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FACTORS AFFECTING THE BUDGRAFTING SUCCESS AND THE SCION GROWTH OF YOUNG BUDDING OF *HEVEA*

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ABSTRACT

The size of the bag in which the stock plant is grown seems to have an effect on the growth of the seedling; from the three bag sizes tested, *ie* 15 x 33 cm, 18 x 38 cm and 23 x 45 cm, it was found that the diameter and the number of leaf whorls of the seedling increased with the increase of the bag size. Though the differences are not statistically significant, the budding success too increased in the same pattern. There was no effect of the bag size on the growth of the scion.

The two types of buds, axillary and scale, showed no difference either on bud grafting success or on the growth of the scion.

The growth stage of the top most leaf whorl of the stock plant, either mature or immature, had no effect on the peeling qualities and budgrafting success though a little higher budgrafting success was seen when the top flush was immature.

There was an effect of the snag, on the scion growth; when the snag was shorter the sprouting took place earlier but, the scion growth was slightly poor as was evident by the diameter and the length of the scion. Long snags delayed the sprouting, but the scion growth was better. The best growth of the scion was obtained when the snag was long with a few leaves attached to it.

Key words: *Hevea*, young budding, bud grafting

INTRODUCTION

Young budding technique has first been introduced into plantations in 1985 (Leong *et al*, 1985) and since then, it has been widely accepted by planters mainly because of the low cost of production than for other polybag planting material.

In fact, young budding is an improvement made on green budding where seedlings in polybags are grafted when they are only 2–3 months old. This, no doubt, reduces the nursery time and thereby the production cost and also suits with the local planting practices; the stock plants raised in the main seed-fall in August can be bud grafted in November – December and two whorled budded plants in polybags are ready for planting in May–June with the onset of monsoon.

Though the green or brown budded polybag plants are recommended for a higher rate of field establishment and for a more uniform stand in the field, the technique still demands for use of a ground seedling nursery and a polybag nursery and requires a period of about 10–12 months to produce a two-whorl plant.

Young budding, on the other hand, requires only a polybag nursery and a two-whorled plant can be produced in about 9 months. Further, as young buddings are raised in polybags, they have all the advantages that a polybag plant could have.

Moreover, unlike in other planting material, almost all the inputs that usually go to raise the stock plant is diverted to scion growth, in young buddings.

Though the experiments on young buddings have been carried out earlier, most of the reported work is from Malaysia. According to their reports, the bag size seems less important than the retention of snag leaves, in producing a bigger budded plant. The growth of the scion was enhanced with the increasing number of snag leaves retained from one to four (Yoon *et al,* 1989).

The chemical `Atrinal' (sodium dikegulac) has hastened the sprouting of the bud. The higher concentration and increased number of applications (7–10) along with the use of surfactant and penetrant seem to have improved the action of `Atrinal' (Ong *et al*, 1989).

As the growth of *Hevea* occurs in flushes, normally two distinguished growth stages can be identified, *ie* the actively growing phase and the resting phase. Among the objectives of the study reported here, the effect of the growth stage of the top flush of leaves at bud grafting, on the budding success was one. Also, the effects of various other factors, such as bag size, clone, the bud type and the length of the snag *etc* on bud grafting success and scion growth were studied.

MATERIALS AND METHODS

For raising stock plants, unselected seeds were used and germinated seeds were planted in polybags filled with top soil mixed with rock phosphate (110 g/bag). Bags were arranged in single rows and the treatments were fully randomized. There

were 7 rows and each row consisted five blocks each containing 24 bags (8 bags from each size).

Observations were made in order to see the effects of following;

(a) Size of the polybag

All bags were made with gauge 500 gussetted black polythene. Three bag sizes, lay flat dimensions, 15 x 33 cm, 18 x 38 cm and 23 x 45 cm, were used. 280 bags were made from each size and bags were perforated prior to filling with soil.

(b) Clone

Only two clones, RRIC 100 and RRIC 121 were used. Half of the plants from each bag size was grafted with one clone and the other half with the other.

(c) Bud type

Half of the total number of plants grafted with each clone was grafted with axillary buds and the other half with scale buds of the same clone. For harvesting axillary buds, the leaves attached to them needed removing, leaving only a small piece of petiole attached to the stem, at least 3 weeks prior to the expected date of using them.

