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TWIN ROOTSTOCK PLANTS OF *HEVEA* DO NOT PERFORM BETTER THAN SINGLE ROOTSTOCK PLANTS

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A study was undertaken to compare the performance of plants having single rootstock (single root system) and twin rootstock (double root system) in terms of growth and yield in *Hevea*. Planting materials with single root system were produced as per the standard technique while plants with two root systems were produced by twin-grafting two stock plants at one whorl stage. Clone RRII 105 was used for the study. The plants were evaluated in the field. The design was RBD with three replications having a plot size of nine plants. Seven treatments were included; twin stocks and single stocks raised in polybags, twin stocks and single stocks raised directly in field by seed-at-stake planting, twin stocks and single stocks raised in seedling nursery and transplanted to the field as budded stumps and polybag plants as control. Annual girth was measured for 13 years and monthly dry rubber yield for four years.

The mean girth of plants having single rootstock and twin rootstock was found to be statistically comparable during immature phase as well as at the time of opening and after tapping for four years. The mean yield of plants having single rootstock and twin rootstock was also found to be comparable. On excavation after 17 years, only less than 27 per cent of the twin rootstock plants were found to have two separate fully developed root systems and in the other cases, either the two roots united or one root had become aborted. The present study showed that twin rootstock plants and single rootstock plants do not differ significantly in growth and yield indicating that twin grafting may not have an added advantage in *Hevea*.

Keywords: Growth and yield, Rootstock, Twin-grafting

INTRODUCTION

In agriculture, splice approach grafting to produce a tree with double root system is carried out in some fruit trees. The resultant tree has more than one root system and the trees are better able to obtain food and water, and can withstand stronger winds (Boonbongkarn, 1960). The twin grafting technique is also used to induce rapid flowering and fruiting (Aumeeruddy and Pinglo, 1988) and also to enhance faster growth and to produce a stronger root system. Some preliminary reports indicate that double and triple grafted material grew more vigorously and had higher fruit set than grafted plants with single rootstocks (Zabedah *et al.*, 1992; Zabedah, 1993). In mango cultivation, grafting success in field

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and later on in field survival is the serious bottleneck in the establishment of mango orchard. In both the cases, mortality of mango grafts in field and initial grafting success may be due to short supply of food material by single rootstock. An experiment was conducted with the objective of overcoming this problem by providing double rootstock (Munde *et al*., 2011). They observed that variety Ratna when grafted on single as well as double rootstock gave maximum grafting success. In mango trees the multiple rootstocks or multi-root system is employed by some farmers for accelerated growth and also to overcome the biennial (alternate) fruiting habit.

There are growers who assume that the growth and yield of *Hevea* tree can be enhanced further by artificially providing two root systems to a single plant by grafting two stocks together and then bud grafting with a high yielding clone. The present study was undertaken to compare the performance of plants having single rootstock (single root system) and twin rootstock (double root system) in terms of growth and yield in *Hevea*.

MATERIALS AND METHODS

Planting materials with single root system were produced as per the standard techniques while, plants with two root system were produced by twin-grafting (approach grafting) two stock plants at one whorl stage. Twin grafted plants were later brown budded using buds from clone RRII 105. Seedlings were planted in advance at the trial area for developing the seed-at-stake plants. The plants were evaluated in the field at Central Experiment Station, Chethackal, Ranni in Pathanamthitta district of Kerala state in a Randomized Block Design with three replications having a plot size of nine plants with 4.9 x 4.9 m spacing. Planting was done in 1994. Extra non-budded twin-grafted seed-at-stake plants were maintained in the trial area for compensating the casualty of the seed-at-stake plants in the following year after brown budding. Causality was recorded and

Table 1. **Details of the treatments**

Sl. No.	Treatment	Treatment details
1.	T1	Twin stocks raised in polybags, brown budded and cut back in May and transplanted to the field with developed scion.
2.	T2	Single stocks raised in polybags, brown budded and cut back in May and transplanted to the field with developed scion
3.	T3	Twin stocks raised in field by seed-at-stake planting, brown budded and cut back in May
4.	T4	Single stocks raised in field by seed-at-stake planting, brown budded and cut back in May
5.	T5	Twin stocks raised in seedling nursery, brown budded in May and transplanted to the field as budded stumps
6.	T6	Single stocks raised in seedling nursery, brown budded in May and transplanted to the field as budded stumps
7.	T7	Polybag plants raised by budded stump planting and planted in the field, as control

vacancy filling was done in the next year. Regular tapping was carried out after attainment of nine years of growth adopting 1/2S d/3 system. The details of the treatment are as shown in Table 1.

Field establishment of twin and single rootstock plants

To study the field establishment of twin and single rootstock plants, survival rate in the field was observed in the first two years.

Growth and yield

To study the performance of the plants data was recorded on annual girth for 13 years and monthly dry rubber yield for a period of four years. The growth parameters included girth during the immature phase for eight years, girth at opening and girth under tapping based on four years of tapping.

