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Short communication

Direct seeding as an alternative to transplanting for guayule in southeast Queensland

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ABSTRACT

Guayule (*Parthenium argentatum* Gray) is a source of high quality rubber and low-allergenic latex. Commercial potential of guayule to produce high value latex products has increased due to the increased incidence of deadly diseases in humans. The objective of this study was to investigate the potential of direct seeding in southeast Queensland as an alternative to establishment by the current high cost transplanting method. Experiments were conducted for 2 years at Gatton, Queensland using physical and chemical seed treatments. NaOCl plus GA_3, osmo-priming with polyethylene glycol, seed pelleting and seed tape planting were tested. Planting depth had a significant influence on seedling emergence. Emergence at 18 mm depth (1.5 seedlings/m) was significantly reduced compared with 10 mm depth (2.9 seedlings/m). Osmo-priming was effective in increasing germination from 36 to 47%. It also improved seedling emergence and vigour. Osmo-priming significantly increased establishment (7.5 seedlings/m) compared with untreated seed (3.3 seedlings/m). NaOCl plus GA_3 did not have a significant influence on germination (38%) or seedling emergence (5.0 seedlings/m) but increased survival at 42 days after planting. Establishment as a percentage of emerged seedlings was high for both osmo-primed and NaOCl plus GA_3 treatments with 89 and 88% respectively, whereas untreated seed had only 70% survival. Osmo-priming also increased vigour as indicated by increased root length (101 mm), shoot height (123 mm), and seedling dry matter (379 mg/seedling) compared with the control (83, 107 mm and 206 mg/seedling, respectively).

1. Introduction

Guayule (*Parthenium argentatum* Gray) is a semi-arid species native to the Chihuahuan Desert in northern Mexico and south western Texas (Whitworth and Whitehead, 1991). It is a source of high quality rubber that was commercially extracted during the early part of last century (Thompson and Ray, 1989). In the late 1970s, synthetic rubber prices increased due to higher petroleum prices. This created renewed interest in guayule as a source of commercial natural rubber and research programs improved its potential. These efforts have made considerable progress with the release of improved lines with fast growth and high yielding capacity (Ray et al., 1999; Dissanayake et al., 2004; Dissanayake et al., 2007). Efficient rubber and latex extraction techniques have also been developed (Schloman and Wagner, 1991; Cornish, 1996). In parallel with these improvements, demand for latex products also increased during the 1980s with the outbreak of deadly diseases such as Acquired Immune Deficiency Syndrome (AIDS). Guayule latex is low-allergenic, and therefore, use-

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ful for manufacture of high-value latex products (Siler and Cornish, 1994). These improvements have enhanced guayule's potential as a commercial crop.

Despite all these developments, establishment is still a major constraint for commercial production of guayule because of the high cost involved in the current widely used method of transplanting (Bucks et al., 1986; Foster and Moore, 1992; Foster et al., 1999). The method involves growing seedlings in a glasshouse for 1 month, hardening them outside for 2 months, and then transplanting into the field at 3 months. Establishment by transplanting was estimated to cost about US$ 1600 ha^{-1} in the USA, (Foster and Coffelt, 2005).

Transplanting has been adopted as the most reliable method of establishment because of difficulties encountered due to physical qualities of seed. Size, colour, and weight of guayule seed vary greatly and these attributes affect seed germination (Jorge et al., 2007). The average guayule produces very small and easily damaged seeds. Average length and width of a seed are 2.5 and 1.8 mm, respectively (Tipton et al., 1981), and 1 kg contains about one million seeds, or 1 mg per seed (Naqvi and Hanson, 1980; Siddiqui et al., 1982; Coates, 1985; Bucks et al., 1986). Seed size affects seedling emergence, vigour, growth and thus precision planting (Naqvi and Hanson, 1980; Bucks et al., 1986; Thompson and Ray, 1989; Chandra, 1991).

Physical seed treatments such as pelleting have increased establishment of many crops (Taylor et al., 1998). Seed pelleting allows nutrients and other seed amendments (protectants and hormones) to be applied to the seed as well as increasing seed size and making irregular seed rounded; this facilitates seed placement for small seeded species. Seed tape planting in which seed is imbedded in biodegradable paper improves establishment of direct seeded crops by protecting the seed as well as allowing even spacing.

