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Efficacy of bio-agent and fungicides for the management of charcoal rot disease of soybean

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Abstract
Soybean is the main crop of Madhya Pradesh covered 55-60% share of the total production. Gradually soybean production and their quality go down due to unfavorable climatic condition and occurrence of biotic and a biotic factors. An extensive surveyed was done during the crop period from seedling stage to pod formation stage in the kharif 2017. and found that nearly 63 percent of crop was damaged in due to occurrence of charcoal rot A field experiment was conducted to study the efficacy of bio-agent and the chemical fungicides for the management of charcoal rot in two successive soybean seasons in kharif 2018-19 and 2019-20.Pooled mean data of both years on disease management indicated that bio-agent and fungicides alone and in combinations significantly reduced the incidence of charcoal rot disease in comparison to untreated control. Seeds treated with Trichoderma viride and plant sprayed by Azoxystoribin at pod formation stage gave maximum disease control (89.41%) followed by seed treatment with Pseudomonas fluorescens and sprayed by Tebuconozole (84.07%). whereas seed treated with thiram and plant sprayed with Carbendazim showed 70.71% disease control. Application of farm yard manure before sowing and soil treated with T. viride reduced 73.21% disease incidence. Maximum grain yield (13.94q/ha and 17.12q/ha) was obtained in T. viride and azoxystorbin treated plot in both the experimental years 2018-19 and 2019-20. This treatment not only gave the highest yield but also gave higher return.

Keywords: Soybean, bio-control agents, chemical fungicides, hand sprayer

Introduction

Soybean (*Glycine max* L.) is one of the most important crops grown among fifty countries of the world. Soybean is a best source of vegetative protein and oil (Herridge *et al*. 2008, Prevost *et al*. (2010) [5, 9]. In India, it is grown in 108.83 lakh hectare land and in Madhya Pradesh, soybean known as yellow gold and covered more than 30% cultivated area in the kharif season. Unfortunately this crop suffered from various diseases among them charcoal rot caused by Macrophomina phaseolina (Tassi) Goidanich is one of the most important and devastating disease of soybean resulting in reduced yield and seed quality. This disease partially affected several newly released commercial varieties JS 93- 05, JS 97- 52, JS 20 -29, JS 20- 69, NRC 37, RVS 2001-4.M. phaseolina is a necrotrophic phytopathogen with a wide host range infecting more than five hundred cultivated and wild plant species (Khan, 2007) [6]. Many of the pathogenic species attacked on economically important crops such as corn, sorghum, bean, sesame, sunflower and safflower in addition to soybean (Singh *et al*. (2008) [4]. The fungus infects plants from seedling stage to maturity in the presence of high temperature and high relative humidity and disease ranked second in losses of the soybean yield after yellow mosaic (Sebastian *et al*. (2016) [10]. Charcoal rot control is very difficult due to their soil and seed born nature and time of appearance from seedling to pod formation stage. M. phaseolina invade the root of soybean at an early stage but symptoms appear at the flowering stage. Efforts made to control the disease by adjusting sowing date, crop rotation, plant population, manipulate or reduced the doses of chemical fertilizers has been attainted (Sebastian *et al*. 2016) [10]. But chemical fungicides were not effective against the disease. The application of bio-control agentsare being used either alone or in combinations. There are only few investigations on the biological control capability of *Trichoderma* spp. against soybean charcoal rot (Shali *et al*. 2010, Belkar and Gade. 2013) [11, 1]. Therefore, the objective of the present investigation is to find out the best combination of bio -agent and chemical fungicide against the control of charcoal rot of soybean.

Materials and Methods

During the Kharif season of 2017-18 an extensive survey have been conducted with the collaboration of State Agriculture Department in different varieties of soybean sown in Narsinghpur district for disease incidence and losses caused by the disease. Plant showed typical symptoms of disease were collected from the fields and brought in lab for pathogencity test. After rinsed with water, samples cut in to small pieces and followed the complete surface sterilization process. Sterilized small pieces of affected plant sample dried with sterilized filter paper, poured on agar plate and kept in incubator for growth. Procedure for identification of pathogen was applied and confirmed the pathogen as Macrophomina phaseolina. On the basis of survey result, an experiment was conducted at Krishi Vigyan Kendra-Narsinghpur (MP) during the kharif seasons of 2018-19 and 2019-20 in to three replication. Total eight treatments were maintained in the field with bio-agents and chemical fungicides. Soybean variety JS 20-69 was used and sown as per norm of each treatment in the selected plot with recommended agronomical practices. Trichoderma viride and Pseudomonas fluorescens were used for seed dressing @ rate of 10 g /kg seed and 5kg/ ha used for soil treatment with the help of dried soil of the field before sowing of soybean seeds. Chemical fungicides i.e. carbedazim and thiram were applied 2.5-3.0 g/kg seed for seed treatment. Spraying of fungicides was conducted before pod formation stage. Observation of disease incidence were recorded at 25 DAS and on pod formation stage and average year wise observation was summarized in the Table 1.Hight of different treatments were recorded separately. Experimental treatment wise yield data was recorded after harvesting of the crop.

