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RESEARCH PAPER

Influence of Microbial Inoculants on Nutrient Dynamics in Oil Palm Nursery

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ABSTRACT

A study was conducted to assess the influence of microbial inoculants on growth and nutrient dynamics in oil palm nursery. Results were found significant among the treatments for the parameters studied. Seedling growth and nutrient availability was more under integrated application of chemical fertilizers and microbial inoculants as compared to the control, individual and combined application of microbial inoculants. The seedling growth, macro and micro nutrient availability in potting mixture and nutrient uptake by seedlings was significantly better under the treatment 25% Recommended Dose of Fertilizers (RDF) and combined application of microbial inoculants.

Keywords : microbial inoculants, biomass, nutrient, oil palm

INTRODUCTION

Oil palm (*Elaeis guineencies* Jacq.), the most productive oil yielding crop in the world, is cultivated in an area of 2.06 lakh ha in India. It is perennial in nature with economic life span of 25-30 years and mainly propagated by seedlings which are grown in the nursery for a period of 12 months. Heavy doses of inorganic fertilizers are used for raising oil palm nursery. Chemical fertilizers are expensive and posing threat to the environment. Microbial inoculants are promising components for integrated solutions to agro-environmental problems, because beneficial microbial inoculants possess the capacity to promote the plant growth, enhance nutrient availability and uptake and support the plant health by improving the microflora (Han and Lee, 2005). *Azospirillum* inoculation contributed up to 40% of the total nitrogen requirement of the oil palm plantlets, stimulated top and root growth by 30% and 60%, respectively compared to the control (Amir *et al*., 2001). There is an urgent need to generate the cost effective and sustainable technology to cut down the quantity of chemical fertilizers used commonly in oil palm nurseries in India. Thus, an experiment was conducted to study the influence of microbial inoculants on growth and nutrient dynamics in oil palm nursery.

MATERIALS AND METHODS

The experiment was laid out in completely randomized design (CRD) with eleven treatments and five replications. The treatments were T1-*Azotobacter chroococcum*, T2-*Azospirillum brasilense*, T3-*Bacillus megaterium*, T4-*Glomus aggregatum*, T5-*Frateuria aurentia*, T6-combination of above types of microbial inoculants (MI), T7-Recommended dose of fertilizers (RDF: 30 g N, 38 g P and 25 g K/seedling/yr), T8-75% RDF+MI, T9-50% RDF+MI, T10-25% RDF+MI and T11-control (without chemical fertilizers and microbial inoculants).Tank silt and FYM mixed in 2:1 ratio by volume/volume basis were used as a potting mixture. Each microbial inoculants culture was applied three times during the nursery period i.e., @ 10 g/seedling at the time of planting the seed sprouts, 40 g/seedling after 4 months and 40 g/seedling after 8 months of the nursery. Source of fertilizers was Diammonium phosphate (DAP) and NPK complex (17:17:17). Fertilizer application was started from the second month onwards and continued till 11th month at monthly intervals. Uniform seed sprouts of Tenera hybrid (1140 D x 1988 P) were raised in double stage nursery by adopting the recommended package of practices. Observations were recorded on growth parameters *viz*., seedling height, number of leaves/seedling, stem girth and total biomass by following the standard methods. Soil samples were collected from all the treatments and analyzed for pH, EC, OC, P, K, Ca, Cu, Fe, Mn and Zn by using standard methods. Similarly, leaf samples (3rd leaf from the top) were collected from each treatment and analyzed for N, P, K, Ca, Mg, Cu, Fe, Mn and Zn using standard methods. The data were analyzed statistically as per standard procedure (Gomez and Gomez, 1984).

RESULTS AND DISCUSSION

Results of the study (Table 1) revealed that different treatments of microbial inoculants and chemical fertilizers significantly influenced all the growth parameters. Seedlings exhibited maximum height in T10 which was found significantly superior to other treatments and the minimum height was observed in T11. Improved seedling height under T10 may be due to increased nutrient availability, better uptake of nutrients and photosynthesis. In addition, growth promoting hormones released by bio-inoculants might have promoted the seedling height. Leaf production was highest in seedlings treated with T10 and T7 followed by T6, T4, T9, T5, T8 and T1, while the lowest was recorded in T11. The treatment T10 recorded the maximum stem girth closely followed by T8 and T7, while it was the minimum in T2 which was found on par with T5 and T11. The seedlings grown with T10 were found more vigorous and this is attributed to better seedling height, leaf production and stem size. The total biomass production was maximum in T10 whereas, it was minimum in T11. The treatments T10, T9 and T8 were found non-significant with one another for total biomass. Increased biomass production in T10 was due to better vegetative growth particularly more leaf and root production and large stem.

