PRE-HARVEST DESICCATION OF HERBAGE SEED CROPS AND ITS EFFECT ON SEED QUALITY

H. M. ROBERTS AND D. J. GRIFFITHS

ABSTRACT

Seed crops of perennial ryegrass S321 and tetraploid hybrid ryegrass Sabrina were sprayed with 3 pt diquat in 30 gal. water/ac (4.21 diquat in 337 l water/ha) a few days before the normal date for harvest. Very low germination values were obtained when the harvested seed was later tested and the production of abnormal seedlings from the treated crops was attributed to the presence of diquat in the seed. On the basis of these results the use of diquat is not recommended as a pre-harvest desiccant for ryegrass seed crops.

INTRODUCTION

In recent years the direct harvesting of legume seed crops has been greatly facilitated by the use of chemical sprays which desiccate the above-ground parts of the crop. As a result, many clover seed crops, which would otherwise have been a total loss, have been successfully harvested. The technique is very effective on red clover and lucerne, and allows direct combining of the crop 3–5 days after spraying in all but the wettest weather. Defoliation of white clover is also possible, but as regrowth is much more rapid than in red clover at the ripe seed stage, harvesting has to proceed very soon after treatment. In good weather white clover stands have been sprayed in the morning, cut and swathed in the afternoon and combined from the swath the following day. Another method, effectively employed with white clover, is to cut the untreated crop and apply the desiccant 2–3 days later to dry the material in the swath and to control regrowth.

Cases of seed damage resulting from spraying legume seed crops with chemical desiccants, such as diquat, have not been reported up to the present time and observations made on a seed crop of Sabtoron red clover at this Station, sprayed with 4 pt diquat in 30 gal. water/ac, have revealed no ill effects.

For grass-seed crops, which are generally earlier in ripening than legume crops, pre-harvest desiccation would normally be considered only as a means of saving a promising crop in inclement weather. Nevertheless, some growers, especially those growing late ryegrass for seed on the better soils, have been using this chemical as a means of tackling the problem of excessive secondary growth at harvest time. Unfortunately some seed stocks derived from crops thus treated have given depressed germination after short-term storage and so the problem was further investigated at this Station.

MATERIALS AND METHODS

Small areas in seed crops of perennial ryegrass S321 and tetraploid hybrid ryegrass Sabrina were sprayed with 3 pt diquat in 30 gal. water/ac just before the normal date of seed harvest. The Sabrina crop was sprayed on 11 July when its seed moisture was 45% and S321 on 4 Aug. when its seed moisture was 38%.

The above-ground parts of the Sabrina crop became bleached and dessicated on the second day after the spray treatment, but the stems maintained their original rigidity and general succulence. The same degree of bleaching was not exhibited by the S321 crop until the third day. Sequential harvests from both crops were made at intervals to provide seed samples for germination and biochemical studies.

The laboratory germination tests were conducted according to the International Seed Testing Association rules for ryegrass varieties, with the addition of 0.2% solution of KNO₃ to the germination pads to overcome a possible...
dormancy condition. In addition, glasshouse germination tests were conducted in boxes, using John Innes Compost No. 3.

All seed samples for testing were stored at 0°C.

**RESULTS**

Germination tests were conducted on three dates, in Aug. and Dec. of the harvest year and a final test in June of the following year. Entire seeds were used for the first two laboratory tests, but husked seeds (caryopses only) were included as an additional variant in the final test. The results obtained, together with those derived from the control plots, are shown in Table 1.

Table 1 clearly indicates that germination capacity was adversely affected by spraying the crops at the seed moistures indicated and harvesting at intervals within 9 days of treatment. Not only was the germination capacity of the seed significantly reduced, but there was also a very high incidence of abnormal seedlings with restricted root and shoot systems compared with normal seedlings. Indeed, practically all the seedlings derived from seeds taken from the sprayed plots of both varieties, especially those harvested within 2 and 4 days of spraying, exhibited such abnormalities.

The data from the Aug. test indicate that some improvement in germination was obtained by delaying the harvest date after spraying and that diquat was more detrimental to the viability of Sabrina than to S321. It is probable that these varietal differences may be attributable to the differing moisture levels at which the varieties were sprayed, Sabrina at 45% and S321 at 38%.

At the second test made in Dec. the percentage of sprouted seeds was slightly higher than in the Aug. test. Again, the seedlings were mainly abnormal, though S321 did also produce some normal seedlings.

After the second germination test, the seed samples were subjected to chemical examination for the presence of diquat; the results are given in Fig. 1, which shows clearly that diquat has been translocated through the plant to the seed. It is significant that the Sabrina seed samples taken two days after spraying contained three times as much residual diquat (200 µg/g seed) as the corresponding S321 samples. It appears that the decay rate is rapid in Sabrina and that if the crop had been left unharvested for 14 days following the application of diquat, there would be very little residual diquat in the seed.

