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EVALUATION OF THE PRESOWING DROUGHT HARDENING OF WHEAT

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SUMMARY

Presowing drought hardening had little effect on grain yield in environments where the yield exceeded 20 quintals/ha. In environments where there was more severe stress and the control yield was less than 17 quintals/ha the plants from drought hardened seed had a mean yield increase of 12% over the control in spite of only 60% of the trials in this yield zone showing any response.

The increased yield stability of plants from drought hardened seed appears to be sufficient to warrant careful consideration as to the adoption of this technique in regions where wheat yields below 17 quintals/ha are fairly frequent.

I. INTRODUCTION

Presowing drought hardening of wheat, brought about by soaking seed in water and subsequently air-drying, has been reviewed by May, Milthorpe and Milthorpe (1962) and Genkel (1964). They concluded that plants from treated seed showed an increased drought tolerance which could lead to higher yields under certain environmental conditions. Woodruff (1969) showed that the treatment reduced the rate at which critical relative water contents developed during periods of moisture stress. He concluded that the techniques could be of practical value in regions where the first severe internal water stress occurs late in plant development. Occurrence of the first severe stress at anthesis or during grain development is a common feature of Queensland wheat crops.

The present paper reports a series of small-plot and semi-commercial trials carried out to assess the practicability of using the technique commercially in Queensland.

II. MATERIALS AND METHODS

Seed treatment.—In the small-plot trials, seed wheat cv. Timgalen or cv. Gamut was soaked, completely submerged, in tap water for 24 hr. Excess water was then drained and the wheat was spread in a single layer on a concrete apron directly exposed to sunlight. When it had dried back to 12% it was bagged ready for planting up to 6 months later.

In the semi-commercial trials, 40 quintals of seed wheat cv. Timgalen were soaked, completely submerged, in tap water for 24 hr in large concrete vats. Excess water was drained off and the seed augered into large kilns where it was dried to 12% moisture in 10 hr by brisk air movement at a temperature of 36°–38°C. At hourly intervals the grain within this kiln was remixed, by hand, to even out the drying process. The dried seed was then augered into bags ready for planting 3 months later.

Trial design and methodology.—

Three small-plot trial series were carried out in Queensland between 1967 and 1970.

Trial series 1 compared the yield of plants from drought hardened seed and untreated seed for two wheat cultivars (Timgalen and Gamut) over a range of plant populations (11, 22, 44 and 66 kg/ha) at five sites. The experimental design was a randomized block with four replicates. Plots were 15 m long by 9 rows wide with 12 cm between rows. Sowing was done by a cone planter. No significant ($P < 0 \cdot 05$) differences occurred between treatments in plant establishment. Yield results have been previously reported (Woodruff 1970).

Trial series 2 compared the grain yield from drought hardened and control seed over three planting times (May, June, August) over two locations. Trial design was a split plot with sowing times as main plots and seed treatments as subplots. There were six replications. Plot size and planting procedure were the same as in trial series 1.

Trial series 3, comprising two trials comparing the yields from drought hardened and control seed, were undertaken by Queensland Department of Primary Industries Advisers. Design was a randomized block with four replicates. Plot size was approximately 25 m by 4 m and sowing was done with a combine.

All the above trial results were analysed by analysis of variance. In addition, data from three field trials previously reported (Woodruff 1969) have been included.

Forty semi-commercial field trials, spread throughout the wheat-growing regions of Queensland, were established during 1970, under the supervision of Department of Primary Industries Advisers. Each trial consisted of two adjacent blocks of 8 ac or more, one of which was planted to drought hardened seed and the other to untreated control seed.

Planting and harvesting were undertaken by the individual farmers following their normal farm practice. The yield results were analysed by a paired t-test.

III. RESULTS AND DISCUSSION

Figure 1 presents the grain yield obtained from two cultivars over a range of plant population and a number of sites, the data being taken from Woodruff (1970). The treatments and sites at which significant ($P < 0 \cdot 05$) positive effects on yield were gained by the use of drought hardened seed are indicated. No significant negative effects were recorded. The effects of seed treatment were variable between sites and within sites with respect to plant population and cultivar. Positive yield responses to the treatment occurred only in plants subjected to a degree of "stress" as shown by such responses being restricted to yield levels below $1 \cdot 7$ tonnes/ha and also to plant populations which were non-optimal for grain yield at that site.

