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Potential of Various Fungi for Biomass Production of Castor

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Abstract: An experiment was conducted to evaluate biomass production of castor (*Ricinus communis*) with inoculation of native Arbuscular Mycorrhizal Fungi (AMF), *Trichoderma harzianum* and *Aspergillus niger*. In castor, dual treatment of mycorrhiza and *T. harzianum* was better for shoot length (29.5 cm), root length (40.3 cm), fresh shoot weight (4.90 g), fresh root weight (1.13 g), number of leaves (10) and leaf area (75.5 cm²) than dual treatment of mycorrhiza and *A. niger* or mycorrhiza alone. These findings established the potential of the fungi for increase in biomass of castor.

Key words: *Ricinus communis*, *Trichoderma harzianum*, *Aspergillus niger*, AMF and Biomass

INTRODUCTION

Castor (*Ricinus communis* L.) belongs to family Euphorbiaceae of dicotyledons (Cooke, 1908). The plant is an annual herb when grown as crop. Spiny fruits have three seeds. Thick, yellowish or almost colourless oil obtained from the seeds. Seed oil content varies from 45-57%. Castor oil has long been used for medicinal purposes. Castor oil is used in treating skin disorders, mild diarrhoea and minimises pains of constipation. It is used to lubricate the wheels of machines. Dyes, varnishes, paints, contain this oil. Its water resistant property is useful in making protective coverings and insulation. Castor wax produced by the hydrogenation of pure castor oil is used in polishes, electrical condensers, carbon paper and as a solid lubricant. Oil cake makes an excellent fertilizer (Iqbal *et al.*, 2012).

The number of fungi recorded in India exceeds 27000 species and is one of the largest biotic community (Manoharachary *et al.*, 2005). Arbuscular Mycorrhizal Fungi (AMF) belong to phylum Glomeromycota (Schenck and Perez, 1988). AM fungi live in symbiosis with cultivated and noncultivated plants (Nelson and Achar, 2001; Hasan *et al.*, 2001). Fungi improve the supply of water and nutrients like phosphate and nitrogen, to the host plant (Pulido *et al.*, 2003). Enhanced plant nutrition in AMF plants is achieved by increasing the surface area of soil explored compared with non-AMF plants (Clarkson, 1985). Alguacil *et al.* (2012) characterised the AMF diversity in soil cultivated with

Jatropha curcas and *Ricinus communis* where they observed that *R. communis* rhizosphere soil showed higher AMF diversity than *J. curcas* soil. Sannazzaro *et al.* (2005) showed higher values of net growth and shoot/root ratio in *Lotus glaber* as effect of *Glomus intraradices* colonization.

Aspergillus is among the most successful group of moulds playing important roles in natural ecosystems and the human economy. Most species degrade complex plant polymers. *Aspergillus* is involved in industrial production of enzymes (amylases), chemicals (citric acid) and food stuffs (soya sauce). Moulds are important in cycling of chemical elements, particularly in the carbon cycle (Bennett, 2010). Akhtar and Siddiqui (2006) found that inoculation of AM fungus *Glomus intraradices* with *A. niger* and *Bacillus* (B22) caused a greater reduction in root-rot of chickpea and results in increased plant growth. Medina and Azcon (2010) suggested that under drought or heavy metal stress conditions, AMF improve plant nutrition and growth. They applied *Aspergillus niger* treated dry olive cake and sugar beet waste and found increased aggregate stability, soil enzymatic activities, water soluble carbon and water soluble carbohydrates as well as nutrient availability.

Jaklitsch *et al.* (2006) summarised different *Trichoderma* species as a normal inhabitant of soil. *Trichoderma* helps in biological control of fungus induced plant disease in soil. It is said to effect seed germination and enhance phosphorus uptake by plants. Shaban and El-Bramawy (2011) found that *Trichoderma*

control disease and improve yield in branches, pods and seeds in *Cicer arietinum* and *Lupinus terms* under greenhouse conditions.

Commercial castor production requires high doses of costly organic fertilizers. The use of fungi like AMF, *Trichoderma* and *Aspergillus* has been reported to be beneficial and economical on several crops (Dai *et al.*, 2011; Benzohra *et al.*, 2011). With this background, the present investigation was carried out.

MATERIALS AND METHODS

Soil analysis: The black clayey soil used for pot experiment was collected from nearby field. Soil was sterilised in autoclave. Total Phosphorus (P) was calorimetrically determined and total Nitrogen (N) was determined by micro Kjeldhal digestion and measured according to Jackson (1971). Potassium (K) was examined by a digital flame photometer.

Pot experiment: The experiment was conducted in three fungal treatment pots (T₁-AMF: T₂-AMF+*A. niger*: T₃-AMF+*T. harzianum*) and one control pot (T₄-control) without fungal inoculum. AMF, *A. niger* and *T. harzianum* inoculums were isolated from soil. Seeds were sterilised with 1% HgCl₂. Two castor seeds were scarified and sown in each pot. AMF, *A. niger* and *T. harzianum* was applied in pot soil according to treatments.

Ninety Days After Sowing (DAS) shoot length was measured above ground level, root length was measured by uprooting plants, the number of leaves per plant was observed on the same day. One sample leaf (fifth from top) was taken for leaf area measurement Data collected was subjected to Standard Error of Mean and CD at 5% (Mungikar, 1997).

