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Integrated evaluation of fungicides, botanicals and bioagents against anthracnose of mungbean on natural field condition

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Abstract
Perusal of results indicates that least percent disease intensity of anthracnose was reported with fungicidal seed treatment with Carbendazim + spraying with Propiconazole. This was followed by spraying of Propiconazole alone. Combine seed treatment of Carbendazim + *T. viride* also exhibited encouraging result in reducing disease intensity, while spraying of Garlic extract recorded least effect against *C. lindemuthianum*. Percent mean disease control was noticed in range of 19.56% (Garlic) to 25.50% (Carbendazim + Propiconazole). The highest mean percent disease control was noticed in treatment, Carbendazim + Propiconazole (25.50%) over rest of the treatments. Least mean disease control was reported with treatment, Garlic (19.56%) respectively. Among fungicides tested, Carbendazim + Propiconazole recorded highest seed yield (2180 kg/ha), over unsprayed control (yield 1500 kg/ha). The second best fungicide found was Propiconazole 25 EC, which recorded seed yield of 2150 kg/ha over unsprayed control. Fungicides, Carbendazim + propiconazole and Propiconazole were found effective in respect of the seed yield. Whereas treatment, Carbendazim + *T. viride* recorded seed yield 2100kg/ha. While, Carbendazim recorded seed yield (2050kg/ha.) over unsprayed control. Bioagent, *T. viride* recorded seed yield (2000kg/ha.) and Botanical, Garlic, reported seed yield was 1800kg/ha respectively.

Keywords: Fungicides, botanicals, bio agents, anthracnose, *Colletotrichum lindemuthianum*

Introduction
Anthracnose of mungbean caused by *Colletotrichum lindemuthianum* (Sacc. and Magn.) Bri and Cav. is a cosmopolitan seed borne disease. Infection of a susceptible cultivar in favourable conditions leading to an epidemic may result in 100% yield losses (Araya, 1989; Sharma *et al*., 1994; Sharma and Sugha, 1995; Somavilla and Prestes, 1999; Fernandez *et al*., 2000) [1, 17, 18, 19]. Despite the availability of management practices like seed and foliar treatment with fungicides, crop rotation, use of certified seed and genetic resistance etc, bean anthracnose is still of regular occurrence in most of the areas. Best strategy to manage disease is planting resistant cultivars, which is most effective, least expensive and easiest for farmers to adopt. However, high pathogenic variability present in the pathogen population (Pastor-Corrales *et al*., 1995; Sharma *et al*., 1999; Mahuku and Riascos, 2004; Sharma *et al*., 2007; Padder *et al*., 2007) [14, 11, 16] renders their use ineffective due to continuous breakdown of the resistance mainly in recommended cultivars with good agronomic and marketability traits (Sharma et al., 1994; Kumar *et al*., 1997) [14, 7]. Hence in the present study, biocontrol agents, botanicals along with fungicide (Bavistin) were evaluated under *in vitro* conditions and their integration was studied under *in vivo* to evolve an effective management strategy.

Materials and methods
The field experiment was conducted on the research farm of the Department of Plant Pathology, College of Agriculture, Badnapur during *Kharif* 2015, using susceptible mungbeanvarietyBPMR-145.

Details of the experiment
Design: RBD, Variety: BPMR-145, Replications: Three, Plot Size: 3.0 x 1.8m^2, Spacing: 30 x 10 cm, Treatments: Seven (7) T_1: Seed treatment with Carbendazim @ 2gm/kg seed, T_2: Foliar spray with Propiconazole @ 0.1%, T_3: Seed treatment with *T. viride*@ 10gm/kg seed, T_4:

Foliar spray with Garlic @ 10%, T_5: Seed treatment with Carbendazim @ 2gm/kg seed+ foliar spray with Propiconazole @ 0.1%, T_6: Seed treatment with Carbendazim @ 2gm/kg seed + Seed treatment with *T. Viride* @ 10gm/kg seed, T_7: Control (Untreated).

A total of two sprayings of all the treatments were undertaken at interval of 15 days, starting first spraying at first appearance of the disease. One plot per replication was maintained as unsprayed control without receiving any fungicides.

Observations on anthracnose disease intensity were recorded before and after each spraying and last observation on anthracnose was recorded at 15 days after last spraying. Observations on anthracnose were also be recorded from its first appearance at 15 days interval and continued till 15 days before harvesting.

