The effect of soil on the phytotoxicity of residues of vulpia myuros

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Summary. A laboratory study was conducted to investigate the allelopathic potential of silvergrass (Vulpia myuros (L.) Gmel) residues and the effect on its phytotoxicity of adding soil to the residue. Aqueous extracts of silvergrass residues inhibited seed germination, coleoptile and root growth of wheat. The phytotoxicity was residue rate dependent. The allelopathic potential of silvergrass residues was affected by the presence of soil. As the ratio of soil : residue increased, the toxicity of silvergrass residues declined.

Introduction

Silvergrasses *(Vulpia* spp.) are common weed components of crops and pastures in southern Australia. An increase in the area under direct drilled crops has helped this weed to flourish (4). Large quantities of their residues are often left on the soil surface carrying over from one season to the next (9).

Previous research has demonstrated the allelopathic effects of silvergrass residues on the germination and growth of crops and pastures. The degree of phytotoxicity appears to be dependent on such factors as weathering of residues including ultraviolet light and moisture pretreatment (8, 9). This paper reports a study of soil as a factor affecting phytotoxicity of silvergrass residues.

Methods

The experiment was carried out in laboratory conditions. The treatments were set as I : I , 1:5, I : 10 (silvergrass residues to soil by weight), with controls of residue alone and soil alone. Aqueous extracts of each treatment were used to assess their individual phytotoxicity measured by a petri dish bioassay using wheat cv. Vulcan as the test species.

Residues of V. *myuros* were collected in December 1991 from pure species swards provided by the Agriculture Research Institute, Wagga Wagga. These were oven dried at 40?C for 72 hours and stored in dry conditions until commencement of the experiment. A fine, sandy loam soil was used to determine the effect on the phytotoxicity of the residues. Based on the ratio of residue to soil, 10 g chopped residue was thoroughly mixed with desired amounts of soil in a 250-mL Erlenmeyer flask, and enough distilled water was added to saturate the mixture. The same processes were applied to another 10 g chopped residues and to 10g soil, respectively, as controls. All flasks were stoppered with non-absorbent cotton wool, completely enclosed in aluminium foil, and placed in an incubator at 20?C, in the dark, for decomposition of 6 days. The liquid of each treatment was filtered and centrifuged for 30 min at 3900 rpm. The supernatant was decanted and used for bioassays. The pH values of extracts were determined.

Measurement of extract phytotoxicity by bioassay

The bioassay of seed germination and the early growth of wheat were carried out simultaneously. but separately, to test the phytotoxicity of aqueous extracts.

Twenty seeds of wheat were placed in a petri dish (9 cm diameter) with one No. I Whatman filter paper and 5 mL of each extract added. The control treatment of the bioassay received 5 mL of distilled water. The petri dishes were kept in a dark incubator at 24?C and germinated seeds were recorded after 48 hr, expressed as percentage of 20 seeds.

The seedling elongation bioassay used fifteen germinated seeds in each petri dish with the remainder of procedures as for the seed germination test. After 48 hr. the length of the longest seminal root and coleoptile length were measured.

Each extract treatment was replicated three times and the average values per petri dish were used for statistical analyses. The bioassays were arranged in a randomized complete block design. Data were subjected to analysis of variance and means were compared by Duncan's new multiple-range test at the 5% level of significance.

Results and discussion

Aqueous extracts from the treatments of residue alone, I: I ratio and 1:5 ratio significantly depressed the germination of wheat, while those from 1:10 ratio and the soil alone had no significant effects (Fig. 1). The most severe inhibition was associated with the treatment of the residue alone. The addition of soil to residues significantly alleviated the inhibition of germination. As the amounts of soil added to residues increased, germination percentage also increased Thus, the phytotoxicity of aqueous extracts was dependant on the relative ratio of residues to soil.

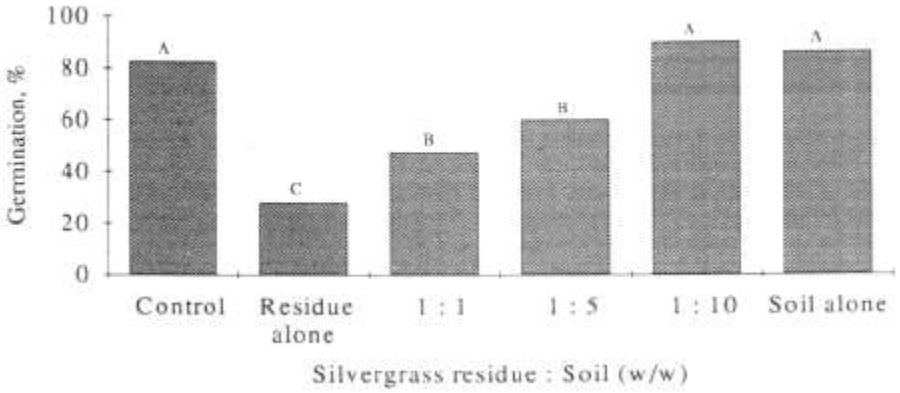

Figure 1. The phytotoxicity of silvergrass residues on germination as affected by soil addition. Means identified by the same letter are not significantly different at the 5% level, Duncan's new multiple-range test.

