Interactions between butterfly pea (*Clitoria ternatea*) and rubber vine (*Cryptostegia grandiflora*)

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Summary The competitive impact of butterfly pea (*Clitoria ternatea* L.) on rubber vine (*Cryptostegia grandiflora* R.Br.) was studied under seven planting combinations (each species grown in pure stands and in mixtures in a replacement series of five different proportions) at three nitrogen fertiliser levels (0, 48, 96 kg N ha^{-1}) at the early establishment phase. When grown in pure stands, both species increased their shoot and root dry weight yield in response to increasing levels of nitrogen. Rubber vine, however, exhibited a greater response than butterfly pea. In mixed stands, rubber vine and butterfly pea did not appear to compete with each other at all nitrogen levels. This resulted in an over-yielding response in all mixture combinations in terms of shoot and root yields. Total shoot and root mass of mixed stands significantly out-yielded their highest yielding pure stands by 8% and 27% respectively. Results suggest that butterfly pea not only failed to reduce shoot and root growth of rubber vine, but actually improved its growth performance. Consequently, the introduction of butterfly pea to suppress rubber vine is not warranted.

Keywords Rubber vine, butterfly pea, competition.

INTRODUCTION

Rubber vine (*Cryptostegia grandiflora* R.Br.) is a toxic woody weed of rangeland and native plant communities and is commonly found in the dry-tropics of central and north Queensland (Bebawi *et al*. 2002). Large infestations of rubber vine make mustering almost impossible. Competition from pasture species for soil moisture or soil nutrients has failed to limit rubber vine seedling establishment (Brown *et al*. 1996). Current control techniques include an integrated use of herbicides, mechanical control, biocontrol and fire practices (Vitelli *et al*. 1994). In habitats, such as riparian areas, that are sensitive to fire, mechanical and chemical control, biocontrol is the only tool available. Other biotic tools, such as interspecific competition, which might supplement current control strategies, need to be explored. The present study investigated the competitive effect of butterfly pea (*Clitoria ternatea* L.) at different nitrogen levels, with a view to assessing its potential to suppress rubber vine biomass during the early establishment phase of this weed.

MATERIALS AND METHODS

The competing species Butterfly pea is a self-regenerating, vigorous, twining, forage legume (Duke 1981) and was selected as the competing species in this study primarily because it has the potential to shade out rubber vine, thereby adversely affecting its growth and survival (Polhamus 1962).

Experiment The experiment was a 3 × 7 factorial replicated three times using a complete randomised design. Factor A comprised three N-fertiliser treatments (0 (control), 48 and 96 kg N ha^{-1}). The N-fertiliser source was CK 88 NPK compound fertiliser with an NPK ratio of 15.1%:4.3%:11.5%. Factor B was designed so that the proportions of butterfly pea and rubber vine in the mixture were varied while the overall density of seedlings was constant in a 'replacement series' (de Wit and van den Bergh 1965). The factor comprised seven planting combinations consisting of six plants in each pot (approximately 48 × 10^4 plants ha^{-1}), comparable to common field rubber vine densities. The seven planting combinations and their proportions were pure stands of butterfly pea (B, 100%), five mixtures of butterfly pea (B) and rubber vine (R): [B:R (83%:17%), B:R (67%:33%), B:R (50%:50%), B:R (33%:67%), B:R (17%:83%)] and pure stands of rubber vine (R, 100%). The experiment was initiated in May 1997 and repeated in May 1998.

Butterfly pea and rubber vine plants were germinated from seed in 'Jiffy-7' pelleted pots and transplanted three weeks after sowing to 40 cm diameter plastic pots filled with 20 kg (dry weight) potting mix. The NPK composition in each pot was equivalent to 1 mg kg^{-1} NO_3-N, 625 mg kg^{-1} P and 0.81 meq 100 g^{-1} K. N-fertiliser was broadcast in split applications, half at sowing and half four weeks after sowing. The plants in each pot were evenly spaced (approximately 10 cm between adjacent plants) in a circular pattern at the time of transplanting. Pots were then placed in the open-air and received 180 mL of water day^{-1}, which was equivalent to 657 mm rain over the course of the experiment – being the annual average rainfall for Charters Towers (Willcocks and Young 1991). In the final few months of the experiment a very light rust (*Maravalia cryptostegiae* (Cummins) Ono) infection was observed on all rubber vine plants irrespective of sowing combination. The level of infection did not appear to affect the growth of the plant as flowering still occurred on most rubber vine plants. The shoots and roots of both butterfly pea and rubber vine were harvested 12 months after sowing. At harvest, the shoots of butterfly pea and rubber vine were cut at ground level, placed in paper bags and oven dried at 100°C for seven days and their dry weights recorded. Roots were washed to remove potting mix and also dried at 100°C for seven days and weighed.

