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RESERACH ARTICLE

THE EFFECT OF COMBINED INOCULATION OF AM FUNGI AND PHOSPHATE SOLUBILIZING BACTERIA (PSB) ON NUTRIENT UPTAKE OF BHENDI (*ABELMOSCHUS ESCULENTUS.*L.)

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ABSTRACT

The combined inoculation effect of AM Fungi and Phosphate solubilizing bacteria (PSB) on nutrient uptake of Bhendi (*Abelmoschus esculentus.* L.) was carried out in this study. The plant seedlings harvested at various incubation days(30, 60 and 90) transplantation with two different treatments (single inoculation of AM Fungi and PSB) resulted in uptake of roots nutrients contents, the combined inoculation of AM Fungi and PSB showed an excellent in uptake of nutrients like N, P ,K ,Ca, Mg, Fe and Zn concentrations in Bhendi than single inoculation.

Key words: AM Fungi, PSB, nutrient uptake.

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INTRODUCTION

AM fungi is the most abundant kind of mycorrhizae found in association with every taxonomic group of plants and the list of species not infected is probably far shorter than the infected ones. These fungal associations are beneficial to crop plants in many ways, including enhancing the nutrient availability especially phosphorus, enhancing water uptake, inducing resistant against diseases and increasing the yield (Lekberg and Koids, 2005).Phosphorus solublizing biofertilizers are carrier based preparations containing living cells of microorganisms like bacteria, fungi and actinomycetes which may help in increasing crop productivity by way of helping in solubilization of insoluble phosphorus, stimulating plant growth by providing hormones, vitamins and other growth promoting substances. Phosphate Solubilizing Bacteria (PSB) are capable of hydrolyzing organic and inorganic phosphorus from insoluble compounds and PSB produce phosphatase like phytase that hydrolyse organic forms of phosphate compounds efficiently (Zehra, 2010). Bhendi (*Abelmoschus esculentus.* L.) or ladies finger is an important vegetable crop of the tropical countries and most popular in India, Nigeria, Pakistan, Cameroon, Iraq and Ghana. Though, it is virtually not grown in Europe and North America, yet, lot of people in these countries have started liking this vegetable because of the rich source of vitamin A and folic acid, besides carbohydrates, phosphorus, magnesium and potassium. The world total area and production under bhendi is reported to be 1148.0 thousand ha and 7896.3 thousand tons respectively. India ranks first with 73 per cent of world production. India has a slight increase in area and production from 2006-07 to 2010-11. The area has increased from 396.0 thousand ha to 498.0 thousand ha and the production has increased from 4070.0 thousand tons to 5784.0 thousand tons (Indian horticulture database - 2011).

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MATERIALS AND METHODS

Location of the study

All the laboratory experiments were carried out in the Department of Agriculture Microbiology, Faculty of Agriculture, Annamalai University, Annamalai nagar, Tamilnadu. The pot culture experiments were carried out at the pot culture yard of the Department of Agriculture Microbiology, Annamalai University and the field experiments were conducted at Sivapuri village, Cuddalore District, Tamil Nadu.

Collection of biofertilizers

The AM Fungi *Glomus fasciculatum*and PSB *Bacillus megaterium* were obtained from department of Microbiology, Tamil Nadu Agricultural University, Coimbatore.

Experimental design

The pot cuture experiment was carried to know the response of Bhendi plant to coinoculation of *Glomus fasciculatum*and *Bacillus megaterium*. The bhendi plants were grown in cemented pots containing sterilized mixture of sand and soil (1/1 w/w) ratio. The pots were placed accoprding to a completely randomized design. Seeds of Bhendi were surface sterilized with 0.05% sodium hypo chloride for 45 min before sowing them into a 5 cm depth of growth media. Five to six seeds were sown in each pot and after a week of germination time they were thinned to one plant per pot. The plants were grown in natural photoperiods for three months. Inoculum of *Glomus fasciculatum* (20gms/kg of soils)and 20 ml of *Bacillus megaterium* was laid around the seed.

Treatments

T1-Control
T2-single inoculation of *Glomus fasciculatum*
T3-Single inoculation of *Bacillus megaterium*
T4- Combined inoculation of *Glomus fasciculatum*and *Bacillus megaterium.*

Nutrient analysis

Periodical data on nutrient parameters were recorded at 30,60, 90 days interval. The shoot samples were randomly collected per treatment plot using a clean knife and the roots were carefully dug up with a hand –held hoe. The plant tissue were separated into root and shoot thoroughly washed with distilled water, oven dried at 70oc for 48 hours and ground using a Thomas stainless milling machine. The total nitrogen was estimated according to Markham method, Markham, roy (1942). The calorimetrically fallowing the vanadomolybolate method Jack son (1973). The potassium content in the plants was determined by flame photometry. The concentrations of ca and mg in each plant digestion sample were measured using an AAS, whereas the flame photometer. The micro elements (fe, Mn and Zn) concentrations in the roots were determined using an AAS. The nutrient concentrations obtained were multiplied by the mean dry weights of the roots to obtain the nutrient uptake per treatment.

