Effects of stress on efficacy of pinoxaden on oats

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Summary Cereal growing in Australia was revolutionised with the introduction of selective wild oat herbicides; in particular, those herbicides which inhibit the enzyme acetyl-coenzyme A carboxylase (Group 'A' mode of action). The continued use of this type of chemistry is threatened unless growers undertake and retain a strong resistance management strategy. Unfortunately, as a result of grower (and adviser) focus on resistance, a less than ideal efficacy result is often deemed to be associated with development of resistance whereas environmental influences may well be the major cause. This, in turn, may wrongly limit the number of times growers use a Group 'A' herbicide, depriving them of a valuable tool.

Thus, the importance of environmental influences on efficacy are often overlooked. Stress effects have been shown to adversely affect efficacy of Group 'A' herbicides on wild oat. For example; low water or low nitrogen reduced efficacy of fluazifop (Dickson *et al*. 1990) while temperature at application, minimum temperatures prior to application and soil water deficit influenced efficacy of clodinafop-propargyl on *Avena* spp. (Medd *et al*. 2001). Typically labels have a restraint similar to: *DO NOT apply if weeds are growing very poorly due to stress from factors including very dry conditions, waterlogging, frosts, pre-emergent herbicides or nutrient deficiency*. But, these aspects are often not fully taken into account.

Trials were undertaken to compare efficacy of the relatively new Group 'A' active, pinoxaden, to evaluate the effects of soil moisture, nutrient and temperature stresses on efficacy on oats. The results assist in understanding why, in some years, the overall efficacy of Group 'A' herbicides in a particular region are generally lower than overall expectations. Undoubtedly, the combination of stresses and low level resistance contribute to reduction of efficacy in some paddocks in some years.

Keywords Wild oats, pinoxaden, resistance, temperature, water stress, efficacy.

INTRODUCTION

The activity of selective herbicides is affected by a range of factors including herbicide rate, water rate, weed growth stage and weed resistance status.

Pinoxaden is a relatively new 'Group A' active, used for control of wild oats, canary and paradoxa grass and suppression of annual rye grass in wheat and barley. There are no reported studies on effects of environmental conditions on pinoxaden efficacy. The influence of water stress, a 48 h lower temperature (4°C) and added fertiliser were assessed in relation to efficacy of pinoxaden on cultivated oat in pot trials.

MATERIALS AND METHODS

Soil medium was prepared with equal parts of red earth and river sand. Fertiliser was mixed into a sub- sample of soil and placed in each of five pots (10 cm). The remaining soil was added to a further 35 pots. Three seeds of cultivated oats (*Avena sativa*) were sown into each of the forty pots at 20 mm depth. Pots were placed in a tray of water and allowed to *water up* for two hours. Pots were placed on benches at ambient temperatures and watered every three to four days until plants were at the three leaf stage.

Three water stress regimes, one fertiliser treatment and one lower temperature treatment were allocated to pots (Table 1). Two rates of pinoxaden; label and half label rate (15 g and 7.5 g a.i. ha^{-1}), were applied to respective treatments (Table 1). Pinoxaden was applied at the equivalent of 75 L total spray ha^{-1} using a medium spray quality. Two treatments were identical (3 and 6) and used as a cross check on repeatability of results within the trial. Pots were laid out in a randomised complete block design and re-randomised, within each of five replicates, each week.

The number of dead/dying (necrotic/yellow) growing points on plants in each pot was counted 21 days after application. Data was transformed ($\sqrt{(x+0.5)}$) before analysis and back transformed for presentation.

RESULTS

Pinoxaden applied at label rate (15 g a.i. ha^{-1}) was associated with more ($P < 0.05$) dead growing points then where half label rate was used at both moderate and normal water regimes respectively (Treatments 2–5; Table 1). The number of dead growing points was higher ($P < 0.05$) in plants grown under a normal or moderate water regime than where severe water stress was applied (2, 3, 1; Table 1).

Table 1. Efficacy of pinoxaden on oats grown in pots under a range of moisture or temperature regimes.

WATER STATUS*	PINOXADEN RATE (g a.i. ha^{-1})	DEAD GROWING POINTS**
1 SEVERE	15	0.34 c
2 MODERATE	15	1.92 ab
3 NORMAL	15	2.79 a
4 MODERATE	7.5	0.16 c
5 NORMAL	7.5	0.34 c
6 NORMAL	15	2.53 ab
7 #NORMAL + FERTILISER	15	2.53 ab
8## NORMAL	15	1.74 b

* SEVERE = water withheld from pots until plants wilted for 48 h, pinoxaden applied and pots watered 12 h later; MODERATE = water withheld from pots until plants wilted for 24 h, pots watered, pinoxaden applied 36 h later; NORMAL = pots watered every three to four days.
# fertiliser added to soil medium pre-sowing.
pots placed in a growth chamber at 4°C for 48 h pre-spray and 12 h post-spray.
** Mean number of dead growing points (max. 3 pot^{-1}), means followed by the same letter do not differ significantly ($P<0.05$), data transformed ($\sqrt{(x+0.5)}$) before analysis and back transformed for presentation.

There was no effect of fertiliser (7) on the number of dead growing points in comparison with the normal water and temperature regimes (3,6) (Table 1). A lower temperature pre-application (8) was associated with reduced control ($P < 0.05$) in comparison with ambient temperature for one treatment (3) but not the second (6).

DISCUSSION

Reduced efficacy of pinoxaden on oats in association with water stress in this trial supports earlier findings on other 'Group A' herbicides. Medd *et al*. (2001) identified that temperature at application, minimum temperatures prior to application and soil water deficit influenced efficacy of clodinafop on *Avena* spp. Likewise, Xie *et al*. (1997) observed that both water stress and high temperatures reduced efficacy of several selective herbicides on wild oats (*A. fatua*).

Overall, the relatively mild lower temperature (4°C) imposed tended to have a lower number of affected plants than where ambient temperatures were applied. Presumably, had frost temperatures (below zero degrees) being imposed, this difference in efficacy would have been larger.

Environmental conditions are often disregarded when assessing reasons for a less than adequate result. Results of this study emphasise that users need to be not only aware that stress conditions may adversely affect the efficacy of herbicides, but also take them into consideration when assessing efficacies that are less than expected. Unfortunately, where resistance tests are not undertaken, and a particular herbicide has been previously used, the presumption is often that resistance is the problem and subsequently use of a product may be unjustifiably reduced.

The fact that the effect of severe water stress was equivalent to use of half label rate of pinoxaden highlights the importance of applying herbicides to actively growing plants and avoiding conditions of stress.

The reduced efficacy, in response to stress, for pinoxaden is similar for other herbicides; for example, fluazifop and glyphosate (Dickson 1990), clodinafop (Medd *et al*. 2001), diclofop and fenoxaprop (Xie *et al*. 1997).

In the field, extended periods of dry weather or frost conditions (<0°C), are not uncommon and impose high levels of stress on plants. Following rain or warmer weather, users should ensure that the target weed has recovered from stress before applying herbicides.

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