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Exploitation of *Metarhizium anisopliae* (Metch.) Sorokin for management of gall weevil *Alcidodes colaris* Pascoe in pigeonpea

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ABSTRACT

Field experiments were conducted in *Kharif* 2001 and 2002 wet season to verify the performance of *Metarhizium anisopliae* isolate (Ma2) @ 2 x 10^{12}, 1 x 10^{12} and 5 x 10^{11} conidia per ha *vis-à-vis* recommended insecticides (chlorpyriphos 400 g a.i. ha^{-1} and endosulfan @ 700 g a.i. ha^{-1}) and untreated check against pigeonpea gall weevil at University of Agricultural sciences, Dharwad. Drenching of *M. anisopliae* @ 2 x 10^{12} conidia per ha at 15 days after germination did not lag much behind the chemical toxicants in pest suppression. Efficacy came at par with chemical toxicants at 30 days after treatment. The yield difference between fungus and chemicals drenching was only four per cent.

Key words: *Alcidodes colaris*, Gall weevil, *Metarhizium anisopliae*, Pigeonpea, Management

Gall weevil (*Alcidodes colaris)* is one of the important insect pests of pigeonpea in transitional belt of Karnataka and is causing 25-30 per cent reduction of plant population in the field (2). It attacks basal region of the seedlings resulting in its dislodging and drying of plants. Since the pest inhabits in soil near the basal portion of stem, prediction of its infestation, distribution of population and damage are rather difficult. Therefore, the drenching of entire field with chemical toxicants becomes necessary to get protection from gall weevil. However, drenching is not only uneconomical but also hazardous to soil health and non-target organisms. Hence, attempts are necessary to find an eco-friendly alternative to chemicals, which can persist for longer time and cause mortality of pest. Among mycopathogens, *Metarhizium anisopliae* (Metch.) Sorokin effectively causes mycosis to gall weevil *in vitro* (4). Therefore, the field experiment was conducted in pest endemic areas in order to measure its efficacy under field condition.

MATERIALS AND METHODS

Field experiments were conducted in *Kharif* 2001 and 2002 wet season to evaluate the performance of *Metarhizium anisopliae* isolate (Ma2) at three doses *i.e.*, @ 2 x 10^{12}, 1 x 10^{12} and 5 x 10^{11} conidia per ha *vis-à-vis* recommended insecticides (chlorpyriphos 400 g a.i. ha^{-1} and endosulfan @ 700 g a.i. ha^{-1}) and untreated check (UTC) against pigeonpea gall weevil. The experiment was laid out at the Main Agricultural Research Station, University of Agricultural Sciences, Dharwad, Karnataka in a randomized block design with six treatments replicated four times. The pigeonpea cv. Maruti was sown in the first week of July 2001 and second week of July 2002 in a plot size of 6 m x 6 m with a spacing of 60 x 20 cm. Recommended agronomic practices were followed to raise the crop except for gall weevil management. Incidence of the gall weevil on pigeonpea started around 10-15 days in both the years. The treatments were imposed 15 days after germination by drenching @ 1500 l of solution per ha at the base of plant. Observations were recorded on number of plants infested, gall weevil population and number of diseased grubs from 30 plants selected at random by destructive sampling in each treatment at 15 and 30 days after drenching. The change in pest density in per cent and field mycosis over UTC was worked out. Grain yield at harvest was taken.

RESULTS AND DISCUSSION

The data presented in Table 1 indicate that during both the years and in the pooled analysis, chlorpyriphos and endosulfan emerged as the most effective treatments recording significantly low population of around three healthy grubs for every 30 plants at 15 days after treatments. The microbial pathogen at higher dosage did not lag much behind. The effectiveness of fungus was reduced successively with decrease in conidial dosage indicating the inferiority of these treatments. In the absence of any suppressing factor in the untreated plot, population of grubs remained at around 13 for every 30 plants.

Distinctive differences existed between microbial and non-microbial treatments in respect of diseased larvae. Extent of mycosis calculated from diseased larvae to total number of larvae differentiated the microbial treatments in accordance with conidial load applied. Absence of diseased grubs in other treatments suggested absence of native fungus in the ecosystem. These inferences hold good for individual years and as well for pooled data.

Severity of the pest was assessed with reference to damage caused to the plants. As against the highest plant infestation of around 43% in the untreated check, endosulfan and chlorpyriphos could lower down the same to 10.83 and 11.66%, respectively followed by the highest dosage of *M. anisopliae* (18.99%). Similar trend was noticed in 2002 as well as in pooled data (Table 1).

