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EVALUATION OF ENTOMOPATHOGENIC FUNGI AGAINST *PEREGRINUS MAIDIS* (ASHMEAD)

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ABSTRACT

The present study to evaluate entomopathogenic fungi for the management of sorghum shoot bug, *Peregrinus maidis* (Ashmead) revealed that, among the entomopathogens applied in various methods (foliar spray and whorl application along with FYM), Raichur strain (UASR BC VL 1) of *Lecanicillium lecani* (2×10^8CFU) @ 2g/l directed to whorl region excelled in reducing shoot bug population (5.49/plant), % plant damage (58.62%) and superior plant growth parameters over all other EPF (Entomopathogenic fungi) treatments which was on par results with standard check, cypermethrin 25% EC @ 0.50ml/lit directed to whorl region (5.78/plant & 65.46%). Whereas, all the EPF treatments and untreated control showed superiority in conserving the natural enemy population (spiders and coccinellids) but standard check due to its chemical properties led to the reduction in the beneficial insects with lowest spider (0.54/plant) and coccinellid (0.87/plant) population.

Key words: Coccinellids, Delphacidae, entomopathogenic fungi, farm yard manure, foliar spray, Hemiptera, *Lecanicillium lecani*, *Metarhizium anisopliae*, shoot bug, sorghum, spiders

Sorghum [*Sorghum bicolour* (L.) Moench] is one of the major sources of food for millions of people in tropics and semi-arid tropics of world (Dolly et al., 2019). In India, sorghum is cultivated in an area of 4.80 million ha with an annual production of 4.40 mt (Anon, 2020a) of grain with a productivity of 1005 kg/ha (Anon, 2020b). It has been reported that nearly 150 pests are known to attack the crop at various stages from the day of sowing till harvest (Reddy and Davies, 1979 and Jotwani et al., 1980). Shoot bug *Peregrinus maidis* (Ashmead) (Hemiptera: Delphacidae) is a major sucking pest of sorghum in Northern dry zone of Karnataka. It has been reported that sorghum shoot bug could cause overall loss of, 31.85 % in grain and 33.53 % in fodder yield under unprotected condition during rabi season (Akshatha et al., 2020). In view of these, there is an urgent need to find alternative measures that is friendly to the environment. Among the various components of biocontrol, entomopathogens in general and mycoinsecticides (entomogenous fungi) are most versatile biological control agents. Moreover, there were minimal studies in relation to the management of shoot bug through entomopathogens unlike brown plant hopper. Therefore, efforts were made with the following objectives for the management of *P. maidis* by using entomopathogenic fungi (EPF) in rabi sorghum.

MATERIALS AND METHODS

The studies on the evaluation on entomopathogenic fungi in the management of *P. maidis* was conducted during rabi season using M 35-1 sorghum variety. A field experiment was laid out in Complete Randomized Block Design (CRBD) with three replications during rabi season, 2020-21 at Regional Agricultural Research Station (RARS), Vijayapur, Karnataka, India with following eleven treatments after 30 days after emergence. All the cultural and other operations except plant protection measures were carried out in the experimental plot as per the recommended package of practices (Anon, 2018). SPAD stands for Soil Plant Analysis Development meter which is an equipment which was used to calculate the relative chlorophyll content from the sorghum leaves. SPAD-502 was used as suggested by Markwell et al. (1995). % reduction of shoot bug population over control was worked out using Henderson and Tilton (1955) formula:

$$\text{Corrected \% (1)} = \frac{\text{n in Co before treatment} \times \text{n in T after treatment}}{\text{n in Co after treatment} \times \text{n in T before treatment}} \times 100$$

Where, n = Insect population, T = treated, and Co = control

RESULTS AND DISCUSSION

Results indicated that the mean effect of treatments on *P. maidis* incidence and % reduction over control was significantly highest in foliar application of Raichur strain (UASR BC VL 1) of *Lecanicillium lecani* (2x 10^8CFU) @ 2g/ l directed to whorl region (4.44/ plant and 63.49%) and foliar application of commercial *L. lecani* (2x10^8CFU) @ 2g/ l directed to whorl region (5.49/plant and 58.62%) and they excelled their effect over standard check insecticide, cypermethrin 25% EC @ 0.50ml/l directed to whorl region (5.78/ plant and 65.46 (Table 1). These findings were similar to those of Harichandra and Shekharappa (2009) that *M. anisopliae* and *Verticillium lecanii* recorded minimum leafhoppers/ three leaves and maximum yield of 38.80 and 38.50 q/ ha, respectively. Patil et al. (2012) on the efficacy of *V. lecanii* (1.150/0 WP) against sucking pest complex on transgenic *Bt* cotton indicated that Verticel @ 7.50 kg/ ha registered least number of thrips, aphids and leafhoppers and found to be on par with acetamiprid 20SP @ 100 g/ ha. Reddy et al. (2013) stated that *B. bassiana*, *M. anisopliae*, *L. lecani* @ 5 g/ l having 1x10^8 CFU along with standard check- acephate 75% SP @ 1.5 g/ l were effective against *Nilaparvata lugens* Stal in paddy. Against *N. lugens* Chinniah et al. (2016) and Bailal et al. (2020) observed similar results.