(d) The growth stage of the top flush of leaves at bud grafting

This could not be controlled but however, about 30% of the plants were with immature top leaf whorls, at bud grafting. The remaining 70% was with hardened top leaf whorls.

(e) Snag treatments

The plants with successful grafts were used for this; four treatments are given below.

Treatment 1 – Long snag with 3 leaves attached to it.
Treatment 2 – Stock shoot removed just below the second leaf whorl (current recommendation).
Treatment 3 – 15 cm long snag.
Treatment 4 – 50 cm long sang.

Plants were fertilized according to the recommendations throughout the period (see appendix 1).

Statistics

Means were compared by using t–test and a discrete multivariate analysis (log linear models) was used to identify the relationships between the variables. The statistical procedure CATMOD of the SAS statistical package was used in the analysis.

RESULTS

(1). The effect of the bag size on seedling growth.

The diameter and the number of leaf whorls of the stock plants grown in small, medium and large bags, increased with the increase of the bag size (Fig.1). Although the mean diameters at bud grafting are significantly different, the differences between the means of small and medium size bags and medium and large size bags were only 3% and 6% respectively. However, when the small and medium bags were considered the difference in the diameter and the number of leaves were not significant, but, there was a significant difference ($p = 0.001$) between the medium and large bags for both the diameter and the number of leaf whorls.

Also, the mean number of leaf whorls is almost similar of the plants grown in small and medium bags but, however, it is higher in those grown in large bags and is significantly different ($p = 0.001$) from medium size bags. The mean number of leaf whorls obtained for small, medium and large bags were 2.66, 2.67 and 2.97 respectively.

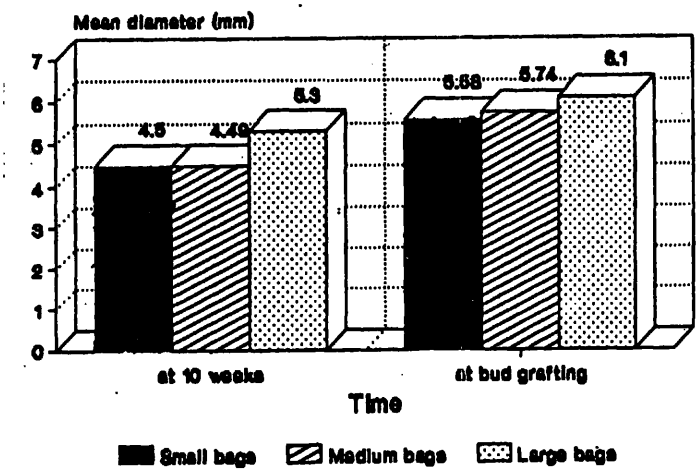

Fig. 1. The effect of the bag size on seedling diameter (n=280).

2. The effect of the bag size on budding success.

The percentage success of the grafts also increased with the increase of the bag size. Results obtained for clone RRIC 121 are shown in figure 2. However, this was not significant (X_2 = 0.855).

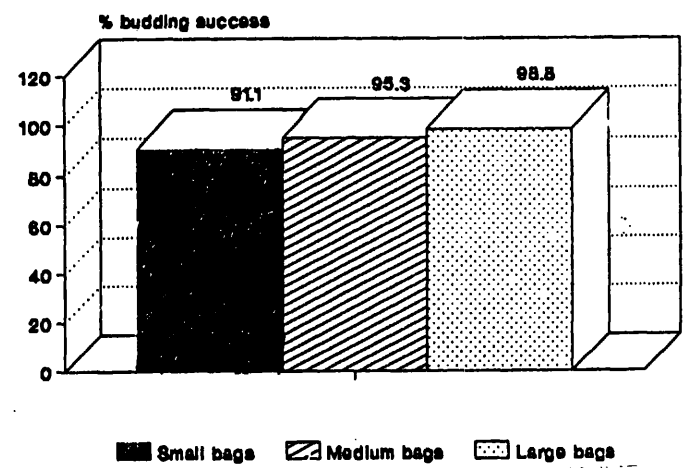

Fig 2. The effect of the bag size on bud grafting success.