It is evident from the results that better growth and biomass production (Table 1) were realized in combination of different types of microbial cultures as compared to individual application and control. Similarly, enhanced seedling growth was reported in coffee (Swarupa 1996), cashew (Kumar *et al*., 1998), tamarind (Parameshwari *et al*., 2001) and mango (Sivakumar, 2001). The results also indicated that the performance of seedlings was better under combined application of chemical fertilizers and microbial inoculants rather than individual application and this might be because of positive interaction between chemical fertilizers and biofertilizers (Sharma and Bhutani, 1998). In most of the cases, the growth of seedlings was significantly better under individual treatments of microbial inoculants as compared to that of control. The present results are in agreement with the findings of Motta and Munevar (2005) and Shamala (2010) in oil palm seedlings. The beneficial effects of biofertilizers on plant growth are ascribed to production of plant growth promoting substances such as gibberellins, cytokinins and auxins (Dobbelaere *et al*., 1999), improvement of water and nutrient uptake, especially those of limited availability in soil such as P, N and micronutrients (Bashan *et al.,* 1990), production of antibiotic metabolites which are effective against soil borne pathogens and production of B-group vitamins and amino acids that promote rooting capacity (Rodelas *et al*., 1993). The above factors might have promoted the growth in seedlings treated with microbial inoculants as compared to the control.

Results (Table 2) revealed that there were significant differences among the treatments for the nutrient availability and EC, whereas the difference in pH of the potting mixture was non-significant amongst the treatments. Highest EC was noticed in T7 and T8

Table 1: Influence of microbial inoculants on growth and biomass production of oil palm seedlings

Treatment	Seedling height (cm)	Leaves/seedling	Stem girth (cm)	Dry matter (g)
T1:AZT	128.16	17.33	28.00	378.95
T2:AZS	128.86	16.33	24.90	284.35
T3:PSB	131.63	16.66	27.46	323.10
T4:AMF	136.03	17.66	28.36	356.35
T5:FRA	131.73	17.33	25.33	346.54
T6:MI	137.66	17.66	29.26	394.73
T7:100%RDF	144.13	18.00	30.20	430.30
T8:75%RDF+MI	143.26	17.00	30.60	474.40
T9:50%RDF+MI	144.50	17.33	29.36	460.76
T10:25%RDF+MI	151.86	18.00	32.26	497.43
T11:Control	121.36	15.66	25.40	253.69
CD (P-0.05)	5.83	1.21	2.22	49.37

and it was lowest in T11, closely followed by T3 and T4. Significant improvement in availability of organic carbon (OC), K, Cu, Fe and Zn contents in potting mixture was observed in T10. Maximum P and Ca availability in potting mixture was recorded with T7 while the minimum levels of OC, P, K and Ca were recorded under T11. The higher values under T7 might be due to application of high dose of chemical fertilizers. Similarly, T7 recorded the maximum level of Mn whereas the minimum was quantified in T5. The maximum and minimum levels of Zn in potting mixture were noticed in T10 and T2 respectively. Better availability of OC, K, Cu, Fe and Zn under T10 might be correlated with improved microbial population in potting mixture. It is a proven fact that microbial organisms multiply faster (synergistic effect) at lower dose of chemical fertilizers. Similar findings were reported in oil palm nursery (Noor *et al.*, 2009) and teak nursery (Seema Paroha *et al.*, 2009).

All the treatments differed significantly (Table 3) with regard to the concentration of macro and micro nutrients in leaves. Among the treatments, the uptake of NPK by oil palm seedlings was found maximum under T10, while it was minimum with T11. T10 recorded the highest level of Ca and the lowest level was recorded in T5. The maximum and minimum accumulation of Mg was observed under T2 and T4, respectively. Maximum Cu assimilation was noticed in T10 and T6 whereas minimum was observed in T11.

Table 2: Influence of microbial inoculants on availability of nutrients in potting mixture

