Impact of claying on grass weed management and profitability

John Blake[1] and Sally Peltzer[2]
[1] Centre for Cropping Systems, Box 483, Northam, Western Australia 6401, Australia
[2] Department of Agriculture of Western Australia, Albany, Western Australia 6330, Australia

Summary Two trials that include studies on the impact of claying on grass weed seedbanks are reported. The first is an intensive research trial on the seedbank longevity of annual ryegrass (*Lolium rigidum* Gaud.) and is situated at Esperance Downs Research Station in the southern region of Western Australia. The second is a broadscale trial undertaken with the Lake Mears TopCrop Research Group in the central wheatbelt of Western Australia.

The results have been encouraging across the two very different environments with claying of non wetting soils providing significant up to 64% increase in emergence of grass weeds at the break of season and up to 52% increased control of grass weeds in crop. The grower group observations on the impact of claying in grass weed management are consistent with the results from these trials.

The systems benefits for integrated weed management are significant and need to be factored into any economic assessment of ameliorative treatments for non-wetting sands. The yield and grain quality benefits from claying were significant in the rotation.
Keywords Claying, resistance, weed seedbanks.

INTRODUCTION

Non-wetting soils cover over two million hectares in Western Australia. Water-repellent soils can delay seeding and therefore shorten the growing season as well as aggravate land degradation (Carter *et al*. 1998) In the southern and central regions of the agricultural areas of Western Australia some success with treating non-wetting sands with clay has been achieved.

Grower groups including the Lake Mears TopCrop Research group (Brookton, WA) and the Corrigin Farm Improvement Group have reported weed management problems with paddock areas that have become non-wetting. The unreliability of pre-emergents on these areas has meant high use of both pre-emergent and post-emergent herbicides. Growers consider that this results in those paddocks with non-wetting areas developing grass weed banks with chemical resistance at a faster rate.

The impact of soil ameliorative treatments (claying, soil wetters and furrow sowing) on weed emergence and crop production was investigated. A research trial at Esperance examined the impact of tillage on weed emergence and subsequent seedbank decline and a broadscale trial at Brookton involving a no-till system studied both weed emergence and crop production. The trials were separate investigations with different designs but are complimentary.

MATERIALS AND METHODS

Trial 1 – Esperance Downs Research Station The seedbank longevity of annual ryegrass (*Lolium rigidum* Gaud.) in non-wetting sands was measured at Esperance, Western Australia (33.8°S, 121.9°E, annual rainfall 619 mm). The field trial commenced in 2001 and was part of a long-term study into the seedbank longevity of a variety of cropping weeds.

The trial had four treatments (uncultivated, tilled to a depth of 5 cm, tilled plus 100 L soil wetter ha^{-1} and tilled plus 100 tonnes subsoil clay ha^{-1} in a complete randomised block design with four replicates. Seedling emergence was counted every 4–6 weeks after the break of the season. The trial was similar in design and method to those presented in this publication (see Peltzer and Matson 2002 for further details).

Trial 2 – Brookton, WA This was a broadscale trial with the Lake Mears grower group, Brookton, WA. The objective was to measure the response in crop yield, grain quality, and grass weed management to various treatments for ameliorating non-wetting sands. The grass weeds are annual ryegrass (*Lolium rigidum* Gaud.) and brome grass (*Bromus diandrus* Roth.) The broadscale trial design was to enable the use of farm-scale equipment in a trial area of four hectares with each plot 0.25 ha in size. The four treatments were:

1. Control.
2. Clay spread at 100 t ha^{-1}.
3. Clay spread at 200 t ha^{-1}.
4. Furrow seeding with press wheels.

There were four replicates.

The pre-sowing treatments included Spray.Seed™ at 0.5 L ha^{-1} and trifluralin at 1.6 L ha^{-1} (plus Roundup™ at 0.8 L ha^{-1}, pre-season). The trial was sown to Wheat (cv. Brookton) in 2000 and Barley (cv. Stirling) in 2001. The clay treatments were applied April 2000 and measurements commenced in May 2000.

RESULTS

Trial 1 – Esperance Cultivating the soil increased the emergence of annual ryegrass seedlings by over 30% (Figure 1) (P <0.05). The treatments imposed to ameliorate non-wetting, tilled plus wetter and tilled plus clay, further increased their emergence by 25 and 64% respectively (P <0.05).

Trial 2 – Brookton WA This trial commenced in March 2000 and the claying treatments were applied to lupin stubble in April 2000. In the first year there was no response to any of the treatments in the wheat crop partly because the 2000 season had an exceptionally dry (decile 1) finish.

In the second year (2001), claying the soil increased the number of emergent weeds prior to seeding (Figure 2) (P <0.05). There was no effect of furrow-sowing. This was the barley phase of the rotation. The autumn-early winter crop establishment phase had a dry period following limited early rains.

