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GROWTH OF DIRECT-SEEDED AND BUDDED STUMP POLYBAG RUBBER (*HEVEA BRASILIENSIS*) PLANTS UNDER DIFFERENT NUTRIENT MANAGEMENT SYSTEMS

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Two polybag nursery experiments were conducted at the Central Experiment Station of the Rubber Research Institute of India, Chethackal during 2008-2009 with the objective of comparing the growth performance of two types of planting materials *viz*., direct-seeded and budded stump rubber (*Hevea brasiliensis*) plants under inorganic fertilizers and integrated nutrient management with different organic sources. The experiments were laid out in a completely randomized design with eight treatments and four replications. The treatments comprised of chemical fertilizers alone and in combinations with cow dung slurry, groundnut cake, neem cake and plant growth promoting rhizobacteria (PGPR). Significant difference was observed in growth of the two planting materials to the application of inorganic fertilizers alone and in combination with different organic sources. Integrated application of chemical fertilizers with cow dung slurry, groundnut cake, neem cake or PGPR produced significantly higher dry matter than standard practice of chemical fertilizers alone in direct-seeded and budded stump polybag plants. Planting materials produced through direct-seeding was significantly superior in diameter, height, number of whorls, fibrous root and dry matter compared to the budded stump plants.

Keywords: *Azotobacter*, Buddability, Cow dung slurry, PGPR

The long immaturity period of rubber (*Hevea brasiliensis*) ranging from 7 to 8 years is one of the major economic disadvantages of commercial rubber cultivation. This problem could be overcome by using advanced planting materials. The higher growth rate of the advanced planting materials in field can reduce the immaturity period considerably. Significant progress has been made over the years in developing improved planting materials with optimum growth potential through the use of appropriate rootstocks and improved budgrafting techniques. Among the different planting materials, polybag plants got wide acceptance by the farmers because of easy establishment, uniformity and better performance in the field. Polybag plants can be prepared by two different methods *viz*., planting the budded stump in polybag and

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planting germinated seeds in polybags and budgrafted *in situ*.

To achieve better growth and vigour of the young plants, adequate and frequent manuring is recommended. The present fertilizer recommendation for polybag plants is N, P, K and Mg @ 6:6:2.4:1 g plant^{-1} as urea, rock phosphate (RP), muriate of potash (MOP) and magnesium sulphate ($MgSO_4$). Integration of chemical fertilizer with organic sources has been reported to enhance nutrient uptake in many crops. The present study was conducted to compare the growth performance of these two types of planting materials *viz*. direct-seeded and budded stump polybag rubber plants under chemical as well as integrated nutrient management (INM) practice with different organic sources.

Two polybag nursery experiments were conducted at the Central Experiment Station of the Rubber Research Institute of India, Chethackal during 2008-2009. Black polythene bags (55 x 25 cm) were filled with 10 kg top soil collected from the farm for the first experiment to raise direct-seeded polybag nursery. The initial nutrient status of the soil was estimated following standard analytical procedures (Jackson, 1958). Rock phosphate (Rajphos) @ 20 g bag^{-1} was mixed with the top 15 cm soil layer. Seeds germinated within 10 days of sowing were planted in the polybags. The experiment was laid out in completely randomized design with eight treatments and four replications having 35 plants per plot. Six weeks after planting, the following treatments were incorporated in four splits at 20 days interval.

In standard practice (T1), N, P, K, Mg @ 6:6:2.4:1 g plant^{-1} were applied as urea, RP, MOP and $MgSO_4$ respectively. Whereas in treatment T4 source of N and P were water soluble and the source was ammophos (20:20) and K and Mg sources were MOP and $MgSO_4$ respectively. In treatment following integrated nutrient management practice, T2, cow dung slurry alone and T3, cow dung slurry containing ground nut cake applied in addition to the standard practice (T1). The treatments T5, T6 and T7 were with integrated nutrient management practice with cow dung slurry alone, cow dung slurry containing ground nut cake and cow dung slurry containing neem cake applied respectively in addition to T4. Cow dung alone @ 50 kg and in combination with 5 kg groundnut cake or 5 kg neem cake was mixed with 500 L water and kept for one week. The supernatant liquids @ 500 mL plant^{-1} for each combination were applied to the respective treatment. Plant growth promoting rhizobacteria (PGPR) comprising a mixture of phosphate solubilizing bacteria (*Bacillus* sp), nitrogen fixing bacteria (*Azotobacter* spp) and plant growth promoting rhizobacteria (*Pseudomonasspp*) @10 mL plant^{-1} was integrated with 50 per cent of T4 in the treatment T8. In T8, inorganic fertilizers were applied 15 days after the application of PGPR. The diameter of plants was recorded four months after planting and percentage buddability was assessed. Plants were destructively sampled to estimate the dry matter production (DMP).