Treatment	pH	EC (dS/m)	OC (%)	P (ppm)	K (%)	Ca (meq/100g)	Cu (ppm)	Fe (ppm)	Mn (ppm)	Zn (ppm)
T1:AZT	8.36	0.037	1.21	16.05	1.51	7.67	1.46	10.30	31.20	2.28
T2:AZS	8.29	0.039	1.24	17.67	1.78	6.45	1.52	8.89	25.82	2.14
T3:PSB	8.37	0.031	1.28	19.51	1.72	6.07	1.59	10.51	29.94	2.24
T4:AMF	8.35	0.032	1.35	18.34	1.84	7.12	1.62	12.14	33.56	2.54
T5:FRA	8.17	0.037	1.31	18.29	1.86	6.04	1.49	12.19	24.58	2.34
T6:MI	8.31	0.038	1.50	20.88	1.89	7.58	1.66	12.98	35.56	2.65
T7:100%RDF	8.28	0.056	1.48	27.83	1.85	7.95	1.68	13.43	38.54	2.78
T8:75%RDF+MI	8.35	0.055	1.47	25.72	1.88	7.83	1.73	15.61	31.47	2.69
T9:50%RDF+MI	8.16	0.038	1.58	24.41	1.92	7.58	1.78	15.16	32.27	2.56
T10:25%RDF+MI	8.27	0.035	1.65	21.88	1.98	7.38	1.82	15.74	33.36	2.86
T11:Control	8.38	0.030	1.08	15.63	1.39	5.99	1.41	9.58	25.98	2.39
CD (P-0.05)	NS	0.008	0.06	2.75	0.16	0.49	0.23	1.81	4.96	0.33

Table 3: Influence of microbial inoculants on concentration of leaf nutrients in oil palm seedlings

Treatment	N (%)	P (%)	K (%)	Ca (%)	Mg (%)	Cu (ppm)	Fe (ppm)	Mn (ppm)	Zn (ppm)
T1:AZT	3.23	0.30	1.47	0.73	0.38	8.11	124.31	140.00	13.08
T2:AZS	3.02	0.33	1.33	0.79	0.57	7.99	116.91	169.60	13.62
T3:PSB	3.16	0.36	1.39	0.97	0.38	7.12	117.65	153.13	13.78
T4:AMF	3.24	0.48	1.52	0.56	0.25	6.83	87.22	170.76	15.36
T5:FRA	3.21	0.30	1.56	0.51	0.30	6.37	79.09	142.66	12.64
T6:MI	3.27	0.48	1.60	0.94	0.41	10.10	139.57	181.75	15.48
T7:100%RDF	3.12	0.49	1.65	0.68	0.36	6.80	212.70	238.33	14.18
T8:75%RDF+MI	3.25	0.49	1.52	0.97	0.38	7.64	189.97	206.08	13.92
T9:50%RDF+MI	3.22	0.64	1.59	0.99	0.41	9.55	197.78	191.90	15.43
T10:25%RDF+MI	3.36	0.68	1.76	1.06	0.42	10.95	162.78	186.66	16.47
T11:Control	2.72	0.26	1.29	0.70	0.38	6.15	65.90	158.07	12.36
CD (P-0.05)	0.23	0.08	0.14	0.13	0.06	1.41	18.01	24.78	0.67

The concentration of Fe was maximum in T7 whereas the minimum Fe content was estimated in T11. Maximum Mn content was recorded under T7 while the minimum was estimated in T1. Zn uptake was maximum under T10 and it was minimum in T11. Significant improvement in nutrient assimilation by seedlings treated with microbial inoculants might be attributed to enhanced plant growth as compared with untreated seedlings. It was observed that integrated approach of biofertilizers and chemical fertilizers enhanced the nutrient uptake in oil palm nursery (Amir *et al*., 2005), ber seedlings (Aseri and Rao 2005) and teak seedlings (Seema Paroha *et al*., 2009).

Combined application of microbial inoculants (T6) significantly increased the availability of OC, P, K, Cu, Fe, Mn and Zn in potting mixture when compared to control. Results were almost similar for accumulation of nutrients in leaf tissues under combined application of microbial inoculants (T6) as compared to control. Current results are similar to the findings reported in pungam seedlings (Venkatesh *et al*., 1998). Among the individual treatments of microbial inoculants, AMF (T4) was found significantly superior to the control in respect of OC, P, K, Cu, Fe, Mn and Zn availability in potting mixture and N, P, K, Cu and Zn concentration in leaves. The root system of oil palm is functionally dependant on AMF to obtain nutrition (Corley and Tinker 2003) and this may be the main reason for enhanced uptake of nutrients by oil palm seedlings treated with AMF. This is further supported by Widiastuti and Tahardi (1993) in oil palm seedlings.

It can be concluded from the results and discussion that better results were obtained under integrated application of bio and chemical fertilizers rather than individual or combined application of different types of microbial inoculants and the control. Similarly, results were found better under combined application of microbial inoculants as compared to individual application and the control. Of all the treatments, better growth and more biomass were recorded under integrated application of microbial inoculants and 25 per cent recommended dose of chemical fertilizers. Similarly, more nutrient availability in potting mixture and nutrient assimilation by seedlings was observed with integrated application of microbial inoculants and 25 per cent recommended dose of chemical fertilizers. In view of the above findings, microbial inoculants and biofertilizers can be used commercially for sustainable raising of oil palm nursery without affecting seedling growth and vigour.