3. The effect of the bud type on budding success.

Percentage budding success for axillary and scale buds of clone RRIC 121 were 98.2% and 91.9% respectively indicating better performance of axillary buds, over scale buds.

4. The effect of the growth stage of top flush of leaves on budding success

The results obtained are shown in figure 3.

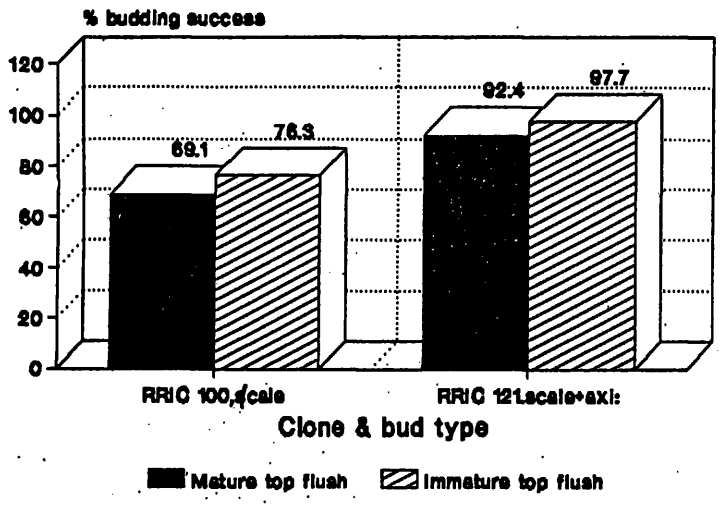

Fig. 3. The effect of the growth stage of top flush of leaves on budding success.

The growth stage of the top flush of leaves had no effect on the grafting success though the success rate was slightly higher when the top leaf flush was immature; the differences were not statistically significant.

However, when the three bag sizes, two bud types and the two growth stages of top flush of leaves were considered, the results on budgrafting success of clone RRIC 121 can be summarized as follows in Table 1.

As it can be seen in the Table 1, the percentage budding success increases with the increase of the bag size, irrespective of the bud type or the growth stage of the top flush of leaves, except in one case where 100% budding success was obtained for the plants grown in small size bags (when the top flush of leaves mature and

with axillary buds) while this was only 95% for those grown in medium size bags. Statistically there is no evidence of association between the bag size and the budding success.

Table 1. *Percentage budding success of clone RRIC 121*

Bud type	Top	Bag size				
	flush	S	M	L	mean 1	mean 2
Axillary	mature	100%	95%	100%	98.3%	
	immature	94.4%	100%	100%	98.1%	98.2%
Scale	mature	78.3%	86.2%	95%	86.5%	
	immature	91.7%	100%	100%	97.2%	91.9%
	Total	91.1%	95.3%	98.8%		95.1%

S = Small M = Medium L = Large

mean 1 – % budding success irrespective of the bag size.
mean 2 – % budding success irrespective of the bag size and the top flush of leaves.

5. The effect of the snag treatment on the sprouting of the scion.

The sprouting percentages are given in the Table 2.

It seems that the bag size does not have any effect on the sprouting of the scion bud. In fact, when the treatments 1 and 2 are considered together, % sprouting is highest in small bags (81%), than in large bags (78%) and lowest in medium size bags (77%). However, there is no statistical evidence for any effect of the bag size on sprouting.

As shown in Table 2, there was an effect of the snag on the time of sprouting. The longer the snag, the longer the bud takes to sprout (Figure 4). But, this difference diminishes with time. As the total sprouting % of treatments does not seem to be affected by the length of the snag, it seems that the presence of snag leaves too has only little effect on the % sprouting.

Table 2. *Percentage sprouting of treatments 1–4 of clone RRIC 121 for the period from 13/3 to 22/5/92*

Tr.	Bud type	Bag size	13/3	20/3	27/3	24/4	8/5	22/5	x 1	x 2
1	A	S	14	14	50	71	86	86		
		M	6	6	41	47	59	65		
		L	12	12	47	53	76	88	80	
	S	S	8	31	31	77	77	77		
		M	0	14	50	64	71	79		
		L	24	24	59	71	76	76	77	78
2	A	S	25	44	53	76	76	76		
		M	36	57	79	79	79	79		
		L	35	50	72	72	72	72	76	
	S	S	15	54	54	77	85	85		
		M	0	31	85	85	85	85		
		L	24	41	65	71	71	76	82	78
3	A	S	47	60	67	93	93	93	93	
	S	S	36	50	57	79	79	79	79	86
4	A	M	38	63	75	88	88	88		
		L	47	59	71	76	76	76	82	
	S	M	8	69	92	92	92	92		
		L	13	50	75	81	88	88	90	86

