THE EFFECT OF AVAILABLE SOIL MOISTURE ON GLYPHOSATE EFFICACY

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Summary. A range of summer and winter crop and weed species were grown at four (5, 30, 55 and 100%) available soil moisture (ASM) contents and treated with glyphosate at two different rates. Glyphosate was ineffective when plants were grown at 5% ASM (independent of the rate of application). However, under conditions of 55% and 30% ASM there were significant differences among the species and between the herbicide rates in the efficacy of glyphosate. In some species, herbicide activity was reduced at intermediate levels of ASM, even though the plants showed no visual signs of moisture stress. The agronomic implications of this are discussed.

INTRODUCTION

The increasing use of reduced tillage practices in cereal production is resulting in a greater reliance on cost effective chemical weed control during the fallow. However, these weeds may experience moisture stress and it is presently recommended that translocated herbicides should not be applied during such periods. This conflicts with the need to remove the weeds which reduce soil moisture that is being stored for the following crop, and also the need to apply the herbicide at the most susceptible growth stage.

This study aims to examine the efficacy of glyphosate applied at various rates to a range of plant species grown under various available soil moisture (ASM) contents.

METHODS

Three grass (liverseed grass, *Urochloa panicoides*, barnyard grass, *Echinochloa colona* and green panic, *Panicum maximum*) and three broad-leaved species (peanut, *Arachis hypogaea*, siratro, *Macroptilium atropurpureum*, and mintweed, *Salvia reflexa*) were grown in a glasshouse in summer at four soil moisture contents and treated with two rates of glyphosate as shown in Table 1.

Table 1. Glyphosate application rates [kg a.i. ha^{-1} (w/v)]

Plant species	Low rate	High rate
Peanut	0.225	0.300
Siratro	0.225	0.300
Mintweed	0.150	0.225
Barnyard grass	0.150	0.225
Green panic	0.150	0.225
Urochloa	0.150	0.225
Safflower	0.300	0.450
Rape	0.450	0.900
Wild radish	0.450	0.900
Indian hedge mustard	0.200	0.300

A second trial, conducted in a glasshouse over winter, examined the response of rape, *Brassica napus*, safflower, *Carthamus tinctorius*, Indian hedge

mustard, *Sisymbricum orientale*, and wild radish, *Raphanus raphanistrum* to similar soil water and herbicide treatments (Table 1). The various species were included because of their probable difference in adaptation to soil moisture deficits. The experimental design for both trials was a randomised complete block with three replications. The species constituted the main plot, with soil water and herbicide rate arranged at random within each main plot.

The plants were grown in 2 L pots with a sealed plastic liner and contained 1.4 kg of oven-dried black earth. Sufficient seeds were planted in each pot in order to select three uniform plants five days after emergence (DAE). Initially all pots were maintained at 100% ASM by the daily addition of water to the required gravimetric weight. Fifteen DAE, water was withheld in all but the control (100% ASM) treatment until the water content had been lowered to the respective treatments of 5, 30 and 55% ASM. Each treatment including the control was then maintained at this water content by the daily addition of water. Glyphosate was applied four days after establishment of the 5% ASM treatments. By this time the plants had from four to six leaves, depending on species and water treatment. Herbicide was applied by a hand-held boom with an 8001E even flat nozzle operating at 210 kPa which delivered 100 L. Agral^{R} 60 at 0.3% (v/v) was applied with the glyphosate.

Plant injury was scored every second day after application and continued for 26 days. The score used a linear scale ranging from no injury (0) to complete kill (10) and incorporated the symptoms of chlorosis, necrosis and growth retardation (2).

RESULTS AND DISCUSSION

There were significant interactions of the species, ASM content and rate treatments in the summer trial (Fig. 1). All species growing under the 5% ASM showed a high tolerance to the herbicide, independent of the rate of application. However, at 30 and 55% ASM there were differences among the species and between the rates of herbicide in the amount of plant injury. At the higher rate of application, there was effective control (similar to the 100% ASM treatment) in mintweed, green panic, and barnyard grass, when grown under 55% ASM. This is in contrast to the other species and in particular peanut where there was a linear loss of efficacy with decreasing ASM content. Subsequent trials (not reported here) have verified this difference in response between peanut and mintweed even at a higher herbicide rate. These later studies also have attempted to relate the difference in response to the adaptive mechanisms of the two species to soil moisture deficits.

