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Stem canker management in rice fallow rabi blackgram in Krishna district of Andhra Pradesh

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Abstract
On farm trials in ten locations were conducted to evaluate efficacy of IDM strategies with emphasis on use of bio-control agents for seed treatment and soil application for management of soil borne fungal disease 'stem canker' in blackgram and to create awareness among the farming community during rabi 2018-19 to 2019-20 in the farmer's fields in Krishna District of Andhra Pradesh. Evaluation of popular blackgram varieties was also done against greengram variety in 2014-15 to see their tolerance/resistance to the disease. None of the blackgram variety tested was found tolerant to the disease while greengram showed tolerance by giving good yield. By adoption of IDM practices in both the years, the incidence of the disease was reduced to 7.86 per cent compared to 22.32 in farmers practice. This has resulted in increase in the average cost of cultivation by Rs. 2522.00 per hectare and the average net income was improved by Rs. 26083.00 per hectare compared to the farmers practice. The average yield levels (1187 kg/ha) improved by 85.075 per cent compared to farmers practice (505.5 kg/ha) giving a clear indication that adoption of IDM practices helped in reducing the stem canker disease incidence and damage and improving yield, helps in improving the net income levels to the resource poor farmers.

Keywords: Blackgram, stem canker, IDM, *Trichoderma viridi*, yield and net income

Introduction
Blackgram (*Vigna mungo* L.) is of special significance in Andhra Pradesh as it fits well in rice–pulse cropping system as a relay crop under low input management particularly in Krishna–Godavari and North Coastal zones as rabi rice fallow pulse. In Andhra Pradesh it is cultivated in 12.5 lakh acres with a production of 3.29 lakh tonnes and with a productivity of 263 kg/acre (Vyavasaya Panchagam 2018) [1].

Of the several problems hindering the realization of good yields in blackgram, soil borne diseases in rabi rice fallows are increasing day by day due to continuous cultivation of the crop in the same soils solely relying on chemical fertilizers leading to depletion of the soil organic carbon content having adverse affect on the beneficial soil microbial fauna. Among them, stem canker is attaining greater significance as it is causing mortality of the plants from the beginning of the crop growth till flowering and pod formation. Initially the disease appeared in some pockets of a village 'Kavuthavaram of Gudavalleru' mandal in Krishna district and later it spread to all parts of the district causing severe losses to the blackgram farmers.

Stem canker in blackgram caused by *Macrophomina phaseolina* (Tassi) Goid is a necrotropic fungal pathogen attacking major food crops including, pulses, oil seed crops and fiber crops. It causes a variety of diseases such as dry root rot, seedling blight, charcoal rot and stem rot in different crops. Due to its strong scletorial persistence in soil, it is difficult to control *M. phaseolina* (Shahidul Islam, 2012) [2]. The fungus survives by producing sclerotia that remain viable for more than four years in soil and crop residues. (Oviya, 2019) [3].

The pathogen is seed-borne and with seed-to-seedling transmission and its presence was documented in infected seeds (Pun *et al.*, 1998) [4]. *Macrophomina* infection causes both pre- and post-emergence plant mortality. In rice fallows, symptoms appear on 4 weeks old black gram crop as raised white cankers at the base of the stem. These cankers enlarge gradually and turn as raised brown streaks spreading upwards. Plants are stunted and leaves turn dark green, mottled and reduced in size. Normal leaves on the affected plants drop suddenly and dry. Flowering and podding is greatly reduced, plant wither and die. The affected plants can be easily pulled out leaving dried, rotten root portions in the ground. The rotten tissues of stem and root contain a large number of black minute sclerotia (Rangaswami, 1993) [5].

Several management strategies were tried to contain this disease with marginal results. Of them, few resistant cultivars developed have often exhibited only partial resistance (Demooy *et al.*, 1989) [6] and are not either fit for cultivation or available to the farmers. Other recommended control practices includes soil solarisation (Lodha *et al.*, 1997) [7], planting later-

later-maturing cultivars (Pearson *et al*., 1984) [8] and crop rotation **(**Singh *et al*., 1990) [9]. Other efforts *viz.,* soil fumigation (Pearson *et al*., 1984), and applying irrigation water to reduce the disease promoting effects of drought (Kendig *et al*., 2000) [10] are also not effective.

Chemical control of soil borne diseases are difficult for they not effective and economically not affordable for low income small scale farmers. It offered control for a short time only and is not an ultimate approach in the long run. Chemical control measures, with broad-spectrum fungicides, create imbalances in the microbial community, which may be unfavorable for the activity of the beneficial organisms and also lead to the development of resistant strains. The chemical seed treatments are recommended for the management of seed borne fungal pathogens. However they have the following deficiencies. They created environmental pollution. They have harmful side effects on human beings and animals.

