# EFFECT OF CROP ESTABLISHMENT METHOD AND HERBICIDE USE ON SORREL POPULATIONS IN WHEAT

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Summary. On an acid, duplex soil in N.E. Victoria direct drilling of wheat after application of paraquat plus diquat (250 to 500 g $ha^{-1}$ plus 125 to 250 g $ha^{-1}$) resulted in sorrel populations of 183, 150 and 50 plants $m^{-2}$ in 1981, 1982 and 1983 respectively, when measured near crop maturity. Populations were reduced to 132, 78 and 7 plants $m^{-2}$ respectively where the above treatment was followed by dicamba 140 g $ha^{-1}$ plus 2,4-D amine 350 g $ha^{-1}$ applied in the wheat crop. If glyphosate 540 g $ha^{-1}$ plus dicamba 140 g $ha^{-1}$ was used before direct drilling, and dicamba plus 2,4-D used in the crop, populations were 108, 16 and 21 plants $m^{-2}$ respectively. Cropping after conventional cultivation resulted in a steady increase in sorrel population from 77 to 136 plants $m^{-2}$ over the 3 year period. Cultivation followed by use of dicamba plus 2,4-D in the crop reduced densities to 48, 33 and 20 plants $m^{-2}$ respectively.

## INTRODUCTION

Sorrel (*Rumex acetosella*) is a common weed in cereal crops in the higher rainfall cropping areas of north-east Victoria and in other parts of the State, such as the south-west (Velthuis and Amor,1982). It appears to have increased in recent years as a problem weed in crops, particularly in association with direct drilling after use of paraquat plus diquat, a method of crop establishment now widely used in the north-east.

Sorrel is a difficult weed to control. It is a perennial with an extensive horizontal rooting system, and to control an infestation this root system must be killed. In addition, plants can be produced from seed.

In view of the apparent association of sorrel with certain crop establishment systems an experiment was established in 1981, near Rutherglen, in north-east Victoria, to look at the effect over several seasons, of different crop establishment methods and herbicide usage on sorrel populations.

## MATERIALS AND METHODS

The experiment was located in a paddock where a heavy infestation of sorrel in pasture had been established for some years.

Soil on the site was a hard yellow duplex type, similar to Rutherglen loam, type A (Poutsma and Skene, 1961). Table 1 gives various soil characteristics as determined in July 1982.

Table 1 Soil characteristics of the experimental site, July 1982

| | pH | Total N (%) | Org. C (%) | Exch. Mn (ppm) | Exch. Al (ppm) | Exch. cations (m.e./100 g) | | | | | Bulk Density (g/cc) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | $Ca^{++}$ | $Mg^{++}$ | $Na^{+}$ | $K^{+}$ | $H^{+}$ | |
| 0-7.5 cm | 5.3 | 0.12 | 1.5 | 61 | 39 | 0.9 | 0.3 | <0.1 | 0.6 | 8.1 | 1.26 |
| 7.5-15 cm | 4.9 | 0.07 | 0.7 | 71 | 69 | 0.8 | 0.13 | <0.1 | 0.3 | 6.3 | 1.62 |

Treatments in the experiment are shown in Table 2, and were repeated on the same plot each year.

Wheat was sown into a cultivated seedbed (C), or was direct drilled (DD), using a combine with cultivation points removed and narrow points (40 to 60 mm) fitted to sowing tynes. Cultivated seedbeds were prepared by two passes of a scarifier, commencing one to four weeks before sowing or with two to four passes, commencing six to eight weeks before sowing. In addition both methods included a final pass with heavy harrows. One cultivation with an off-set disc was used to breakup clods and sorrel roots in 1981.

On direct drilled treatments, sorrel and other weeds present before sowing were controlled with paraquat plus diquat (p+d) at 250 g plus 125 g $ha^{-1}$ (1981), 500 g plus 250 g $ha^{-1}$ (1982) or 375 g plus 188 g $ha^{-1}$ (1983); or, paraquat plus diquat as above, with dicamba at 140 g $ha^{-1}$ (p+d + dic.); or, glyphosate (gly) at 540 g $ha^{-1}$ plus dicamba at 140 g $ha^{-1}$; or, 2,4-D amine at 500 g $ha^{-1}$ plus dicamba at 140 g $ha^{-1}$, followed by paraquat plus diquat at the above rates. Treatments containing paraquat and diquat were applied six to ten days before sowing, all others were applied 15 to 21 days before.

Wheat was sown in May or June each year. Cultivars were Kewell (1981), Oxley (1982) and Millewa (1983).

In some treatments wheat was sprayed (W sp'd) at the early to mid tillering stage with dicamba at 140 g plus 2,4-D amine 350 g $ha^{-1}$ to control sorrel in the crop.

Treatments were in randomized blocks with four replicates; plot size was 16 m by 4 m. Herbicides were applied in 80 l of water $ha^{-1}$ at 210 K Pa.

