Herbicide and fertilizer application trials to improve production in Giant rat's tail grass (GRT) infested pastures.

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Summary Giant rat's tail grass (GRT) (*Sporobolus natalensis* (Steud.) T.Durand & Schinz and *S. pyramidalis P.Beauv.*) is an invasive weed of pastures. Conventional control efforts for GRT centre on pasture management, the use of chemical and mechanical control and plant competition. To improve management options, recent studies in south-east Queensland have focused on (a) better understanding the residual effects of the most widely used herbicide (flupropanate) and (b) fertilization to determine if it can enhance forage quality and utilization of GRT, particularly in high rainfall environments. In the herbicide trial, granular or liquid flupropanate were applied at label recommendation of 1500 g a.i. ha^{-1}, to mature GRT plants growing in one of five soil types and to pots containing soil only. Residue levels were monitored annually in both soil and in GRT for four years. In an initial ungrazed fertiliser trial eight rates of nitrogen (0 – 300 kg N ha^{-1}) were applied to a GRT infested setaria (*Setaria sphacelata (Schumach.) Stapf & C.E.Hubb.*) pasture. A second integrated trial was testing the combination of four fertiliser (0, 50, 100 and 200 kg N ha^{-1}) and two herbicide applications (± herbicide) under grazed conditions.

Irrespective of soil type, GRT plants in the herbicide trial contained 22±0.3% (granular) and 31±1.3% (liquid) of the applied flupropanate after 12 months, with levels dropping to <5% after 24 months. Flupropanate in the corresponding soil pots were 20±1.7% (granular) and 7±1.3% (liquid) after 12 months, with similar levels recorded after 24 months. No significant difference was observed between flupropanate formulations when applied to bare soil at 12 (83±3.3%) and 24 (73±1.8%) months after application. Whilst a range of plant response measurements are being undertaken in the fertilizer trials, in this paper we focus on changes in leaf tensile strength and differences in grazing patterns. GRT leaf material was found to have a much higher tensile strength than setaria, and it increased with maturity for GRT but not setaria. Increased fertilisation had a weak negative correlation (*P=0.065*) with leaf tensile strength. In the grazed trial, irrespective of fertilizer regimes, cattle introduced to 5-week-old regrowth tended to heavily graze both GRT and setaria over the first 2 weeks, particularly setaria which was grazed lower (24.1 cm) than GRT (38 cm). This has allowed wick wiper applications of a flupropanate + glyphosate based mixture to be applied to the taller GRT plants, with efficacy and non-target damage assessments the focus of on-going monitoring.

Keywords *Sporobolus natalensis*, GRT, fertilising, nutrition, flupropanate, tensile strength.

INTRODUCTION

Sporobolus natalensis and *Sporobolus pyramidalis*, commonly known as Giant rat's tail grass (GRT) is an invasive weed of pastures, natural reserves, forestry and utilities with the capacity to reduce the productivity of agricultural land, decrease land value, reduce the biodiversity of natural ecosystems and increase control expenses to non-sustainable levels (Simon and Jacobs 1999). The grasses are of extremely low palatability and high tensile strength, and when tussocks are mature, livestock generally avoid utilising the plant. GRT was introduced into Australia through contaminated seed, with *S. pyramidalis* now widespread from Cooktown in north Queensland and south to the New South Wales Central Coast, whilst *S. natalensis* is found widespread from Rockhampton in central Queensland to Port Macquarie on the mid north coast of NSW (AVH 2017). Populations of both species are present in the Northern Territory (AVH

2017). The importance of these species is reflected in both being Weeds of National Significance with estimated annual losses of $60 million per annum to the cattle industry in northern Australia.

Current control efforts for GRT center on the use of chemical and mechanical control, plant competition and pasture management. Despite the production of a best practice manual for GRT management, control has not been achieved and GRT continues to spread into new areas. This paper reports on recent studies in south-east Queensland aimed at better understanding the residual effects of the most widely used herbicide (flupropanate) and determining if fertilisation can enhance forage quality and utilization of GRT, as part of an integrated management approach.