There were substantially reduced grass weed levels across all of the treatments within the crop at anthesis in both 2000 and 2001 (Figure 3). In 2000, there was no difference in the number of grass weeds at anthesis in the clayed treatments compared to the control (Figure 3) (P <0.05). In 2001, the number of grass weeds at anthesis was less in the clay treatments than in either the furrow-sown treatment or the control (Figure 3) (P <0.05). The vigour of the grass weed plants was highest in the unclayed areas where there was low crop density (Figure 4) and less competition. This was observed but not measured and will now be measured from the 2002 season onwards.

The higher rates of clay (above 100 t ha^{-1} of clay) appeared to have slightly less weeds than the 200 t ha^{-1} rate, however this was not significant. These trends maybe dependent on the rainfall distribution and the size of the germinating rains.

In 2000, there was no difference in the crop establishment of wheat between the treatments (Figure 4). In 2001, there were low barley densities in the unclayed areas compared to those that were clayed (P <0.05). These plants were associated with staggered emergence, low establishment percentage (measured at the post-crop tillering stage) and lowered crop vigour resulting in lower yields (Figure 5). The grain yield responses to the ameliorative treatments were highly significant in the second year (Figure 5). There were decreased grain screenings in the barley with claying (Figure 6).

Applying an expensive ameliorative treatments such as claying had a one off expenditure of \$167 ha^{-1} but represented a long term investment. Claying lasts well over 10 years (Dan Carter pers. comm.). Applying

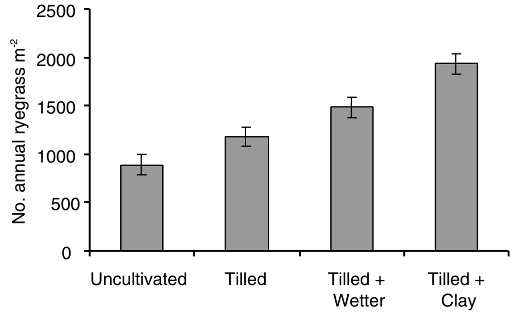

Figure 1. The number of emergent annual ryegrass seedlings, either tilled, tilled plus wetter, tilled plus clay or left uncultivated (mean of four replicates). (LSD = 327) (P = 0.05).

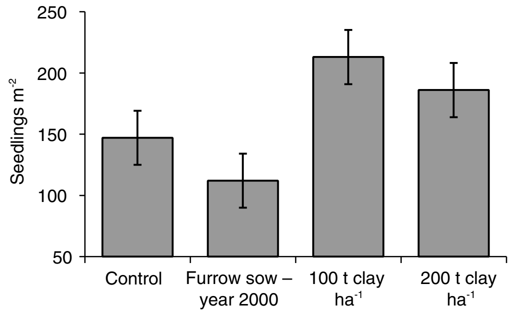

Figure 2. The number of emergent grass weed seedlings (annual ryegrass and brome grass), in plots either pre-treated with two levels of clay, furrow-sown or left untreated (mean of four replicates) (LSD = 49) (P = 0.05).

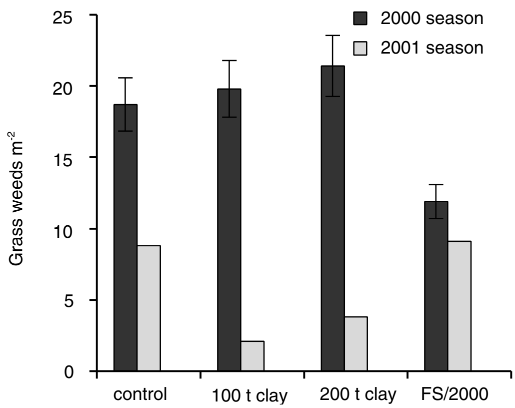

Figure 3. The number of grass weeds at anthesis in plots either pre-treated with two levels of clay, furrow-sown or left untreated (mean of four replicates) (LSD = 4.29) (P = 0.05).

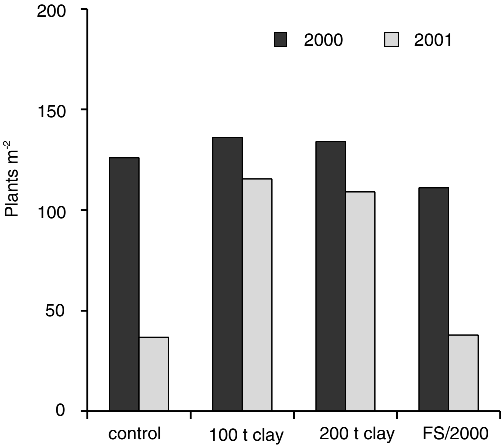

Figure 4. Cereal establishment (wheat in 2000 and barley in 2001 (plants m^{-2})) in response to treatment of non-wetting sands (mean of four replicates). LSD = 27.4.

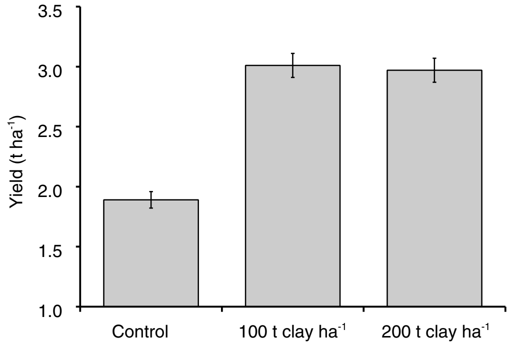

Figure 5. Barley yield in response to treatment of non-wetting sands include claying as ameliorative treatment. (mean of four replicates), (LSD = 247 kg ha^{-1}) (P = 0.05).

