Effects of tri-allate and N fertilization on wheat grain yield and its components

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Summary

An experiment was carried out in semi-arid conditions of Central Spain, to study the effect of pre-emergence applications of the herbicide tri-allate, applied doses of 1.2 kg a.i. ha^{-1} on a wheat field heavily infested by wild oat (*Avena sterilis* ssp. *macrocarpa* Mo.) The main plots, treated or not with herbicide received 0, 42, 84 or 126 kg ha^{-1} N. The control of the weed was 52 or 82% in the two different years, according to the adequacy of rainfall in autumn/winter time. Only when tri-allate is used is there a clear response on number of ears per m^2 and consequently wheat grain yield. The wild oat competition grew with increasing N rates.

Introduction

Tri-allate is a herbicide which is still used in some countries to control wild oats in cereal crops. Applied prior to emergence, tri-allate inhibits the shoot growth of wild oat seedlings (Banting 1970). So far, the response to this herbicide has been studied in several wild oat strains (Watkins 1970). However, for tri-allate to show activity on wild oat, it must be soluble and adequately distributed in the soil (Moyer *et al.* 1981). It has also been found that its use in autumn is more effective than in spring time (Miller and Nalewaja, 1980). This not only increases the grain yield, but also produces a progressive decrease of wild oats population (Fernández Quintanilla *et al.* 1987).

It is know that wild oat competes for N with wheat, affecting its growth and yield (Gonzalez Ponce 1988), wild oat being better able to utilize the added N thus gaining a competitive advantage over wheat (Carlson and Hill 1985).

Little response to N fertilization has been found in wheat fields heavily infested by wild oats (Bodrero *et al.* 1982). No interactive effects were found, between the use of herbicide, such as barban, and N fertilization in barley crop (Pfeiffer and Holmes 1961).

Materials and methods

The experiments (1983–85) were located in Toledo province, in a semi-arid cereal cropping area in Central Spain. The selected field had an established heavy infestation (162±8 plants m^{-2}) of wild oat (*Avena sterilis* ssp. *macrocarpa* Mo.) and very little other competitive weeds (6±2 plants m^{-2}), such as *Fumaria*, *Galium*, *Scandix* and *Capsella*.

The soil, a sandy loam with a sandy clay subsoil and very poor in total N (0.06%), was fertilized prior to sowing the wheat with 43.7 kg ha^{-1} P as calcium superphosphate and 41.5 kg ha^{-1} K as potassium chloride. The wheat was sown on November 9 in 1983/84 and on October 23 in 1984/85, with 125 kg ha^{-1} of wheat cv. Pané 247, a standard variety in the area.

Six days after sowing and prior to seedling emergence of wheat or wild oat tri-allate [(S-2,3,3-trichloroallyl N, N-di-isopropyl (thiocarbamate)] formulated as Avadex BW-40, was applied at a rate of 1.2 kg a.i. ha^{-1} in some of the main plots, but not in the control plots. The application was with four 110° flat fan spray tips operating at a pressure of 3 bars with a drop size of 300 µ.

The main plots were divided into sub-plots, which were given different rates of N fertilization 0, 42 (low), 84 (medium) and 126 (high) kg ha^{-1} N. The N was applied 60% prior to sowing as ammonium sulphate and 40% at the beginning of tillering stage, as calcium ammonium nitrate.

A split-plot design was used with four replications per treatment and each sub-plot had a size of 8 m^2. At maturity of wheat, in June, grain yield and its components were measured on each sub-plot by taking four sub-samples of 0.25 m^2 each. In addition, in one of the replicates (8 plots), the average number of wild oat plants per square metre were counted. The data of wheat were analysed by ANOVA method and standard errors were calculated.

Results and discussion

In autumn/winter time of 1984/85, the rainfall was 341.8 mm, while in 1983/84 was 112.0 mm. This joined to characteristics of the subsoil, permitted a more favourable distribution of the herbicide in the soil in the first than in the second period without problems of losses by lixiviation. So, the mean control of wild oats in 1984/85 was 82%, 208±19.7 and 37±3.6 plants for the control and triallate-treated plots respectively and in 1983/84 was 52%, 225±20.3 and 108±9.9 plants. N rate apparently did not affected wild oat density, which is contrary to that obtained by Catizone and Toderi (1974), who found an increase of wild oat plants with growing N rates.

Table 1 shows the significant effects of climate on wheat grain yield and its components. Also, tri-allate produced significant effects on grain yield, number of ears per m^2 and grain weight, and the N rates had significant effects on grain yield and number of ears per m^2.

Also Table 1 and Figures 1 and 2 showed that there were significant interactions such as year × N rates on grain weight. Thus in 1983/84 the maximum of this yield component was reached at 42 and 84 kg ha^{-1} N, while in 1984/85 there was a growth response with the N rates, both in the control or with use of herbicide. There was a significant interaction year × tri-allate on the number of grains per ear, thus in 1983/84 these decreased with the use of the herbicide, but increased in 1984/85. Finally there was a significant interaction, tri-allate × N rates, not found for the herbicide barban and N in barley crop (Pfeiffer and Holmes 1961). This affected grain yield and number of ears per m^2, thus only the use of tri-allate provides a positive response to N fertilization on these parameters. No triple interactions occurred.