Table 1. Performance of *M. anisopliae* against *Alcidodes colaris* in pigeonpea at 15 days after treatment imposition

Treatment	Healthy grubs*			Mycosed grubs*			Mycosis (%)			Plants infested (%)		
	2001	2002	pooled	2001	2002	pooled	2001	2002	pooled	2001	2002	pooled
M. anisopliae (2 x 10^{12} conidia /ha)	4.00 b	3.00 a	3.50 a	4.50 a	2.60 a	3.55 a	52.94 a	46.43 a	50.35 a	18.99 b	15.84 a	17.42 b
M. anisopliae (1 x 10^{12} conidia / ha)	5.25 c	4.50 b	4.88 b	3.75 b	2.15 b	2.95 b	41.67 b	32.33 b	37.67 b	26.66c	25.00 b	25.83 c
M. anisopliae (5 x 10^{11} conidia /ha)	8.00 d	6.25 c	7.13 c	2.50 c	2.05 b	2.28 c	23.81 c	24.69 c	24.22 c	33.33 d	29.16 b	31.25 d
Chlorpyriphos 20EC (400 g a.i. /ha)	2.50 a	3.50 a	3.00 a	0.00 d	00.00 c	0.00 d	0.00 d	00.00 d	0.00 d	11.66 a	13.33 a	12.49 a
Endosulfan 35EC (700 g a.i. /ha)	3.25 b	3.75 ab	3.50 a	0.00 d	00.00 c	0.00 d	0.00 d	00.00 d	0.00 d	10.83 a	14.17 a	12.50 a
Untreated check (UTC)	13.75 e	12.50 b	13.13 d	0.00 d	00.00 c	0.00 d	0.00 d	00.00 d	0.00 d	42.83 e	43.17 c	43.00 e

*Observed / 30 plants. Means followed by the same alphabet in vertical columns did not differ significantly (P=0.05) by DMRT

Higher incidence of grub (17.75/ 30 plants) than at previous interval was evident from counts made in the untreated check at 30 days after treatment imposition (Table 2). Significantly lower grub population of 1.5 per 30 plants was the contrasting result from earlier observation in the highest dosage of *M. anisopliae*. Chlorpyriphos, *M. anisopliae* @ 1 x 10^{12} conidia per ha and endosulfan treatments were next to follow with a population of around three. Findings of 2002 and pooled analysis confirmed the above observations.

Extent of mycosis caused by the microbial treatments in both the years followed closely with the spore load used. As at previous interval of observation, death of larvae due to fungal infection was not encountered. However, untreated check registered a trivial proportion of death due to microbial action unlike at 15 days after treatment imposition.

With the lapse of 15 days period, activity of weevil increased to 62.50 from 42.81% in 2001 and to 56.66 from

Table 2. Performance of *M. anisopliae* against *Alcidodes colaris* in pigeonpea at 30 days after treatment imposition

Treatment	Healthy grubs*			Mycosed grubs*			Mycosis (%)			Plants infested (%)		
	2001	2002	pooled	2001	2002	pooled	2001	2002	pooled	2001	2002	pooled
M. anisopliae (2 x 10^{12} conidia /ha)	1.50 a	1.75 a	1.63 a	4.75 a	3.90 a	4.33 a	76.00 a	69.03 a	72.65 a	21.66 b	18.33 a	19.99 b
M. anisopliae (1 x 10^{12} conidia / ha)	3.00 b	4.20 c	3.60 b	4.00 b	3.50 b	3.75 b	57.14 b	45.45 b	51.02 b	35.00 c	28.33 b	31.67 c
M. anisopliae (5 x 10^{11} conidia /ha)	5.75 c	5.50 d	5.63 c	3.25 c	3.30 b	3.28 c	36.11 c	37.50 c	36.81 c	39.60 c	35.83 c	37.72 d
Chlorpyriphos 20EC (400 g a.i. /ha)	3.00 b	3.60 b	3.30 b	0.00 d	00.00 c	0.00 d	0.00 d	00.00 d	0.00 d	14.99 a	19.99 a	17.49 a
Endosulfan 35EC (700 g a.i. /ha)	3.20 b	3.55 b	3.38 b	0.00 d	00.00 c	0.00 d	0.00 d	00.00 d	0.00 d	14.16 a	21.66 a	17.91 a
Untreated check (UTC)	17.75 d	15.75 e	16.75 d	0.50 d	00.00 c	0.25 d	2.73 d	00.00 d	1.47 d	62.50 d	56.66 d	59.58 e

