Evaluation of improved lines of guayule (*Parthenium argentatum* Gray) for commercial rubber

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Abstract

This study was initiated to evaluate the performance of improved guayule germplasm in Australia. Five lines (AZ-1, AZ-2, AZ-3, AZ-5 and AZ-6) released jointly by the United States Department of Agriculture (USDA) and the University of Arizona were planted at Gatton, Queensland. Earlier released USDA lines, N565 and 11591, were used as standards. Three months old glasshouse grown seedlings were transplanted in a randomized complete block design in early September 2001. During the first 30 weeks, plant establishment, height, width and stem diameter were analysed. All lines, except the line AZ-5 (83%), had good establishment with over 95% survival rate. Results showed significant differences for plant height and width from 5 to 30 weeks after transplanting. Lines AZ-2 and AZ-3 grew most vigorously compared to all the other lines. At 30 weeks, AZ-3 produced the best results with mean plant height and width of 55.2 cm and 75.2 cm, respectively. Next best was AZ-2 with mean plant height of 52.9 cm and width of 74.1 cm. Compared to 11591 and N 565, there was a substantial increase in plant height and width for AZ-2 and AZ-3. AZ-6 produced the next promising results with mean plant height and width of 44.8 cm and 63.1 cm, respectively. Plant heights of lines AZ-1 (44.7 cm), AZ-5 (43.6 cm) and AZ-6 (44.8 cm) were significantly different only from the line N 565 (32.7 cm). Stem diameter showed no significant differences at 30 weeks of age. Results indicate that the lines AZ-2 and AZ-3 performed well with faster growth rate during the study period and may have the potential to produce greater biomass and rubber yields.

Keywords

Natural rubber, guayule, improved lines, growth

Introduction

Natural rubber is one of the most important raw materials used for the manufacture of more than 40,000 products (1). Its consumption accounts for over 6 million tons annually (2). Currently, a single tropical tree species, *Hevea brasiliensis,* produces all this natural rubber (1). However, guayule that has been used as a source of commercial rubber during the early 1900s is a potential rubber crop for semiarid regions in the world (3,4). Guayule produces similar rubber to that of *Hevea* (4). It has been shown that individuals sensitive to *Hevea* latex do not react to guayule latex (5). This further increases guayule's potential as a commercial rubber crop as the demand for low allergenic latex products continues to grow (6). Still, low rubber yields have been the main barrier for its commercial success (7,8). Accordingly, high yielding lines with fast growing ability have been developed to elevate the commercial potential of guayule (7,9).

Performance of guayule has been evaluated in Australia in the past in different stages. These studies also concluded that guayule was not economic with the then existing low yielding lines (10,11). However, research has not been carried out in Australia to evaluate improved high yielding lines from the USA. The objective of this study was to compare the performance of these improved lines with the earlier lines released by the United States Department of Agriculture (USDA).

Materials and Methods

The study was initiated in June 2001 at the Gatton Campus of the University of Queensland. The soil type of the site was a Lawes Black Earth, self-mulching cracking clay with less than 0.5% slope. The pH of the soil was 7.9 and soil organic carbon content was 1.2%. The site receives an average annual rainfall of 763 mm which is summer dominant with 68% of rain usually falling between October and March. Summers are warm to hot with maximum temperatures of 28-33?C, although heat waves up to 40?C can occur. During winter, minimum temperatures are usually from 6?C to 10?C. Frosts are possible during June, July and August.

Seeds from seven guayule lines were used for this study. These included five new improved lines, AZ-1, AZ-2, AZ-3, AZ-5 and AZ-6, released jointly by the USDA and the University of Arizona (9), and two earlier released USDA lines, N 565 and 11591, as controls. Seeds were treated to break dormancy using the recommendations of Naqvi and Hanson (12). Seedlings were raised in a glasshouse for three months from June to August. Then the seedlings were transplanted in the field.

The experimental design used was a randomized complete block with three replicates. Plastic mulched raised beds at 1.5 m spacing were prepared to transplant the seedlings. Plots consisted of 4 rows each with 10 plants at 0.35 m spacing. A trickle system was set up to irrigate the plants. Seedlings were irrigated daily during the first week after transplanting and then once a week for three weeks. Thereafter, supplementary irrigation was provided to reduce stress on plants.