Whorl application of Raichur strain (UASR BC Ma 2) of *M. anisopliae* (2x 10^8CFU) @ 1000g mixed with FYM @ 500 kg/ ha (1.64 spiders/plant) and foliar application of commercial *L. lecani* @ 2x10^8CFU (2g/ l-1.41 coccinellids/ plant) is effective and safe to natural enemies. Cypermethrin 25EC @ 0.50 ml/ l was highly toxic to spider and coccinellids and significantly reduced these. These findings are in conformity with reports of Chi et al. (2005) who indicated that predatory spiders and water bugs were higher in fungal treatments. Venkatreddy et al. (2013) reported that *L. lecani* treated plot recorded 9.5 spiders/ hill whereas, chemical treated (acephate 75 SP) plot showed less spider counts of 4.3/ hill and relatively less toxic to predators. Patil et al. (2012) mentioned that, the lower numbers of coccinellids were recorded in standard check (acetamiprid). Results pertaining to plant growth and yield parameters had shown that Raichur strain (UASR BC VL 1) of *L. lecani* (2x10^8CFU) @ 2g/ l directed to whorl region had shown superiority in higher no. of leaves (9.33/ plant), single leaf area (351.71 cm^2), plant height (205.97 cm), relative chlorophyll content (56 SPAD), panicle emergence (92.03%), panicle length (26.10cm), panicle weight (77.32 g), grain yield (2265 kg/ ha) and fodder yield (46.03 q/ ha) which was on par to standard check cypermethrin 25EC @ 0.50 ml/ l. The studies clearly concluded that Raichur strain (UASR BC VL 1) of *L. lecani* (2x 10^8CFU) @ 2g/ l directed to whorl region had shown superiority over all other EPF treatments and on par to the standard check cypermethrin 25EC @ 0.50 ml/ l, which lead to the reduction in shoot bug population, but in contrast to standard check, EPF applied treatments encouraged natural enemies.

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AUTHOR CONTRIBUTION STATEMENT

Dharavath designed, conducted experiments and wrote manuscript. Karabhantanal analysed data. All authors read and approved the manuscript.

CONFLICT OF INTEREST

Authors clearly state that there is no conflict of interest.

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Table 1. Evaluation of entomopathogenic fungi against *P. maidis* in rabi sorghum

Treatments	No. of shoot bugs/ plant*	% reduction of shoot bugs/ plant over control**	No. of natural enemies		% plant damage due to shoot bug at 90 DAS*	No of Leaves per plant	Single leaf area (cm)	Plant height (cm) at harvest	Relative chlorophyl index (SPAD)	Panicle emergence (%) *	Panicle length (Cm)	Panicle Weight (gms)	Grain yield (kg/ ha)	Fodder yield (q/ ha)
			No. of spiders/ plant	No. of cocci-nellids/ plant										
T_1: Whorl application of Raichur strain (UASR BC Ma 2), *Metarhizium anisopliae* (2×10^8CFU) mixed with FYM (1000g + 500 kg/ha)	13.24 (3.71)^{bc}	30.25 (33.37)^{bc}	1.64 (1.46)^{b}	1.23 (1.32)^{a}	16.87 (24.25)^{b}	8.67^{bcd}	338.17^{cd}	186.33^{d}	54.20^{bc}	85.93 (67.97)^{bc}	22.40^{bc}	71.25^{c}	1875^{d}	39.17^{cde}
T_2: Foliar application of Raichur strain (UASR BC Ma 2), *Metarhizium anisopliae* @ 2×10^8CFU (2g/ l) directed to whorl region	11.18 (3.42)^{bc}	29.39 (32.83)^{c}	1.49 (1.41)^{b}	1.34 (1.35)^{a}	14.63 (22.49)^{b}	8.93^{bcd}	341.28^{bcd}	195.4^{bcd}	54.50^{ab}	87.62 (69.40)	23.60^{abc}	72.31^{bc}	1956^{d}	41.45^{bcd}
T_3: Foliar application of Raichur strain (UASR BC VL 1), *Lecanicillium lecani* @ 2×10^8CFU (2g/ l) directed to whorl region	4.44 (2.22)^{a}	63.49 (52.83)^{a}	1.49 (1.41)^{b}	1.23 (1.32)^{a}	10.06 (18.49)^{a}	9.33^{ab}	351.71^{abc}	205.97^{ab}	56.00^{ab}	92.08 (73.65)^{ab}	26.10^{a}	77.32^{ab}	2265^{ab}	46.03^{ab}
T_4: Whorl application of Raichur strain (UASR BC VL 1), *Lecanicillium lecani* (2×10^8CFU) mixed with FYM (1000g + 500 kg/ha)	9.56 (3.17)^{bc}	36.24 (37.01)^{b}	1.54 (1.43)^{b}	1.37 (1.37)^{a}	13.22 (21.32)^{b}	9.03^{abc}	347.03^{abc}	199.84^{abc}	55.70^{ab}	90.57 (72.12)^{ab}	24.40^{abc}	74.87^{bc}	2190^{bc}	43.25^{abc}
T_5: Whorl application of commercial *Metarhizium anisopliae* (2×10^8CFU) mixed with FYM (1000g+500 kg/ ha)	14.37 (3.86)^{c}	25.01 (30.01)^{c}	1.58 (1.44)^{b}	1.31 (1.35)^{a}	16.65 (24.08)^{b}	8.57^{cd}	337.00^{cd}	181.77^{de}	53.80^{abc}	88.65 (70.31)^{b}	22.20^{bc}	70.24^{c}	1790^{e}	37.70^{de}
T_6: Foliar application of commercial *Metarhizium anisopliae* @ 2×10^8CFU (2g/lit) directed to whorl region	11.98 (3.53)^{bc}	37.81 (37.95)^{b}	1.48 (1.41)^{b}	1.35 (1.36)^{a}	17.78 (24.94)^{b}	8.67^{bcd}	346.19^{abcd}	190.2^{cd}	54.80^{abc}	85.67 (67.76)^{bc}	22.90^{bc}	71.13^{c}	1860de	39.65^{cde}