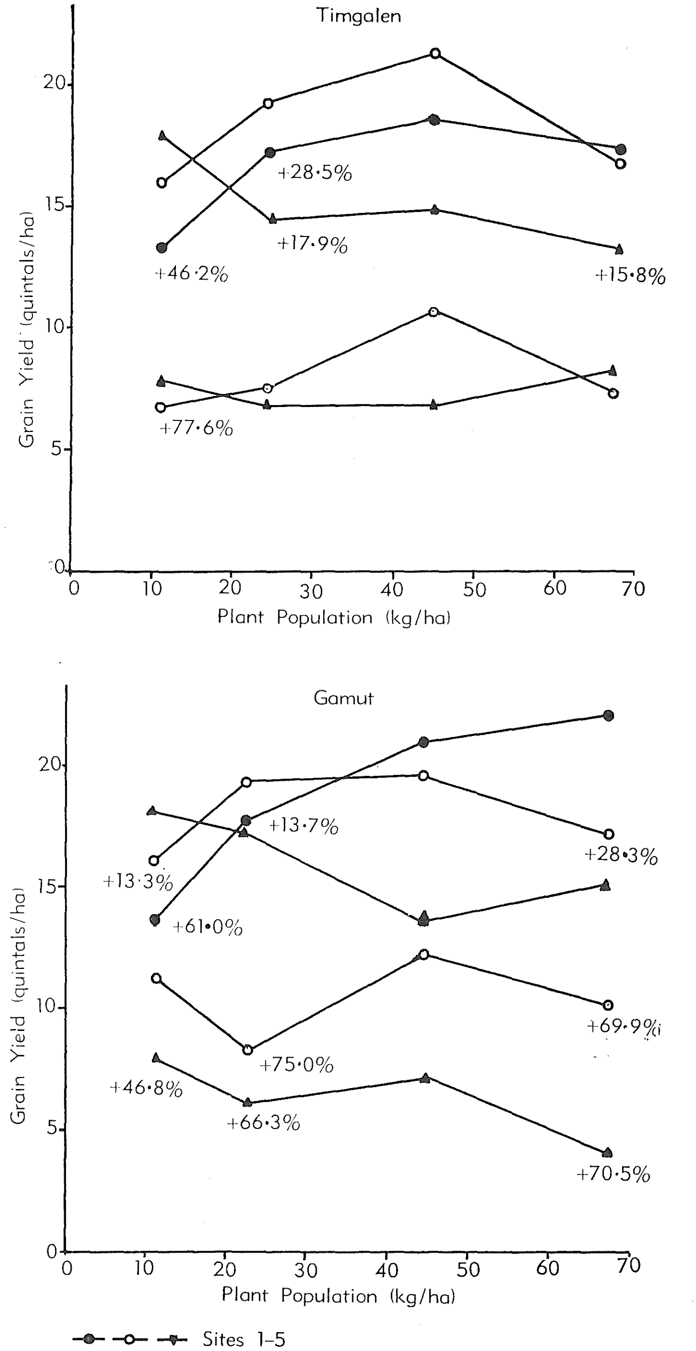

Fig. 1.—Grain yield response to plant density at five sites. The percentage changes to use of drought hardened seed are shown against the treatments showing a significant ($P < 0{\cdot}05$) response.

TABLE 1

COMPARISON OF YIELD RESULTS FROM COMMERCIAL AND EXPERIMENTAL DROUGHT HARDENING TRIALS

Parameter	SEMI-COMMERCIAL TRIAL PLOTS					SMALL-PLOT TRIALS				
	Yield Range of Control Plots (q/ha)					Yield Range of Control Plots (q/ha)				
	4–10	11–17	18–24	25–31	32–38	4–10	11–17	18–24	25–31	32–38
No. of trials	3	14	13	8	4	11	8	12	—	—
No. of trials or treatments showing increase or decrease over control	+ 1 − 1 = 1	+ 11 − 3 = 0	+ 6 − 4 = 3	+ 3 − 4 = 1	+ 1 − 3 = 0	+10(+4)* − 1 (0)	+6(+3)* − 2 (0)	+8(+3)* −4 (0)	—	—
Mean yield response (%) ..	+ 7·0	+ 12·9*	+ 0·6	− 0·8	− 5·2	+ 26·9	+ 14·5	+ 7·5		

(+ x)* and * significantly different ($P < 0{\cdot}05$).