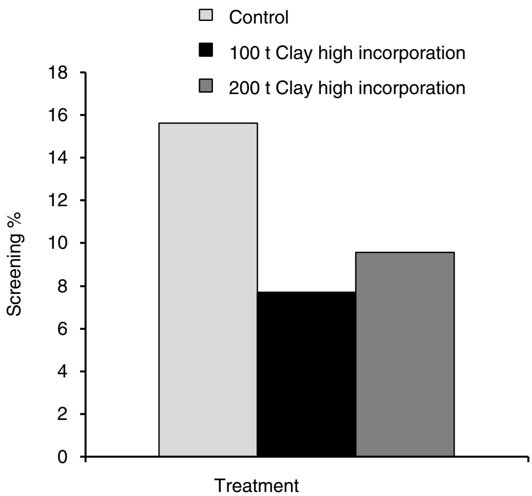

Figure 6. Barley screenings (per cent) in response to claying (mean of four replicates). LSD = 2.71% in per cent of screenings.

and incorporating 100 t ha^{-1} of clay had a cost year^{-1} of $21.65 (annualised over 10 years) but nonetheless substantially increased the rotational gross margins compared to the control.

DISCUSSION

Non-wetting can result in pockets of dry soil after the opening rains and can represent a significant crop management challenge including in the area of grass weed management.

The addition of clay to ameliorate non-wetting increased the number of annual ryegrass seedlings that emerged at Esperance. There was also an increase in grass weed emergence after the break of the season but before sowing at Brookton with the addition of clay. This with appropriate weed control related to less weeds within the crop during the growing season.

External water is essential for seed germination mainly for seed imbibition (Egley 1986). If the soil is not evenly wet then some non-dormant but viable seed will not germinate. Under normal soil wet conditions, the decline of annual ryegrass from the seedbank is approximately 80% (Peltzer and Matson 2002). If there are pockets of dry soil that do not wet up, then the annual ryegrass seeds are likely to remain dormant and the seedbank decline rate is expected to fall (W. Roy pers. comm.). In 2001, claying also substantially increased the plant density of barley. The crop establishment of wheat did not differ between the treatments in 2000, indicating that either the effect of claying did not occur until the second year or that 2000 was too dry for the effects of ameliorating non-wetting to show up. In observations, grass weeds ‘filled the gap’ and became more vigorous in the untreated and water-repellent plots. This was due to low and varied crop establishment and resulted in the crop being less competitive with the background grass weed population (Department of Agriculture 1993).

The addition of a soil wetter increased the emergence of annual ryegrass at Esperance but not to the same extent as the clay. It is likely that the wetter had a slight herbicidal action on the emerging seedlings due to the timing of application (Dan Carter pers. comm.). Tillage increased the number of seedlings compared to the uncultivated treatment at Esperance. Tillage increased germination in the first year after seed set in a seedbank study in Western Australia due likely to breaking of light and dark dormancy (Peltzer and Matson 2002).

Furrow sowing is another method of managing water-repellent soils. A furrow is a groove in the soil surface and sowing into it can place the seed in or near more consistently wet soil (Department of Agriculture 1997). Furrow sowing in 2000 realised a small decrease in in-crop weeds possibly due the grading of weed seeds into the dry ridges where the weed seeds did not wet up. Furrow-seeding was not repeated in 2001 and these plots in 2001 behaved similarly to the untreated plots and had lower weed seed and crop germination.

At Brookton there were higher barley yields and better quality grain in the clayed treatments. This is partly due to the reduced competition with weeds. The number of brome grass and annual ryegrass was less than 20 m^{-2} in all of the treatments but were more vigorous in the unclayed plots. This could relate to a reduction in yield up to 30% (Moore and Moore 2002). It is more likely however, that the higher yields of barley relate to better crop establishment and amelioration of non-wetting (Carter *et al*. 1998). The recommended plant density for barley is 100 plants m^{-2} for maximum yield (Department of Agriculture 1995) which occurred in the clayed treatments. There were less than 40 m^{-2} plants in the unclayed plots. The increased screenings associated with the unclayed plots could be due to the decreased water relations at the end of the growing season (Dan Carter pers. comm.). These plants also had to compete with weeds for water at the end of the season. These increased screenings could also be related to the more uneven and later emergence of the crop or various chemical differences, for example, increased cation exchange capacity with claying.

Increased yields, decreased screenings and decreased weed numbers all related to higher profits.

ACKNOWLEDGMENTS

We are grateful to GRDC for providing the funding for both studies. We would like to thank Tammy Witt and staff from the Esperance Downs Research Station for their assistance in the maintenance of the seedbank trial. We would especially like to thank Daya Patabendige (WADA) who established the Brookton trial, Kim Wilkinson for managing the trial on his property and also the grower groups who have contributed to the study in the Central wheatbelt.

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