Study of the root system

The roots were excavated after 17 years to study the structure and morphology of the root systems. Five plants from each plot and a total of fifteen plants from each treatment were randomly selected and excavated with the help of earth mover machine. In order to study the penetration of the primary tap root in different types of propagation techniques (polybags, seed-at-stake and budded stumps) the length of the excavated primary tap root was recorded.

RESULTS AND DISCUSSION

Field establishment of twin and single root stock plants

Higher number of casualties were observed in plants with twin rootstocks compared to the single rootstock plants in the first year of planting but once the plants established in the field, the casualty was comparatively less in twin rootstock plants as observed in the second year (Table 2). Survival rate of plants raised in field by seed at stake planting in both twin and single rootstock seedlings was less compared to respective polybag plants as well as budded stump plants.

Table 2. **Casualty under different treatments**

Treatment	Casualty %	
	First year	Second year
T1	40.7	25.9
T2	22.2	33.3
T3	51.9	25.9
T4	74.1	55.5
T5	66.7	22.2
T6	22.2	33.3
T7 (control)	14.8	22.2

Growth in twin and single rootstock plants

The mean girth of plants having single rootstock and their counterpart twin rootstock was found to be comparable statistically during the immature phase as well as at the time of opening and after tapping for four years (Table 3). In majority of the cases the single rootstock plants had higher mean girth than their counterpart twin rootstock plants. At the time of opening for tapping the highest mean girth of 52.66 cm was recorded by control plants (T7) and lowest of 45.63 cm by twin rootstocks raised in seedling nursery and planted in field as budded stumps (T5). On tapping for four years highest mean girth of 66.5 cm was recorded by single rootstocks raised in polybags (T2) and lowest of 59.95 cm by twin rootstocks raised in field by seed-at-stake planting (T3).

Table 3. **Mean girth of the plants (cm) during immature phase, at the time of opening for tapping and after tapping**

Treatment	Immature phase							Mean girth at opening for tapping (9th year)	Mean girth after tapping for four years
	2nd year	3rd year	4th year	5th year	6th year	7th year	8th year		
T1	7.92	14.35	22.43	31.12	39.14	42.46	48.28	52.63	64.02
T2	11.44	16.99	25.87	31.69	38.82	42.80	48.00	52.40	66.50
T3	7.55	11.61	17.74	24.11	30.56	33.58	40.03	45.86	59.95
T4	8.08	10.11	17.55	23.23	31.79	37.08	42.30	49.46	64.01
T5	7.44	10.10	17.18	23.81	30.90	35.22	43.13	45.63	60.23
T6	8.23	13.40	20.75	28.93	35.61	39.56	45.56	50.03	65.46
T7	10.71	16.80	23.28	29.98	37.11	41.39	48.06	52.66	64.91
CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS

Yield in twin and single rootstock plants

The commencement of tapping was late as 70 per cent of the seed at stake plants (T3 and T4) attained tappable girth only by the ninth year of planting. The latex yield of trees having single rootstock and twin rootstock was found to be statistically comparable in the first, second, third and mean yield over four years of tapping (Table 4). In general twin rootstocks raised in field by seed-at-stake planting (T3) exhibited the lowest yield and in the fourth year it gave significantly low yield of 32.06 g $t^{-1}t^{-1}$. However, mean yield over four years of tapping was comparable among treatments. The highest mean yield was recorded by control plants (61.08 g $t^{-1}t^{-1}$) and the twin rootstock plants raised in field by seed-at-stake planting showed the lowest mean yield (43.57 g $t^{-1}t^{-1}$).

Study of the root system

Roots were excavated after 17 years of planting to study the root system in both twin as well as single rootstock plants. Only 20 per cent of the trees with twin rootstocks

Table 4. **Latex yield (g $t^{-1}t^{-1}$) of the plants**

Treatment	1st year	2nd year	3rd year	4th year	Mean yield over four years
T1	69.52	54.85	60.61	54.05	59.75
T2	63.62	56.41	67.64	50.72	59.59
T3	53.24	44.60	44.40	32.06	43.57
T4	72.50	50.65	68.14	50.81	60.52
T5	52.67	44.68	54.75	44.39	49.12
T6	58.15	52.90	58.95	47.68	54.42
T7	71.08	54.27	65.90	53.09	61.08
CD (P=0.05)	NS	NS	NS	10.80	NS

Fig. 1. Root system in twin rootstock plants with two separate fully developed root systems

raised in polybags, 13.3 per cent twin rootstocks raised in field by seed-at-stake planting and 26.6 per cent twin rootstocks raised in seedling nursery and planted in field as budded stumps were found to have two separate fully developed root systems (Table 5 & Fig. 1). In other cases either the two roots might have united to become a single root or one root has become aborted (Fig. 2). In twin graft trees when two separate roots were present, the size of each root system is only half of the roots present in single stock trees (Fig. 3). This could be one of the reasons for comparable growth and latex yield of single and double rootstock trees.