MATERIALS AND METHODS

Flupropanate potted trial A 5 × 2 × 3 factorial experiment was undertaken using a complete randomised design and four replications. Factor A was five contrasting soil types (chromosol, dermosol, ferrosol, kurosol and vertosol) assigned to main plots, factor B was two pasture treatments (GRT, bare ground) assigned to subplots, and factor C was three herbicide treatments (nil, liquid, granular) assigned to sub-subplots.

The different agricultural soils were collected from locations in south-east Queensland known to sustain GRT populations (AVH 2017). At each site ~950 kg of soil was mechanically removed by scraping the top 10 cm of soil from a 5 m × 5 m area. The soil was transported to the Ecoscience Precinct (ESP) at Dutton Park where it was sieved through a 2 mm mesh.

Mature GRT plants (*S. natalensis*) were collected from a cattle property near Conondale, Queensland (26°42'53"S; 152°41'51"E) and transported to ESP. There they were separated into single tillers containing an established root system and placed in 4 L pots filled with 4000 g of oven dry equivalent soil from each of the five selected soil types. Plants were then grown for two months in a glasshouse prior to herbicide application. No inflorescences were present at the time of spraying. Throughout the entire experiment each pot was maintained at 40% soil moisture content, which provided sufficient water for plant growth and microbial activity without the leaching of any herbicide from the pot.

The liquid herbicide application of flupropanate (1564 g a.i. ha^{-1}) (Grow Choice Tussock™ Herbicide) was applied using a 12 V electric powered fine air compressor unit (Iwata Studio Series) with 0.35 mm nozzle and operating pressure of 1 mPa. Each plant was sprayed just prior to the point of run-off (~400 L ha^{-1}), with the fine nozzle and a spray guard attachment ensuring the solution was applied directly to the plant without any contamination to the soil. For granular application, a 5 ml vial containing a perforated lid was used to uniformly apply granular flupropanate (1564 g a.i. ha^{-1}) (Granular Products GP Flupropanate Granular Herbicide) to the soil surface. Bare ground pots were also treated to a uniform application of both liquid and granular formulation of flupropanate. The concentration rate used in this experiment was based on the recommended application rate of flupropanate for GRT control given on the label.

At three, six, 12, 24 and 48 months post-herbicide treatment, 24 samples for each soil type were randomly selected for flupropanate determination. Data for 12 and 24 months only are shown in this paper. The soil from each pot was removed, passed through a 2 mm sieve and mixed thoroughly to ensure that the sample was uniform. A 200 g subsample was then removed from each pot for flupropanate soil analysis and delivered to the Department of Environment and Science, Chemistry Centre at ESP.

At the designated sampling times, GRT plants were also removed from each pot and their fresh weight recorded before placing the samples in a drying chamber set at 25°C. A lower temperature was selected to avoid potential heat impacts with the herbicide. The plant samples remained in the drying chamber for 10-14 days. Once the samples were dry, they were processed through a 200 V electric plant grinder (Culatti Type MFC), using a 0.5 mm mesh and delivered to the Chemistry Centre at ESP for flupropanate residue determination.

Soil and plant data was statistically analysed using ANOVA, but beforehand it was transformed using an arcsine transformation. If significant treatment differences were detected ($P<0.05$), the means were separated using Fishers' Protected Least Significant Difference (LSD) test. Data was back transformed for presentation.

Fertiliser trials The field site was located near Mapleton (26°62'S; 152°87'E) and comprised a dense infestation of GRT (average of 2 ± 0.07 plants m^{-2}) within a setaria based pasture (*Setaria sphacelata (Schumach.) Stapf & C.E.Hubb.*). In February 2022 a randomized complete block experiment was established with eight treatments each replicated three times. Experimental units were 5 m × 4 m plots with a 2 m buffer between blocks. Treatments comprised eight rates of nitrogen (0, 25, 50, 75, 100, 150, 200 and 300 kg N ha^{-1}). Initially the trial site was fenced (to exclude grazing), slashed and all cut material removed from each plot. Plots were then fertilized, which entailed an initial base application of Diammonium phosphate (DAP; 138.89 kg ha^{-1}) followed by the addition of Urea to achieve the designated rates of nitrogen. Fertiliser was applied using a handheld Ozito® spreader. Whilst a range of plant response measurements are being undertaken, in this paper we focus on changes in leaf tensile strength between GRT and setaria at 5 and 9 weeks after slashing and fertilization. This was achieved by testing a minimum of five leaves of each species per plot using a device developed by Dr. Marcelo Benvenutti (Queensland Department of Agriculture and Fisheries, Gatton, QLD, Australia) to replicate the way cattle grip and tear grass material during grazing.