Tr – Treatment (1–4)

Bud Type – A – Axillary S – Scale
Bag size – S – Small M – Medium L – Large

x 1 – Mean sprouting %, irrespective of the bag size.
x 2 – Mean sprouting %, irrespective of the bag size & the bud type.

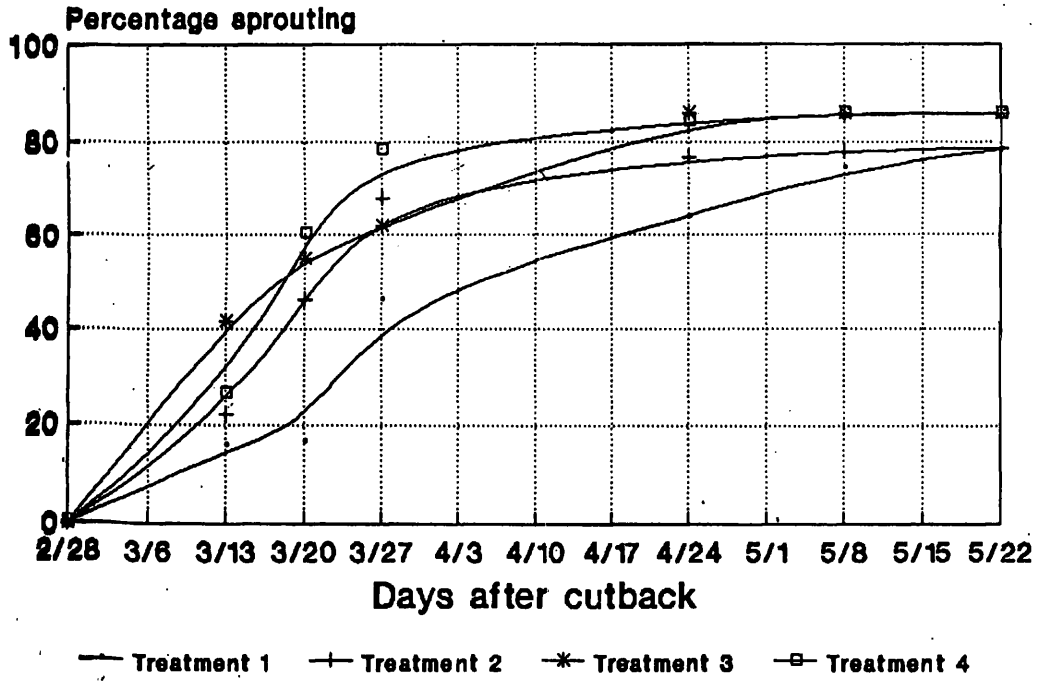

Fig. 4. The effect of the snag treatment on the time of sprouting.

However, it is clear that the length of the snag has more influence on the sprouting time than on the sprouting percentage. Also, a clear pattern cannot be seen between bud type and the sprouting percentage. When the treatments 1 and 3 are considered, axillary buds are better, but with treatments 2 and 4, scale buds are better. However, the sprouting percentages are shown in figure 5 for the two types of buds.

As figure 5 shows, the sprouting gets little delayed with scale buds compared to axillary buds but this effect disappears in 3 weeks.

