

SEED PRODUCTION OF CLONES PB 86, RRIC 100 AND RRIC 121 IN THREE RUBBER GROWING AREAS OF SRI LANKA.

Priyani Seneviratne, A Nugawela, K A G B Amaratunge, R P Karunasena
and S Wilbert

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ABSTRACT

The rubber seed production in wet rubber growing areas in Sri Lanka has gone down to very low levels, in the recent past, affecting the culling process that should be adopted in establishing rootstock nurseries. From the three rubber growing areas studied, satisfactory seed production, irrespective of the clone, was observed only in Kegalle region. Regional differences may be due to direct or indirect influences of the climate and weather during flowering and pod set. Clonal differences seems to be existing in regions where climate or the weather is favourable for spread of diseases. Further, RRIC 100, being a resistant clone for *Oidium* and *Phytophthora*, produced a higher percentage of good quality seeds compared with the other two clones, PB 86 and RRIC 121 which have below average tolerance to these two diseases. However, currently, country as a whole produces enough seeds to fulfill country's annual seed requirement for the production of rootstocks, provided the seeds are collected and transported without delay.

Key words: *Hevea*, rubber, seed production, climate & weather, disease incidence.

INTRODUCTION

Seed production is a necessity in *Hevea* plantations as the production of planting material requires grafting of seedlings. Seeds of all clones recommended for commercial planting are recommended to be used for production of rootstock and no shortage of seeds have been reported until recently. In fact, attempts had been made to use the enormous amount of rubber seeds that were allowed go waste on rubber estates in the past. The main commercial products obtained from the rubber seed are its oil and animal feed. The annual production of seeds can be as high as thousands of metric tons. Nevertheless, areas where leaf diseases are prevalent appears unsuitable for seed production. *Oidium haveae* attacks immature leaves and flowers causing premature leaf and flower fall that result in a marked reduction in the quantity of seeds produced per hectare. *Phytophthora palmivora*, by attacking the pods, causes widespread pod

rot. Therefore, areas where there is rain during seed development would also be unsuitable for seed production.

Until early 1980's, there were recommended clones such as Tjir 1 to collect seeds for rootstock nurseries. However, as the clones recommended for plantations changed, the older ones recommended to collect seeds gradually disappeared from our plantations and smallholdings. Therefore, the availability of seeds of clones recommended for seed collection also reduced gradually. To solve the problem of seed shortage, seeds of all clones were tested for their performance as rootstocks and seeds of clones recommended for plantations were approved to establish rootstock nurseries. The rootstock clone may affect the sprouting time as studied by Samaranayake *et al* (1980) and the growth of the scion (Combe and Gerner, 1977). However, selection of vigorously growing seedlings has always been emphasized as an important factor than selecting seeds from a particular clone (Samaranayake, 1975).

Also, there can be one or two clones, the seeds of which perform better than other clones as rootstocks (Combe and Gerner, 1977). Growing such clones to collect seeds for establishment of rootstock nurseries may not be practical or economically viable, if the other characteristics such as yield, resistance to diseases, are not favourable to recommend them for commercial planting. Nevertheless, forest plantings in blocks would be a practical and economical approach to the problem provided that suitable lands are available for this.

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Though the current recommendation is to collect seeds from all recommended clones for commercial planting, the production of seeds in some rubber growing areas, has been very poor in the recent past. The aim of the present study was to evaluate clones for seed production and if possible to find out reasons related to poor seed production in some rubber growing areas.

MATERIALS AND METHODS

Three main rubber growing areas, Kegalle, Kalutara and Ratnapura were chosen to conduct the trial. In Kalutara region, two experimental sites were chosen, one at Dartonfield, close to the research station, and the second one at Perth estate, about 40 km North-West of Dartonfield. Three commonly planted clones, PB 86, RRIC 100 and RRIC 121 were selected. Details of all experimental blocks are summarized in Table 1.

In the clearings selected, an area of 50' x 50' (2500 ft²) was marked approximately in the middle of each clearing and cleaned of all immature pods and old seeds left from the previous year's seed fall. All the new seeds fallen onto the marked area were collected weekly, throughout the seed fall, i.e., from late July to early November. They were brought to the Institute and sown on germination beds with a minimum delay in most of the cases that day it self. The time required for the germination was not monitored, but they were given enough time for germination.

