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Evaluation of certain entomopathogenic fungi against soil insect pests of potato

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Abstract
An experiment was carried out at Experimental Farm, Department of Horticulture, Assam Agricultural University, Jorhat during 2014-15 and 2015-16. Potato variety "Kufri Megha" was raised in 18 m^2 plot containing 9 treatments including control and was replicated 4 times. The treatments were *Metarhizium anisopliae* (AAU strain, Biometa) 15 kg/ha; *Beauveria bassiana* (AAU strain, Biosona) 15kg /ha; Imidacloprid 20 g a.i./ha as soil drenching; Malathion 5% dust 40kg/ha as soil application; *Metarhizium anisopliae* (Ma4-NBAII strain)15 kg /ha; *Metarhizium anisopliae* (Ma35-NBAII strain) 15kg /ha; *Beauveria bassiana* (Bb5a-NBAII strain) 15 kg /ha; *Beauveria bassiana* (Bb23-NBAII strain) 15 kg /ha, along with imidacloprid 17.8 SL @ 20 g. a.i. /ha (0.4 ml/l) and Malathion 5% dust 40kg/ha taken as standard check and Untreated control against subterranean pests of Potato. Among the various treatments evaluated against potato, imidacloprid was the most effective and proved to be the best in reducing the population of red ant (*Dorylus orientalis*) with 10.25% during both the years 2014-15 and 2015-16. Amongst, biopesticides *M. anisopliae* (Ma-35), *M. anisopliae* (Ma-4) and *B. bassiana* (Bb-23) were very much effective after imidacloprid and Malathion. An average yield of 76.87 & 80.75, 78.02 & 78.75 and 78.75 & 79.00 q/ha were recorded in the *M. anisopliae* (Ma-35), *M. anisopliae* (Ma-4) and *B. bassiana* (Bb-23) treated plot during 2014-15 and 2015-16, respectively. Regarding, yield increase over control 14.145 & 50.93%, 20.60% & 47.19% and 16.19% & 47.67% yield increase over control were recorded in *M. anisopliae* (Ma-35), *M. anisopliae* (Ma-4) and *B. bassiana* (Bb-23) treated plot during 2014-15 and 2015-16, respectively.

Keywords: Potato, BIPM, soil insect pests, entomopathogenic fungi, *Agrotis ipsilon*, *Dorylus orientalis*

Introduction
Potato (*Solanum tuberosum* L.) is one of the most important food crops both in developed as well as developing countries. The biological value of potato protein is very high and also it contains sufficient quantity of vitamin B and C [1]. India is the 2nd largest producer of potato in the world recorded an increase in area from 0.24 million hectare in 1950-51 to 2.18 million hectare in 2017-18 with corresponding increase production from 1.66 to 49.34 million tons [2] & the productivity improved from 6.92 tons/hectare in 1950-51 to 22.63 tons/hectare in 2017-18. In Assam, the total production of potato was 708.63 thousand tons in year 2012-13 from the area of about 95.43 thousand hectare with a productivity of 7.42 tons/ hectare which is increases to 1072.78 thousand tons in year 2017-18 from the area of 99.7 thousand hectare with productivity of 10.76 tons/hectare [2]. Potato is subjected to attack by large numbers of insect pests from the time of planting to the harvesting [3]. This crop may be attacked by more than 100 arthropods and around 140 species of nematodes belonging to 45 genera throughout the world, out of which cut worm (*A.* spp.) and red ant (*D. orientalis*) are the major sub terranean pests of potato in India. In India *A. ipsilon* is the most common species of cut worm reported to be causing damage of 35-40 per cent in Patna, Bihar [4, 5]. The losses in tuber yield in potato crop due to cutworm have been estimated to be 12-40 per cent in different parts of India [6]. Red ant (*Dorylus orientalis*) is distributed throughout the world. In India they are distributed in almost all the states including Arunachal Pradesh and Assam [7]. generally, the Red ant appears during winter months and remains active till onset of monsoon and it is one of the most important soil pests of potato reducing the yield up to 40% in West Bengal [8]. Moreover, Red ant is a polyphagous pests can attack a number of crop including potato, cauliflower, cabbage, groundnut, sugarcane, and coconut seedlings in the North-Eastern states and North India [9]. Tuber infestation by red ant may be as high as 51.77-61.50 per cent [10]. They cause damage on underground potato tubers by creating minute holes (2-3 mm diameter) on tubers and clean out the soft peels [11].