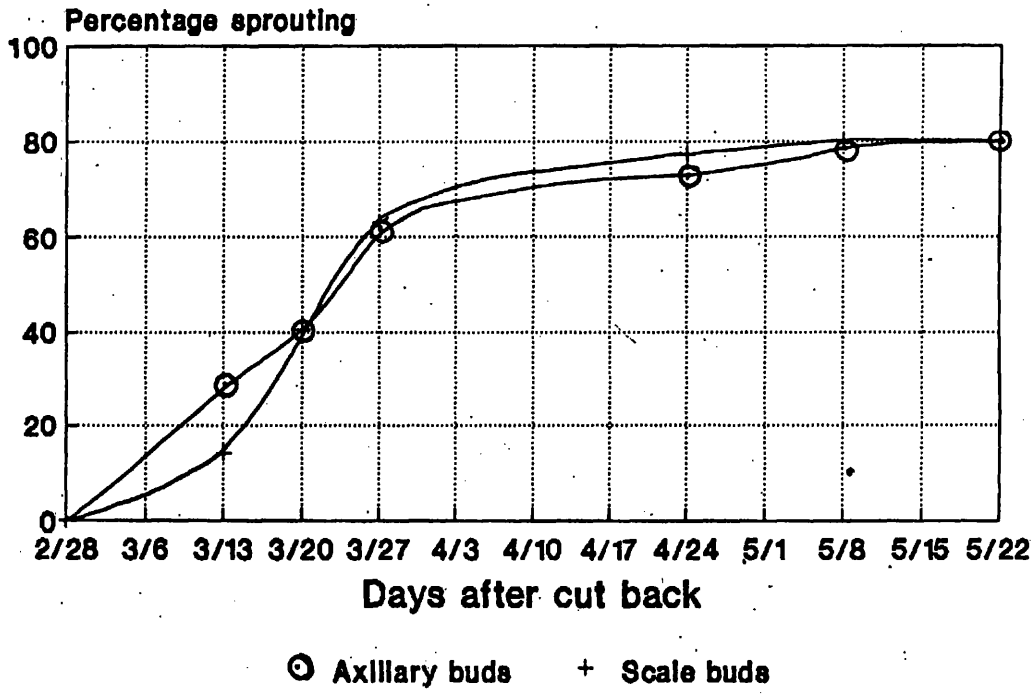

Fig. 5. The effect of the bud type on sprouting percentage.

6. The effect of the snag on the scion growth

The growth of the scion was determined by the diameter, the length and the number of leaves it contained. Figure 6 shows the effect of the snag on the diameter of the scion.

The highest mean diameter (6.75 mm) was seen with treatment 1 where the snag was long and with leaves. The treatment 4 (50 cm snag), treatment 2 (45.8 cm snag) and treatment 3 had the means of 6.55, 6.08 and 5.97 mm respectively. The statistical analysis showed that the treatments 1 and 4 are significantly different (P=0.05) from treatments 2 & 3.

The mean lengths of the scion shoots of 4 treatments are given in Table 3.

There was an association between treatments 1 & 2 and bag sizes. It was also found that when medium size bags were used, treatment 1 was better (mean = 45.7) than treatment 2 (mean = 32.54) but for large size bags the treatment 2 was better (mean = 36.4) than treatment 1 (mean = 34.1).