Measurements and analysis For each variable (shoot and root yield), analysis of variance was performed to test differences between treatments. To describe the performance of mixed stands in relation to pure stands (controls), the terms 'competitive' and 'non-competitive' were used. A mixture is described as 'competitive' when it 'over-yields' that of the more productive pure stand or 'under-yields' that of the less productive pure stand, and 'non-competitive' when its yield lies between the yields of the two pure stands.

RESULTS

Shoot yield Shoot yields of mixed stands were significantly ($P < 0.05$) greater than pure stands of either butterfly pea or rubber vine (Figure 1). At 0, 48 and 96 kg N ha^{-1}, shoot yields of pure stands of butterfly pea averaged 19.8, 21.1 and 20.8 t ha^{-1} compared to 12.7, 15.2, and 14.9 t ha^{-1} for rubber vine. Shoot yields of mixed stands over-yielded the highest yielding pure stand by 8%, 7% and 10% at 0, 48 and 96 kg N ha^{-1} respectively (Figure 1). This indicates that shoot yields of both species behaved competitively across all nitrogen levels (Figure 1).

Root yield Significantly ($P < 0.05$) greater root yields were detected in mixed stands of butterfly pea and rubber vine compared to pure stands of either species (Figure 1). At 0, 48 and 96 kg N ha^{-1}, root yields of pure stands of butterfly pea averaged 11.6, 12.0 and 13.3 t ha^{-1} compared to 10.7, 13.1 and 12.2 t ha^{-1} for rubber vine. Root yields of mixed stands over-yielded the highest yielding pure stand by 31%, 21% and 17% at 0, 48 and 96 kg N ha^{-1}. Root yields of both species behaved synergistically across all nitrogen levels (Figure 1).

DISCUSSION

In mixed stands, both rubber vine and butterfly pea avoided competition with each other at all nitrogen levels. This resulted in an over-yielding response in terms of shoot and root dry weights in all mixture combinations. The synergistic behaviour of the two species in mixed stands suggests that each species is affected more from intra- than from inter-specific competition. Other species mixtures such as *Festuca pratensis* Huds. and *Lolium perenne* L. were also shown to out-yield pure stands (Whittington and O'Brien 1968). The non-competitive behaviour of rubber vine towards butterfly pea was surprising because rubber vine is reported to be an aggressive species (Tomley 1995).

Increases in shoot dry weight yield of pure stands of both butterfly pea and rubber vine in response to increasing levels of nutrient availability concur with findings reported for other species such as *Protoea repens* (L) L. and *Acacia saligna* (Labill.) H.L.Wendl. when grown in isolation (Witkowski 1991). Pastoralists in central Queensland have been adopting butterfly pea as a long-term ley legume over the past few years due, in part, to more attractive beef markets compared with those for wheat (Pengelly and Conway 2000). Our results suggest that adoption of butterfly pea in the pasture system is likely to encourage the growth of rubber vine in North Qld due to their synergistic behaviour. The proliferation of other weeds, such as nodding

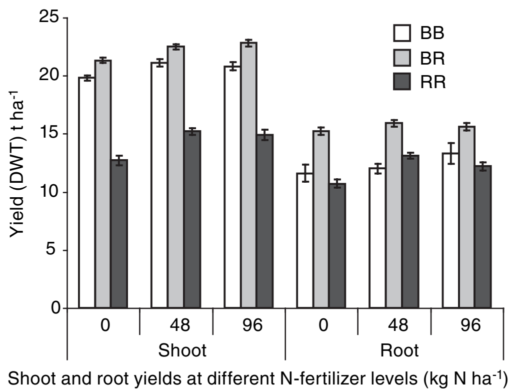

Figure 1. Shoot and root yield performance of pure stands of butterfly pea (BB) and rubber vine (RR) and five mixed stands of both species (BR) (irrespective of mix ratio) as affected by nitrogen level over 12 months. Bars indicate the SE of the mean.

thistle (*Carduus nutans* L.) in southern Australian pastures, was attributed to the addition of legumes in the pasture system (Popay and Medd 1995).

The findings of this study showed that during the early establishment phase, mixed stands of rubber vine and butterfly behaved synergistically under a broad range of potting mix N-levels. Increasing resource availability, particularly nitrogen, either by addition of N-based fertiliser or nitrogen fixing plants such as butterfly pea, is also expected to increase biomass production of pure stands of rubber vine. We recommend management practices that avoid introduction of both butterfly pea and nitrogen-based fertilisers in rubber vine-infested areas. Other pasture species, such as grasses, that may be competitive with rubber vine should be investigated to broaden control options for rubber vine infestations in riparian zones.

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