Unfortunately, in Assam a very little works had been carried out for management of sub-terranean insect pests. However, injudicious use of synthetic chemical pesticides is also not acceptable because of the ill affect associated with this practice. Keeping in view of the importance of biopesticides an experiment was executed to determine the efficacy of different bio-pesticides against potato cut worm (*Agrotis ipsilon*) and red ant (*Dorylus orientalis*).

Materials and Methods

The Experiment was executed in the Experimental Farm, Department of Horticulture, Assam Agricultural University, Jorhat during 2014-15 and 2015-16 by using Randomised Block Design (RBD). Potato variety "Kufri Megha" was raised in 18 m^2 plot containing 9 treatments including control. The treatments were *Metarhizium anisopliae* (AAU strain, Biometa) 15 kg/ha; *Beauveria bassiana* (AAU strain, Biosona) 15 kg /ha; Imidacloprid 20 g a.i./ha as soil drenching; Malathion 5% dust 40kg/ha as soil application; *Metarhizium anisopliae*(Ma4-NBAII strain)15 kg /ha; *Metarhizium anisopliae* (Ma35-NBAII strain)15 kg /ha; *Beauveria bassiana* (Bb5a-NBAII strain) 15 kg /ha; *Beauveria bassiana* (Bb23-NBAII strain) 15 kg /ha, along with imidacloprid 17.8 SL @ 20 g. a.i. /ha (0.4 ml/l) and Malathion 5% dust 40kg/ha taken as standard check and Untreated control. The biopesticides *viz* AAU strain and NBAII strains of *M. Anisopliae*, *B. Bassiana*, and malathion dust *was* applied as soil application at sowing time, 35 and 60 days after sowing. Similarly three sprays of Imidacloprid were given as soil drenching. Observation on per cent incidence of damaged tubers by target pests *Agrotis ipsilon* (Cut worm) and *Dorylus orientalis* (Red ant), was recorded after harvesting of the crop. Yield of marketable potato was also determined at harvest.

Results and Discussion

Impact of various entomopathogenic fungi (1x 10^8 spores/ gm @ 5 g/l) along with imidacloprid 17.8 SL @ 20 g. a.i. /ha (0.4 ml/l) and Malathion 5% dust 40kg/ha taken as standard check against subterranean pests of Potato is presented in table 1. Perusal of data revealed that the population of cut worm (*Agrotis ipsilon*) and red ant (*Dorylus orientalis*) was at par during pre-spraying in different treatments. Among the various treatments evaluated against potato, imidacloprid was the most effective and proved to be the best in reducing the population of red ant (*Dorylus orientalis*) with 10.25% during both the years 2014-15 and 2015-16; and 21.0% & 22.5% due to Malathion 5% dust treated plot. However, 11.25% & 9% tuber infestation by cut worm, *A. ipsilon* was recorded in imidacloprid treated plot and 13.5% & 20.0% in malathion treated plot during 2014-15 and 2015-16, respectively. Regarding yield, 83.90 & 89.50 and 79.37 & 81.25 q/ha recorded in imidacloprid and malathion treated plot during 2014-15 and 2015-16, respectively. Amongst, biopesticides *M. anisopliae* (Ma-35), *M. anisopliae* (Ma-4) and *B. bassiana* (Bb-23) were very much effective after imidacloprid and malathion. An average yield of 76.87 & 80.75, 78.02 & 78.75 and 78.75 & 79.00 q/ha were recorded in the *M. anisopliae* (Ma-35), *M. anisopliae* (Ma-4) and *B. bassiana* (Bb-23) treated plot during 2014-15 and 2015-16, respectively. Pandey and Tiwari (1999) reported that about 43.4% of larval mortality of *Agrotis ipsilon* was found due to application of botanicals [12].