The daily germination percentage was also tested using two batches of seeds collected and transported from Kegalle and Matale areas during the same seed fall. This was tested by sowing one thousand seeds from each batch and examining daily for any germinated seeds.

The total number of seeds collected, number of good seeds by appearance, the percentage of germination etc., were recorded for each batch of seeds. Information on general upkeep of the clearings, general seed production in each estate (this year and last year), disease incidences were also gathered by sending a questionnaire.

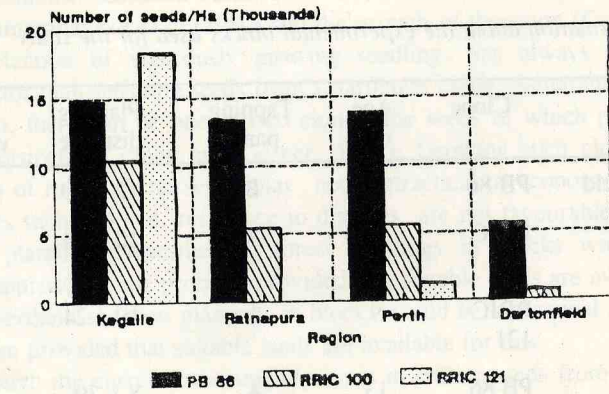
Table 1. Information about the experimental blocks used for the study

Region	Estate	Clone	Age (Y)	Tapping panel	Planting distance	Total extent(Ha)
Kalutara	Dartonfield	PB 86	17	B	12 x 20	9.82
		RRIC 100	9	A	10 x 24	6.58
		RRIC 121	9	A	10 x 24	10.42
	Perth	PB 86	13	A	8 x 30'	5.26
		RRIC 100	8	A	15 x 16'	12.26
		RRIC 121	9	A	8 x 30'	10.21
Kegalle	Pallegama	PB 86	12	B	15 x 16'	8.73
		RRIC 100	7	A	15 x 16'	11.51
		RRIC 121	8	A	15 x 16'	10.33
Ratnapura	Rambukkanda	PB 86	11	A	15 x 16'	8.23
		RRIC 100	9	A	15 x 16'	10.12
	Palmgarden	RRIC 121	10	A	15 x 16'	2.47

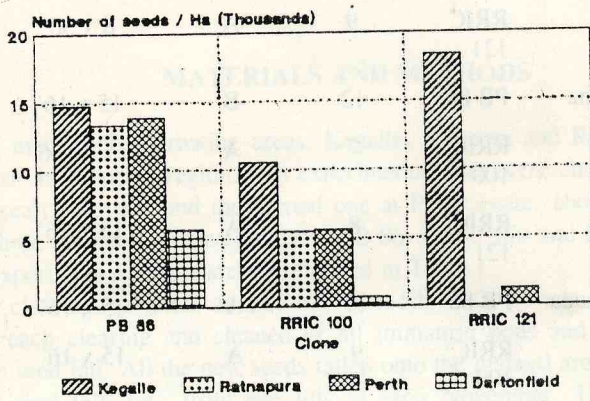
RESULTS

The production of seeds

The quantity of seed production varied in the three regions. However, satisfactory seed production was observed only in Kegalle region. The total number of seeds per hectare per clone is given in Fig. 1.



(a)



(b)

Fig. 1. The total number of seeds per hectare. (a) for the four experimental blocks in three regions and. (b) for three clones.

Kegalle Region shows the best production of seeds irrespective of the clone (Fig.1a). However, clonal differences exist in all regions. PB 86 and RRIC 100 have produced seeds in all regions but, RRIC 121 has not produced seeds either in Ratnapura or at Dartonfield (Fig.1b). But, this clone has yielded the highest number of seeds at Kegalle. Nevertheless, a PB 86 shows the highest and RRIC 121 the lowest total production of all four experimental blocks.