In the winter trial (Fig. 2) there was also a significant interaction among the treatments. Again, there was little injury at the very low soil moisture treatment. However, in contrast to the summer trial, there was no loss in efficacy when plants of all species were grown at 55% of ASM. There was a significant increase in control at the higher rate. In all but rape, there was a significant reduction in the effectiveness of the herbicide applied at the high rate as ASM was reduced to 30%. This apparent difference in response between the summer and winter trials may be attributed to the differences in the transpirational demand (and therefore minimum plant water status) on the plant during the day. In summer there was a larger vapour pressure deficit between the leaf and the ambient air, and it has been demonstrated that the apoplastic translocation of glyphosate is influenced by those factors affecting transpiration (2).

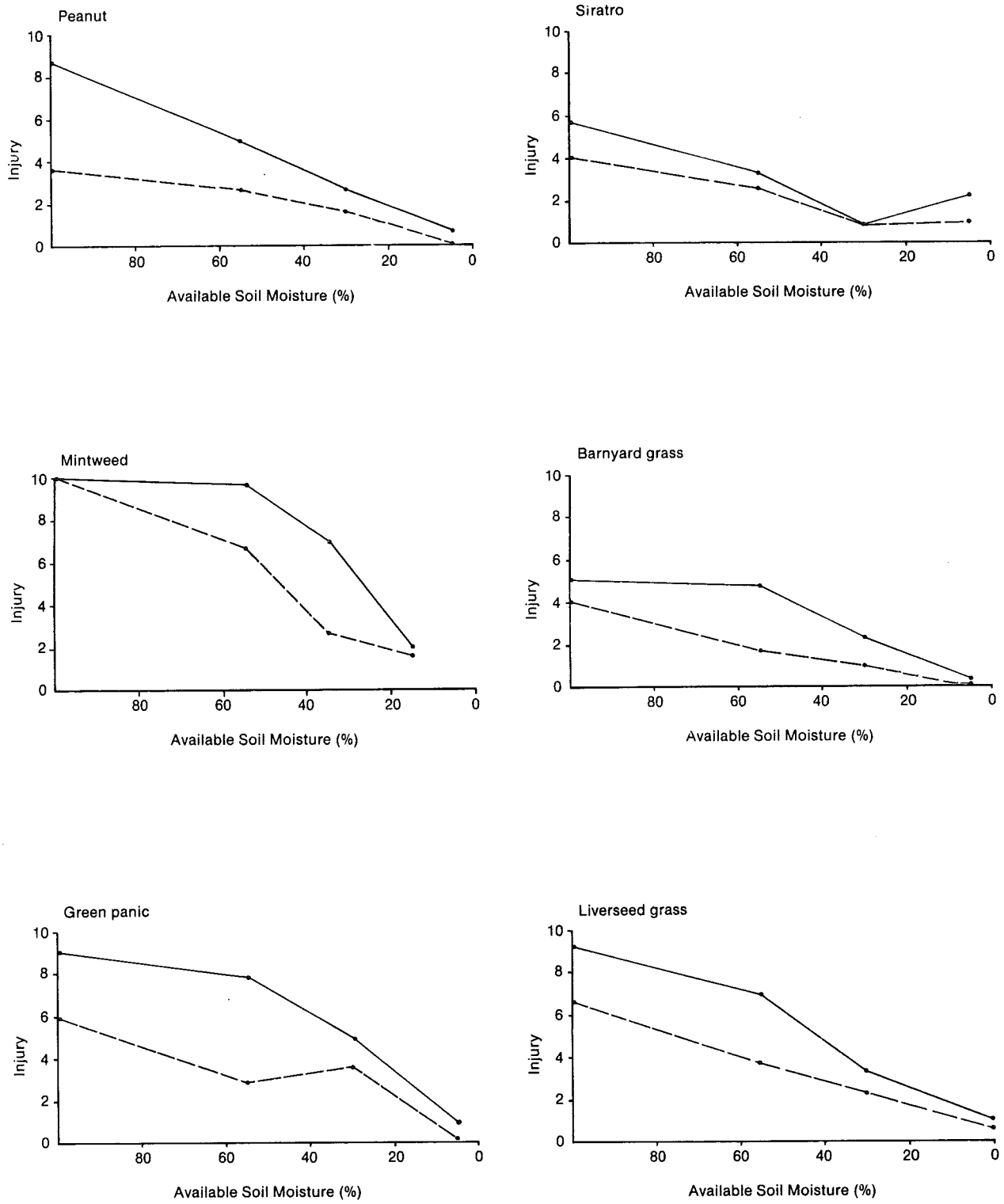

Figure 1. Effect of soil moisture and herbicide rate on the injury by glyphosate on summer plant species 26 days after treatment. L.s.d. (P = 0.05) 1.4 (—— high rate; —•—•— low rate)