RESULTS AND DISCUSSION

The effect of the different treatments (single, AM Fungi, PSB) on root nutrient content of plant is presented in Table 1,2. All nutrient concentrations were significantly influenced by the application of the microbial inoculations. The dual inoculation (T4) resulted in significantly higher N, P, K, ca, Mg, Fe, Mn and Zn compared to the application of biofertilizer might be due to their influence in en chancing the reactive surface of the soil. Seedlings inoculated with PSB + AM Fungi displayed improved maximum nitrogen uptake (1.32 %in roots) over control and other treatments. Seedlings inoculated with AM Fungi, PSB, AM Fungi + PSB improvement in phosphorous uptake was maximum in T4 (0.72 %) followed by T2 (0.62 %) and T3 (0.66 %) and T1 (0.45 %). Potassium uptake was (0.33 %) higher in T4 inoculated seedlings but at the same time it was also found lower in control. Calcium uptake was improved in all treatments under study and recorded maximum improvement (1.39 %) in seedlings with AM Fungi+PSB. Magnesium concentration was maximum in dual inoculated seedlings. The improvement in uptake of iron was maximum (913.03 ppm) in AM Fungi +PSB inoculated seedlings followed by AM Fungi, PSB alone.

Manganese and zinc uptake was also found higher in seedlings inoculated with different biofertilizers and improvement was noticed maximum up to 142.50 ppm and 26.23 ppm in AM Fungi +PSB inoculated seedlings respectively. The same trend was observed in root samples. In the present study enchanced nitrogen level in AM Fungi and PSB treated plant attributes to the enchanced nitrate reductase activity in host , release of hydrolytic enzymes which mobilize enzymes nitrogen and decompose organic material present in the soil in presence of phosphate solubilizing bacteria. In addition the extra radical hyphae which extend beyond the deplention zones of the host root increases the transfer rate of nutrients such as N. in this study the enchanced levels of phosphorous in the plant tissue in AM Fungi treated planted attributes to the production of phosphate solubilizating enzymes which catalyzes the release of inorganic phosphorous from organic complexes in thr soil.
In the addition the increased surface area of the external mycelium resulted in more phosphorous acquisition.

Table 1. Effect of AM Fungi and PSB on major nutrient contents (%) in roots of bhendi

Treatment	Nitrogen			Phosphorous			Potassium			Calcium			Magnesium		
	Incubation days treatment														
	30	60	90	30	60	90	30	60	90	30	60	90	30	60	90
T1	0.72	0.82	0.92	0.18	0.26	0.42	0.17	0.22	0.30	0.29	0.38	0.42	0.18	0.25	0.38
T2	0.95	1.09	1.18	0.29	0.49	0.62	0.23	0.26	0.36	0.38	0.46	0.6	0.25	0.35	0.45
T3	0.88	1.00	1.17	0.35	0.52	0.57	0.21	0.24	0.33	0.35	0.52	0.64	0.23	0.34	0.44
T4	1.13	1.22	1.32	0.08	0.62	0.62	0.27	0.27	0.42	0.43	0.58	0.68	0.33	0.45	0.55

Table 2. Effect of AM Fungi and PSB on Iron, Manganese and Zinc contents (ppm) in roots of bhendi

Treatment	Iron			Manganese			Zinc		
	Incubation days treatment								
	30	60	90	30	60	90	30	60	90
T1	1481.43	1495.53	1505.43	138.47	146.40	146.40	25.13	32.27	38.33
T2	1528.40	1546.47	1563.33	144.73	158.33	158.33	37.30	45.53	53.10
T3	1505.57	1518.20	1532.67	142.37	154.60	154.60	34.70	42.83	50.77
T4	1531.43	1564.70	1589.00	151.00	165.80	165.80	39.57	48.70	57.67

The resulted increase of P in dual inoculation was due to the further solulization of P by PSB through the production of organic acids, ion chelation, increasing root cell permeability and interacting with AM Fungi supporting its establishment and function. The studies carried out also emphasized the enchanced P uptake in mixed inoculation compared to AM Fungi alone. Apart from from well known effect of AM Fungal association on phosphate uptake, the external hyphae of the AM Fungi can also provide a good delivery system for mg, fe and mn. In the present study low concentraction of K, Zn, Ca, Mg, Fe, and Mn in conrol plants is because of absence of mycorrhizal association with the root system of these plants. Greater mobilization of these nutrients in mycorrhizal plants attributes to mass flow and root interception to the extent permitted by greater absorption of water and improved root growth. Lal L (2002). It has shown that mycorrhizal plant can extract more water from soil and have higher root hydrolytic conductivity than non mycorrhizal plants Marschener (2006). In addition the mycorrhizal plants are able to extract more nutrients from the soil through their extra matricular mycelium which facilitates the easier absorption of these nutrients. Enchanced ca and mg acquisition probably resulted from chelation of ca+2 and mg+2 by organic acids. Plants may secrete compounds that complex fe-sideospores. These fe-complexes may be absorded intact by the p[lant increasing the supply of fe to the plant . the mycorrhizal plants are known to differ from their non- mycorrhizal counterpart6s in the rate of exudation and some contribution of these components to improved uptake of nutrients can be expected. These compents of the exudates such as amino, phenolic and carboxylic acids can promote easier diffusion of these nutrients by forming soluble complexes. The plant roots because of the mycorrhizal establishment change the chemical compostion of root exudates and these are often source of nutrients to associate in mycorrhizosphere Ruiz-Lozano *et al.,* (1995). The high nutrient concentration in the plants treated with AM Fungi and PSB is because of stimulation of AM Fungi by the PSB are some soil bacteria have been shown to directly influence AM Fungal germination and growth rate. Specific bacteria together with AM Fungi may create a more direct synerigism that supports more nutrients acquisition Lindermann RH (2000).

Conclusion

The present study clearly shown that co-inoculation of AM Fungi and PSB played significant role in improving the growth and nutrient uptake of bhendi seedlings there by producing good quality planting stock. The plants which were treated with AM Fungi and PSB exhibited more levels like nitrogen, phosphorous, potassium, calcium, magnesium and micronutrients such as iron, manganese and zinc. There seedlings may perform better growth, survival and more biomass production in nutrient improverished soil.

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