Chemical seed treatments have also been developed to increase germination, establishment and improve seedling vigour. Treatment with NaOCl plus GA_3 increased guayule seed germination under laboratory conditions (Naqvi and Hanson, 1980). Khan et al. (1978) reviewed a number of studies and found that osmo-priming with polyethylene glycol (PEG) improved establishment of direct seeded crops such as lettuce (*Lactuca sativa*), parsley (*Petroselinum crispum*), onion (*Allium cepa*), soybean (*Glycine max*), pea (*Pisum sativum*), and sweet corn (*Zea mays*). Osmo-priming also enhances the viability and vigour characteristics of guayule seeds (Chandra and Bucks, 1986). Conducting glasshouse pot experiment, Chandra (1991) found that osmo-priming with PEG increased seedling number and accumulation of shoot dry matter.

To date, the potential of physical and chemical seed treatment methods in direct-seeding of guayule crop has not been investigated in Australia. Therefore, the objective of this study was to investigate direct seeding using improved seed treatment techniques under Australian conditions.

2. Materials and methods

Field experiments were conducted during 2002 and 2004 on the research farm of the Gatton Campus of the University of Queensland (latitude 27°33′S, longitude 152°20′E, altitude 89 m). The soil type of the trial site is a Lawes Black Earth, self-mulching cracking clay with less than 0.5% slope. The soil pH was 7.9 and organic carbon content was 1.2%.

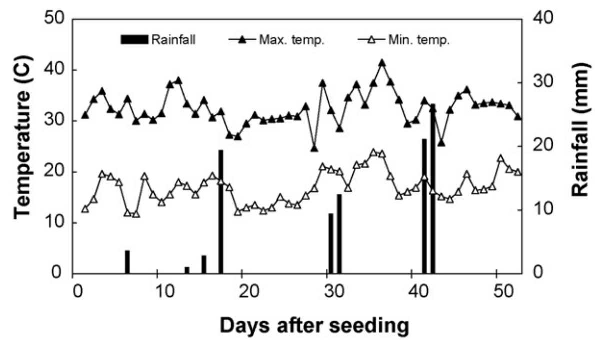

Fig. 1 – Daily rainfall, maximum and minimum temperature of the trial site for 2002.

In 2002, 4-week-old AZ-3 seed harvested at Gatton was osmo-primed with PEG by the method outlined by Chandra (1991). Later, the treated seed was air dried and divided into three treatments: (a) control, (b) pelleted by Heritage Seed Pty Ltd., Toowoomba, Queensland with a lime coating comprised of protectants and a range of macro- and minor nutrients, and (c) incorporated into seed tapes at the rate of 15 seeds/m by Livyn Pvt. Ltd., Sydney, New South Wales.

Laboratory germination of each seed lot was performed prior to field planting. Samples of 50 randomly selected seeds were replicated three times. Germination tests were carried out in 10 cm diameter glass petri dishes with three layers of filter papers moistened with demineralised water. Seed germination occurred under 8/16 h of light and dark daily and 20 °C, the optimum temperature for germination of guayule seed (Da Cruz, 2003). Germination counts were conducted for a period of 14 days.

Land preparation was carried out by a duck-feet tine cultivator operated in two directions followed by two harrowings with a tractor-mounted rotavator. Finally, the field was rolled to obtain a uniform seedbed. The experimental design was a randomised complete block with four replicates. Plot size was a single row 8 m long with rows 1 m apart.

The field was irrigated by sprinklers 4 days prior to seeding on 31 October 2002. A Mini Air pneumatic planter used to plant both the osmo-primed only and osmo-primed plus pelleted seeds was calibrated for a seeding rate of 47–48 seeds/m. Shallow furrows were opened to allow manual planting of seed tapes.

Because planting depth is a crucial factor for emergence of small-seeded species such as guayule, two depths, 10 and 18 mm, were used to investigate effect of planting depth on seedling emergence of all three seed treatments.

The field was irrigated daily for the first 10 days, and then the irrigation frequency was gradually reduced until the end of the third week. No water was applied afterwards. Rainfall and temperatures during the study period were also recorded (Fig. 1). Dimethyl 2,3,5,6-tetrachloro-1,4-benzenedicarboxylate (DCPA) was sprayed 1 day after planting at a rate of 4.5 kg ai/ha to control weeds.