EFFECTS OF STUBBLE TREATMENTS ON SUBSEQUENT WHEAT CROPS

Following the harvest of the wheat crop on the Darling Downs in south-eastern Queensland, there are two immediate choices available to the farmer: he may either burn the stubble, a practice which is widely adopted, or retain it so that it is eventually mixed with the surface soil. One view of the latter practice is that it leads to reduction in yield due to plants having a restricted supply of available nitrogen. It is, of course, an established fact that straw or other undecomposed organic matter present in quantity at the time of sowing will adversely affect crop growth. With regard to wheat, Peterson (1950) drew particular attention to this fact, finding that it was necessary in Utah to apply chemical nitrogen to mulched wheat to compensate for the reduction in soil nitrates resulting from the use of straw. This paper is concerned with some aspects of this subject.

Materials and Methods

Field investigations were carried out on an area located on plain country in the Jondaryan district. The natural vegetation comprised native grasses, mainly Queensland blue grass (*Dichanthium sericeum*) and pitted blue grass (*Bothriochloa decipiens*), with some tall oat grass (*Themeda avenacea*) and species of *Panicum*.

The land was first ploughed in August 1945 and the first crop, setaria, planted in September 1946. From then onwards up to the time the investigation commenced in 1956, a programme of winter cropping was carried out. The soil was a dark grey brown clay of the Waco Association, with a chemical analysis as set out in Table 1.

TABLE 1

CHEMICAL ANALYSES OF SOIL FROM TRIAL AREA

—	Depth (in.)				
	0–4	4–8	8–12	24	36
pH	7·6	7·6	7·9	8·4	8·8
Av. P_2O_5 (p.p.m.)	>400	>400	>400	>400	>400
Total N (%)	·08	·08	·08	·06	—
Repl. K (m-equiv. %)	2·25	1·63	·79	—	—
K as % tot. repl. bases	3·51	2·44	1·62	—	—
Tot. repl. bases (m-equiv. %)	64	66·8	48·8	—	—

The investigation comprised two field trials, both of which were set down as randomized blocks—7 x 4 for the first trial in 1956-57 and 8 x 4 for the second trial in 1957-58. For both experiments, the stubble to which treatments were applied was estimated by quadrat sampling to yield 2000 lb of air-dry material per ac. The plot size was 1/20 ac.

Treatments employed were as follows:

(*a*) Control (stubble retained; no fertilizer applied)

(*b*) Urea at 40 lb per ac, broadcast on stubble

(*c*) Urea at 80 lb per ac, broadcast on stubble

(*d*) Ammonium sulphate at 87·6 lb per ac, broadcast on stubble

(*e*) Ammonium sulphate at 175·2 lb per ac, broadcast on stubble

(*f*) Urea at 40 lb per ac as a spray on stubble

(*g*) Urea at 80 lb per ac as a spray on stubble

(*h*) Stubble burnt, no fertilizer applied (Second trial only).

Treatments were applied to the stubble on December 19, 1956, and December 17, 1957, respectively. The broadcast applications of urea and ammonium sulphate were evenly distributed by hand. Spray applications were made with a 1 h.p. Marino spray unit mounted on a truck, the spray being applied at 160 gal per ac to the standing stubble at a pressure of 250 lb/sq. in. A wetting agent was incorporated in the spray at the rate of 4 oz per 100 gal. The burning of the stubble in the particular plots of the second experiment was facilitated by the ploughing of border furrows.

Following the application of treatments, land preparation for the wheat crop proceeded along normal lines, using scarifier and combine. Plots were sown to the variety Festival on July 15, 1957, and July 2, 1958, respectively, at 55 lb per ac. In both 1957 and 1958, composite soil samples were taken for the estimation of available soil nitrogen.

The trials were harvested on November 16, 1957, and December 5, 1958, using standard farming equipment. Plot yields were recorded for both seasons. Composite 12-lb grain samples were obtained for quality assessment in 1957, while in 1958 2-lb grain samples were taken for protein testing. Some samples were also checked for mottling.

The rainfall received during 1957 was below normal and the crop suffered from the dry conditions. The following year, however, the growing season was better and the crop did not suffer any undue stress due to lack of moisture.

Results

Observations made at regular intervals during the course of the experiment revealed that fragmentation of the stubble was a progressive feature and there were differences in this regard between the various treatments.

Data relating to the availability of nitrogen in the soil are given in Table 2.

TABLE 2

AVAILABLE SOIL NITROGEN
(p.p.m. nitrate nitrogen)

Stage	Treatment	Depth (in.)				
		0–4	4–12	12–24	24–36	36–48
		1957				
Planting (22.vii.57)	Control	4·9	7·0	3·9	1·9	0·4
	80 lb urea spray	7·0	8·4	4·9	2·2	0·9
Flowering (15.x.57)	Control	1·5	1·2	1·1	1·3	1·7
Harvest (15.xi.57)	Control	4·3	2·4	1·2	1·1	1·5
		1958				
		0–4	4–12	12–18	18–24	24–36	36–48
Planting (4.vi.58)	Control	17·0	14·4	17·6	16·5	17·3	14·3
	80 lb urea spray	17·7	16·2	20·8	21·1	17·5	14·1
	Stubble burnt	27·4	22·8	15·1	13·6	14·6	13·9
Flowering (13.x.58)	Control	3·1	3·4	—	—	—	—
	80 lb urea spray	2·9	7·8	—	—	—	—
	Stubble burnt	3·8	5·7	—	—	—	—

The mean treatment yields of wheat grain for both trials for both seasons are recorded in Table 3. No significant differences in yield were obtained.