Biological control of soil borne fungi with antagonistic fungal bio-control agent may be the promoting option for achieving lasting results with least effect on non target organisms and on soil. Use of antagonistic organisms against *Macrophomina* root rot has been well documented in several crops (Lokesha & Benagi 2007; Anis *et al.* 2010) [11, 12]. Among the fungal antagonists, *Trichoderma spp* are generally the most frequently reported. Application of *T. harzianum* as seed treatment, suspension for soil drenching or wheat husk bran culture reduced infection of *Rhizoctonia bataticola* (former name of *M. phaseolina*) to 18%, 28% and 14%, respectively, as compared to 70% in the control variant (Parakhia & Vaishnav, 1986) [13]. The members of the genus *Trichoderma* are very promising against soil born plant parasitic fungi. These filamentous fungi are very wide spread in nature, with high population densities in soils and plant liters. They are saprophytic, quickly growing, easy to culture and they can produce large amounts of conidia with long life time. (Manczinger and Kredics, 2002) [14].

Soil application of talc based formulation of *T. harzianum*, *T. polysporum* and *T. viride* effectively controlled the root rot (*M. phaseolina*) of eggplant under field condition (Ramezani, 2008) [15]. It has been suggested that *Trichoderma* might affect plant growth as a result of its ability to influence plant hormones and vitamins (Harman *et al*., 2004) [16]. Such substances could influence the early stages of plant growth with better development of plant roots. Thus, they might be able to sequester more phosphate and other mineral ions liberated as a result of solublization by microorganisms. In most of the studies, *Trichoderma* mediated plant growth promotion has been attributed to indirect mechanisms *viz.*, control of plant pathogens and induced resistance. Though, few of the studies have been focused on the level of minerals and other direct means of growth promotion (Ousley *et al*., 1994) [17].

Thus, an attempt was made to evaluate resistant/tolerance reaction of cultivated blackgram varieties to stem canker and to evaluate the effectiveness of IDM module in comparison with local tolerant cultivar 'tutu minum' for effective management of stem canker in rice fallow rabi blackgram in the farmers' fields.

Materials and Methods

The present investigation was carried out in ten locations in farmers' fields of in Koutharam, Kongamcherla village of Gudlavalleru mandal of Krishna district in different years from 2014-15 to 2019-20, where farmers cultivate blackgram in large area during *rabi* season. For evaluation of the resistance /tolerance reaction, four popularly grown blackgram (LBG 752, LBG 645, LBG 685, PU 31) and one green gram (LGG 460) variety were used and the trial was carried out in replicated sick plots of farmers where disease is appearing every year. On farm trials were conducted in selected farmers' fields with an objective to evaluate IDM module in comparison with tolerant variety for effective management of stem canker so that the same package may be popularized among the farming community for better management of the sucking pests and viral diseases in blackgram.

T1 – Integrated Disease Management Practices (IDM)

- Deep summer ploughing
- Seed treatment with Tebuconazole 2ml/kg seed, or *Trichoderma viridi* @ 10 g/kg seed.
- Soil application of *Trichoderma viridi* @ 2-4 kg augmented in 100 kg of FYM and neem cake
- Spraying of hexaconazole 2 ml/lt as prophylactic spray at 25 days after seed sowing
- Spot drenching with Carbendazim 2 g/li

T2: Cultivation of tolerant variety Tutu minumu

T3: Farmers practice – Spraying of only fungicides (Non IDM)

- Spraying different fungicides for disease management (Nativo, SAAF, mancozeb)

Each treatment was imposed in 0.4 Ha with blackgram "LBG 752" variety, which is the popularly grown variety. Recommended package of practices were followed for raising the crop. Weather conditions during the period of investigation is characterized by temperature range of maximum 26.5 to 32.5 and minimum 10.5 to 20.5 ºC with no rainfall during the crop growth period. Seed treatment was done with *Trichoderma viridi* @ 10 g/kg. of seed. Soil application of *Trichoderma viridi* was done after mixing 2 kg. of the same to 100 kg. of FYM and incubated for 10 days to one acre. Hexaconazole @ 2 ml/lt was sprayed as prophylactic measure 25 days after sowing of the crops to keep the development of the diseases at check. Where ever the disease appeared, drenching was done with carbendazim @ 2.0 g/lt. All other plant protection measures were taken to check the pests and diseases damage. Data were recorded from ten randomly selected plants from each field leaving border rows. The observations were recorded to assess the percentage of affected plants. The seed yield, cost of cultivation, net benefit and cost benefit ratios were calculated.

$$\text{Per cent incidence of the diseases} = \frac{\text{Number of diseased plants in one sq. meter}}{\text{Total number of plants in one sq. meter}} \times 100$$

Results and Discussion

a. Varietal screening

An experiment was conducted in 2014-15 to evaluate the resistance/tolerance of the commonly grown blackgram cultivars in comparison with one greengram variety in the farmers fields in Kavuthavarm village of Gudlavalluru mandal, where the stem canker diseases is appearing continually in three replicated plots. In the sick plots, the varieties LBG 752, LBG 645, LBG 685, PU 31 and LGG 460 were observed for their reaction to the disease. It was observed that all the varieties of the black gram are susceptible to the stem canker and died due to the disease but the green gram tolerated the crop and gave good results. It

gave a yield of 22.5 qt/Ha against complete loss in blackgram varieties. In several crops development of the resistant cultivars is a prime object; however, the developed cultivars have often exhibited only partial resistance (Demooy *et al*., 1989) [6] and are not either fit for cultivation or available to the farmers.