Sorrel populations were counted in 10 to 16, 25 by 25cm samples per plot, before and after herbicide treatment in the wheat crop, and in April 1982 to 1984 as a measure of the effect of previous seasons treatments on sorrel regeneration in autumn. The count in April was not made on the six to eight week cultivation treatment because working had already commenced. Sorrel populations were also counted across direct drilled plots in early June 1981, before the experiment started.

Within each year sorrel plants grew from both roots and seed. Plants growing from roots, and the associated root systems were the main target of control measures, but plants from seed were also important because they had the potential to establish a new infestation. Because of the difference in their significance both types were counted separately where possible. As plants grew larger towards the end of the season it was more difficult to tell the difference between the types (seedlings were identified by the presence of cotelydon leaves) and both were counted together in November 1981 and September 1983. In this paper plants growing from seed are referred to as seedlings (sdgs) while plants from roots, or well established plants from either source are referred to as rosettes (ros). Sorrel plants growing from roots often grew in dense clumps. Individual shoots were counted as separate plants where possible, but separating clumps was often difficult, particularly at the last count each year, and some counting error may have occurred.

The effect of treatments on sorrel flower number was estimated in November 1981 and 1982 and December 1983 from a count of flower panicles in three $m^2$ samples per plot, and counts of the average number of flowers per panicle for each treatment.

Table 2 Effect of crop establishment method and herbicides on sorrel, 1981 to 1984

| Treatments* | Sorrel $m^2$, 1981 | | | Sorrel $m^2$, 1982 | | | | | | Sorrel $m^2$, 1983 | | | | | Sorrel $m^2$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 13 Aug | | 5 Nov | 29 April | | 19 Aug | | 4 Oct | | 22 April | | 13 July | | 7 Sept | 16 April 1984 |
| | ROS** | SDG** | | ROS | SDG | ROS | SDG | ROS | SDG | ROS | SDG | ROS | SDG | | (ROS) |
| 1. C 1-4 wks | 162 | 165 | 77 | 132 | 49 | 147 | 139 | 112 | 146 | 15 | 107 | 8 | 158 | 136 | 329 |
| 2. C 1-4 wks,W sp'd | | | 48 | 77 | 47 | 139 | 106 | 33 | 36 | 3 | 78 | 3 | 101 | 20 | 127 |
| 3. C 6-8 wks | 102 | 149 | 50 | - | - | 180 | 146 | 129 | 112 | - | - | 2 | 160 | 107 | - |
| 4. C 6-8 wks,W sp'd | | | 33 | - | - | 68 | 46 | 24 | 17 | - | - | 1 | 60 | 18 | - |
| 5. DD,p + d | 170 | 168 | 183 | 257 | 168 | 298 | 116 | 150 | 77 | 10 | 255 | 3 | 50 | 50 | 329 |
| 6. DD,p + d,W sp'd | | | 132 | 174 | 113 | 194 | 75 | 78 | 7 | 6 | 116 | 1 | 33 | 7 | 157 |
| 7. DD,p + d + dic, W sp'd | 120 | 100 | 99 | 180 | 114 | 191 | 84 | 60 | 5 | 10 | 135 | 0 | 38 | 5 | 144 |
| 8. DD,gly + dic, W sp'd | 41 | 168 | 108 | 60 | 316 | 160 | 141 | 16 | 6 | 2 | 164 | 1 | 204 | 21 | 181 |
| 9. DD, 2,4-D + dic, p + d,W sp'd | 66 | 226 | 133 | 172 | 335 | 150 | 84 | 38 | 20 | 3 | 122 | 0 | 100 | 10 | 73 |
| LSD (P=0.05) | 72 | NSD | 89 | 77 | 200 | NSD | NSD | 51 | 62 | NSD | NSD | NSD | 106 | 31 | 125 |

* C 1-4 wks = cultivated, first pass 1 to 4 weeks before sowing
C 6-8 wks = cultivated, first pass 6 to 8 weeks before sowing
DD = direct drilled with narrow point combine, cultivating tynes lifted
p + d = Paraquat plus diquat )
gly + dic = glyphosate plus dicamba ) See materials and methods heading for rates
W sp'd = wheat crop sprayed at early to mid tillering with dicamba 140 g $ha^{-1}$ plus 2,4-D 350 g $ha^{-1}$

** ROS = rosettes (established plants and plants growing from rootstocks)
SDG = seelings (distinguished by presence of cotelydon leaves)

April counts were made before seasonal treatments were imposed, July/Aug count before in-crop spraying and Sept, Oct and Nov count after in-crop spray had taken effect.

Wheat grain yields from the whole plots were obtained with a Hege harvester in 1982 and 1983.

## RESULTS

Sorrel population. Sorrel densities from 1981 to April 1984 are shown in Table 2.

Densities measured across the site in early June 1981 before treatments were commenced were 320 rosette plants $m^{-2}$ and 200 seedlings $m^{-2}$.

Differences in populations were not statistically significant for some times of counting, despite fairly large differences (e.g. August 1982). This lack of significant differences was due largely to high variability across replicates.

Sorrel flower production. Sorrel flower counts are shown in Table 3. These figures are intended as an indication of the effect of treatments on sorrel seed production, and plant vigour.