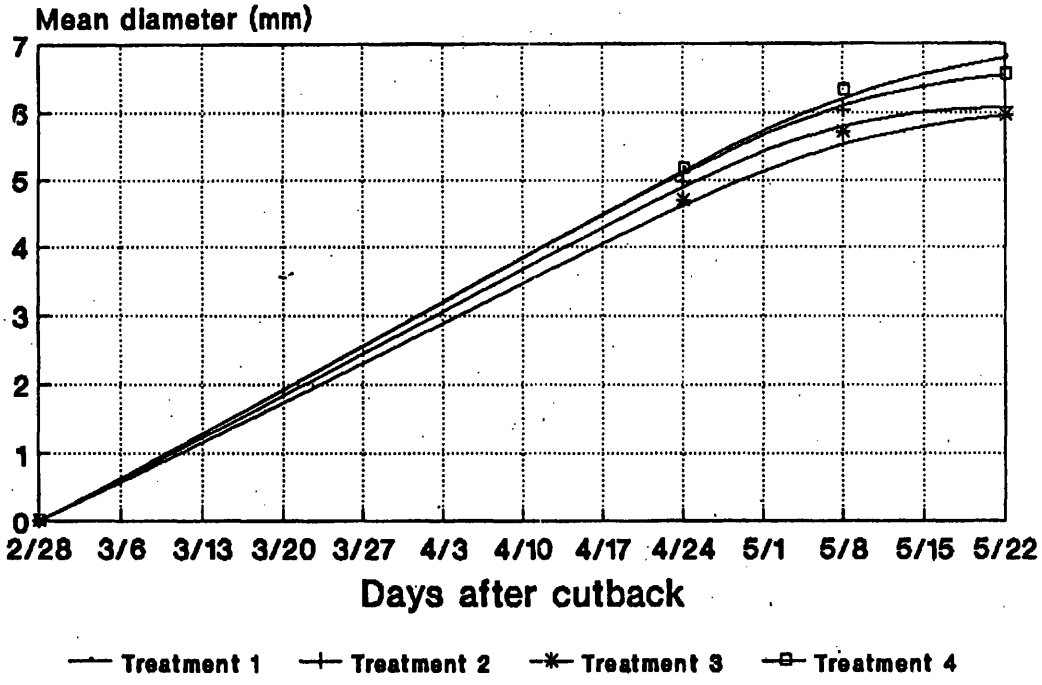

Fig. 6. The effect of the snag on the diameter of the scion.

However, the effect of the 4 treatments, irrespective of the bag size, shows that the mean length of the scion is highest when the snag contained leaves on it (Fig. 7). The mean length of 39 ± 3 cm was observed with medium size bags when the snag carried 3 leaves attached to it. Figure 7 also shows that the effect of the presence of leaves on the snag is larger than the effect of the length of snag, on the growth of the scion. However, there was no evidence from statistics to show any effect of the snag treatment on the scion growth, when the effect of the bag size was not concerned.

A slight increase in the number of leaves with the increase of bag size is seen with the treatment 2. But this is not observed with the treatment 1.

Table 3. *Mean length of the scion shoots of snag treatments 1–4.*

Tr	Bag size			mean	length	(cm)		mean
		13/3	20/3	24/3	24/4	8/5	22/5	
1	S	2.75	16.7	13.4	21.5	28	30.5	
	M	–	2.0	7.6	24.9	36.4	39.5	
	L	11	12.5	13.4	21.5	29.7	34.5	33.8
2	S	5	12.9	14.3	17.8	27.6	30.6	
	M	1	8.8	13	17.5	24.8	26.7	
	L	3.12	10.3	10.4	20.6	30.1	34.0	30.5
3	S	3.28	8.2	13.5	21.8	28.3	31.8	31.8
4	M	1	5.5	8.7	21.5	32.3	34.5	
	L	1	5.7	6.9	20.6	28.3	31.4	32.9

S = Small M = Medium L = Large

Mean – The final mean length irrespective of the bag size.

When the 4 treatments are considered, irrespective of the bag size, the mean number of leaves were 13.5, 12.8, 14.2 and 14.8 for the treatments 1,2,3 & 4 respectively. The highest being the treatment 4 indicates the retention of snag leaves has no effect on the number of leaves on the scion. However, the highest number of leaves was seen in medium size bags when the snag is 50 cm long but contained no leaves.

The effect of the snag treatment on the number of leaves of the scion is given in Table 4.