The responses of seedlings to aqueous extracts (Fig. 2) were consistent with the results of germination (Fig. 1). Aqueous extract from the treatment of the residue alone reduced elongation of the coleoptile by 41%, radicle elongation by 72% and reduced germination by 70%. When the ratio of residue : soil decreased to 1:10, these responses decreased to 19% and 54% for coleoptile and radicle length, respectively, and 5% stimulation of germination (though statistically not significant). The difference in root length between the residue alone and 1:1 residue : soil treatment was not significant. but the difference in coleoptile length was highly significant. The soil extract did not stimulate or inhibit the coleoptile when compared with the control, but significantly stimulated the root length.

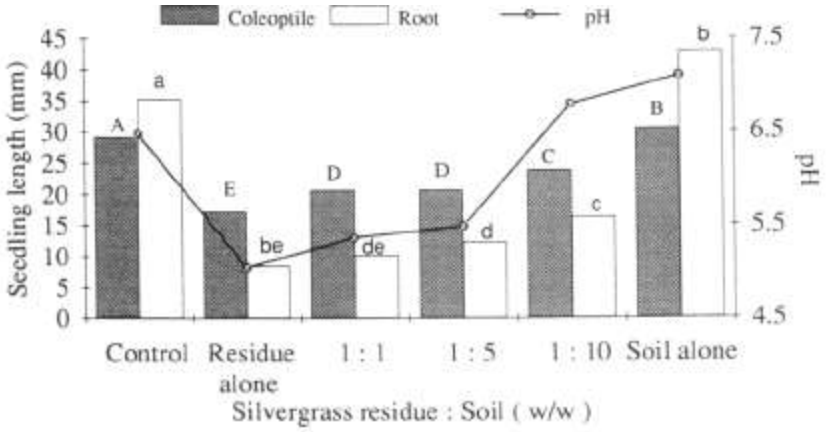

Figure 2. The effects of adding soil to silvergrass residues on phytotoxicity and pH of their aqueous extracts. Means identified by the same letter are not significantly different at the 5% level, Duncan's new multiple-range test.

The pH values of extracts increased as the amount of soil added to residues increased (Fig. 2). There was a high correlation between increased pH and decreased phytotoxicity (r^2 = 0.99** for root, r^2 = 0.83** for coleoptile. r2 = 0.94** for germination).

Patrick (7) reported that toxic substances were only extracted from clumps of residue in which the percentage of soil did not exceed 80% on a fresh weight basis. Read and Jensen (10) showed that extracts from residues screened off soil were the most phytotoxic on seedling growth of four plant species, extract from the soil after screening off residues the least phytotoxic, while the extract from the mixture of soil and residue was intermediate in phytotoxicity. Chou and Patrick (3) also found that the toxicity decreased as the amounts of soil incorporated into corn residue was increased. This may be due to the fact that phytotoxins leached from the residues were absorbed by soil particles or organic matter, or degraded by soil microorganisms (1, 2, 5). Weston and Putnam (11) claimed that the presence of soil microorganisms was not necessary for the development of quackgrass (Agropyron repens) toxicity in soil, but reduced the toxicity of quackgrass residues in soil.

The stimulation of the growth of wheat by aqueous extract of soil without residues of Vulpia indicates little or no phytotoxins in the soil. Guenzi and McCalla (6) pointed out that the concentrations of phenolic acids, potential phytotoxins, extracted from soil appeared to be low relative to concentrations required for phytotoxic effects on plant growth. They also found high concentrations of two phytotoxins in subtilled soil as compared with the ploughed soil.

It is clear from these results that in order to reduce the phytotoxic effects of silvergrass residues on crops and pastures, the amount of residues carried over from one season to the next must be reduced. Management practices which reduce residues on the soil surface or decrease the impact of phytotoxin concentrations from residues in the soil include burning or residue incorporation. Other measures in the pasture phase include pasture cleaning in winter. heavy grazing and fodder conservation in the spring.

Acknowledgements

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