Five plants per treatment, per replication were selected randomly and tagged for recording the observations. Two leaves (bottom, middle and top) from main branch on each observation plant were selected for recording observations and per cent anthracnose disease intensity was worked out. At harvest of the crops, observations on seed yield were recorded in all the treatments and yield data was present on hectare basis.

Result and Discussion

Percent Disease Intensity (PDI)

Results revealed that all the fungicides, botanical and bioagent tested were found effective and significantly reduced disease intensity over control.

Among fungicides, seed treatment with Carbendazim + foliar spray with Propiconazole recorded least mean disease intensity (27.23%) over control. The second best fungicide found was Propiconazole @ 0.1%, which recorded minimum mean disease intensity (28.26%) over control. This was followed by Carbendazim + *T. viride* (28.80%), Carbendazim (29.09%), *T. viride* (29.16%) and Garlic (29.50%) respectively.

Both the bioagent and botanical were found comparatively less effective than the fungicides in case of reducing anthracnose. Of the bioagent tested, *T. viride* recorded (29.16%) mean percent disease intensity over unsprayed control. Among botanical tested, Garlic (*A. sativum*) recorded (29.50%) mean percent disease intensity over unsprayed control.

Thus, all the fungicides, bioagent and botanical tested were found effective against anthracnose of mungbean over unsprayed control.

After I spray, disease intensity was ranged from 27.18% (Carbendazim + Propiconazole) to 29.54% (Garlic) as against 37.49% over unsprayed control. Among all treatments tested, treatment, Carbendazim + Propiconazole recorded significantly least disease intensity (27.18%). This was followed by Propiconazole (28.51%).

The anthracnose disease intensity recorded after II spray was ranged from 25.20% (Carbendazim + Propiconazole) to 28.95 % (Garlic) as against 39.70% percent control. Among all the treatments tested, Carbendazim + Propiconazole exhibited least disease intensity (25.20%). This was followed by Propiconazole (26.23%), Carbendazim + *T. viride* (27.10%), Carbendazim (28.76%), *T. viride* (28.08%) and Garlic (28.95%) as against 39.70% in control. Among all the treatments, seed treatment with Carbendazim + spraying with Propiconazole (25.20%) recorded significantly least disease intensity.

Perusal of results indicates that least percent disease intensity of anthracnose was reported with fungicidal seed treatment with Carbendazim + spraying with Propiconazole. This was followed by spraying of Propiconazole alone. Combine seed treatment of Carbendazim + *T. viride* also exhibited encouraging result in reducing disease intensity, while spraying of Garlic extract recorded least effect against *C. lindemuthianum.*

Percent Disease Control (PDC)

Result in (Table 11) obtained on percent disease control achieved after I and II spray revealed that all the treatments significantly reduced percent disease control of anthracnose in Cv. BPMR-145 over untreated control.

Before I spray, the maximum mean percent disease control was achieved in treatment, Carbendazim + Propiconazole (12.48%). This was followed by treatment, Propiconazole (10.30%), Carbendazim + *T. viride* (10.27%), Carbendazim (12.24%), *T. viride* (10.48%) and Garlic (10.39%). The least control was recorded with treatment, Garlic (10.39%).

After II spray, percent disease control was observed in range of 27.08% (Garlic) to 36.52% (Carbendazim + Propiconazole). This was followed by treatments, spraying with Propiconazole (33.93%), seed treatment with Carbendazim + *T. viride* (31.74%), seed treatment with Carbendazim (27.56%), *T. viride* (29.27%) and spraying with Garlic (27.08%).

Percent mean disease control was noticed in range of 19.56% (Garlic) to 25.50% (Carbendazim + Propiconazole). The highest mean percent disease control was noticed in treatment, Carbendazim + Propiconazole (25.50%) over rest of the treatments. Least mean disease control was reported with treatment, Garlic (19.56%) respectively.

The results are in agreement with Gawade *et al.* (2009) [6], who reported that the fungicide, Carbendazim (@ 0.1%) was found the most effective and economical in controlling the pod blight of soybean, followed by fungicide Mancozeb. Efficacy of botanicals, garlic, onion and bioagents *T. viride* and *P. fluorescens* were also reported earlier by several workers (Sharma *et. al.*, 2004, Gawade *et al*., 2009 and Padder *et al*., 2010, Mohammed A., 2013) [6, 11, 8].