REFERENCES

Amir, H.G., Shamsuddin, Z.H., Halim, M.S., Ramlan, M.F. and Marziah, M. 2001. Effects of azospirillum inoculation on N_2 fixation and growth of oil palm plantlets at nursery stage. *J. Oil Palm Res.* **13**: 3389-3402.

Amir, H.G., Shamsuddin, Z.H., Halim, M.S., Marziah, M. and Ramlan, M.F. 2005. Enhancement in nutrient accumulation and growth of oil palm seedlings caused by PGPR under field nursery conditions.*Communications soil sci. and plant analysis*. **36**: 2059-2066.

Aseri, G.K. and Rao, A.V. 2005. Interaction of bioinoculants and chemical fertilizers on biomass production, rhizopshere activity and nutrient uptake of ber. *Indian J. Forestry.* **28**(4): 401-405.

Bashan,Y., Harrison, K. and Whitmoyer, R. 1990. Enhanced growth of wheat and soybean plants inoculated with *Azospirillum brasilense* is not necessarily due to general enhancement of mineral uptake. *Applied Envi.Microbiology.* **56**: 769-775.

Corely, R.H.V. and Tinker, P.B. 2003. The oil palm. 4th Edition, Blackwell Science Ltd., Oxford, UK.

Dobbelaere, S., Croonenborghs, A., Thys, A., Vande Broek. and Vanderleyden, J. 1999. Phytostimulatory effect of *Azospirillum brasilense* with type and mutant strains altered in IAA production in wheat. *Plant Soil.* **212**: 155-164.

Gomez, K.A. and Gomez, A.A. 1984. *Statistical Procedures for Agricultural Research.* John Wiley and Sons, New York.

Han, H.S. and Lee, K.D. 2005. Phosphate and potassium solubilizing bacteria effect on mineral uptake, soil availability and growth of egg plant. *Res. J. Agri and Biological Sci*. **1**: 176-180.

Kumar, D.P., Hegde, M., Bagyaraj, D.J. and Madhava Rao, A.P. 1998. Influence of biofertilizers on the growth of cashew rootstocks. *Cashew*. **12**(4): 3-9.

Motta, D.V. and Munevar, F.M. 2005. Response of oil palm seedlings to mycorrhization. *Palmas J.* **26**: 11-20.

Noor Aishah, O., Amir, H.G., Chan Lai Keng and Othman, A. R. 2009. Influence of various combinations of diazotrophs and chemical N fertilizer on plant growth and N2 fixation capacity of oil palm seedlings. *The J. Aril. Sci.* **42**(3): 139-149.

Parameshwari, K., Srimathi, P. and Malarkodi, K. 2001. Influence of biofertilizer pelletization on elite seedling production of tamarind in nursery. *Seed Res*. **29**(1): 58-62.

Reddy, D.V.S., Kumar, S.N. and Prabhu, S.R. 2001. Evaluation of alternative media to potting mixture for raising coconut seedlings in poly bags. *J. Plantation Crops.* **29**(1): 62-65.

Rodelas, B., Slameron,V., Mortinez, T. and Lopez, G.M. 1993. Production of vitamins by *Azospirillum brasilens* chemically defined media. *Plant Soil*. **153**: 97-101.

SeemaParoha, Chandra, K.K. and Rakhi Yadav. 2009. Integrated effect of biofertilizers and fertilizers on growth and nutrient acquisition by *Tectona grandis*. *J. Trop. Forestry*. **25**(I&II): 54-61.

Shamala, S. 2010. Growth effects by arbuscular mycorrhiza fungi on oil palm seedlings. *J. Oil Palm Res.* **22**: 796-802.

Sharma, S.D. and Bhutani, V.P. 1998. Response of apple seedlings to VAM, Azotobacter and inorganic fertilizers. *The Hort. J*. **1**: 1-8.

Sivakumar, U. 2001. Effect of bacterial inoculants on mango rootstocks. *Madras Agril. J*. **88**(7-9): 486-487.

Swarupa, S.G. 1996. Study on the effect of biofertilizers on the growth of CxR seedlings. *J. Coffee Res*. **26**(2): 62-66.

Venkatesh, A., Mallika, V., Vanangamudi, K., Ravichandran, V. and Vinaya Rai, R.S. 1998. Impact of biofertilizers on morpho-physiological attributes in pungam (*Pongamia pinnata* (L) Pierre) seedlings. *Applied Agril. Res. and Ext*. **1**(1): 7-11.

Widiastuti, H. and Tahardi, J.S. 1993. Effect of vesicular-arbuscular mycorrhizal inoculation on the growth and nutrient uptake of micropropagated oil palm. *Menara Perkebunan.* **61**: 56-60.