Table 1. Influence of tri-allate and N rates on grain yield of wheat and its components in 1983/84 and 1984/85.

Source of variation	d.f.	Mean squares values			
		Grain yield	Ears per m^2	Grains per ear	Grain weight
Blocks	3	12.966	15.851	110	11
Years (y)	1	60.460**	12.544	8.510***	1.369**
Error(a)	3	3.791	13.786	29	26
Tri-allate(T)	1	88.751***	79.242***	33	150***
Y × T	1	181	5.256	420***	0.3
Error (b)	6	5.739	12.181	64	12.7
N rates (N)	3	36.364***	21.950*	122	25
Y × N	3	1.383	1.045	127	63**
T × N	3	10.240**	20.207*	195	15
Y × T × N	3	3.406	6.383	255	5.4
Error (c)	36	21.378	69.239	1.126	143

*, **, ***. Significant at the 5%, 1% and 0.1% probability levels.

Footnote:

This paper was presented at the First International Weed Control Congress, 17-21 February 1992, Melbourne, but did not appear in the proceedings.

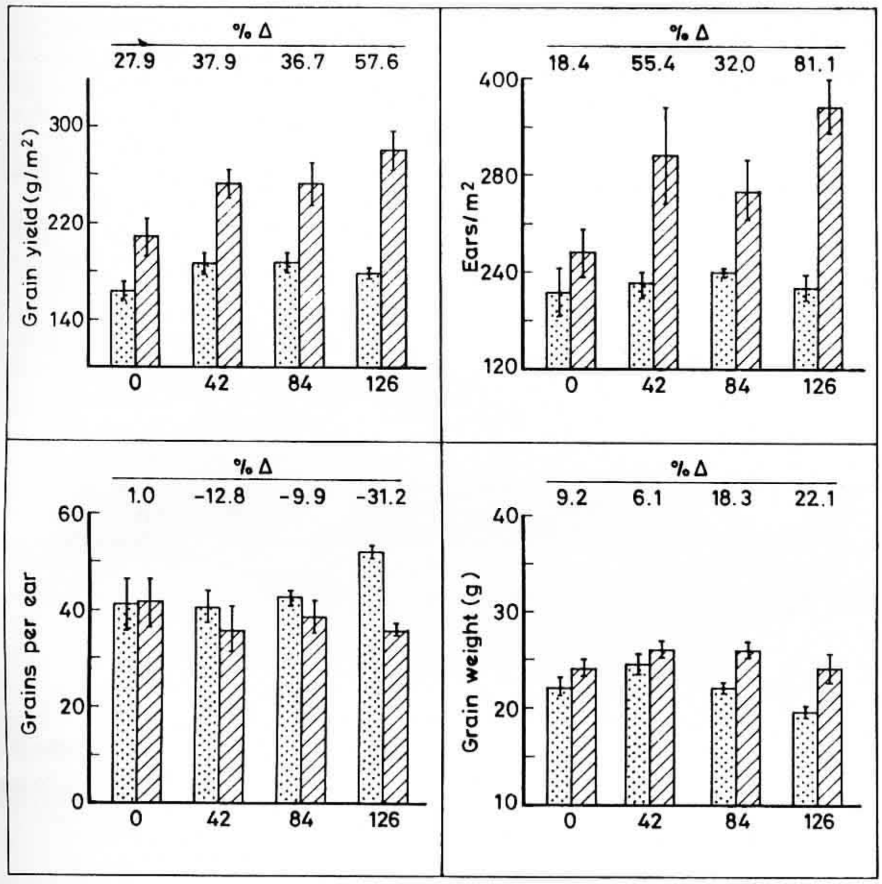

Figure 1. Mean grain yield of wheat and their components, obtained by use [hatched] or no use of tri-allate [dotted] at different N rates, in 1983/84. Bars indicate s.e. Also showed is %Δ due to tri-allate.