The quality of seeds

Some seeds collected from each experimental block of all regions were bad or inferior in quality as determined by their appearance: seed coats were light brown or pale yellow and usually lacked endosperm or had infected endosperm or were devoid of it (Fig.2). Pods too were collected in all experimental blocks, and they always contained inferior quality seeds as described.

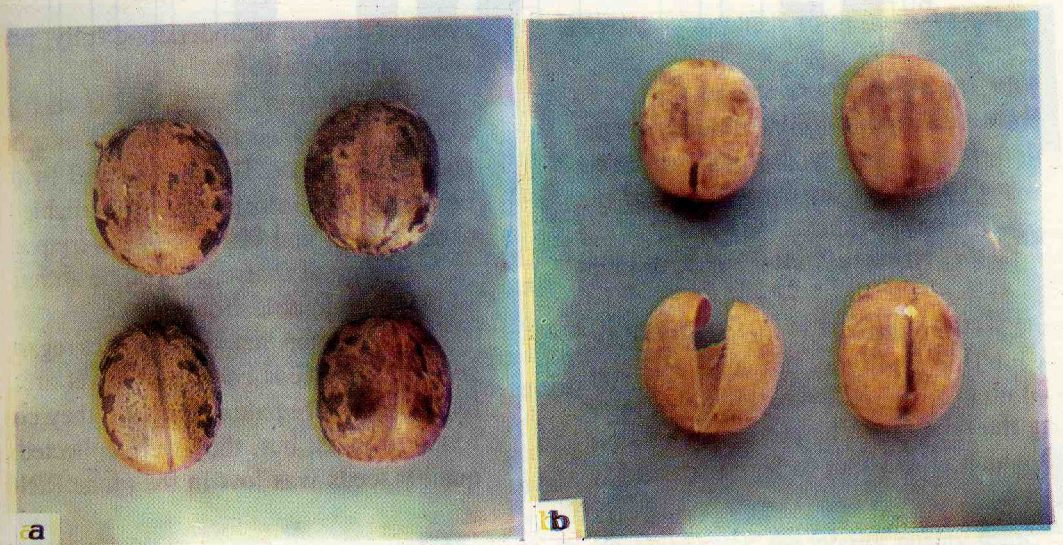


Fig.2. The types of seeds collected (a). Good quality and (b). Inferior quality.

Seed production in Sri Lanka

When the seeds were collected, first they were grouped by their external appearance and only good seeds were sown in germination beds. The percentage of good and inferior quality seeds are shown in Fig.3.

The quality of the seeds may be related to the clone. PB 86 having the highest percentage of inferior quality seeds. RRIC 100, shows the least number of infected or inferior quality seeds.

The number of good quality seeds that can be collected from one hectare is shown in Fig.4.