Regarding, yield increase over control 21.33% & 67.29% recorded in imidacloprid treated plot and 16.84% & 51.87% in malathion treated plot during 2014-15 and 2015-16, respectively. Moreover, 14.145 & 50.93%, 20.60% & 47.19% and 16.19% & 47.67% yield increase over control were recorded in *M. anisopliae* (Ma-35), *M. anisopliae* (Ma-4) and *B. bassiana* (Bb-23) treated plot during 2014-15 and 2015-16, respectively. However, similar trend of findings with effecacy of entomopathogenic fungi also recorded by (Barsics *et al*., 2013; Bruck, 2005; and Ferron, 2018;) [13, 14, 15,]. Similarly, Borkakati *et al*., 2019 also reported *B. bassiana* is very much effective to control sucking pests of another solanaceous vegetable *Bhut Jalakia* [16].

Table 1: Effect of Local and NBAII strains against soil insects in potato

Treatments	Dose	% infested tubers by *D. orientalis*		% infested tubers by *A. ipsilon*		Yield (Q/ha)		Increased yield over control (%)	
		2014-15	2015-16	2014-15	2015-16	2014-15	2015-16	2014-15	2015-16
M. anisopliae (AAU strain) Biometa	15 kg/ha	23.5 (28.93)^{c}	23.25 ^{c} (28.84)	23.0 (28.62)^{cd}	23.75 ^{f} (29.18)	76.97 ^{c}	76.25 ^{d}	14.52	42.52
B. bassiana (AAU strain) Biosona	15 kg/ha	21.50 (27.60) ^{bc}	22.00 ^{de} (27.99)	20.75 (27.06)^{cd}	20.00 ^{cd} (26.58)	78.30^{bc}	80.75 ^{c}	15.70	50.93
B. bassiana (Bb-5a) NBAII strain	15kg/ha	19.75 (26.54) ^{b}	15.50 ^{b} (23.20)	16.75 (23.95)^{b}	17.25 ^{b} (24.55)	83.12^{ab}	85.00 ^{b}	15.40	58.87
B. bassiana (Bb-23) NBAII strain	15kg/ha	19.25 (26.00) ^{b}	19.50 ^{c} (26.22)	23.75 (29.13)^{d}	22.50 ^{ef} (28.33)	78.75 ^{bc}	79.00 ^{cd}	16.19	47.67
M. anisopliae (Ma-4) NBAII strain	15kg/ha	19.0 (25.81)^{b}	20.75 ^{cd} (27.11)	P19.5 (26.18) ^{bc}	21.25 ^{de} (27.46)	78.02 ^{c}	78.75 ^{cd}	20.60	47.19
M. anisopliae (Ma-35) NBAII strain	15kg/ha	23.75 (29.15)^{c}	21.25 ^{cd} (27.46)	22.75 (28.45) ^{cd}	19.25 ^{c} (26.04)	76.87 ^{c}	80.75 ^{c}	14.14	50.93
Malathion 5% dust	40kg/ha	21.0 (27.24) ^{bc}	22.25 ^{de} (28.15)	13.50 (21.33)^{a}	20.00^{cd} (26.57)	79.37^{abc}	81.25^{c}	16.84	51.87
Imidacloprid	20g a.i./ha	10.25 (18.61) ^{a}	10.25^{a} (18.66)	11.25 (19.55)^{a}	9.00^{a} (17.46)	83.90^{a}	89.50^{a}	21.33	67.29
Untreated control	----	31.75 (34.24)^{d}	34.25 ^{f} (35.82)	34.25 (35.80)^{e}	36.5^{g} (37.18)	66.0^{d}	53.50 ^{e}		
CV %		7.21	1.96	8.90	1.62	6.15	3.59		
CD =0.05		2.01	4.97	2.44	4.10	4.94	3.14		

Figures in parenthesis are transformed angular values

Means followed by the same letter in a column are not significantly different

Conclusion

All the entomopathogenic fungi evaluated during the course of study exhibited equally more or less efficacies in suppressing the population of subterranean pests of potato compared to untreated control.

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