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EFFECT OF STUBBLE BURNING AND APPLIED NITROGEN ON WILD OAT (AVENA LUDOVICIANA) GERMINATION

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SUMMARY

A trial was carried out to investigate the effect of stubble burning (two densities of stubble), with and without nitrogen fertilizer, on the germination of *Avena ludoviciana* seeds.

Uneven distribution of wild oat seed in the soil of the trial site and comparatively low stubble densities minimized the effect of stubble burning. However, results tend to show that a wild oat germination response can be expected from stubble burning. The effect of nitrogen fertilizer on wild oat germination obscured all effects from other treatments in the early germinations of wild oat. The treatment effects, as measured by wild oat germination, decreased as the season progressed.

I. INTRODUCTION

It has been observed on the Darling Downs of Queensland for a number of years that wild oats appear to germinate in greater numbers on areas where the winter cereal stubble had been burnt in the previous season than on areas where the stubble had been ploughed in. This burning effect has been observed and reported by several workers (Viel 1963; Thurston 1964; Mears 1965), mainly with the species *Avena fatua.*

Survey work (Watkins 1967) has shown that the dominant species of wild oats on the Darling Downs is *A. ludoviciana.* Several observation plots were put down in 1965 to see what effect stubble burning had on the germination of this species. Results (unpublished) reveal that, in some instances, a fivefold wild oat germination increase could be expected from burning stubble when compared with the germination from unburnt areas. Previous work (Watkins 1966) had also shown that applied nitrogen fertilizer would increase the germination of *A. ludoviciana.*

As the common practice on the Darling Downs is to burn the stubble, and in recent years the use of nitrogen fertilizer has increased in the area, some information was needed on the effect of stubble burning, with and without nitrogen fertilizer, on the germination of *A. ludoviciana.* This paper gives the results of a field trial.

II. EXPERIMENTAL

A trial was laid out in a known wild oat infested area in the Formartin District on the Darling Downs. The soil type was a heavy black earth, self-mulching clay. Treatments included the effect of stubble burning (at two densities of stubble), with and without nitrogen fertilizer, on the germination of wild oat, using no-stubble plots as comparison. In all there were 10 treatments and 4 replications. Plots were 7 ft by 50 ft with a 7 ft buffer area between plots.

Barley was planted at right-angles to the plots, and after harvest the stubble on the buffer strips and the no-stubble plots was cut and raked off. A heavy stubble density was achieved by cutting the stubble in adjacent 7 ft x 50 ft plot areas and spreading this evenly through the appropriate trial plots. The cut stubble was placed vertically so as to simulate, as near as possible, the effect of standing stubble. Stubble was burnt as soon after harvest as possible and an attempt was made, using thermocrayons and maximum mercury thermometers, to measure the temperature under the stubble fires.

Nitrogen fertilizer was applied in January as 100 lb urea per acre, subsequent to the taking of surface soil samples (0–3 in.) for nitrate determinations. A second group of soil samples was taken in May.

Wild oat counts were made as the seed germinated, and the area was immediately cultivated.

All plots were subject to the usual farm practices of chisel ploughing and cultivation during the season.

III. RESULTS

Soil nitrates.—Table 1 gives the nitrate analysis results of the two soil samples taken.

The January samples, taken before the fertilizer was applied, were not significantly different. Rainfall during the November-January period was 4·76 in., and stubble breakdown was rapid. Hence the effect of the stubble in the top 3 in. of soil was negligible in January.

By May, after a further 3·77 in. of rain, nitrate content of the surface soil had almost doubled in the plots that had no nitrogen fertilizer applied. There was no significant difference in nitrate content between the burnt and the non-burnt plots. The fertilized plots showed a significant nitrate increase in the top 3 in. and again this was not affected by stubble treatment or stubble density. The nitrate content of the top soil (0–3 in.) in the no-stubble plots was comparable with similarly treated plots in the other eight treatments.

Wild oat germination.—Unfortunately, the wild oat distribution over the area was more uneven than had been anticipated and results were clouded by this effect. The coefficient of variability for the germination figures (Table 2) was 31%; hence the necessary differences for significance were high, and only the nitrogen effect could be determined with any degree of accuracy.

TABLE 1

EFFECT OF STUBBLE AND NITROGEN FERTILIZER ON SOIL NITRATE CONTENT IN TOP 3 IN. OF SOIL

Fertilizer applied after January samples were taken

Treatment		Nitrate content (p.p.m. NO_3)	
		Jan. 1967	May 1967
1. Existing stubble, unburnt;	no N	5·0	11·0
2. Existing stubble, burnt;	no N	7·4	13·3
3. Existing stubble, unburnt;	with N	4·2	19.8
4. Existing stubble, burnt;	with N	4·0	21·3
5. Twice existing stubble, unburnt;	no N	4·9	9·0
6. Twice existing stubble, burnt;	no N	5·4	13·3
7. Twice existing stubble, unburnt;	with N	5·7	21·8
8. Twice existing stubble, burnt;	with N	6·7	28·0
9. No stubble;	no N	4·6	10·0
10. No stubble;	with N	4·7	23·3
Mean		5·3	17·1
Necessary differences for significance	5%	N.S.	8·0
	1%	N.S.	10·8