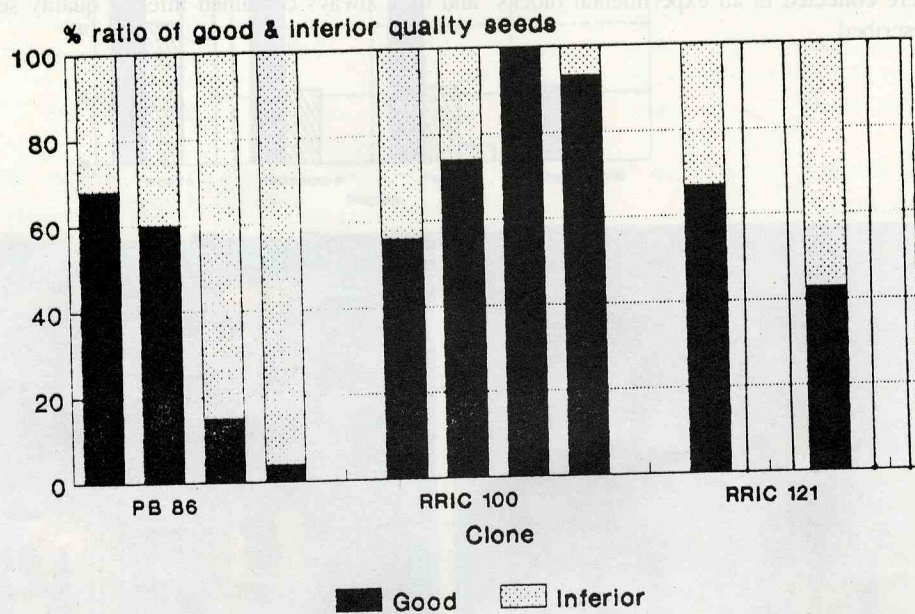


Fig.3. The percentage of good and inferior quality seeds of three clones for four experimental sites. (The four bars for each clone represent the areas Kegalle, Ratnapura, Perth and Dartonfield, in that order, from the left. No seed production was observed in RRIC 121 either in Ratnapura or in Dartonfield).

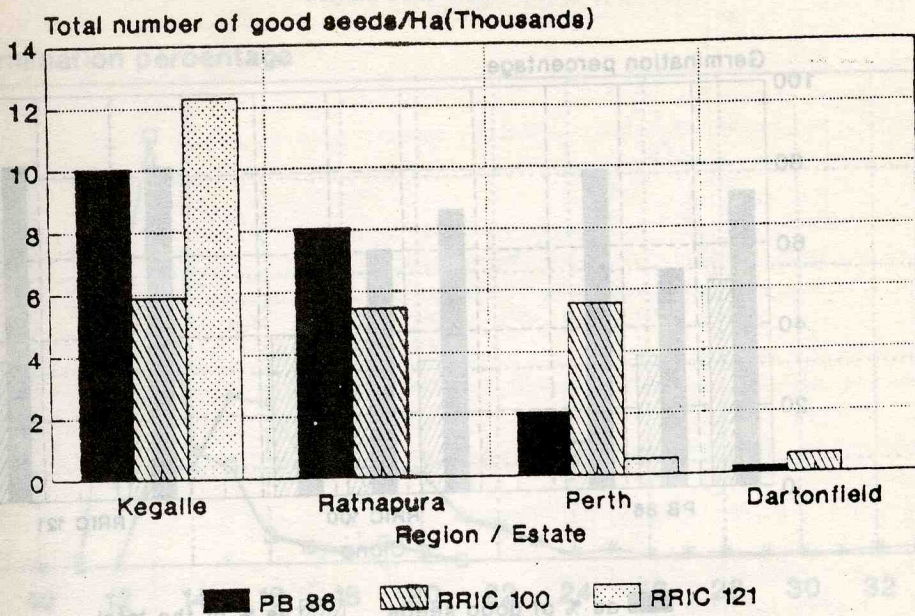


Fig.4. The total number of good quality seeds that can be collected per hectare from each clone in each region.

As Figure 4 shows, the regional effect is much higher than the effect of clones. RRIC 121 has produced the highest number of seeds in Kegalle where as this clone has not produced a single seed either in Ratnapura or in Dartonfield.

Seed germination

Though only good quality seeds, selected by their external appearance, were sown in germination beds, the germination percentages were different and sometimes low. Anyhow, the seed germination was calculated as a percentage of the amount of good quality seeds and also as a percentage of the total number of seeds collected, and are shown in Fig.5.

Though it was planned to collect seeds at weekly intervals, there were instances of delays for 2-3 weeks. In such cases, all germinated seeds were also collected. Further, the number of seeds in some experimental blocks was very small and therefore the germination percentage may not be representative. However, in general practice, the inferior quality seeds, as explained earlier, are not even collected. Therefore, the germination expressed as the percentage of the number of good quality seeds gives us an idea of the germination percentage of the seeds.