*Observed / 30 plants. Means followed by the same alphabet in vertical columns did not differ significantly (P=0.05) by DMRT

Table 3. Cost effectiveness of *M. anisopliae* treatment against *Alcidodes colaris* in pigeonpea

Treatment	Yield (q ha^{-1})			Increase in yield over control (%)	Additional			
	2001	2002	pooled		Yield (q ha^{-1})	Cost (Rs.)	Return (Rs.)	IBCR
M. anisopliae (2 x 10^{12} conidia /ha)	9.19 b	11.50 b	10.36 b	39.62	2.94	600	3528	5.88
M. anisopliae (1 x 10^{12} conidia / ha)	8.52 c	10.69 c	9.67 c	30.32	2.25	400	2700	6.75
M. anisopliae (5 x 10^{11} conidia /ha)	7.62 d	9.32 d	8.47 d	14.15	1.05	300	1260	4.20
Chlorpyriphos 20EC(800 g a.i. /ha)	9.63 a	11.98 a	10.81 a	45.69	3.39	1000	4068	7.01
Endosulfan 35EC (1400 g a.i. /ha)	9.49 a	12.09 a	10.79 a	45.42	3.37	1080	4044	6.32
Untreated check (UTC)	6.59 e	8.25 d	7.42 e	--	--	--	--	-

Means followed by the same alphabet in vertical columns did not differ significantly (P=0.05) by DMRT.

43.17% in 2002. Endosulfan and chlorpyriphos safeguarded the plants significantly by restricting the damage to about 22% or less. Infestation to plants gradually decreased with increase in fungal dosage from 37.72% @ 5 x 10^{11} conidia to 31.67% at 1 x 10^{12} conidia to around 20% at the highest dosage of 2 x 10^{12} conidia per ha. This is due to the self-perpetuation and longer persistence of bio-agent in soil. Literature did not provide any comparative study either from India and elsewhere against the pest as it is of regional importance. However, effective control of black vine weevils in cranberry field (1) by the fungus *M. anisopliae* @ 1 x 10^{13} conidia/ha partially corroborates the present study. More than half of the plant population was damaged when the pest was not confronted with any induced lethal factor. Application of *M. anisopliae* at higher rate was found as good as chemical insecticides (Fenthion) in reducing root damage by *L. negatoria* and recorded higher sugarcane yield (7). Large scale field trials to control gray back cane grub using *M. anisopliae* @ 3.3 x 10^{13} conidia per ha in Australia revealed 50-60 and 70-90% reduction of pest population in plant cane and ratoon crop, respectively (3, 6, 7). According to Rath *et al.* (5), application of Bio 1020® (a commercial formulation of *M. anisopliae*) @ 0.5 – 1.0 g per plant was sufficient to suppress white grub damage significantly in tea plantation. *Metarhizium anisopliae* has shown considerable potential to manage the root feeding scarab, *A. couloni* in Australia. Application of the fungus to pasture soil in winter caused substantial mortality of the larvae and pupae by 27 weeks and decline in populations of the pest continued in subsequent years (5). Reduction in grub number led to greater retention of pasture grasses, reduced weed invasion and increased pasture productivity.

Treatment effect was manifested on yield in both the years of study. Grain yield in the untreated check was 7.42 q ha^{-1} as compared to 10.81 and 10.79 q ha^{-1} obtained in chlorpyriphos and endosulfan, respectively which were at par with each other (Table 3). Next to follow was higher dosage of *M. anisopliae* (10.36 q ha^{-1}) which registered 39.62% more yield over UTC. Cost effectiveness was highest in chlorpyriphos (7.01) followed by mid dosage of *M. anisopliae* (6.75), endosulfan (6.32) and highest dosage of *M. anisopliae* (5.88). The fungus at lowest dose was least rewarding (Table 3).

Though there exists significant yield difference between the chemical and higher dosage of mycopathogen treatment, it is only about 45 kg ha^{-1}. Therefore, if mycopathogen is used for treatment over large area and assessed for long term benefits, the difference in use of chemicals and mycopathogens will not only be obliterated but also the bio-agents will surpass with successive cropping season with increase in inoculum load, besides safeguarding edaphic environment.

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