TABLE 2

EFFECT OF STUBBLE BURNING AND NITROGEN FERTILIZER ON THE GERMINATION OF WILD OAT

Seedlings per square yard

Treatment		Counts at 31/v/67	Counts at 14/vii/67	Counts at 24/viii/67	Total
1. Existing stubble, unburnt;	no N	96·03	86·79	59·40	242·22
2. Existing stubble, burnt;	no N	132·99	97·68	49·17	279·84
3. Existing stubble, unburnt;	with N	224·73	105·60	50·82	381·15
4. Existing stubble, burnt;	with N	211·20	113·19	62·04	386·43
5. Twice existing stubble, unburnt;	no N	82·50	81·51	68·31	232·32
6. Twice existing stubble, burnt;	no N	119·13	92·73	52·14	264·00
7. Twice existing stubble, unburnt;	with N	155·10	109·89	55·44	320·43
8. Twice existing stubble, burnt;	with N	183·15	106·92	48·51	338·33
9. No stubble;	no N	78·87	82·83	53·46	215·16
10. No stubble;	with N	168·83	100·55	61·71	330·89
Mean		145·23	97·77	56·10	299·10
Necessary differences for significance	5%	67·33	N.S.	N.S.	113·66
	1%	91·33			153·49

Only the first count taken in May showed significant differences, these occurring in the nitrogen-treated plots. Although the burnt-only plots (treatments 2 and 6) showed germination increases over the control plots (treatments 1 and

5), these differences were not significant. By July, the effect of fertilizer and burning on the germination of wild oat was diminishing, although the trends were still there. The August counts revealed that treatment effects had disappeared altogether.

The total germination counts revealed the trends set mainly in the first count, and indicated that applied nitrogen would cause a large increase in wild oat germination, regardless of the presence or absence of stubble. The effect of stubble burning without applied nitrogen was, however, consistent in its increase of wild oat germination over unburnt plots. If the wild oat population had been more even, these differences may have been significant.

Temperatures under a stubble fire.—Although two densities of stubble were burnt (800 lb/ac and 1600 lb/ac), surface and soil temperatures were similar under the fires. The thermocrayons were used in a similar manner to that of Tothill and Shaw (1968). They found that the lag time for response to heat on the back of the thermocrayon discs was 13 sec, which is a considerable time under a stubble fire. The present trial revealed that the maximum mercury thermometers used had an even longer lag period than the thermocrayons and recorded temperatures below those of the latter. Temperature ranges reached (by the thermocrayons) were surface 120–149°C, $\frac{1}{4}$ in. deep 75–990°C, $\frac{1}{2}$ in. deep 65–74°C and 1 in. deep $<$ 65°C. Because of the lag period, these temperatures were probably lower than those actually reached.

At the time of stubble burning, the soil was very dry and loose, and the soil temperature at 1 in. depth under bare soil was 46°C. Hence the effect of the stubble fire would not have penetrated much beyond the 1 in. depth of soil.

IV. DISCUSSION

Two factors clouded the results from this experiment. These were the uneven distribution of wild oat seed over the trial, and the comparatively low yield of barley straw, which led to a low-intensity fire.

One point of importance, however, was the effect that applied nitrogen had on wild oat emergence, in the presence or absence of stubble. Results showed that if nitrogen fertilizer was to be used by farmers to stimulate wild oat seed to germinate, stubble could be left unburnt. The effect of the fertilizer on wild oat seed would be the same as that under burnt stubble conditions. This would be of value in areas where stubble was retained for soil erosion control.

Despite the non-significant differences in the germination figures between the burnt and unburnt treatments (no nitrogen), the increase in germination in the burnt plots is consistent and large; it is particularly large in the May count. This then tends to support the work by Viel (1963) and also to verify results obtained by the author in early observation plots on the Darling Downs.

The effect of stubble fires on wild oat appears to be one of sudden exposure of surface and any shallow buried seed to high temperature, which affects the caryopsis or floret case, or both, in some way so that the seeds germinate more

readily in the following season. Stubble fires would not kill many seeds, as most intact wild oat florets have buried themselves before stubble burning is carried out. The floret always enters the ground with the embryo lowermost; thus when the floret is completely buried, the embryo in *A. ludoviciana* is from ¾ in. to 1 in. from the the surface and hence beyond the main temperature effect.

The reason for the stimulating effect of nitrogen fertilizer on wild oat seed germination is still not known.

The general conclusion from the experiment and other observations is that stubble burning appears to have some stimulating effect on wild oat seed germination. If nitrogen fertilizer is applied, however, the effect of burning, as indicated by initial wild oat germination in the following season, is obscured by the nitrogen effect to such an extent that the presence or absence (either by burning or cutting and removal) of stubble is immaterial from a wild oat germination point of view.

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