Seed production in Sri Lanka

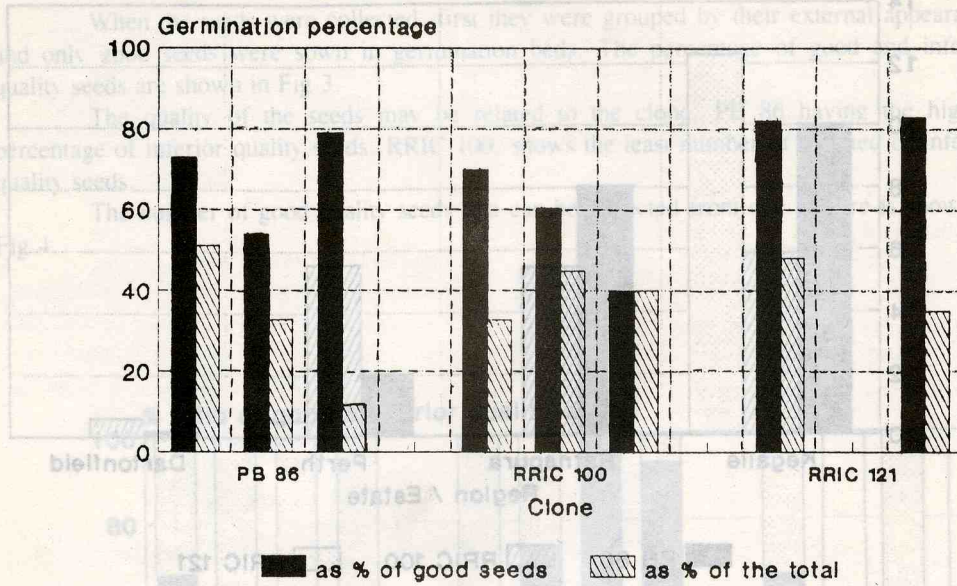


Fig.5. The germination percentage of the seeds expressed as the percentage of good quality seeds and as the percentage of total seed production. The three paired bars for each clone represent three experimental blocks, Kegalle, Ratnapura and Perth in that order from the left.

The germination pattern of mixed clonal seeds collected and transported from Kegalle and Matale areas during the same seed fall is shown in Fig.6.

Germination percentage of the seeds from Kegalle and Matale areas were 55% and 50.3% respectively. Nevertheless, the time taken for the two batches to complete germination was different. Also, the percentage of seeds germinated during the recommended period, i.e., within the second week of the seed saw, was different, 10% and 40% for seeds from Kegalle and Matale respectively. This difference is mainly attributable to the long delay in the germination time of the seeds from Kegalle. However, if the crop of the first four harvests collected on alternate days is considered, the germination percentages were 42.2% and 48.8% for seeds from Kegalle and Matale respectively. When this was given as a percentage of the total number that germinated, 78% and 97% were obtained for the seeds of Kegalle and Matale respectively.

In the present study, the germination time was not monitored for the seeds collected from experimental blocks. Nevertheless, they were kept on germination beds for about one month, therefore, even the very late germinates were given a chance.

