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Improved guayule lines outperform old lines in south-east Queensland

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Abstract

Guayule (*Parthenium argentatum* Gray) is a source of high quality rubber and low-allergenic latex as well as resin for use as a wood preservative. Demand for high value latex products has increased with the advent of deadly diseases such as AIDS. The objective of this study was to evaluate the performance of six improved guayule lines (AZ-1 to AZ-6) in south-east Queensland: released jointly by the Agricultural Research Service (ARS) of the United States Department of Agriculture (USDA) and The University of Arizona. Trials were conducted at two sites, Chinchilla and Gatton. Overall performance of improved lines for plant growth and yield of dry matter, rubber and resin was better at both Gatton and Chinchilla than the standard check lines (N 565 and 11591). AZ-1 and AZ-2 maintained the best combinations of desirable traits, including plant uniformity, early vigorous growth, increased dry matter, and increased rubber and resin yields. Of these two, AZ-2 had more uniform plant growth and has commercial potential for Queensland production areas. In the summer harvest at Gatton, 32-month-old AZ-1 and AZ-2 produced rubber yields of 789 kg/ha and 771 kg/ha, respectively, while controls, N 565 and 11591 produced 675 kg/ha and 618 kg/ha, respectively. At Chinchilla, at 33 months, spring harvested AZ-1 and AZ-2 produced rubber yields of 717 kg/ha and 787 kg/ha; these yields were significantly higher than N 565 and 11591 which produced 385 kg/ha and 380 kg/ha, respectively. Thus, rubber yields of AZ-1 and AZ-2 were consistently high across sites. AZ-1 and AZ-2 produced resin yields of 1158 kg/ha and 1115 kg/ha at Gatton and 1318 kg/ha and 1476 kg/ha at Chinchilla. This compared with a mean of 612 kg/ha and 352 kg/ha for the standard check lines at Gatton and Chinchilla. Thus resin yields of AZ-1 and AZ-2 were consistently high across sites. Rubber content appeared to be influenced by time of harvest although this effect is compounded with plant age. At Gatton, in spring, 17-month-old plants produced a mean rubber content of 7.7% (all lines), while, in summer, when the plants were 32-month-olds, rubber content dropped to 6.4%. At Chinchilla, 33-month-old plants harvested in spring produced a mean rubber content of 7.4%, similar to the spring value at Gatton. By contrast, resin content appeared to be little affected by season.

Keywords: Guayule; *Parthenium argentatum*; Improved lines; Evaluation; Rubber; Resin

1. Introduction

Guayule (*Parthenium argentatum* Gray) is a rubber-producing semi-arid plant native to the Chihuahuan Desert in northern Mexico and southwestern Texas (Whitworth and Whitehead, 1991). It is a source of high quality rubber which has been commercially extracted several times during the last century (Thompson and Ray, 1988). However, intermittent research efforts up until the 1970s were not sufficient for guayule to remain a viable industrial crop. Research efforts initiated during the late 1970s have made considerable progress resulting

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in release of high yielding lines with fast growth (Ray et al., 1999; Ray et al., 2005). In addition, guayule latex is low-allergenic and suitable for production of high value latex products (Siler and Cornish, 1994). The demand for such products has increased since the 1980s due to the outbreak of deadly diseases like acquired immune deficiency syndrome (AIDS). All these aspects have enhanced guayule's commercial potential. Guayule also produces significant quantities of resin useful as wood preservatives (Nakayama et al., 2001).

A very large area in Australia satisfies the climatic requirements of guayule (Nix, 1986). Stewart and Lucas (1986) reported that the potential area suitable for guayule production in Australia is more than 5 million hectares. In parallel to US studies, research in Australia during the 1980s evaluated growth potential and agronomic requirements. These attempts, based on low yielding lines developed during World War II, highlighted the need for further research to increase rubber yields and decrease production costs (Milthorpe, 1984; Ferraris, 1993; Milthorpe et al., 1994).

Studies in the USA and Argentina found that improved lines produced early fast growth and higher rubber and resin yields than old lines (Ray et al., 1999; Coates et al., 2001; Dierig et al., 2001). Evaluation of these lines under Australian conditions is important to investigate commercial potential. Therefore, this study was carried out with the objective to evaluate the performance of six improved guayule lines at two sites, Gatton and Chinchilla in south-east Queensland during the period from 2001 to 2004. Preliminary results from the Gatton trial were reported earlier when plants were 17-month-olds (Dissanayake et al., 2004). Results confirmed overseas research that improved lines performed well with early vigorous growth and higher rubber and resin yields than old lines, N 565 and 11591. We now report that the results from further evaluation of the Gatton trial (up to 32 months) as well as an additional trial at Chinchilla (33 months) confirm the superiority of the improved lines.

2. Materials and methods

2.1. Field sites

Two field sites, Gatton and Chinchilla, were selected within the region suitable for guayule in south-east Queensland (Nix, 1986) for their different environmental conditions (rainfall, temperature and soil type). Gatton site details were presented previously when data for the initial 17 months of growth were reported (Dissanayake et al., 2004). Briefly the Gatton trial was located on an alluvial soil in a climate less extreme than that at Chinchilla. Average annual rainfall for Gatton site is 763 mm (Powell, 1982). However, the study period was comparatively dry with only 1372 mm of rain received after field establishment (Fig. 1). Rainfall was supplemented with irrigation as described in Section 2.5.

The Chinchilla site was located in the agricultural field station of the Chinchilla State High School (latitude: 26°57′27′S, longitude: 150°51′48′E, altitude: 320 m), approximately 300 km northwest of Brisbane. The soil type is very deep, reddish brown sand with pH of the surface soil 6.5 and sub-soils becoming more acidic with depth (Maher, 1996). The soil is non-saline and non-sodic. Low water holding capacity is a major limiting factor in crop production. Soils are low in organic carbon (0.4%) and in almost all nutrients except potassium.

The Chinchilla site receives an average annual rainfall of 633 mm, with 75% usually falling in summer, between October and March. However, the study period was comparatively dry with only 1041 mm of rainfall

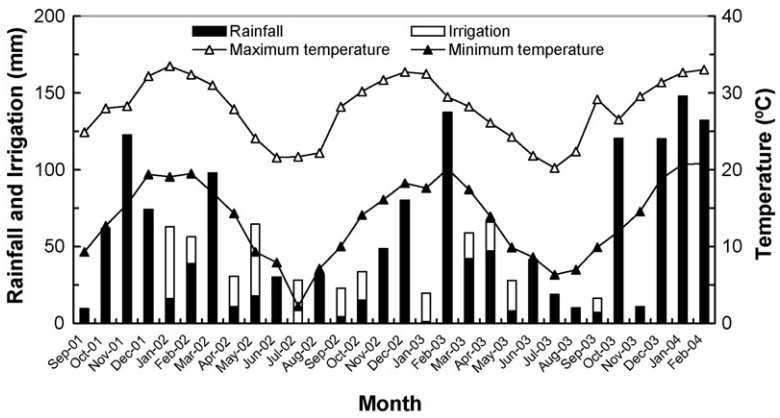

Fig. 1. Monthly rainfall, irrigation, mean maximum and minimum temperatures at Gatton during the study period.