The number of established plants in each plot was recorded at weekly intervals for four weeks until they gave steady counts. Plant growth was monitored by recording plant height, plant width and stem diameter. Plant heights were measured at 5, 12, 19 and 30 weeks after transplanting and plant width and stem diameter were taken at 12, 22 and 30 weeks after transplanting. These data were then subjected to analysis of variance and treatment means were compared by the Tukey’s simultaneous test at the 5% level of significance. Data presented in this paper are those measured at the end of 30 weeks.

Results

Results showed no significant difference for plant establishment among lines and all, except the line AZ-5 (83%) established well with over 95% survival rate. Plant growth analysis (height and width) 30 weeks after transplanting showed significant differences among lines. Plant height and width of lines AZ-2 and AZ-3 were significantly higher for the whole period when compared with lines N 565 and 11591 (Fig. 1 and 2). Table 1 shows that 30 weeks after transplanting AZ-2 and AZ-3 produced the most vigorous plant growth. Line AZ-3 produced the best results with an increase of nearly 70% and 29% in plant height and 57% and 49% in plant width compared to N 565 and 11591, respectively. Performance of line AZ-2 was very similar to line AZ-3.

Table 1: Mean plant height, width and stem diameter of guayule breeding lines at 30 weeks after transplanting

Line	Plant height (cm)	Plant width (cm)	Stem diameter (cm)
AZ-3	55.2 a*	75.2 a*	2.88**
AZ-2	52.9 ab	74.1 ab	2.80
AZ-6	44.8 bc	63.1 abc	2.80
AZ-1	44.7 bc	58.0 abc	2.89
AZ-5	43.6 bc	57.9 bc	2.90

11591	42.9 c	50.5 c	2.82
N 565	32.7 d	47.8 c	2.93

* Means within a column followed by the same letter are not significantly different at the 0.05 level according to
Tukey's simultaneous test.
** F test is not significant at the 0.05 level.

AZ-6 produced the third most vigorous plant growth with mean plant height and width of 44.8 cm and 63.1 cm, respectively. Plant height of AZ-6 was significantly different from the line N 565 but not from the line 11591. Lines AZ-1 (44.7 cm) and AZ-5 (43.6 cm) also produced significantly higher values for plant height when compared with line N 565 (32.7 cm), but percent increase in plant growth was not as high as for AZ-2, AZ-3 and AZ-6. Stem diameter showed no significant differences at 30 weeks of age.