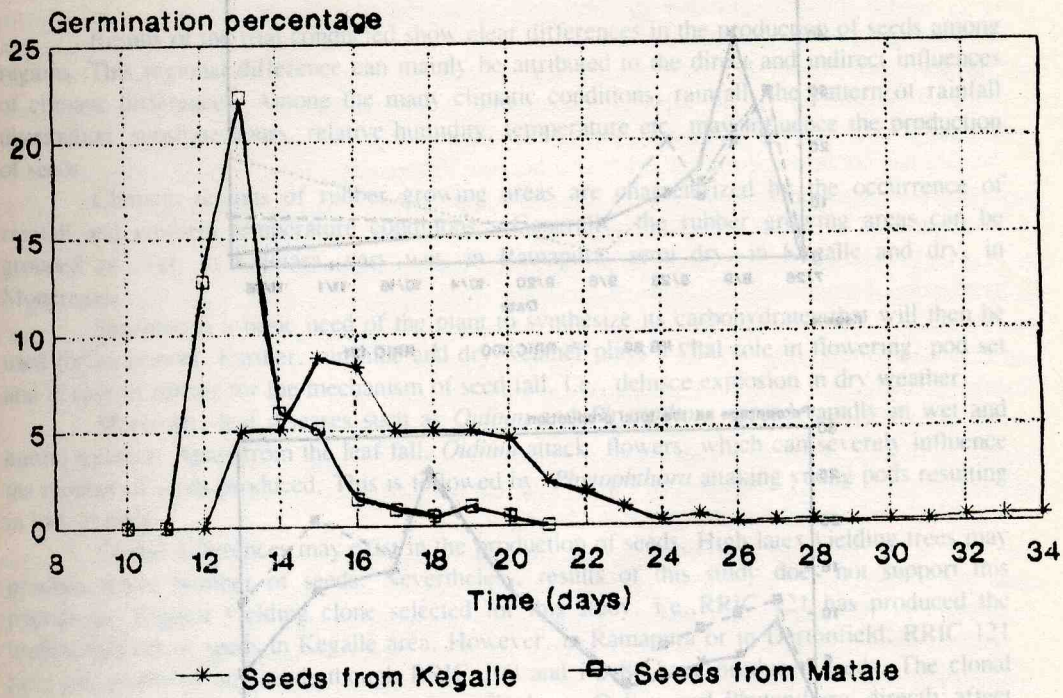
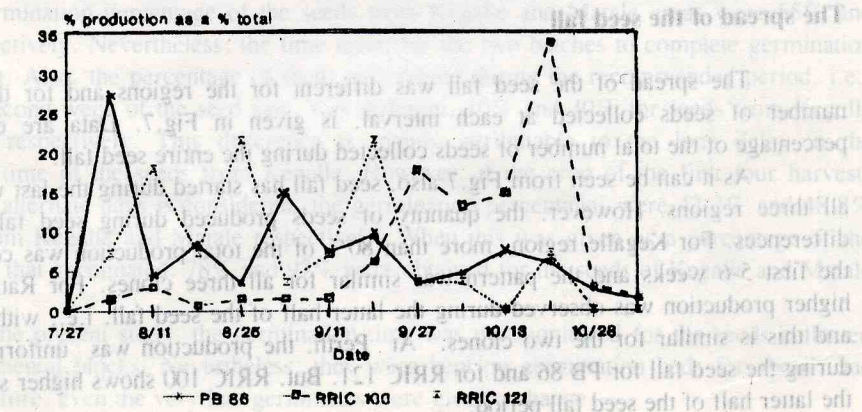
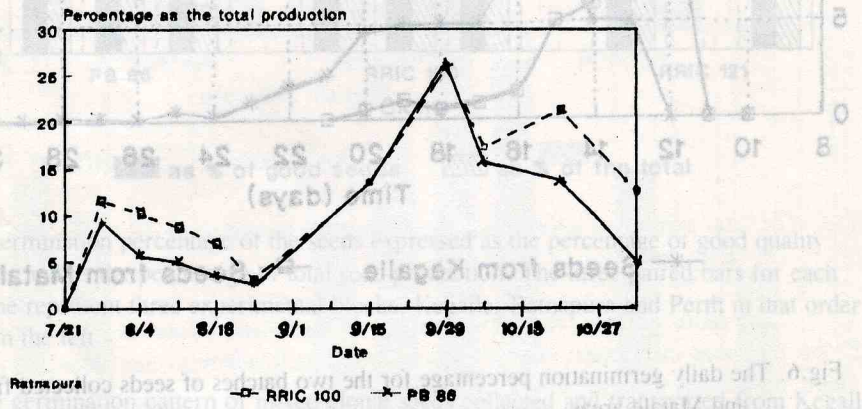
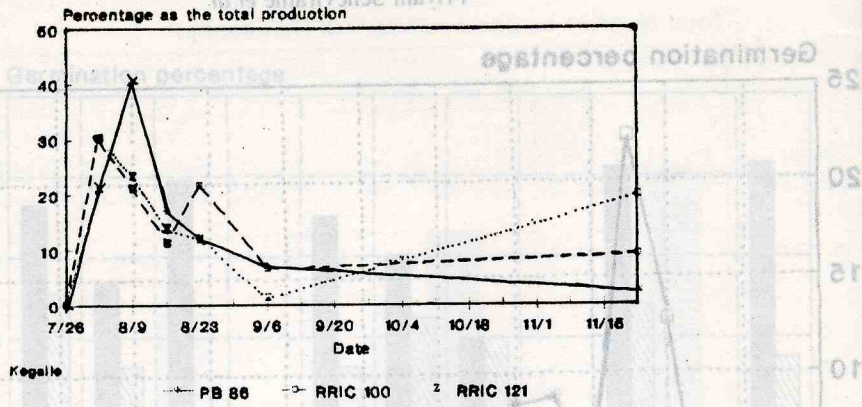


Fig.6. The daily germination percentage for the two batches of seeds collected from Kegalle and Matale areas.