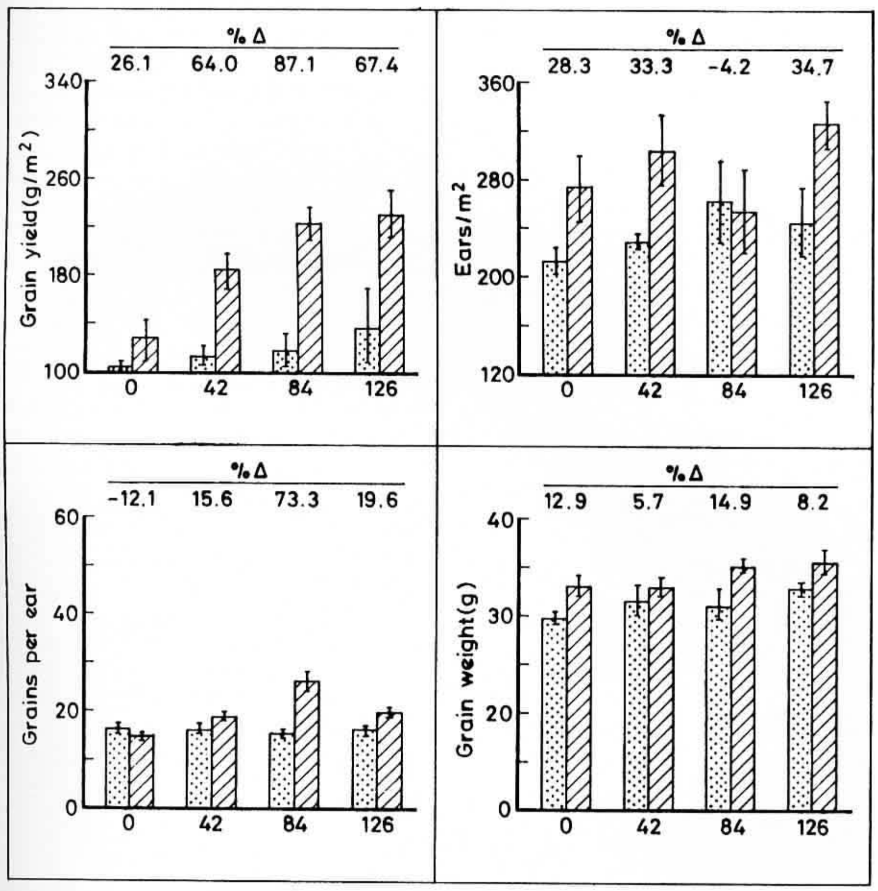

Figure 2. Mean grain yield of wheat and their components, obtained by use [hatched] or no use of tri-allate [dotted] at different N rates, in 1984/85. Bars indicate s.e. Also showed is %Δ due to tri-allate.

There were compensatory effects among the grain yield components to produce a determined yield, induced by the climate, tri-allate or N rates. In our conditions the number of ears per m^2 was the first component inducing the grain yield. Earlier studies showed that the competition of wild oat for N, reduced the number of ears and consequently the wheat grain yield (Gonzalez Ponce 1988), this occurs indirectly through a decrease in the production of tillers.

On the other hand in our soil conditions, with low levels of N, the competition of wild oats with wheat, expressed as number of ears per m^2 and grain yield, grew as the N rates increased. This growth competition to increased N fertilization also was found by Carlson and Hill (1985) under soil with a high level in organic matter.

References

Banting, J.D. (1970). Effect of diallate and triallate on wild oat and wheat cells. *Weed Science* 18, 80-4.

Bodrero, M., Alvárez, J.A. and Leguizamón, E. (1982). Consideraciones sobre algunas prácticas de manejo en la producción de trigo. I. Efecto de algunas secuencias de cultivos sobre la producción de trigo. *Informe Preliminar* 10. INTA. Oliveros. Argentina.

Carlson, H.L. and Hill, J.E. (1985). Wild oat (*Avena fatua*) competition with spring wheat: effects of nitrogen fertilization. *Weed Science* 34, 29-33.

Catizone, P. and Toderi, G. (1974). Effeti di competizione dell'avena spontanea (*Avena ludoviciana* Dur.) sul frumento in funzione di livelli crescenti di infestazione e dialcuni fattori agro-nomici. *Rivista di Agronomia* 7(2-3), 116-23.

Fernandez Quintanilla, C., Navarrete, L., Torner, C. and Andujar, J.L. (1987). Influence of herbicide treatments on the population dynamics of *Avena sterilis* ssp. *ludoviciana* (Durieu) Nyman in winter wheat crops. *Weed Research* 27, 375-83.

Gonzalez Ponce, R. (1988). Competition between *Avena sterilis* ssp. *macrocarpa* Mo. and cultivars of wheat. *Weed Research* 28, 303-7.

Miller, S.D. and Nalewaja, J.D. (1980). Wild oat (*Avena fatua* L.) control with fall and spring applied triallate. *Weed Science* 28(4), 416-418.

Moyer, J.R., Chow, P.N.P. and Dryden, R.D. (1981). Triallate herbicide application with dry and solution N fertilizer. *Canadian Journal of Plant Science* 61 (1), 107-14.

Pfeiffer, R.K. and Holmes, H.M. (1961). A study on the competition between barley and oats as influenced by barley seed rate, nitrogen level and barban treatment. *Weed Research* 1, 5-18.

Watkins, F.B. (1970). Effect of triallate and barban on five strains of wild oat (*Avena* sp.) from the Darling Downs, Queensland. *Queensland Journal of Agricultural and Animal Science* 27, 33-41.