Results and Discussions

Efficacy of bio-agents and chemical fungicides were tested against charcoal rot disease of soybean during kharif seasons of 2018-19 and 2019-20.All the treatments significantly reduced the disease incidence in comparison to control. Biological and chemical seed and soil treatment have been shown to be ware effective to control M. phaseolina on various crops. In kharif 2018-19, lowest disease incidence (14.73%) was recorded in plot seed treated with T. viride and sprayed with Azoxystorbin at the time of pod formation followed by treatment T3 (22.50%). Seed and soil treated with either T. viride or P. fluorescens were minimized the disease incidence in comparison to Thiram plus Carbendazim. In those plots chemical fungicides for seed and soil treatment were less effective against the disease in comparison to plots having bio-agent and fungicides (Table 1). Charcoal rot incidence naturally reduced in the kharif 2019-20. Among the treatments, maximum disease incidence (34.10%) was observed in the plot where Thiram was used for seed treatment and Carbendazim sprayed at the pod initiation stage (T6) followed by treatment 7(FYM + T. viride) and treatment 2(P. fluorescens) applied plot. In control plot, incidence of the disease was recorded 30.96 percent. Combined effect of bio-agent and fungicides either used for seed treatment or soil treatment reduced the disease incidence than alone. Significantly great reduction in disease incidence was observed in T4 plot (6.45%) than T5 (18.50%) and T1 (18.74%). It might be seen that the incidence of disease increased with increased temperature and low moisture at flowering to pod formation stage. Treatment with Carbendazim, Quintozene and Benomyl enhance plant emergence and control the disease (Chauhan (1986a) [3]. Belkar and Gade (2013) [1] reported that seed treatment with either *Trichoderma*. spp. Or P. fluresecens alone or in combination decrease the incidence of disease. Taheri and Taright (2011) [15] and Nikraftan *et al*. (2013) reported that trichoderma induced resistance in plant due to higher production of phenolic compound. Phenolics are oxidized by peroxidases to form more toxic compounds known as quinines which are extremely toxic to fungal pathogen (Gogai *et al*. 2001). Sindhan and Katwasra (2002) [12] also reported that P. fluresecens was effective against the dry root rot disease. Mengistu *et al*. (2013) [7] observed that greater symptoms of charcoal rot appeared in plants stress by high heat and drought, especially when drought occurred during reproductive growth stage Biological antagonists such as Trichoderma spp. and Aspergillus species reduced the incidence of charchol rot of sesame.

Plant height of soybean significantly increased in all the treatments in comparison to control. Highest plant height (51.57 cm) was recorded in treatment 7 (FYM+ T. viride) than treatment 4 (T. viride + Azoxystorbin) and T. viride applied plot (46.35cm). In control plot, plant height recorded as 38.21 cm. There were no significant differences in plant height with other treatments. Plant height was increased in T. viride applied plot might be due to better ability to colonized in rhizosphere zone of the plant. Induced accumulation of phenols in to cell wall act as antimicrobial compounds which lead to the resistance response. Phenolic compounds and flavonoids are two kinds of metabolites of phenypropanoids path way in plants (Cao *et al*. 2005) [2]. Soybean yield data of the kharif seasons 2018-19 and 2019-20 which is summarized in Table 1 indicated that treated plot had significantly more yield than the control. In the year 2018-19, highest grain yield (13.94q/ha) found in treatment 4 (T. viride +Azoxystorbin) than treatment 3(P. fluorescens + tebuconazole). Although no significant differences were found among the treatment 1,T5,T2, T6 and T7. Why crop yield increased in all these treatment than untreated control. In the year 2019-20, same trend in respect to grain yield production was observed. In the present investigation it was observed that application of bio fungicides (bio-agents) as seed treatment and plant sprayed with chemical fungicides reduced the incidence of disease and increased the grain yield as comparison to applied alone.

Table 1: Effect of bio-agent and chemical fungicides on the management of charcoal rot disease and yield of soybean.

Treatment	Percent disease incidence		Pool data of disease incidence (%)	Yield (q/ha)		Pool Yield data (q/ha)	Plant height (cm)
	2018-19	2019-20		2018-19	2019-20		
T1-Soil and seed treated with Trichoderma viride	26.17	18.24	22.21	10.36	13.25	11.80	46.35
T2-Soil and seed treated with Pseudomonas fluorescens	31.15	25.06	28.11	8.52	11.63	10.07	40.75
T3-seed treated with Pseudomonas fluorescens and sprayed tebuconazole	22.50	9.35	15.93	12.47	15.85	14.16	42.19
T4-seed treated with Trichoderma viride and sprayed	14.73	6.45	10.59	13.94	17.12	15.53	46.47

Azoxystorbin							
T5- seed treated with Carbendazim and plant sprayed with Poly tag	26.42	18.50	22.46	9.12	11.76	10.44	41.54
T6- seed treated with Thiram and sprayed Carbendazim	34.10	24.49	29.29	8.02	9.50	8.76	40.72
T7-Soil and seed treated with farm yard manure + Tricoderma viride	27.44	26.15	26.79	8.00	9.13	8.59	51.57
T8-Check (Seed and soil untreated with bio and chemical fungicides)	40.71	30.95	36.56	6.97	6.46	6.71	42.21
CD (p=0 .05)	7.24	4.26	-	2.59	2.95	-	4.87

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