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Integrated management of root rot of castor (*Ricinus communis* L.) caused by *Macrophomina phaseolina* (Tassi) Goid

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Abstract
Castor (*Ricinus communis* L.) is one of the important oilseed crops of India. Occurrence of root rot disease has become a major constraint in recent years for successful and profitable cultivation of castor. The efficacy of various bioagents *viz*. *Tricoderma viride*, *T. harzianum* and *Pseudomonas fluorescens* and different fungicides through seed treatment and soil application were evaluated against *Macrophomina phaseolina* (Tassi.) Goid causing root rot disease in castor. Among the different treatments tested in field condition, the lowest root rot incidence was recorded in the seed treatment of carbendazim 50% WP @ 2 g/kg (17.13%) followed by the seed treatment of carboxin 37.5% + thiram 37.5% @ 3 g/kg (18.18%). Among the different bioagents, seed treatment of *Trichoderma harzianum* found superior in disease control with 26.71% disease incidence followed by soil application and drenching of same bioagent. The maximum yield was recorded in the treatment of carbendazim 50% WP (1332 kg/ha) followed by carboxin 37.5% + thiram 37.5% (1239 kg/ha).

Keywords: Seed treatment, biocontrol agents, fungicide, castor root rot

Introduction
Among the non-edible annual group of oilseed crops, castor constitutes very important position in the oil seed economy throughout the world. Castor is cultivated on commercial scale in 30 countries; India, China, Brazil, USSR are the major castor growing countries in the world (Damodaram and Hegde 2010) [3]. India is the world's principal producer of castor and ranks first both in area and production. Gujarat, Andhra Pradesh, Rajasthan, Tamil Nadu, Karnataka, Madhya Pradesh, Uttar Pradesh, Maharashtra and Orissa are the major castor growing states in the country. Various factors are responsible for low productivity of castor, among them diseases are major concerns. More than 50 pathogens have been reported to infect castor crop but only few of them cause economically important diseases. Amoung them root rot caused by *Macrophomina phaseolina* (Tassi) Goid is the most devastating soil and seed borne disease of castor reported in several castor growing countries (Nanda and Prasad 1974) [7]. The estimated yield loss due to the disease has been reported from 20% to 60% (Savalia *et al.*, 2003) [9]. *Macrophomina phaseolina* (Tassi) Goid has a wide host range and is responsible for causing losses on more than 500 cultivated and wild plant species (Khan, 2007). Integrated Disease Management has emerged as the promising approach for management of soil borne diseases. Considerable success has been achieved by introducing antagonists (bio agents) with FYM and seed treatment with fungicides. Keeping in view, the present investigation was carried out to find the potential of IDM to manage this disease.

Materials and Methods
The freshly collected castor plants having the disease symptoms of stem blight, collar rot and shredded bark of the root were used for isolation. The fungus was isolated, purified and sub-cultured.

Considering the importance of disease, an experiment was conducted to study the efficacy of various bio-agents and fungicides as seed treatment, soil application and drenching for controlling root rot disease of castor caused by *M. phaseolina*. The antagonists *viz*, *T. viride*, *T. harzianum* and *Pseudomonas fluorescens* as seed dresser and soil application along with FYM as well as drenching and other chemicals were evaluated for their efficacy against root rot pathogen in field conditions. The experiment was conducted during *kharif* 2016 at Main

Oilseeds Research Station, J.A.U., Junagadh in a randomized block design with three replications.

The seeds of castor (GCH-4) were sown in artificially inoculated soil with *M. phaseolina* culture. The inoculum prepared in sorghum sand medium was added @ 2 g/dibble at the time of sowing in each plot of 6.00 x 4.50 m size with a spacing of 90 cm between the row and 60 cm between the plants in respective treatments. Required quantity of seed dressing fungicides were incorporated in each treatment before sowing. The bio control agent *T. harzianum* was enriched with farm yard manure prior to one week before sowing and it was applied with seed dibbling. Bio control agent *T. harzianum* was drenched at 30 and 45 DAS.