Seed yield *Kharif*, 2015

Result obtained in respect of efficacy of fungicides, botanicals and bioagents against anthracnose of mungbean and their effect on seed yield of mungbean *Kharif*, 2015 indicated that all the treatments significantly reduced the anthracnose intensity over unsprayed control and thereby increased the seed yield.

Among fungicides tested, Carbendazim + Propiconazole recorded highest seed yield (2180 kg/ha), over unsprayed control (yield 1500 kg/ha). The second best fungicide found was Propiconazole 25 EC, which recorded seed yield of 2150 kg/ha over unsprayed control. Fungicides, Carbendazim + propiconazole and Propiconazole were found effective in respect of the seed yield. Whereas treatment, Carbendazim + *T. viride* recorded seed yield 2100kg/ha. While, Carbendazim recorded seed yield (2050kg/ha.) over unsprayed control. Bioagent, *T. viride* recorded seed yield (2000kg/ha.) and Botanical, Garlic, reported seed yield was 1800kg/ha respectively.

Results obtained in present studies are in conformity with those reported earlier by several workers viz., Chandrasekaran *et al*., (2000) [2], Chandrasekaran and Rajappan, (2002) [3], Gorawar *et al*., (2006) [9] and Gawade *et al*., (2009) [6].

Table 1: Effect of seed treatments and sprayings of fungicides and botanical on percent disease intensity (PDI) and percent disease control (PDC) in mungbean cv. BPMR-145 (*Kharif*-2015)

T. No.	Treatments with Conc.	Method of Application	PDI (Percent Disease Intensity)			Mean %	PDC (Percent Disease Control)			Mean %	Seed yield* (kg/ha)
			Before I pray	After I Spray	After II Spray		Before I pray	After I Spray	After II Spray		
T_1	Carbendazim 2gm/kg	Seed Treatment	29.40 (32.84)	29.10 (32.65)	28.76 (32.43)	29.09 (32.64)	12.24 (20.48)	22.38 (28.23)	27.56 (31.67)	20.73 (27.08)	2050
T_2	Propiconazole 0.1%	Spraying	30.05 (33.24)	28.51 (32.27)	26.23 (30.81)	28.26 (32.11)	10.30 (18.72)	23.95 (29.30)	33.93 (35.63)	22.73 (28.47)	2150
T_3	*T. viride*10gm/kg	Seed Treatment	29.99 (33.21)	29.40 (32.84)	28.08 (32.00)	29.16 (32.68)	10.48 (18.89)	21.58 (27.68)	29.27 (32.75)	20.44 (26.89)	2000
T_4	Garlic 10%	Spraying	30.02 (33.22)	29.54 (32.92)	28.95 (32.55)	29.50 (32.90)	10.39 (18.80)	21.21 (27.42)	27.08 (31.36)	19.56 (26.25)	1800
T_5	Carbendazim + Propiconazole 2gm/kg + 0.1%	Seed Treatment + Spraying	29.32 (32.78)	27.18 (31.42)	25.20 (30.13)	27.23 (31.46)	12.48 (20.69)	27.50 (31.63)	36.52 (37.18)	25.50 (30.33)	2180
T_6	Carbendazim + *T. viride*2gm + 10gm/kg	Seed Treatment	30.06 (33.25)	29.24 (32.73)	27.10 (31.37)	28.80 (32.46)	10.27 (18.69)	22.01 (27.98)	31.74 (34.29)	21.34 (27.51)	2100
T_7	Control		33.50 (35.37)	37.49 (37.76)	39.70 (39.06)	36.90 (37.41)	-	-	-	-	1500
	SE±		0.77	0.74	0.95	0.82	1.12	1.45	0.99	1.19	0.30
	CD (P=0.05)		2.33	2.19	2.85	2.46	3.37	4.33	2.47	3.39	0.92

*- Average of three replications. Figures in parenthesis are arcsine transformation values.

The fungicides found effective against *C. lindemuthianum* in present studies were also reported effective against several *Colletotrichum* species causing anthracnose in other crop plants. Efficacy of these fungicides in controlling anthracnose disease and increasing the yields were reported earlier by several workers (Gawade *et al*., 2009) [6]. The botanicals and bioagents found effective against *C. truncatum* in present studies were also reported effective against *Colletotrichum* species earlier by several workers (Dubey and Ekka, 2003, Pubyang and Tiameren, 2005, Rao and Narayana, 2010) [4, 12, 14].

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