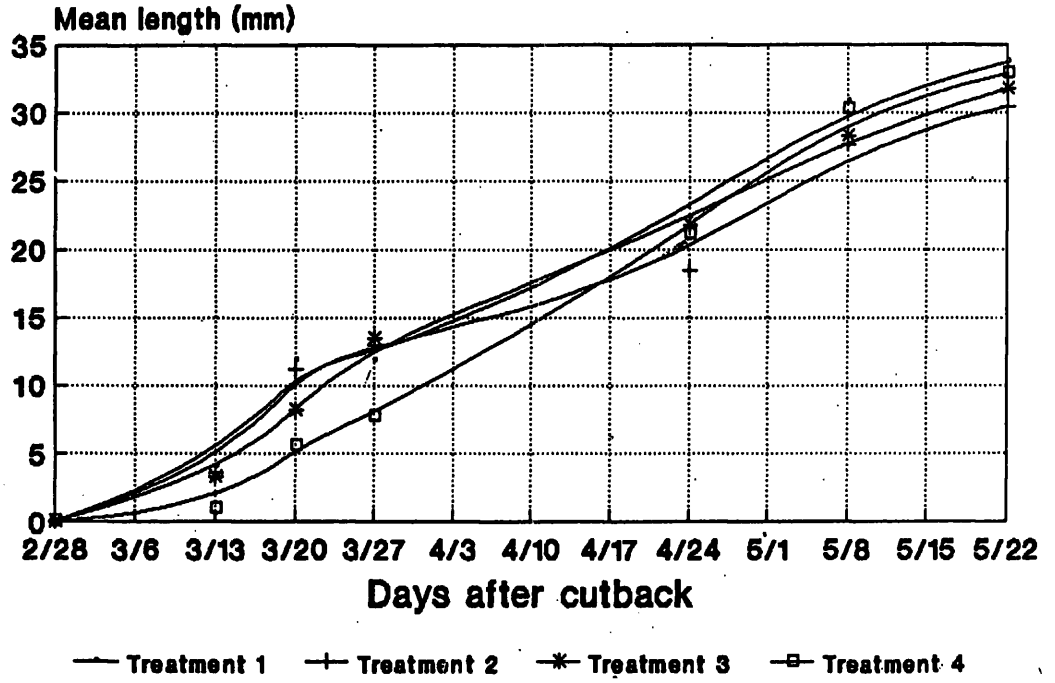

Fig. 7. The effect of the snag on the length of scion.

Table 4. *The effect of the snag treatment on the number of leaves of the scion.*

Treatment	Bag size	Number of leaves			mean
		22/4	8/5	22/5	
1	small	8.25	10.2	12.7	
	medium	9.0	11.4	13.9	
	large	8.5	11.2	13.8	13.5
2	small	8.19	11.2	12.2	
	medium	7.39	11.4	12.2	
	large	7.56	12.4	14.0	12.8
3	small	7.6	11.7	14.2	14.2
4	medium	8.09	14.2	15.5	
	large	8.7	11.9	14.2	14.8

Mean = The total mean number of leaves of 4 treatments.

7. The effect of the bag size on scion growth.

The effect of the bag size on the diameter of the scion, with treatments 1 & 2, is given in the Table 5.

Table 5. *The effect of the bag size on the diameter of the scion.*

Bag size	22/4	8/5	22/5
Small	4.85	5.79	6.18
Medium	5.15	6.11	6.42
Large	5.24	6.59	6.71

Though the diameter of the scion increases with the increase of the bag size, this increase is not statistically significant.

DISCUSSION

From the three bag sizes tested, 15 x 33 cm, 18 x 38 cm and 23 x 45 cm, it was found that the larger bags produced bigger stock plants. However, the difference in the diameter between the plants grown in small and medium size bags was not significant but the diameter of the plants produced in large bags was significantly higher than those produced in medium size bags.

This increase in the seedling diameter was not proportionate to the capacity of the bags, as the medium size bag was 60% bigger than the small bag and then the large bag was 90% bigger than the medium one; accordingly large bag was 3 times bigger than the small bag.

As far as the cost is concerned, the cost of the polythene alone is Rs.0.82, Rs.1.15 and Rs.1.72 for small, medium and large bags respectively (@ Rs.75/= per 1 kg of gauge 500, black polythene).

However, it should be noted that 100% budding success has been obtained with plants grown in small bags also (with axillary buds when the top most leaf whorl was mature). According to Yoon *et al* (1989) it seems that the effects of both bag size and the nutrients on the scion growth are minimal compared to the effect of the retention of snag leaves. They also have used 3 bag sizes, almost similar to those used in the present study, and have reported of production of better plants in small bags when the snag contained leaves, compared to the plants produced in large bags but

with no snag leaves, indicating more effect of the snag than the bag size on scion growth. They have not mentioned of the effect of the bag size on the seedling growth.

Apart from the same dose of fertilizer given, the size of the bag, however, seems to have some effect of the scion growth; the mean diameter of the scion shoots grown in small, medium and large bags were 6.18, 6.42 and 6.7 mm respectively. But there was no statistical evidence for this difference. Also the mean number of leaves were 13.04, 13.83 and 13.99 in the same order. But the mean length of scion shoots in small, medium and large bags were 30.97, 33.6 and 33.3 respectively, showing highest length in medium size bags.