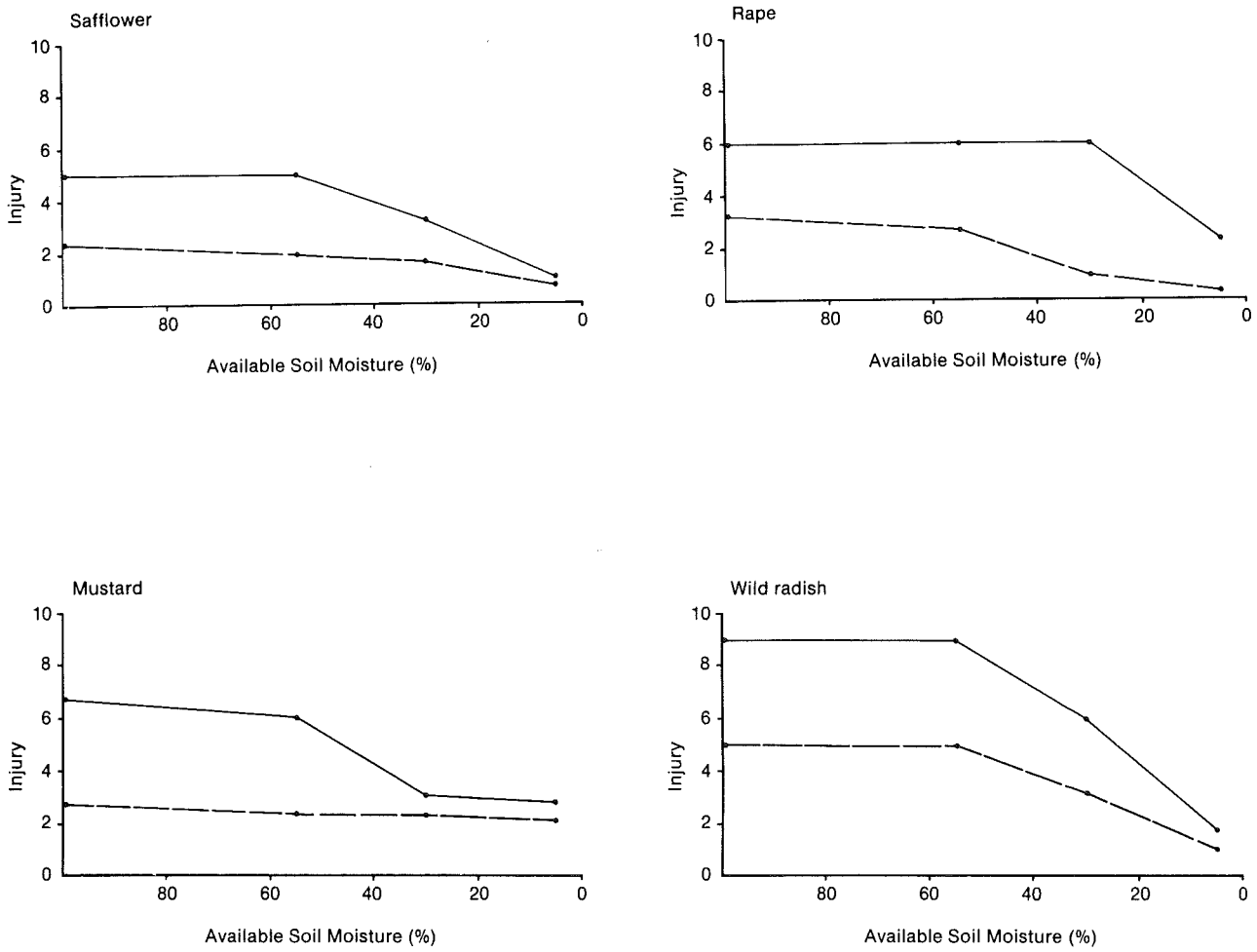

Figure 2. Effect of soil moisture and herbicide rate on the injury by glyphosate on winter plant species 26 days after treatment. L.s.d. (P = 0.05) 1.3 (—— high rate; -•——•- low rate)

There were no visual symptoms of plant stress in peanuts grown at 55% ASM, while in mintweed there was drooping of the leaves at noon under high transpirational demand. While explanations for these differences in efficacy among species under moisture deficits are being sought in terms of the plant water status, it appears that for some species (e.g. peanut), there is a loss in herbicide activity prior to any visual symptoms of moisture stress.

REFERENCES

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