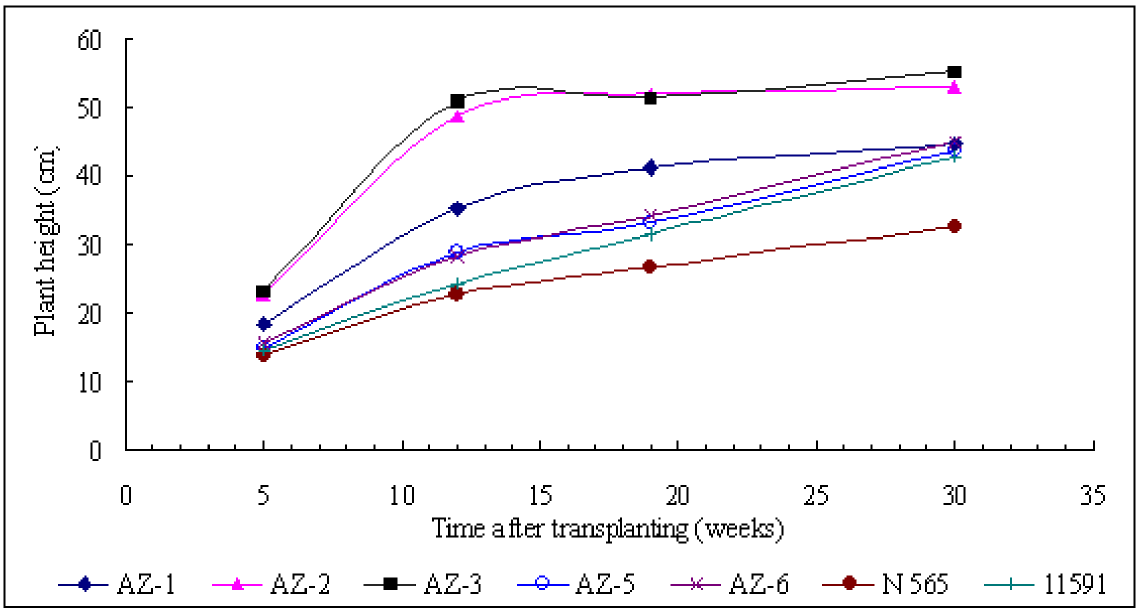

Fig. 1: Plant height of guayule lines from transplanting to age 30 weeks

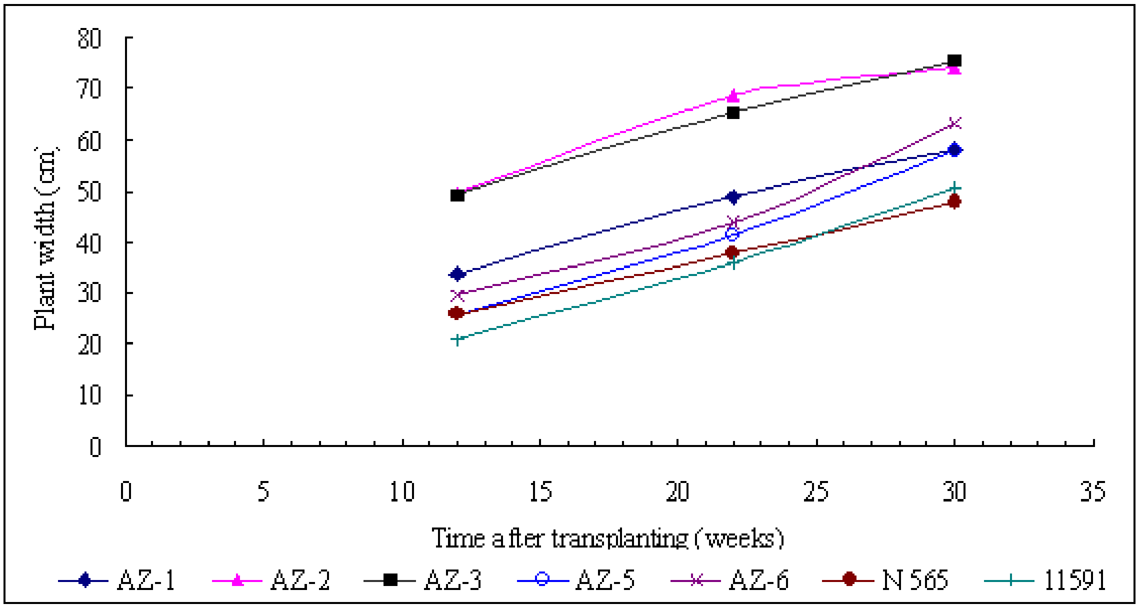

Fig. 2: Plant width of guayule lines from transplanting to age 30 weeks

Discussion

Results show that improved lines performed well in Australia and produced significantly higher plant growth in comparison to earlier released lines. Out of the five improved lines, AZ-2 and Z-3 produced the best results with highest increase in plant growth. Research in the USA revealed that some of these improved lines were capable of producing more than a 100% increase in rubber yield after two years compared to the lines N 565 and 11591 (9). Thus, these lines have the potential to produce significantly higher biomass and rubber yields in the Australian environment. Early vigorous growth of these improved lines could decrease time until harvest (9) and allow faster regrowth in ratoon crops.

Generally, guayule is known as a slow growing plant and hence it is not a good competitor against weeds (13). However, early vigorous growth of these improved lines would enable them to compete more effectively against weeds than older lines.

Conclusion

Plant growth performance of improved guayule breeding lines in particular AZ-2 and AZ-3 was very promising in Australia. At harvest, these lines have the potential to produce significantly higher biomass and rubber yields than older lines. Final rubber yields and the demand for high quality latex would be the two main deciding factors for the initiation of commercial production of guayule in Australia.

Acknowledgment

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