CHLORSULFURON AND DICLOFOP-METHYL EFFECTS ON THE COPPER AND ZINC STATUS AND YIELD OF WHEAT

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Summary. The effects of chlorsulfuron and diclofop-methyl on the status of copper and zinc in three wheat cultivars is described. Diclofop-methyl depressed zinc concentrations in the youngest emerged leaves (YEL's) of three wheat cultivars; the effect was greatest with cv. Halberd and least with cv. Canna. Chlorsulfuron also depressed zinc concentrations, but to a lesser extent than diclofop-methyl. Yields were decreased more by diclofop-methyl than by chlorsulfuron, with the greatest reductions occurring in the Halbred treated with diclofop-methyl. Copper concentrations were either increased or remained the same in both chlorsulfuron and diclofop-methyl treatments.

INTRODUCTION

Crop tolerance to herbicides is influenced by both genetic and environmental factors. Genetic differences in the response of wheat cultivars to diclofop-methyl and chlorsulfuron have been reported in Australia (2, 8, 9), while differences in response to these herbicides may also be due to climatic and edaphic factors as well as agronomic practices (7, 8, 9, 10).

Herbicides may also affect nutrient uptake and translocation in plants. In wheat, nitrogen, phosphorus and potassium uptake is increased by 2,4-D, but translocation is reduced (4), while napropamide has been shown to inhibit nitrogen, phosphorus, copper and zinc uptake (5). Information on how herbicides affect the nutrient status of crops, and consequences for yield, is generally lacking for Australian conditions. Trace elements are often low in W.A. soils with up to one third of tissue samples showing marginal deficiencies of zinc or copper (1). Given that herbicides may affect nutrient uptake, nutrient deficiencies may be induced by herbicides, with consequences for yield.

This paper presents field data on the effect of diclofop-methyl and chlorsulfuron on zinc and copper status and the subsequent yield of three wheat cultivars in a crop tolerance trial in 1983.

METHODS

A field experiment on wheat cultivar tolerance to herbicides was conducted at Lake Grace, W.A. on a yellow loamy sand in 1983. The wheat cultivars Halberd, Gamenya and Canna were sown in a randomised block design with three replications. A superphosphate fertiliser amended with trace elements (8.2% P, 0.66% Cu, 0.3% Zn, 400 ppm Mo) was broadcast at 500 kg/ha prior to seeding. Seeding was at 50 kg/ha, and diammonium phosphate (18% N, 20% P) at 100 kg/ha was drilled with the seed on 8 June 1983. Plots were 2x60 m. Chlorsulfuron was applied at 15 g a.i./ha immediately before seeding and incorporated by sowing. Diclofop-methyl was applied at 375 g a.i./ha in 50 L of water at 150 kPa with 0.25% Agral 60^{R} at the Zadoks 12-13 stage of the crop. Sampling of the youngest fully emerged leaf (YEL's) for nutrient content was conducted on 9 August at which time foliar symptoms of the diclofop-methyl on the crop were visible. Plots were harvested in mid-December using a small plot harvester. Plots were grown on a "new-land" site (no previous history of cropping or pasture) under weed-free conditions. The lack of previous fertilizer history necessitated the high fertilizer input. Incorporation of the superphosphate

by the seeding operation was poor and resulted in low available copper to the crop.

RESULTS AND DISCUSSION

The height of Halberd and Gamenya were reduced by both diclofop-methyl and chlorsulfuron at the time of tissue samplings, and remained shorter than the controls for the duration of growth. Chlorosis was evident in the YEL's at the time of tissue sampling for the diclofop-methyl treatments. Ear emergence was slightly delayed in the cv. Halberd by diclofop-methyl by 3-5 days. Diclofop-methyl depressed zinc content in the YEL's more in Halberd, and to a lesser extent in Gamenya, than in Canna (Table 1). Zinc concentrations of less than 10 ppm (Halberd + diclofop-methyl) indicate deficiency at the time of sampling, while zinc concentrations greater than 15 ppm in the YEL's indicate an adequate supply of zinc (3). Chlorsulfuron slightly depressed zinc levels in Halberd compared to almost no depression in Gamenya or Canna (Table 1). While zinc levels were generally adequate in the controls, copper levels were in the mildly deficient range (1.3-1.6 ppm) (6). Copper concentrations were either increased or remained the same in both chlorsulfuron and diclofop-methyl treatments (Table 1). Diclofop-methyl significantly reduced the yield of Halberd and Canna, but only in the case of Halberd was this depression associated with lowered zinc concentrations in the YEL's at the time of sampling. Chlorsulfuron had no significant effect on the grain yield of any cultivar (Table 1).

Table 1. The effect of chlorsulfuron and diclofop-methyl on the copper and zinc status (ppm) of the youngest emerged leaves (YEL's) and grain yield (t/ha) of three wheat cultivars

	Halberd			Gamenya			Canna		
Herbicide	Cu[a] (ppm)	Zn[a] (ppm)	Yield[b] (t/ha)	Cu (ppm)	Zn (ppm)	Yield (t/ha)	Cu (ppm)	Zn (ppm)	Yield (t/ha)
Control	1.3	15.6	1.24a	1.4	17.2	0.95a	1.5	18.8	1.50a
Chlorsulfuron	2.0	12.9	1.22a	1.5	16.3	0.87a	1.5	17.5	1.37a
Diclofop-methyl	2.1	9.6	0.92b	1.7	12.8	0.85a	1.8	16.6	1.21b

[a] Values for Cu and Zn status (ppm) are from a bulk sample taken from rows 3 and 6 of each replicate.
[b] Yields within columns followed by the same letter do not differ significantly (P = 0.05) as determined by Duncan's Multiple Range Test.

The results reported in this paper provide evidence that diclofop-methyl, and to a lesser extent chlorsulfuron, may depress zinc levels in the YEL's of wheat plants. Yield reductions may be associated with this depressed zinc status in some cultivars. Such a result could suggest a reason as to why cultivars may show differential response to particular herbicides. Particular herbicides may therefore induce trace element deficiencies with the possibility that such deficiencies are cultivar specific.

While the information reported here suggests a possible link between diclofop-methyl, chlorsulfuron and trace element (Zn, Cu) status, an understanding of

the mechanisms is needed. Further work is required to evaluate the extent to which herbicides may limit yield via effects on mineral nutrition, and to determine if the addition of nutrients either to the soil or spray solutions can help alleviate the depression in yield caused by this interaction.

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