Interaction of CCC and Water Deficit on Wheat Yield

2-CHLOROETHYLTRIMETHYLAMMONIUM chloride (CCC) shortens wheat straw and is used to lessen losses caused by lodging, but there is good evidence that it sometimes also increases the yield of wheat in other ways. For example, Humphries, Welbank and Witts[1] reported an increase of 5 per cent in the grain yield of 'Phoebus' spring wheat after spraying with either 2·5 lb. or 5 lb./acre of CCC at the five leaf stage, although plants in the untreated plots did not lodge. They tentatively attributed the increase to the better penetration of light through the crop enabling more ear-bearing shoots to survive.

This explanation, however, seemed less likely in view of our experience in 1965 when CCC did not increase yield, except perhaps in plots with closely spaced rows (4 in.), although the straw was shortened by CCC as much as in 1964.

In 1966, increases in yield were obtained in two experiments although again lodging in untreated plots was negligible. In the first, CCC in amounts of 2·5 lb./acre at the five leaf stage was applied to 'Kloka' wheat in the irrigation experiment at the Woburn Experimental Station. A wheat section of this experiment consisted of three blocks of two plots with one plot irrigated in each block. CCC was applied to half plots and four amounts of nitrogen fertilizer (0·4, 0·8, 1·2, 1·6 cwt./acre) partially confounded with CCC on quarter plots. During a dry period of 2 weeks from May 25, 2 in. of irrigation water was applied. This was beneficial especially in combination with large nitrogen dressings and increased grain yield estimated from sample areas of 2·8 m²/plot by 10 cwt./acre on plots receiving 1·2 or 1·6 cwt. of nitrogen (Table 1). CCC had little effect on the yields from the irrigated plots, but it increased yield from the unirrigated plots by 6 cwt./acre. These increases in yield were associated with more ear-bearing shoots (estimated from a weighed sub-sample from the area of collection) and greater grain weight/ear (Table 1). Plants treated with CCC seemed to lose fewer shoots than untreated plants during a dry spell in the period around ear emergence and so yielded more. More grains on each ear of plants treated with CCC more than offset the smaller weight of 1,000 grains, and so gave a greater grain weight for each ear. The regression of yield on shoot number showed that survival of an additional twenty shoots/m² increased grain by 1·9 cwt./acre. In an experiment at Rothamsted in 1966 with 'Kloka' wheat given four quantities of fertilizer (0, 0·8, 1·6, 2·4 cwt. of nitrogen/acre), although untreated plots did not lodge, CCC again increased yield by an average of 2 cwt./acre—a result very similar to that obtained in 1964.

Observations that CCC increases root growth have mostly been made on plants growing in pots[2], but Hanus[3] points out that root growth in pots may be restricted and the true effect of CCC on root growth can be judged only in the field. We found in both 1964[1] and in 1965 (Table 2) that the weight of root recovered by hand-pulling, that is roots in the top layers of soil, is larger from plants treated with CCC than from untreated plants. Hanus[3] showed that whenever it was applied CCC increased root growth at all depths, and he claimed that the larger root systems were associated with larger yield. Many drought-resistant plants are characterized by relatively large root systems[4] and CCC may have increased yield in our experiments because it increased the amount of roots and so enabled more shoots to survive dry periods when shoot number was declining, especially about the time ears were emerging.

Figures supplied by Dr H. L. Penman show that moisture deficits after ear emergence increased in 1964 and 1966 but decreased in 1965 (when CCC did not increase yield in a normally spaced crop), see Fig. 1. This suggests that drought is most critical near the time of ear emergence and that CCC counteracts it by increasing the size of the root system. The greater effect of CCC at Woburn may be because the sandy soil there is more subject to drought than the clay soil at Rothamsted.

Table 1. SHOOT NUMBERS, GRAIN NUMBER/EAR AND GRAIN WEIGHT/EAR (Mean of 1·2 and 1·6 cwt. of nitrogen/acre)

	'Kloka'				
	Untreated	CCC	Irrigated	Irrigated and CCC	Standard error
Yield of grain (85 per cent dry matter) cwt./acre	37·5	43·5	47·8	49·6	1·67
Ear-bearing shoots (millions/acre)	1·91	1·99	2·07	2·10	0·07
No. of grains/ear	23·8	28·0	28·4	30·8	1·07
Dry weight of grains/ear	0·85	0·95	1·01	1·02	0·04

Table 2. DRY WEIGHT OF WHEAT ROOTS (G/M²) RECOVERED BY PULLING

	'Phoebus' 1964				
	May 14	June 3	June 24	August 24	Mean
Untreated	17	30	44	25	29·0
CCC	16	32	52	26	31·5

	'Opal' 1965							
	May 24	June 15	June 29	July 13	July 27	August 10	August 24	Mean
Untreated	23	61	69	61	64	40	64	54·6
CCC	25	81	83	77	75	51	68	65·7

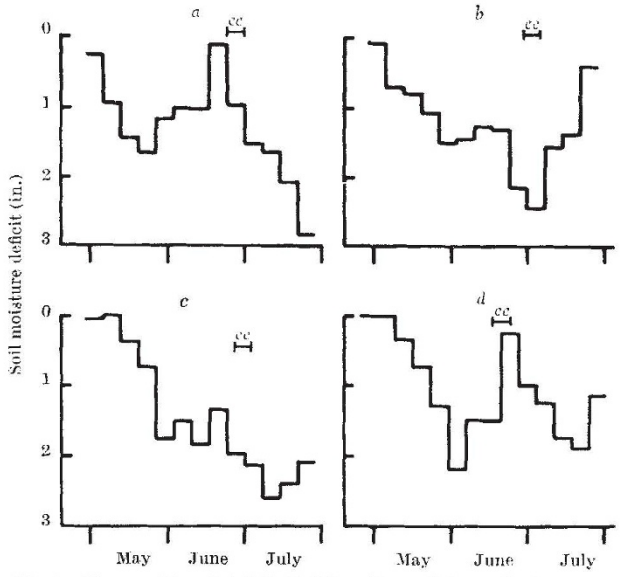

Fig. 1. Mean weekly soil deficits (in.) from May to July. *a*, Rothamsted, 1964; *b*, Rothamsted, 1965; *c*, Rothamsted, 1966; *d*, Woburn, 1966; *ee*, time of ear emergence.

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[1] Humphries, E. C., Welbank, P. J., and Witts, K. J., *Ann. App. Biol.*, **56**, 351 (1965).
[2] Sturm, H., and Jung, J., *Z. Acker-u. Pflanzenbau.*, **120**, 232 (1964).
[3] Hanus, H., *Z. Acker-u. Pflanzenbau.*, **125**, 40 (1967).
[4] Williams, R. F., and Shapter, R. E., *Austral. J. Biol. Sci.*, **8**, 435 (1955).

Selective Phytotoxicity of 2,4-Dichloro 6, (o-chloroanilino)-s-triazine ('Dyrene') to *Circium arvense*

WHILE carrying out a fungicide field experiment for the control of *Botrytis cinerea* on strawberries in an area heavily infested with creeping thistle (*Circium arvense*), it was noted that approximately 50 per cent of the thistles in certain plots died within 2–3 days of making the first