Although the level of diquat in the S321 seed was much lower than in Sabrina, its decay rate was also clearly reduced and a much longer period would be required to bring the level to nil. From the practical point of view, it would not be possible to allow the sprayed crops to be

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**TABLE 1. Effect of diquat on the germination of Sabrina and S321**

<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td>Harvest date in relation to date of spraying (S)</td>
<td>N</td>
<td>A</td>
<td>N</td>
</tr>
<tr>
<td>S+2 days (13 July)</td>
<td>0</td>
<td>20</td>
<td>0</td>
</tr>
<tr>
<td>S+4 days (15 July)</td>
<td>0</td>
<td>35</td>
<td>0</td>
</tr>
<tr>
<td>S+9 days (20 July)</td>
<td>9</td>
<td>44</td>
<td>12</td>
</tr>
<tr>
<td>Control—unsprayed</td>
<td>86</td>
<td>0</td>
<td>87</td>
</tr>
<tr>
<td>S+2 days (6 Aug.)</td>
<td>0</td>
<td>67</td>
<td>3</td>
</tr>
<tr>
<td>S+4 days (8 Aug.)</td>
<td>0</td>
<td>69</td>
<td>3</td>
</tr>
<tr>
<td>S+7 days (11 Aug.)</td>
<td>0</td>
<td>84</td>
<td>12</td>
</tr>
<tr>
<td>Control—unsprayed</td>
<td>90</td>
<td>0</td>
<td>92</td>
</tr>
</tbody>
</table>

N=percentage of normal seedlings  A=percentage of abnormal seedlings (with restricted root/shoot system)

N=percentage of normal seedlings  A=percentage of abnormal seedlings (with restricted root/shoot system)
left unharvested sufficiently long for the diquat level to fall to zero, as most of the seed would have been shed by then.

In order to investigate further the location of the diquat in the seed, a third series of germination tests was conducted in June 1971, after removing the pales from part of each seed lot, to compare the germination of normal and 'husked' seed. A parallel series of tests was conducted by placing husked seeds in a compost medium as described above. Under laboratory conditions the germination levels were similar for normal and husked seed (Table 1). Both seed types produced a higher percentage of normal seedlings than in the previous tests in Aug. and Dec.

However, when the seeds were germinated in the compost there was a significant increase in the percentage of normal seedlings and a corresponding reduction in abnormal seedlings for both normal and husked seed. It is reasonable to assume therefore that the growth inhibitory effect of diquat, as measured by the number of abnormal seedlings, had to a large extent been overcome by sowing in the compost. Nevertheless, the best level of germination in terms of normal seedling production remained approximately 30% lower in the seed samples from sprayed plots than in those from unsprayed control plots.

The slight improvement in the production of normal seedlings by the husked seed would seem to indicate that the pales carried a small proportion of the residual diquat but that the major portion was present in the caryopsis.

**DISCUSSION**

When a formulation of the herbicide diquat was made available in Britain, it was recommended primarily for use as a desiccant for red- and white-clover seed crops, tick beans and peas and as a defoliant for potato crops. Broad-leaved weeds could also be controlled by this chemical group. Its use as a desiccant for grass seed crops was not initially approved as it was known that following its application the germination of unripe seed could be unfavourably affected. Nevertheless, it could be argued that under unfavourable climatic conditions at harvest time its use could be warranted in uniformly ripening seed crops where the proportion of unripe seed would be minimal.

Previous experience at this Station with the pre-harvest desiccation of S22 Italian ryegrass...
by paraquat at 4 pts/ac, similarly showed a reduction in the germination of immature seed from 73% (control) to 13%. But ripe seed was unaffected by this treatment (4), even at a spray concentration of 8 pt in 50 gal. water/ac. Diquat and paraquat appear to be somewhat similar in that both are translocated within the plant, but also have the effect of contact herbicides.

In the present investigation with diquat, the concentration of 3 pt/ac was within the recommended range and the serious reduction in germination capacity, and the abnormal seedling growth, must be attributable, at least in part, to factors other than spray concentration.

It is generally accepted that unripe seeds are more susceptible to spray damage than mature seeds, but in this experiment both Sabrina and S321 appeared to be uniformly ripened at spraying time. Under normal farm conditions the two crops were almost at the stage of combine ripeness since the seed moisture levels of 45% (Sabrina) and 38% (S321) are considered low enough for harvesting (1, 2 and 3).

Information obtained from seed merchants regarding the effect of diquat as a pre-harvest desiccant indicated a reduction of 10-20% in the germination level of ryegrass seed (private communication). It appears, therefore, that the very low germination figures in the present experiment were due to an abnormally high residuum of diquat in the seed resulting from its translocation within the plant.

As the rate of translocation is correlated with the rate of evapotranspiration, it is of interest to compare the weather on the two spraying dates. On 11 July, when Sabrina was sprayed, meteorological data recorded windy conditions, 14 h of sunshine and a mean temperature of 61°F, whereas 3 Aug., when S321 was sprayed, was calm, with 5-4 h sunshine and a mean temperature of 81°F. It can be argued that conditions on both dates, but more especially the windy conditions and the continuous sunshine on 11 July and the high temperature on 3 Aug., were conducive to high transpiration, with perhaps a slight advantage in favour of the conditions on 11 July. When this is considered in conjunction with the inherently higher moisture content in Sabrina at spraying time, the higher diquat content and the faster decay rate of the chemical in the seed of Sabrina can be explained.

A slight improvement in the germination tests of both varieties was obtained by delaying the harvest date, by storing the seed and by conducting the germination tests in soil, rather than on pads in the laboratory. Each of these factors brought about a reduction in the diquat level, either directly or indirectly.

The data obtained in this investigation represent extreme responses to diquat spraying as a result of the prevailing conditions; nevertheless they indicate the dangers in the widespread use of diquat as a pre-harvest desiccant in grass seed crops. A lower spray rate (consistent with satisfactory desiccation), applied at a later stage of ripeness (provided seed shedding does not become an overriding factor), or even a spray applied to the swath rather than to the standing crop, could have resulted in much less damage to seed quality.

ACKNOWLEDGEMENTS

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REFERENCES


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