It was observed that the penetration of the primary tap root depends on the physical properties of the soil, rather than the type of propagation technique (polybags, seed-at-stake and budded stumps). The mean length of the primary tap root after 17 years of planting was 130 cm which was

(a) (b)

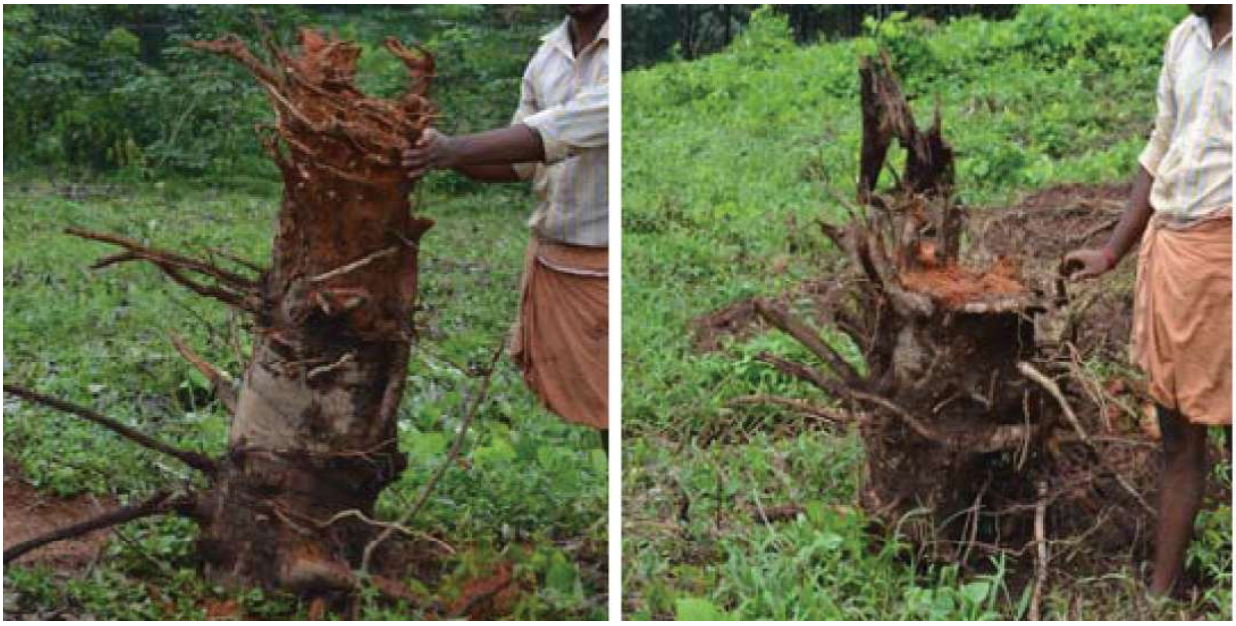
Fig. 2. Root system in twin rootstock plants - (a) two roots united to become a single root (arrow shows the merging line) and (b) one root completely aborted

(a) (b)

Fig. 3. Comparison of the size of the root system (a) twin rootstock and (b) single rootstock

comparable across the different propagation techniques used (Table 5) and thereafter it branches to form small roots. The mean length of the primary tap root was comparable between seed at stake plants where the seeds were directly planted in the field and also budded stumps where the tip of the taproot was pruned before planting (Table 5). The maximum length of the primary tap root observed was 165 cm, which was planted as budded stump. Wherever the tap root finds an obstacle such as hard pan in laterite soil, the vertical growth of the tap root stops bluntly as observed in one of the seed at stake planted tree in which the primary tap root length is only 75 cm (Fig. 4).

The present study showed that twin rootstock plants and single rootstock plants do not differ significantly in growth and yield which indicates that twin rootstocks may not have an added advantage in *Hevea,* contrary to some preliminary reports in other crops indicating that double and triple grafted material grew more vigorously and had higher fruit set than grafted plants with single rootstocks (Zabedah *et al.,* 1992; Zabedah, 1993). Observations by Munde *et al*. (2011) that in mango, variety Ratna when grafted on single as well as double rootstock gave maximum grafting success also supports our results. Observations made also showed that the depth of the



(a) (b)

Fig. 4. Variation in the length of the primary tap root (a) normal (b) short

Table 5. **Root system**

Treatment	No. of roots studied	Mean length (cm) of tap root	No. of plants with two separate root system
T1	15	133.0	3
T2	15	125.5	-
T3	15	122.2	2
T4	15	134.4	-
T5	15	132.0	4
T6	15	129.5	-
T7 (control)	15	133.4	-
CD (P=0.05)		NS	
Mean		130	

primary tap root is comparable among various types of planting materials and depends on the depth of soil and its physical properties.

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