b. Evaluation of IDM module

The results indicate (Table No. 1) that adoption of IDM module with emphasis on use of bio-control agents for seed treatment and soil application helped in reduction of stem canker diseases incidence and thereby the damage. In 2018-19 in IDM plot, the per cent incidence of stem canker was 9.29 per cent while, in the farmers practice it was 26.07 per cent wherein only chemical fungicides were sprayed. In IDM plot, the yield was 1086 kg/ha with a 123 per cent increase over farmers practices (488 kg/ha). In 2019-20 in the IDM plot, the per cent incidence of the diseases was 6.43 per cent while, in the farmers practice it was 18.57 per cent, wherein only chemical fungicides were sprayed, while it is only 2.14 percent in the tolerant variety tutu minum. In IDM plot, the yield was 1288 kg/ha with a 47.14 per cent increase over farmers practices (875 kg/ha). The tolerant variety tutu minum also recorded 35.71 percent higher yield (1188 kg/ha) than the farmers practice.

Table 1: Details of the blackgram yields obtained and stem canker damage

Year	Variety	No. of Farmers	Yield (kg/ha)		Increase in yield (%)	Incidence of disease in IDM plots/sq. mt.		Incidence of disease in check plots/sq. mt.	
			Demo	Check		No. of plants	Percent (%)	No. of plants	Percent (%)
2018-19	LBG 752	10	1086	488	123	2.6	9.29	7.3	26.07
2019-20	LBG 752	10	1288	875	47.14	1.8	6.43	5.2	18.57
	Tutu Minumu	10	1188		35.71	0.6	2.14		

The cost of cultivation, average gross returns, average net returns and benefit cost ratios calculated in each year were presented in table no. 2 indicates that adoption of IDM practices with special emphasis on use of bio-control agents for seed treatment and soil application helped in reduction of stem canker diseases incidence.

In 2018-19, the cost of cultivation was increased by Rs. 6043.00 per hectare in IDM plots; however the net returns were increased by Rs. 25384.00 in IDM plots compared to farmers practice. The increase in the cost of cultivation in IDM plots is due to employment of continual plant protecting measures till the end of the crop against other pests and diseases, where as in the farmers practices, due to death of the plants prematurely due to stem canker, farmers stopped taking up further plant protection operations and hence the cost of cultivation was reduced. Even though, the cost of cultivation was increased in demonstration plots, the net income levels were improved due to realization of good yields after maintaining proper plant stand with IDM measures. In farmers practice very low net incomes (Rs. 2719.00) were realized due to premature death of the plants due to the stem canker disease. The benefit cost ration was 1.97 compared to 1.12 in farmers practice.

In 2019-20, the cost of cultivation was reduced by Rs. 1000.00 and an increase of Rs. 26781 in net returns in IDM plots compared to farmers practice. The cost of cultivation of tolerant variety was also reduced by Rs. 875.00 and the net income was increased by Rs. 20406.00 in comparison to farmers practice. The benefit cost ration in IDM was 1.78 and 1.64 in tolerant variety compared to 1.18 in farmers practice.

Table 2: Details of cost of cultivation, average gross and net income levels

Year	Treatment	Cost of cultivation (Rs. ha^{-1})	Gross returns (Rs. ha^{-1})	Net profit (Rs. ha^{-1})	Benefit cost ratio (B:C)
2018-19	T1: IDM	28918	57021	28103	1.97
	T2: Farmers practice	22875	25594	2719	1.12
2019-20	T1: IDM	45250	80469	35219	1.78
	T2: Cultivation of tolerant variety Tutu minumu	45375	74219	28844	1.64
	T3: Farmers practice	46250	54688	8438	1.18

The data indicates that by adoption of IDM practices with emphasis on seed treatment and soil application of *T. viridi* and other management practices were effectively in managing the stem canker in blackgram. Sundravadana (2002) [18] reported that the seed and soil application of *T. viride* significantly controlled the blackgram root rot caused by *M. phaseolina.* Many species of *Trichoderma* have been used as potent biocontrol agents for a variety of phytopathogenic fungi *viz*. *Sclerotium rolfsii*, *Rhizoctonia solani* and *Pythiums* pp. (Harman *et al*., 2004; Sandhya *et al.*, 2005 and Spadaro and Gullino, 2005) [16, 19, 20]. The response of *Trichoderma* to the presence of a potential host includes production of antibiotic compounds, formation of specialized structures and degradation of the host's cell wall by secretion of hydrolytic enzymes followed by the assimilation of its cellular content (Harman *et al,*. 2004 and Benitez *et al*., 2004) [21].

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