A second integrated trial is testing the combination of four fertiliser (0, 50, 100 and 200 kg N ha^{-1}) and two herbicide applications (±herbicide) under grazed conditions. It comprises a split plot design, with fertilizer treatments allocated to main plots and herbicide applications to sub plots. Each treatment is replicated three times and experimental units comprise 3 m × 5 m plots, with a 1-2 m buffer between blocks. In February 2022 the site was slashed and fertilized using a similar procedure to trial 1. Cattle were excluded for the first five weeks, but then given access to graze the trial, which was located in a 52.6 ha paddock stocked with 70 animals, giving an overall stocking rate of 1 animal 0.75 ha^{-1}. Herbicide treatments were implemented on 19 April 2022 using a customised wick wiper device to apply a herbicide mixture containing 150 g a.i. glyphosate plus 81 g a.i. flupropanate L^{-1}. In this paper we focus on whether there were differential grazing responses between fertilizer treatments prior to the application of herbicides. This was achieved by measuring weekly changes in height of five GRT and five setaria plants permanently located in each plot, except for week 1 when flooding prevented access to the site. Data from both trials was statistically analysed using ANOVA and if significant differences (*P<0.05*) occurred the means were separated using Fishers' Protected Least Significant Difference (LSD) test. Regression analysis was also undertaken to determine the response of fertilization on leaf tensile strength of GRT and setaria.

RESULTS

Flupropanate potted trial No significant difference was observed between soil types for the 12- and 24-month residue analysis. However, the decline in flupropanate irrespective of formulation between 12 (61.2%) and 24 (46.2%) months was significant (*P<0.0005*). Irrespective of time, more than double the amount of flupropanate was recovered in bare soil only pots (77.6%) compared to planted pots (soil plus plant material) (29.8%) Figure 1). The percentage of total flupropanate recovered when applied as a granular application (58.7%) was significantly higher (*P<0.021*) when compared to a liquid application (48.8%), irrespective of soil type, time and pot treatment (Figure 1).

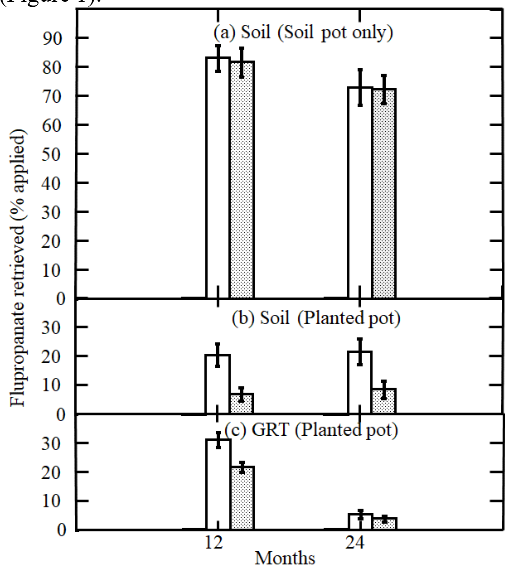

Figure 1. Percentage of applied flupropanate retrieved in soil where plants were excluded (a), and planted pots (b) in soil and (c) within the GRT plant when treated with granular (□) and liquid (▩) flupropanate, at 12 and 24 months post-herbicide application, irrespective of soil type. Error bars represent standard error of the mean.

Fertiliser trials Overall, GRT leaf material was found to have a significantly higher tensile strength (*P<0.05*) than setaria (Figure 2). Age of regrowth (*P<0.05*) also had a significant effect for GRT but not setaria, with 5-week-old regrowth recording lower leaf tensile strengths than the mature 9-week regrowth (Figure 2). Increased fertilisation had a weak negative correlation with leaf tensile strength (*P=0.065*) (Figure 2).