TABLE 3

MEAN TREATMENT YIELDS
(bus per ac)

Treatment	Year	
	1957	1958
Control	11·8	25·9
40 lb urea broadcast	12·2	25·8
80 lb urea broadcast	12·0	25·1
87·6 lb ammonium sulphate broadcast ..	12·4	26·3
175·2 lb ammonium sulphate broadcast ..	12·3	25·0
40 lb urea spray	12·0	26·1
80 lb urea spray	12·0	25·7
Stubble burnt	—	27·1

The 12-lb composite grain samples from the 1957 trial were tested for quality. The following results were obtained:—

Control.—Protein 12·1 per cent. Strong, well-balanced, good extensibility, poor mixing quality. Baking quality poor.

40 *lb urea broadcast.*—Protein 12·8 per cent. Medium strong, well-balanced, fair extensibility, poor mixing quality. Baking quality poor.

80 *lb urea broadcast.*—Protein 13·0 per cent. Strong, well-balanced, good extensibility, poor mixing quality. Fairly good baking quality.

87·6 *lb. ammonium sulphate broadcast.*—Protein 12·7 per cent. Strong, overstable, fair extensibility, poor mixing quality. Fairly good baking quality.

175·2 *lb. ammonium sulphate broadcast.*—Protein 13·2 per cent. Medium strong, well-balanced, fair extensibility, poor mixing quality. Fairly good baking quality.

40 *lb. urea spray.*—Protein 12·9 per cent. Strong, well-balanced, good extensibility, poor mixing quality. Fairly good baking quality.

80 *lb urea spray.*—Protein 11·3 per cent. Medium strong, slightly overstable, fair extensibility, poor mixing quality. Good baking quality.

The above results indicate a general improvement in baking quality following the use of nitrogen fertilizers.

Grain protein content of samples from the various treatments in the 1958 trial is shown in Table 4.

TABLE 4

MEAN PROTEIN PERCENTAGE OF GRAIN (13·5% MOISTURE CONTENT)

Treatment	Mean Protein
Control	13·35
40 lb urea broadcast	14·08
80 lb urea broadcast	14·35
87·6 lb ammonium sulphate broadcast ..	13·65
175·2 lb ammonium sulphate broadcast ..	14·20
40 lb urea spray	13·85
80 lb urea spray	14·10
Stubble burnt	13·60

Necessary differences for significance: 5%, ·49; 1%, ·66.

It will be seen that all but one of the nitrogen treatments (87·6 lb ammonium sulphate broadcast) were significantly ($P < \cdot 05$) better than control. The stubble-burnt plots were not significantly better than the control (stubble retained).

It has been noted by several workers (e.g. Callaghan and Millington 1956) that mottling in wheat is associated with a depletion in soil fertility. As the present experiments were concerned with soil nitrogen it was considered relevant to investigate mottling, even if on a restricted scale. Accordingly, samples of 100 grains were taken at random from each of the protein samples of Block III. Each grain was examined individually and classified as to mottling.

The results of this visual examination of the grains are shown in Table 5.

TABLE 5

GRAIN MOTTLING PERCENTAGES

Class	Treatment							
	Control	Urea 40 lb b'cast	Urea 80 lb b'cast	Amm. Sulp. 87·6 lb	Amm. Sulph. 175·2 lb	Urea 40 lb spray	Urea 80 lb spray	Stubble burnt
NM ..	49	56	73	63	69	58	72	55
SM ..	7	7	8	9	6	7	3	12
M ..	14	19	12	13	10	8	12	10
WM ..	12	15	3	8	6	8	8	7
BM ..	18	3	4	7	9	19	5	16
CM ..	—	—	—	—	—	—	—	—

NM, free from mottling; SM, slightly mottled; M, up to one-third of the grain mottled; WM, one-third to half of the grain mottled; BM, greater than half of the grain mottled; CM, completely mottled.

While there is one discrepancy (40 lb urea spray), the figures in general support the viewpoint that soil fertility and mottling in wheat are inversely associated.

The data presented indicate that continuous grain cropping results in a reduction in the protein content of grain. Similar data have been obtained by McKay and Moss (1949). The trials also show that this reduction in grain protein content is not arrested by stubble burning as opposed to stubble retention.

Evidence is adduced that addition of nitrogen to the stubble is effective in increasing grain protein content. At this stage of cultivation history (13 years), however, no increase in yield resulted from the addition of up to 40 lb of nitrogen per ac. Seasonal conditions, however, especially in 1957, resulted in some moisture stress.

Baking quality was improved in general by the addition of nitrogen either to the stubble or to the soil surface.

The incidence of mottling was not increased by stubble retention as opposed to stubble burning. The addition of nitrogen, however, reduced mottling incidence.

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