The spread of the seed fall

The spread of the seed fall was different for the regions and for the clones. The number of seeds collected at each interval, is given in Fig.7. Data are expressed as a percentage of the total number of seeds collected during the entire seed fall.

As it can be seen from Fig.7 also, seed fall has started during the last week of July in all three regions. However, the quantity of seeds produced during seed fall period show differences. For Kegalle region, more than 80% of the total production was collected during the first 5-6 weeks and the pattern was similar for all three clones. For Ratnapura region, higher production was observed during the latter half of the seed fall, i.e., within 6-11 weeks and this is similar for the two clones. At Perth, the production was uniformly distributed during the seed fall for PB 86 and for RRIC 121. But, RRIC 100 shows higher seed fall during the latter half of the seed fall period.



DISCUSSION

Results of the trial conducted show clear differences in the production of seeds among regions. This regional difference can mainly be attributed to the direct and indirect influences of climatic differences. Among the many climatic conditions, rainfall, the pattern of rainfall distribution, sunshine hours, relative humidity, temperature etc. may influence the production of seeds.

Climatic regions of rubber growing areas are characterized by the occurrence of rainfall and uniform temperature conditions. Generally, the rubber growing areas can be grouped as, wet, in Kalutara, very wet, in Ratnapura, semi dry, in Kegalle and dry, in Moneragala.

Sunshine is a basic need of the plant to synthesize its carbohydrates that will then be used for its growth. Further, sunshine and dry weather plays a vital role in flowering, pod set and in case of rubber for the mechanism of seed fall, i.e., dehisce explosion in dry weather.

Moreover, leaf diseases such as *Oidium* and *Phytophthora* spread rapidly in wet and humid weather. Apart from the leaf fall, *Oidium* attack flowers, which can severely influence the number of seeds produced. This is followed by *Phytophthora* attacking young pods resulting in loss of pods.

Clonal differences may exist in the production of seeds. High latex yielding trees may produce fewer number of seeds. Nevertheless, results of this study does not support this hypothesis. Highest yielding clone selected for this study, i.e., RRIC 121 has produced the highest number of seeds in Kegalle area. However, in Ratnapura or in Dartonfield, RRIC 121 have not produced any seeds though RRIC 100 and PB 86 have produced seeds. The clonal differences in susceptibility to diseases, in particular to *Oidium* and *Phytophthora*, directly affect seed production. Susceptibility to diseases is highly related to the clone and the weather. From the three clones used for this study, RRIC 100 is resistant to both *Oidium* and *Phytophthora*. However, both PB 86 and RRIC 121 have below average tolerance to these diseases (Plant Pathology Department, personal communication). The RRIC 100 clearing selected for this study in Kegalle area was mixed with PB 86 and this may be the reason for fairly higher percentage of inferior quality seeds in this experimental block compared with RRIC 100 blocks in other regions. In fact, all seeds collected from Perth were good and 96% of that collected from Dartonfield were also good though the total number of seeds per hectare at Dartonfield was only 645 which is far below the quantity produced in Kegalle. Further, the RRIC 121 clearing of Kegalle region was mixed with RRIC 100 and this may be the reason for the higher percentage of good seeds in that clearing. In general, in Kegalle area about 30-45% of seeds were of inferior quality, found as seeds or in pods. Generally, inferior seeds are empty and the seed coat is light brown or pale yellow. As *Phytophthora* infected pods generally consisted of rotten endosperm, these seeds may inferior due to other reasons, i.e., under developed. This can happen because of excess production of seeds. However, as the experimental areas were cleaned, prior to collecting seeds, all seeds though they looked premature, had fallen within the

period of the main seed fall i.e., in July-August.