Grain yields. Yields for 1982 and 1983 are shown in Table 3. Yields were very low in 1982 due to a dry season. In 1981, yields were not measured due to the effects of waterlogging on the crop.

Table 3 Effect of treatments on production of sorrel flowers and on crop yields

| Treatments* | Sorrel flowers/$m^{-2}$** | | | Crop Yield (t $ha^{-1}$) | |
|---|---|---|---|---|---|
| | 1981 | 1982 | 1983 | 1982 | 1983 |
| 1. C 1-4 wks | 4,500 | 20 | 680 | 0.48 | 0.92 |
| 2. C 1-4 wks, W sp'd | 650 | 0 | 35 | 0.31 | 1.04 |
| 3. C 6-8 wks | 1,500 | 15 | 580 | 0.57 | 0.94 |
| 4. C 6-8 wks, W sp'd | 140 | 0 | 15 | 0.42 | 1.05 |
| 5. DD, p + d | 11,400 | 400 | 550 | 0.12 | 0.64 |
| 6. DD, p + d, W sp'd | 3,000 | 15 | 40 | 0.22 | 0.89 |
| 7. DD, p + d + dic, W sp'd | 3,450 | 0 | 5 | 0.20 | 0.76 |
| 8. DD, gly + dic, W sp'd | 400 | 0 | 3 | 0.21 | 0.75 |
| 9. DD, 2,4-D + dic, p + d, W sp'd | 740 | 1 | 10 | 0.38 | 0.92 |
| LSD (P=0.05) | - | - | - | 0.19 | NSD |

** Flower numbers are calculated from a count of flowering panicles in 3, $m^{-2}$ samples/plot, and average flowers per panicle for each treatment in November 1981 and 1982 and December 1983.

* Refer to Table 2 for treatment abbreviations

## DISCUSSION

Direct drilling after use of paraquat plus diquat resulted in the highest sorrel rosette densities at most times of counting, although by 1984 densities were also high with cultivation alone.

Spraying of sorrel in the wheat crop with dicamba plus 2,4-D resulted in significant population reductions at most times of counting regardless of prior treatment. The ability of sorrel to flower was also reduced.

The use of glyphosate plus dicamba instead of paraquat plus diquat before direct drilling, resulted in considerably lower sorrel rosette populations at several counts. Although there is a lack of significant difference in counts at November 1981, there was a big difference in sorrel flower production.

These results indicate glyphosate plus dicamba is the most appropriate treatment for pre-sowing control of sorrel in direct drilled seedbeds, particularly if grass weeds are also present. The long term effect of this treatment (or any others) in reducing the sorrel infestation is questionable, however as despite a significant reduction in April 1982, the sorrel densities in April 1984 were still very high.

The effect of using glyphosate plus dicamba or any other pre-sowing treatment except paraquat plus diquat without the follow-up herbicide treatment in the crop cannot be assessed in this experiment, but previous work has indicated that combinations of both treatments are important (Code, unpublished data). The importance of this treatment in the wheat crop is also clearly indicated by reductions in sorrel population counts and flower production figures where herbicide was used in the crop. This occurred in both cultivated and direct drilled treatments.

The addition of dicamba to paraquat plus diquat did not give any significant improvement in control of sorrel, and the use of 2,4-D plus dicamba before sowing was generally not much better than using paraquat plus diquat alone, but could be a worthwhile treatment where there are no grass weeds to be controlled before sowing.

Cultivation had some effect on the sorrel population, presumably by disturbing roots and bringing them to the soil surface where they were dried out, and by burying emerged plants. However this did not always result in a long term effect as indicated by the counts in October 1982, September 1983 and April 1984. There was no significant difference between the two cultivation timings.

The low sorrel rosette numbers in 1983 and high numbers the following April in 1984 are noteworthy. The low numbers in 1983 could be a response to dry conditions in the previous year, and the return back to relatively high numbers by April 1984 could be due to a wet summer for 1983/84.

A wide spread of seed germination occurred when conditions were suitable. In 1981 heavy rains occurred through winter and spring, and flushes of sorrel seedlings were observed emerging from the first count, in June, up until late September. Dormancy in sorrel seed for several years has been reported (Madsen, 1962), consequently a spread of germination over several years could also be expected. Germination spread within seasons and over several years would assist the plant to survive control measures.

The poor crop yields obtained in the experiment were due largely to soil factors. The low soil pH and content of exchangeable magnesium, the high content of manganese and aluminium and the fairly high bulk density below 7.5 cm at this site (Table 1) would not be condusive to obtaining optimum yields of

wheat or pasture (A. Ellington, personal communication, 1984) and the yields obtained, compared to elsewhere in the district, reflect this.

The ability of sorrel to tolerate low pH (Harris, 1970) and its low tolerance of shading (Harris, 1972) could indicate sorrel was present on this site because of soil characteristics that favoured sorrel and reduced crop and pasture vigor. Another experiment is being conducted near Rutherglen to look at the effect of improving soil conditions on the productivity of pasture and crop and on the growth of sorrel.

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