem oil based EC containing Azadirachtin 0.03% EC	5000.0	0.83 (1.15)	0.83 (1.15)	1.27 (1.32)	0.33 (0.91)	1.57 (1.38)	1.40 (1.29)	1.23 (1.31)	0.33 (0.91)	1.07 (1.24)	0.93 (1.19)	0.73 (1.11)	1.03 (1.24)
Quinalphos 25% EC	1000.0	1.03 (1.24)	0.00 (0.71)	0.67 (1.09)	0.33 (0.91)	1.93 (1.55)	0.67 (1.07)	0.00 (0.71)	0.00 (0.71)	1.03 (1.24)	0.33 (1.22)	0.67 (1.08)	0.33 (0.91)
Untreated control		2.05 (1.58)	2.07 (1.59)	2.07 (1.57)	1.33 (1.35)	1.87 (1.49)	1.93 (1.46)	2.00 (1.57)	1.00 (1.22)	1.10 (1.25)	1.13 (1.26)	1.12 (1.27)	1.00 (1.22)
SEm+		0.09	0.12	0.08	0.16	0.29	0.30	0.12	0.08	0.11	0.10	0.07	0.14
CD (P = 0.05)		NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

25% EC @ 1 000 ml/ha which resulted in 94.17 per cent and 94.53 per cent during first season and second season respectively. *B. bassiana* 1.15% WP @ 3 000 g/ha and @ 2 500 g/ha were on par with each other and they resulted in 84.89, 83.71 and 87.66, 83.55 per cent reduction during first and second season respectively. Botanical pesticide neem oil based EC containing azadirachtin 0.03% EC resulted in 69.75 per cent reduction during first season and 67.11 per cent during second season which was on par with *B. bassiana* 1.15% WP @ 2 000 g/ha. The results are in closer proximity with the studies conducted by Srikanth and Seshamahalakshmi (2012) and Prasad and Purohit (2013) which proved efficacy of *B. bassiana* against *H. armigera*.

The yield data presented in Table 2 revealed that the highest yield of 21.00 and 21.64 q/ha was recorded during two seasons (2012-13 and 2013-14) in quinalphos treated plots. Next in order was *B. bassiana* 1.15 % WP @ 3 000 with 18.25, 18.94 q/ha and 2 500 g/ha recorded 17.70, 18.45 q/ha, during first season and second season respectively which were significantly on par. Rest treatments were comparatively less effective but significantly superior to untreated control.

The mycelium growth of *B. bassiana* on the dead larvae were collected from sprayed field and observed in the laboratory which confirmed that cause of gram pod borer mortality was due to *B. bassiana.*

The ascendant natural enemies observed during the study were spiders, cocinellids, and chrysopids. The mean average population prior application during both the seasons (2012-13 and 2013-14) ranged from (0.83 – 2.05/plant) for spiders (1.22-1.93/plant) for coccinellids, (0.93-1.10/plant) for chrysopids (Table 3). All the *B. bassiana* 1.15% WP treated plots were safer to natural enemies while quinalphos treated plots was found toxic to natural enemy population. The present result on the safety of *B. bassiana* to natural enemies is in close agreement with the findings of Nguyen *et al.* (2010).

CONCLUSION

It is concluded that *Beauveria bassiana* 1.15% WP (1×10^8 cfu/g) @ 3 000 and 2 500 g/ha was equally effective to control gram pod borer (*Helicoverpa armigera*) and to increase the chickpea yield. There will be no significant advantage to use *Beauveria bassiana* 1.15 % WP (1×10^8 cfu/g) @ 3 000g /ha as it was equally effective to lower dosage 2 500 g /ha is suggested to control gram pod borer larvae in chickpea crop.

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