The planting distance of trees may affect the production of seeds. The planting distances adopted of the experimental areas were different. However, the density was around 450 trees per hectare and different spacing systems such as 15' x 16 and 8' x 30 had been adopted. Wycherley (1971), reported the correlation between the planting density and the seeds per trees to be negative and highly significant. However, in his trial, the number of seeds per hectare has not been significantly different because the boundary plots yielding equal number of seeds in all densities (ranging from 116 to 1045 trees per hectare). In the present trial all plots were selected in centers of the clearings. Therefore, the density effect should be minimum.

Age of trees or the clearing may be another important aspect that influence seed production. Flowering is a mature characteristic, and, in case of rubber, trees start flowering at 5-6 years of age. During the initial years trees may be producing a smaller quantity of seeds (Personal communication, Plant Breeding Department). From the clearings selected for the present study, the four experimental blocks of RRIC 121 were 8, 9, 9 and 10 years old. For the clone RRIC 100, the clearing were 7-9 years old. PB 86 clearings could not be found at panel A' as it is rarely planted now in plantations, and the ages of the clearings used were between 11-17 years. However, it can be said that the differences shown in the present data are less likely to be related to the age of the clearings.

According to Wycherley (1971), the maximum number of seeds per hectare per year is about 160,000 from a seed garden of prolific clones with continuous flower protection throughout the year. This could go down to zero in monoclonal areas of poor seed bearers without flower protection. However it seems that many factors influence seed production, i.e., climate, weather, resistance to diseases, clone, age of trees, nutrient condition of trees, tapping frequency, etc.

One aim of the present study was to see whether we could find any distinguish reason for the differences in seed production in different regions. From the results obtained the following can be said about seed production.

1. Production of seeds is highly correlated to the region. This may be due to direct or indirect influences of the climate and the weather during flowering and pod set.
2. Clonal difference may not be existing under favorable climatic conditions for seed production.
3. In regions where climate or weather is favourable for spread of diseases, i.e., overcast and humid weather, clonal differences seem to exist specially for the number of good quality seeds.
4. The spread of the seed fall also vary in different regions, again, perhaps relating to the climate or the weather.

However, the most important information is that all clearings of Kegalle region produced an acceptable amount of seeds that can be expected from ordinary plantations

consisting of mixed clons. However, the condition of low production of seeds in wet areas is experienced only during the recent past, i.e., during last 5-8 years and, it seems to have maintained almost unchanged since then. The planters' view on this is also the same.

There was no marked change in the clones grown in wet areas, but PB 86 is losing its hectarage gradually, yet a substantial mature area remains under PB 86.

Therefore, the actual causes seem to be rather complicated, but farmers, in particular nurserymen in wet regions, are affected severely.

However, up to now, the country as a whole is producing enough seeds to fulfill the country's requirement.

The current recommendation for harvesting germinated seeds from germination beds is to use only those germinated within the second week of the seed date. The reason for this is that it has been well established that those germinate early grow into vigorous plants (Jayasekara & Senanayake, 1971, Senanayake, *et al.*, 1975). Also, it has been experienced that when the seeds were stored even for a few days the time required for germination is increased. This often occurs when large quantities of seeds were to be transported long distances. However, as discussed in the results section, though the germination is little delayed, use of the early germinates (those germinate within the first week from the starting date of germination) makes it possible to select the vigorously growing seeds.

However, it is in fact worth studying the actual factors contributing to this low production of seeds in wet regions. Though the present study suggests a high relationship with the production of seeds and the region, it could well be the interaction of different factors, i.e., climate, disease tolerance etc.

The weather data for Dartonfield are available at the RRISL, but unfortunately, Metereology Department does not have weather data for Kegalle region. However, the weather data for Dartonfield for the last 60 years have showed no significant changes. It has been suggested a possible cyclic variation with alternate wet and dry periods of 15 years.

Anyhow, the recurrence intervals has suggested that runs of 2 wet or dry years to be expected only once in a decade, runs of three wet or dry years, once in every 30 years and four wet or dry years, once in every 60 years (Annual Review, 1992). Therefore, the poor seed production during the recent past may not be due to changes in the annual rainfall, but due to cumulative factors which are difficult to distinguish at this phase.

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