Green budding was done in the direct-seeded polybag plants with the clone RRII 105 four months after planting. Green budded plants were opened 21 days after budding and cut back was done one month after opening. The second polybag nursery experiment was initiated using the same soil with green budded stumps of clone RRII 105 on the same day when cut back of direct seeded plants was done. The treatments, plot size and design were similar to the direct-seeded polybag experiment. Treatment imposition was carried out in both the experiments in four splits at 20 days interval, when one whorl became mature. Growth parameters *viz.*, diameter, height and number of whorls were recorded at two and a half months and four months after cut back and planting budded stumps in both the experiments. Plants were destructively sampled to estimate the dry matter production and fibrous root production after four months. The data were analyzed statistically by performing one-way ANOVA (Snedocor and Cochran, 1967) using SPSS (10.0). The growth parameters of direct-seeded and budded stump planting materials were compared after 2.5 and 4 months by performing t- test.

The top soil used for filling the polythene bag was acidic in reaction, medium in organic carbon and low in available P and K. Integration of chemical fertilizers with organic sources significantly influenced the growth of rubber seedlings, four months after planting the germinated seeds when compared to standard practice (Table 1). Among the treatments, plants supplied with N and P in soluble form (ammophos) along with cow dung slurry (T5) or PGPR (T8) recorded the highest diameter. The DMP was significantly increased by conjoint application of chemical fertilizers with cow dung slurry, groundnut cake, neem cake or PGPR conforming to the observations of Syamala *et al.* (2008). Joseph *et al.* (2003) also reported the possibility of using PGPR for improving the growth of rubber seedlings in the nursery. Significantly more number of buddable plants were obtained under treatments with ammophos and its combinations with cow dung slurry, groundnut cake and PGPR over standard practice. Among the treatments, T5 recorded the highest percentage buddability followed by T8.

Effect of inorganic fertilizers alone and INM practices on growth of direct-seeded and budded stump planting materials at two and a half months after cut back is given in Table 2. In the case of direct-seeded polybag plants, significant superiority in diameter was observed in T4, with ammophos which was on par with the treatment T5, with ammophos and cow dung slurry and T8, with 50 per cent of T4 integrated with PGPR. The enhanced growth of plants in T4, T5 and T8 might be due to the immediate availability of soluble form of N and P from ammophos. It was reported that, the nutrient use efficiency of crops can be increased through combined application of organic

Table 1. **Effect of inorganic fertilizers and INM practice on growth parameters of seedlings, four months after planting**

Treatment	Diameter (mm)	Buddability (%)	DMP (g)
T1- Standard practice	6.9	61.4	14.2
T2- T1 + Cow dung slurry	7.3	75.3	23.4
T3 - T1 + Cow dung slurry + Ground nut cake	6.9	63.5	19.8
T4 - Standard practice (N&P as ammophos)	7.1	68.2	22.7
T5 - T4 + Cow dung slurry	7.7	83.4	22.1
T6 - T4 + Cow dung slurry+ Ground nut cake	7.4	77.8	22.5
T7 - T4+ Cow dung slurry + Neem cake	7.3	66.5	23.2
T8 - 50% of T4+ PGPR	7.7	80.0	23.4
SE	0.10	4.27	1.04
CD($P \leq 0.05$)	0.29	12.80	2.98

Table 2. **Effect of inorganic fertilizers and INM practice on growth parameters of planting materials at 2 ½ months after cut back**

Treatment	Direct - seeded		Budded stump	
	Diameter (mm)	Height (cm)	Diameter (mm)	Height (cm)
T1- Standard practice	5.8	39.9	4.4	17.8
T2- T1 + Cow dung slurry	5.9	42.8	4.9	22.1
T3- T1 + Cow dung slurry + Ground nut cake	5.8	39.9	4.8	20.4
T4- Standard practice (N&P as ammophos)	6.3	44.1	5.1	19.7
T5- T4 + Cow dung slurry	6.2	44.3	5.2	20.4
T6- T4+ Cow dung slurry + Ground nut cake	5.7	39.2	5.2	20.8
T7- T4+ Cow dung slurry + Neem cake	5.6	41.4	5.0	18.5
T8 - 50% of T4 + PGPR	6.0	42.9	5.1	18.9
SE	0.11	1.51	0.09	0.58
CD(Pd≤0.05)	0.32	NS	0.27	1.66

manures and mineral fertilizers (Murwira and Kirchman, 1993). In the case of budded stumps, application of N and P in soluble form as ammophos alone or in combination with organic sources *viz*., cow dung slurry, groundnut cake, neem cake or PGPR showed significantly higher diameter than standard practice (T1) or its combinations (T2 and T3). Among the treatments the diameter was highest under application of N and P as ammophos along with cow dung slurry and groundnut cake.

Chemical fertilizers along with organic sources significantly influenced the growth of direct-seeded planting material four months after cut back (Table 3). Among the treatments, diameter was highest in T4, with ammophos. Significant increase in fibrous root production was noticed by the application of ammophos in combination with cow dung slurry, groundnut cake, neem cake or 50 per cent of T4 with PGPR over standard practice or its combinations. Joseph *et al*. (2010) reported the positive influence of PGPR on root development of rubber seedlings. The combination of ammophos with cow dung slurry (T5) recorded the highest fibrous root production and was on par with the treatment combination of ammophos with cow dung slurry and neem cake (T7). Dry matter production was significantly increased by the integration of chemical fertilizers with organic sources compared to chemical fertilizer alone. The INM practice *viz*., T2 and T3 were superior to T1 with standard practice in dry matter production. Also, the INM practice with soluble sources of N and P as ammophos, *viz*., T5, T6, T7 and T8 were superior to T4, with soluble sources of N and P as ammophos alone.