RESULTS AND DISCUSSION

Soil analysis: Soil properties were analysed which included soil pH (7.98), salinity (0.89 mΩ), organic carbon (0.39%), Nitrogen (279.10 kg h⁻¹), Phosphorus

(45.58 kg h⁻¹), Potassium (224 kg h⁻¹), Calcium (46.5 meq), Magnesium (13.71 meq) and Ferrous (<0.10 ppm). The soil characters are described in Table 1.

Pot experiment: The results of the pot experiment are hopeful. The data on shoot length, root length, total plant length, fresh weight, dry weight, number of leaves per plant and leaf area was influenced by treatment of different fungi in castor (Table 2, Fig. 1).

The shoot length and root length differs significantly in various treatments. Maximum shoot length and root length was recorded in plant treated with AMF along with *T. harzianum* (29.5 cm) and (40.3 cm) and minimum was recorded in control plant (16.2 cm) and (22.0 cm), respectively.

Minimum fresh shoot weight and fresh root weight was in control plant (4.90 g) and (1.13 g) maximum in dual treatment of AMF and *T. harzianum* (9.88 g) and (4.25 g). Dual treatment of AMF and *A. niger* resulted in higher fresh shoot weight (9.22 g) and fresh root weight (2.88 g) than in AMF alone treated castor plant (8.10 g) and (2.38 g).

Minimum dry shoot weight was in control plant (0.26 g) while maximum in dual treatment of AMF and *A. niger* (1.31 g). It was followed by dual treatment of AMF and *T. harzianum* (1.27 g) and AMF treated castor plant (0.84 g). Minimum dry root weight was in control plant (0.11 g). It was enhanced by the treatment of AMF (0.27 g), dual treatment of AMF and *A. niger* (0.34 g) and dual treatment of AMF and *T. harzianum* (0.45 g).

Number of leaves and Leaf area in castor was also influenced by different fungal treatments. Maximum number of leaves in castor plant was recorded in dual treatment of AMF and *A. niger* (10) and minimum in control plant (7). Maximum leaf area (fifth leaf from top) in castor plant was recorded in dual treatment of AMF and *T. harzianum* (75.5 cm²) which was followed by dual treatment of AMF and *A. niger* (54.5 cm²) and AMF alone (38.0 cm²). While minimum leaf area was recorded in control plant (26.5 cm²).

Table 1: Physicochemical characters of soil used for pot experiment

Treatment	pH	Sal. (mΩ)	Org c (%)	Avl. N (kg h ⁻¹)	Avl. P (kg h ⁻¹)	Avl. k (kg h ⁻¹)	Ca (meq)	Mg (meq)	Fe (ppm)
Experimental result	7.98	0.89	0.39	279.10	45.58	224	46.5	13.71	<0.10

N: Nitrogen, P: Phosphorus, K: Potassium

Table 2: Influence of different on fungi on biomass production in *R. communis*

Treatment	Shoot length (cm)	Root length (cm)	Total length (cm)	Shoot dry weight (g)	Shoot fresh weight (g)	Root fresh weight (g)	Root dry weight (g)	No. of leaves	Leaf area (cm ²)
AMF	27.50	38.20	65.70	0.84	8.10	2.38	0.27	8.00	38.00
AMF+ <i>A. niger</i>	26.40	25.70	52.10	1.31	9.22	2.88	0.34	10.00	54.50
AMF+ <i>T. harzianum</i>	29.50	40.30	69.80	1.27	9.88	4.25	0.45	9.00	75.50
Control	16.20	22.00	38.20	0.26	4.90	1.13	0.11	7.00	26.50
SEM±	4.46	2.95	7.16	0.24	1.11	0.65	0.07	0.65	10.59
CD @ 0.05	12.39	8.19	19.91	0.78	3.51	2.06	0.23	2.05	33.66



Fig. 1: Influence of various fungi on growth parameters: (T₁: Control, T₂: AMF, T₃: AMF+A. *niger* and T₄: AMF+T. *harzianum*)

Enhancement of yield in agricultural crops depends on various factors like physicochemical characters of soil, climatic factors and agronomical practices. Rhizosphere soil is adobe of various pathogenic and non-pathogenic microorganisms like bacteria as well as symbiotic and pathogenic fungi which exert influence on plant growth at micro level giving macro effect.

In accordance of Selvakumar and Thamizhiniyan (2011) AMF application under stress conditions increase dry weight in chilli plant. Sharma *et al.* (2000) treated seeds of red and white stem castor (*Ricinus communis*) with farmyard manure, AMF and vermicompost and found improved biomass in castor plants and observed 94-95% enhancement in plant height and increase in leaf number. Rao *et al.* (1998) observed increase dry matter by application of AMF along with

castor cake and decrease root nematode in *Solanum melongena* L. cv. Pusa Purple Round. Kour *et al.* (2011) reported significant enhancement in weight of 100 fresh leaves, leaf area and number of leaves in AMF treated mulberry plant in nursery beds. Selvaraj and Malik (2004) examined good response in leaves per plant and plant height of cigar producing tobacco cultivar Vellai Vazhai by AMF (*Glomus aggregatum*) inoculation.

CONCLUSION

From the above experiment it is concluded that castor plant receiving either of dual treatments recorded higher physical parameters, the interactions of the fungal hyphae and production of the fungal biomolecules may assist

growth of host plants. Microbial inoculation seems a promising option for sustainable agriculture. However, further studies are needed to evaluate physiological developments in host plant.

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