From the two types of buds used, both axillary and scale buds yielded similar results as measured by the bud grafting success and the scion growth. But, with scale buds, sprouting was delayed by about one week (Figure 5). The same delay has been noticed with axillary and scale buds when used for brown budding (Samaranayake & Gunaratne, 1977). Also 30% and 10% of the buds grafted has failed to emerge at all from scale and axillary buds respectively. This was not observed in the present study.

The growth stage of the top flush of leaves, too had no effect on either peeling ability of the stock plants or the budding success. However, the grafting success was slightly higher when the top most leaf whorl was immature.

The two clones used showed differences in the bud grafting success where RRIC 121 performed better than RRIC 100.

Retention of snag leaves had a beneficial effect on the scion growth as measured by the diameter and the length though this was not proved by the statistics. The length of the snag had an effect mainly on the time of sprouting. However, when the snag contained leaves, they were normally about 50 cm long, and such snags resulted best scion growth.

Though the initiation of sprouting was little delayed with long snags, specially when they contained leaves, (Figure 4) after about 3 months of cut back the percentage sprouting was almost similar for all treatments. (treatment 1 being the lowest) but, the mean diameter and the mean length of the scion were highest when the snag carried leaves. The number of leaves on the scion had no relationship with the snag treatment, but varied in the range of 13.8 – 14.2, the lowest being the snag with leaves. It should be noted that the number of leaves is not a good parameter to determine the growth since the sizes of the leaves can be different.

This observation of the effect of the snag leaves on the scion growth are in agreement with those of Yoon *et al* (1989) where they have clearly showed the beneficial effects of retention of snag leaves on better scion growth as measured by the leaf area and the total dry matter production.

Also, they have showed that the height of the scion, both at first whorl stage and second whorl stage, had a close relationship with the presence of snag leaves. Further, the effect of the presence of leaves seems higher than that of the length of the snag, on the scion growth. An 80% and 120% gain in total dry weight have been obtained by retaining snag leaves together with the snag cut at the second and third whorls respectively.

In the present study, only one snag treatment had leaves attached to it, and the highest length and the diameter were observed in those plants.

One of the disadvantages of having a long snag with leaves attached, is that the delay in sprouting. But, however, this difference, though very clear at the beginning, diminishes with time and at the end of about 3 months, *ie* when the plants are at two whorl stage and ready for field planting, this is not seen. In fact, the scion length and the diameter were highest at this stage when the snag contained leaves (Figure 6 and Table 3). The other disadvantage is that the extra nicking involved with long snags, as all the axillary buds on the snag need removing for the growth of the scion bud.

A cost analysis done (Personal communication) has shown that the cost on nicking is about 10% of the production cost of the plants under normal conditions with snags cut below the second leaf whorl. With longer snags, a little higher cost on this can be expected. However, it requires careful consideration and further experimenting on the facts, before deciding whether this additional cost on nicking would compensate the better growth that can be obtained by leaving long snags with leaves attached. Also, it would be interesting if the growth of these axillary buds on the long snag can be suppressed by any other means, cheaper and/easier than nicking.

CONCLUSIONS

1. The effect of the bag size on producing a vigorous plant is minimal.
2. The type of bud, either axillary or scale has no effect on grafting success. More buds can be obtained from a single stick if the axillary buds also are used. But the leaves should be removed at least 3 weeks prior to using them.
3. The growth stage of the top flush of leaves has no effect on bud grafting success.
4. Retention of snag leaves improves the growth of the scion although the sprouting is delayed and needs slightly more nicking.

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Appendix 1

Recommended fertilizer mixture for Young Buddings. (RRISL recommendation)

(a) At planting – Rock phosphate at a rate of 110 g per bag mixed to the soil.
(b) Liquid formula– For weekly applications (ceased two weeks before grafting plants). It should be restarted one month after cut back and weekly applications should continue until the plants are ready for field planting.

Composition of liquid formula (by weight)

Mixture – R 9:11:11:4

Sulphate of Ammonia	– 23
Diammoniam phosphate	– 25
Sulphate of potash	– 23
Epsom salt	– 29
Total	– 100

Preparation of liquid formula .

From planting up to 2 weeks prior to grafting.

Dissolve 56 g of mixture in 4.5 liters of water for 90 plants at the rate of 50 ml per bag.

From 1 month after cut back until field planting .

Dissolve 84 g instead of 56 g in 4.5 liters of water.