The growth parameters *viz*., diameter, height, fibrous root growth and dry matter production of budded stump plants (4 months after planting) were significantly increased by the integration of chemical fertilizers with organic sources over standard practice (Table 3). Among the treatments, application of ammophos in combination with organic sources significantly increased the diameter, root growth and dry matter production compared to standard practice (T1) and its combinations (T2 and T3). The treatment, standard practice in combination with cow dung slurry (T2) showed superiority in

Table 3. **Effect of inorganic fertilizers and INM practice on growth characters of planting materials at 4 months after cut back**

Treatment	Direct-seeded				Budded stump			
	Diameter (mm)	Height (cm)	Fibrous root (g)	DMP (g)	Diameter (mm)	Height (cm)	Fibrous root (g)	DMP (g)
T1- Standard practice	8.4	93.4	3.1	40.4	4.8	28.1	0.8	10.9
T2- T1 + Cow dung slurry	8.6	95.3	3.9	51.6	5.1	36.5	1.0	13.6
T3- T1+ Cow dung slurry + Ground nut cake	8.4	91.1	4.0	62.1	5.1	34.3	1.5	16.4
T4- Standard practice (N&P as ammophos)	9.1	96.7	3.3	56.6	5.3	32.6	1.8	22.7
T5- T4 + Cow dung slurry	8.5	96.5	8.0	62.0	5.5	34.3	2.2	25.7
T6- T4 + Cow dung slurry + Ground nut cake	8.1	87.8	7.1	59.6	5.6	34.6	2.0	24.0
T7- T4 + Cow dung slurry + Neem cake	8.2	92.3	7.4	64.9	5.3	33.0	2.9	22.8
T8 - 50% of T4 + PGPR	8.6	89.0	6.6	64.5	5.7	31.9	2.4	24.3
SE	0.11	1.5	0.29	2.9	0.07	1.26	0.14	1.3
CD($P \leq 0.05$)	0.32	4.5	0.88	8.8	0.21	3.79	0.42	3.9

height and was on par with T6, T5 and T3. Among the treatments, the fibrous root production was highest in treatment T7, a combination of ammophos with cow dung slurry and neem cake. It was reported that, cow dung slurry enhance root growth of budded stumps (Punnoose and Lakshman, 2000). The combination of ammophos with cow dung slurry (T5) recorded the highest dry matter production and was on par with the treatment T8, with 50 per cent of T4 and PGPR and T6, with ammophos in combination with cow dung slurry and ground nut cake.

When different sources of N and P were compared, it was observed that, plants supplied with N and P in soluble from as ammophos showed better growth than urea and rock phosphate indicating the beneficial effect of soluble form which are immediately available to the rubber seedlings. Soluble phosphate provides a starter effect on early establishment of the plants and nitrogen in NH_4^+ *form was found to be more effective* in seedling nursery (RRIM, 1973).

The t-test performed in the experiments to compare the growth parameters of direct-seeded and budded stump planting

Table 4. **Comparison on growth parameters of planting materials**

Growth parameter	Planting materials		t-test
	Direct-seeded	Budded stump	
	2.5 months		
Diameter (mm)	5.9	5.0	**
Height (cm)	41.8	19.8	**
No. of whorls	2.0	1.2	**
	4 months		
Diameter (mm)	8.5	5.3	**
Height (cm)	91.5	33.0	**
No. of whorls	2.9	2.1	**
Fibrous root (g)	5.9	2.0	**
Dry matter (g)	57.7	20.1	**

Significant at $P \leq 0.01$

materials after 2.5 and 4 months is given in Table 4. It was observed that, the planting materials produced through direct-seeding was significantly superior to budded stump plants in diameter, height, number of whorls, fibrous root production and dry matter production, irrespective of the treatments. George *et al.* (2008; 2011) reported the advantages of planting direct-seeded polybag planting material over budded stump polybag plants.

The study revealed the positive influence of integrated application of chemical fertilizers and cow dung slurry, groundnut cake, neem cake or PGPR on growth and percentage buddability of rubber seedlings over the application of chemical fertilizers alone. Significant difference was observed in the growth response of direct-seeded and budded stump polybag plants to the application of inorganic fertilizers and organic sources. Application of N and P as ammophos with cow dung slurry, groundnut cake, neem cake or PGPR produced significantly higher dry matter over standard practice in direct-seeded and budded stump polybag plants. Planting materials produced through direct-seeding was significantly superior in diameter, height, number of whorls, fibrous root production and dry matter over the budded stump plants. Vigorous, good quality planting materials with high growth potential can be developed through the technique of direct-seeding in polybags followed by *in situ* budding and managing the nutrient inputs through chemical fertilizers and organic manures or bio-fertilizers.

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