The irrigations and insecticidal control measures were also carried out as and when required. Periodical observations on root rot incidence were recorded at 60, 120, 160 and 180 DAS and data on disease incidence were recorded from total number of plant observed; using following formula.

$$\text{Per cent Disease Incidence} = \frac{\text{Number of infected plants}}{\text{Total number of plants observed}} \text{ X } 100$$

Result

The effective bio-control agents and chemicals, which were found promising under laboratory studies were further evaluated for the management of root rot (*M. phaeolina*) disease of castor under field conditions. The data presented in table 1 revealed that the effects of all the treatments were found significantly superior over control in managing the root rot disease of castor. Minimum disease (17.13%) was recorded in seed treatment of carbendazim, which was statically at par with carboxin 37.5% + thiram 37.5% (18.18%). While in biocontrol agents seed treatment of *Trichoderma harzianum* (26.71%) found superior. Disease incidence for other treatments was ranged between 26.99% (thiram) to 32.96% (*Pseudomonas fluorescens*). Remaining all treatments were found at par with each other.

The yield was also significantly higher in all treatments as compared to control. The highest yield 1332 kg ha-1 was obtained in the seed treatment of carbendazim, which was statically at par with carboxin 37.5% + thiram 37.5% (1239 kg ha-1). Whereas next best treatments were seed treatment of tebuconazole, thiram, *T. harzianum*, carbendazim 12% + mancozeb 63%, mancozeb gave 1068, 1067, 1053, 1046 and 1013 kg ha-1 castor seed yield, respectively. However, least effective treatments were *i.e. T. harzianum* soil application enrich with FYM 250 kg applied with seed dibbling (994 kg ha-1), *T. viride* (957 kg ha-1), *T. harzianum* 50 gm/10 lit water drenching at 30 DAS + 45 DAS (947 kg ha-1) and the lowest yield (909 kg ha-1) was obtained in *Pseudomonas fluorescens.*

Table 1: Effect of different chemicals and bio-control agents on root rot disease incidence and yield of castor seed.

Sr. No.	Treatments	Disease incidence* (%)	Yield* (kg/ha)
T_1	Carbendazim 50% WP	24.45 (17.13)	1332
T_2	Carboxin 37.5% + Thiram 37.5%	25.24 (18.18)	1239
T_3	Thiram 75% WP	31.30 (26.99)	1067
T_4	Mancozeb 75% WP	31.80 (27.77)	1013
T_5	Tebuconazole 2% DS	32.04 (28.14)	1068
T_6	Carbendazim 12% + Mancozeb 63%	33.24 (30.05)	1046
T_7	*Trichoderma harzianum*	31.12 (26.71)	1053
T_8	*T. harzianum* soil application enrich with FYM 250 kg applied with seed dibbling	31.33 (27.03)	994
T_9	*T. harzianum* 50 g/10 lit water drenching at 30 DAS + 45 DAS	31.40 (27.15)	947
T_{10}	*Trichoderma viride*	33.29 (30.12)	957
T_{11}	*Pseudomonas fluorescens*	35.04 (32.96)	909
T_{12}	Control	46.30 (52.27)	510
	S.Em. ±	2.20	85.07
	CD at 5%	6.45	249.50
	CV %	11.83	14.57

* Average of three replications at 180 DAS

Data were arcsine transformed before analysis

Numerals in parentheses are re-transformed value.

These result revealed that significantly higher yield and maximum disease control were obtained in the seed treatment of carbendazim and carboxin 37.5% + thiram 37.5% in fungicides and *T. harzianum* in bio control agent. So these could be recommended for controlling disease under field condition.

These result is supported by the finding of Chauhan (1988) [1] who demonstrated good control of *M. Phaseolina* by seed treatment with carbendazim. Similarly, Jaiman *et al.* (2009) [5], Chilkuri and Giri (2014) [2] and Shumaila and Khan (2016) [10] also found the same result. Sankar and Jeyarajan (1996) [8] and Hooda *et al.* (2000) [4] found *T. harzianum* as the most effective one followed by *T. viride*.

The present result indicated that seed treatment of fungicides and incorporation of bioagents in soil are reported a new information for the management of castor root rot disease in Saurastra condition.

Conclusion

Field experiment of integrated management of root rot, indicated that of seed treatment of carbendazim 50% WP @ 2 g/kg and seed treatment of carboxin 37.5% + thiram 37.5% @ 3 g/kg was quite effective in controlling castor root rot pathogen. The alternative application of these chemicals reduces the risk of development of resistance in pathogen. In case of bioagents, seed treatment, soil application and drenching of *Trichoderma harzianum* at 30 DAS + 45 DAS was also found effective against castor root rot pathogen. Such information will be helpful in formulation of IDM schedule for the management of disease.

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