(contd.)

T_7: Whorl application of commercial *Lecanicillium lecani* (2×10^{8}CFU) mixed with FYM (1000g + 500 kg/ ha)	10.91 (3.38)^{bc}	32.66 (34.85)^{b}	1.54 (1.43)^{b}	1.36 (1.36)^{a}	14.63 (22.49)^{b}	8.67^{bcd}	348.05^{abc}	195.3^{bcd}	55.40^{ab}	88.93 (70.57)^{b}	23.80^{abc}	70.14^{c}	2150^{c}	42.80^{bcd}
T_8: Foliar application of commercial *Lecanicillium lecani* @ 2×10^{8}CFU(2g/l) directed to whorl region	5.49 (2.45)^{a}	58.62 (49.96)^{a}	1.46 (1.40)^{b}	1.41 (1.38)^{a}	11.87 (20.15)^{ab}	9.00^{a}	348.73^{ab}	200.37^{abc}	54.90^{abc}	90.36 (71.91)^{ab}	25.40^{ab}	75.01^{abc}	2250^{ab}	45.35^{ab}
T_9: Neem based insecticide 1500 PPM @ 4 ml/ l	11.54 (3.47)^{bc}	38.96 (38.62)^{b}	1.28 (1.34)^{b}	1.14 (1.28)^{a}	15.07 (22.84)^{b}	8.67^{bcd}	340.74^{bcd}	196.8^{bcd}	54.40^{abc}	87.89 (69.64)^{bc}	23.60^{abc}	73.62^{bc}	1895^{d}	39.81^{bcd}
T_{10}: Cypermethrin 25% EC @ 0.50ml/lit directed to whorl region	5.78 (2.51)^{a}	65.46 (54.00)^{a}	0.54 (1.02)^{a}	0.87 (1.17)^{b}	8.25 (16.69)^{a}	9.67^{a}	355.91^{a}	208.3^{a}	56.70^{a}	95.61 (77.91)^{a}	26.60^{a}	80.14^{a}	2330^{a}	48.30^{a}
T_{11}: Untreated control (water spray)	35.32 (5.98)^{d}	0.00 (0.00)^{d}	1.52 (1.42)^{b}	1.37 (1.37)^{a}	27.67 (31.74)^{c}	8.33^{d}	333.53^{e}	176.45^{e}	52.90^{bc}	80.35 (63.69)^{c}	22.20^{c}	65.12^{d}	1670^{f}	34.55^{e}
SE.m.±	0.17	1.62	0.02	0.03	1.14	0.21	4.12	3.22	0.74	2.03	0.97	1.68	29.09	1.71
CD (p=0.05)	0.52	4.87	0.07	0.10	3.43	0.63	12.36	9.67	2.23	6.08	2.92	5.05	87.27	5.14
CV (%)	14.41	15.66	12.45	14.33	17.03	11.67	16.02	14.27	14.20	16.33	14.30	13.56	14.90	16.32

Bioagents procured from UAS, Raichur. Commercial bioagents procured from Greenlife Biotech Laboratory. DAA- Days After Application *Figures in parentheses square root transformed/ angular transformed values

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