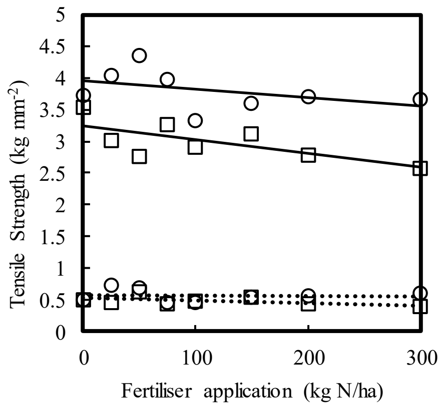

Figure 2. Relationship between leaf tensile strength and fertilizer application of 5 (□) and 9 (O) week old regrowth of GRT (solid line) and setaria (dotted line).

In the grazed trial, initially there was a significant plant height difference (*P<0.05*) between fertilizer treatments for setaria (Figure 3), but not GRT (*P>0.05*). The unfertilized control treatment tended to have the shortest setaria plants (54.2 cm), while the two highest fertilizer treatments had the tallest plants (71.7 to 77.3 cm). GRT averaged 67.9 cm across all fertiliser treatments. Following the introduction of cattle, both GRT and setaria were grazed heavily over the first 2 weeks, particularly setaria which was grazed lower than GRT. At this stage, GRT and setaria averaged 38 and 24.1 cm respectively, with no significant differences (*P>0.05*) between fertilizer treatments. Only small reductions in plant height occurred over the following four-week period, with GRT and Setaria averaging 34.2 and 16.7 cm after six weeks grazing, respectively (Figure 3).

DISCUSSION

While the integrated fertilizer and herbicide trial under grazed conditions is ongoing, the results reported above provide some valuable insights for the integrated management of GRT. Flupropanate is thought to be mostly absorbed through the root system, and when applied to foliage is reliant on rain to be washed onto the soil for root uptake. Results here suggest flupropanate can also be absorbed through the green or actively growing foliage of GRT, translocated to the roots and exuded into the soil, albeit <10% of applied is found in the soil. Despite having higher leaf tensile strengths than setaria, cattle readily consumed 5-week-old regrowth of both setaria and GRT. However, they had a tendency to graze setaria lower to the ground (i.e. 16.7 versus 34.2 cm after 6 weeks grazing) which provides a point of differentiation for subsequent herbicide applications to control GRT using wick wiper style equipment. If flupropanate is included in wick wiper herbicide mixtures it has the potential to provide some residual control of GRT. Despite a slight reduction in the leaf tensile strength of GRT ongoing measurements (e.g. nutritional analysis) and monitoring is required to determine any benefits of fertilization in high rainfall environments.

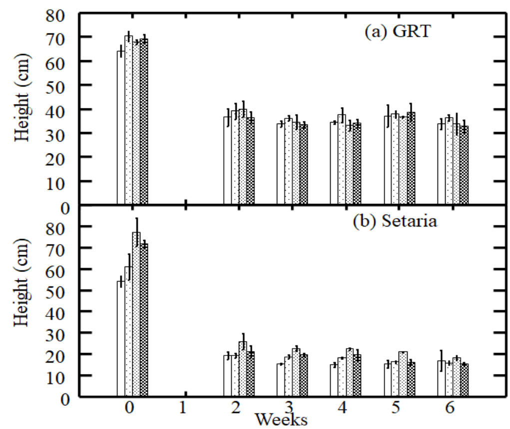

Figure 3. Influence of different nitrogen rates [unfertilised control (□), 50 (□), 100 (□), and 200 (▩) kg N ha^{-1}] to weekly height (cm) measurements of (a) GRT and (b) Setaria. Error bars represent standard error of the mean.

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REFERENCES

AVH 2017. Atlas of Living Australia (AVH). Australia's Virtual Herbarium, Council of Heads of Australasian Herbaria. Available at: http://avh.chah.org.au

Simon, B.K and Jacobs, S.W.L. (1999). Revision of the Genus *Sporobolus* (Poaceae, Chloridoideae) in Australia. *Australian Systematic Botany* 12,375-448.