Woodruff (1969) suggested that positive responses to the use of drought hardened seed were more likely when a stress occurred at a "sensitive" stage of plant development and was followed by favourable environmental conditions after the stress period. These results from density trials, however, suggest that the effects of the treatment are sensitive and unpredictable enough to differentiate between the differences in phenology and stress level which could arise between different plant population levels and cultivars at one site.

The yield data from semi-commercial trials and that from the small plot trials is presented in Table 1 and Figure 2. The small-plot trial data include only the 22 and 44 kg/ha plant populations from the density trials, since this corresponds to the range of seeding rates used in the semi-commercial trials.

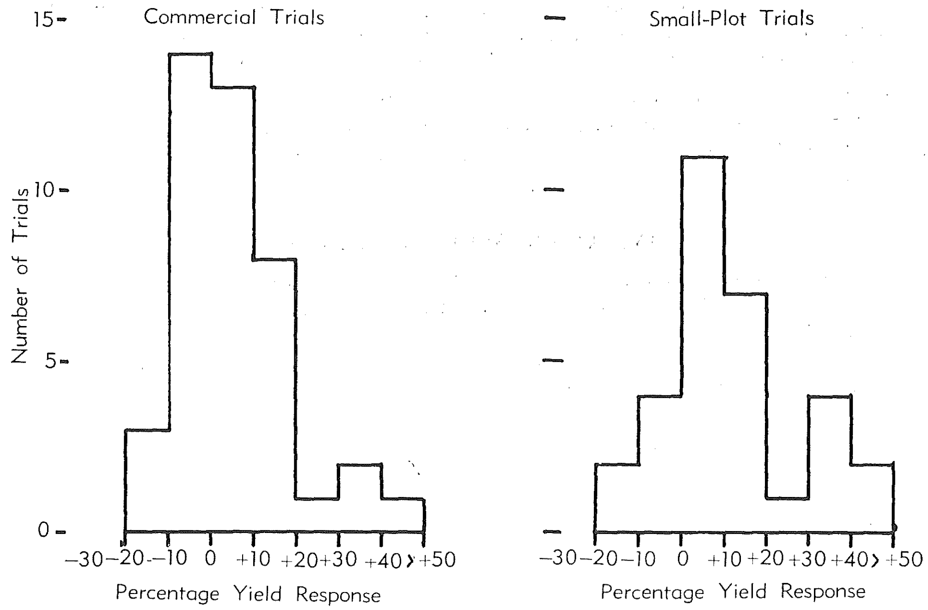

Fig. 2.—Percentage yield response due to use of drought hardened seed.

The yield results from the semi-commercial trials presented in Table 1 again showed large variations in the grain yield response to the use of drought hardened seed. Both positive and negative yield responses occurred, with the former being confined to the lower yielding sites and the latter to the higher yielding ones. The frequency of yield responses to the treatment in the lower control yield range ($<$ 17 q/ha) was similar in both commercial and experimental trials. The overall yield response was, however, lower in the former than in the latter. The separation of the data from the two major trial series is made due to the uncertainty as to whether or not the results are from a single population. This uncertainty arises because of the different drought hardening techniques imposed in the two series of trials and to the possibility of some cultivar or seed provenance interaction with the drought hardening process.

The actual percentage yield responses of the individual trials, both commercial and experimental, are presented in Figure 2. These histograms show skewing in the positive yield response direction and this was greater in the experimental than in the semi-commercial trials. Whether this was due to these two series being from different populations or to year and/or averaging effects over a large area of land is uncertain at this stage.

The overall results to date suggest that the presowing drought hardening treatment has no positive effect and occasionally has a negative effect on grain yield in environments where the control yield exceeded 20 q/ha. In environments where the control yield was less than this, due presumably to a higher degree of plant "stress", the plants from drought hardened seed had a mean yield increase in the semi-commercial trials of 12% over the control. This increase proved highly significant ($P < 0{\cdot}01$) by a paired t-test. It must be noted, however, that not all sites in this yield category showed an increased yield.

The distribution of yield responses to the use of drought hardened seed suggests that the treatment imbues some degree of yield stability and that this is sufficiently large to warrant careful consideration as to the adoption of this technique in regions where wheat yields below 17 q/ha are fairly frequent.

Further pilot commercial studies to determine the cost and effectiveness of a seed treatment plant, the interaction between this treatment and cultivars and the effect of different origins of seed are at present under study.

IV. ACKNOWLEDGEMENTS

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