Effects of Brassicaceae seed meal-amended soil on germination and growth of weed seeds

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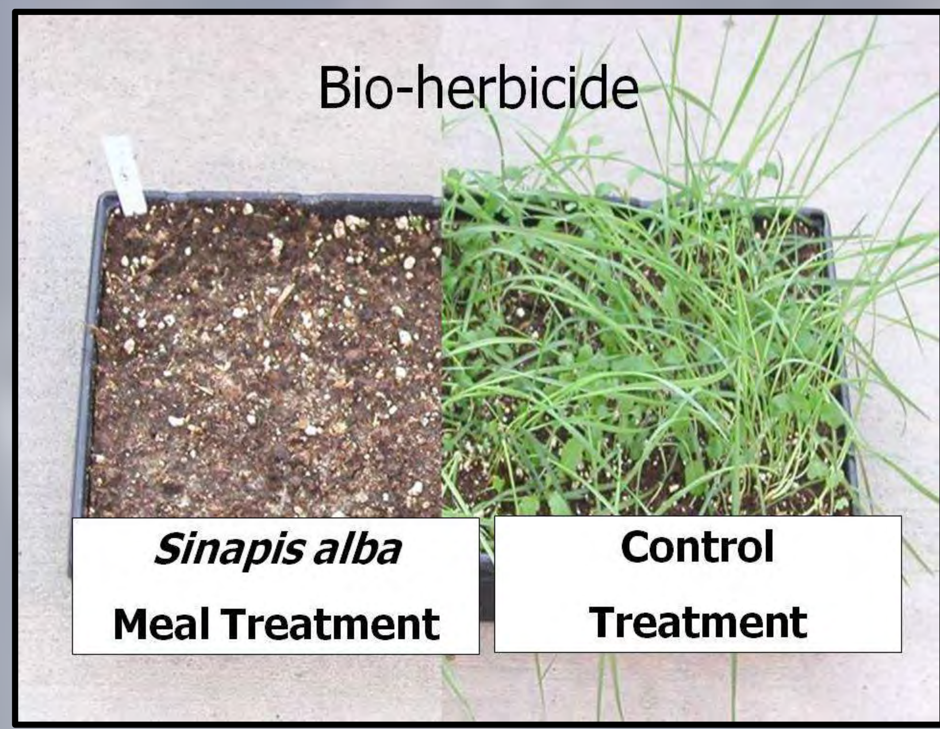
ABSTRACT

Concerns over increased use of synthetic herbicides has increased interest in biological control of weeds. Brassicaceae plants contain glucosinolates that break down into herbicidal compounds in the soil. The effect of three types of seed meal, rapeseed, Indian mustard, and yellow mustard were evaluated for weed control properties in glasshouse tests. Overall, mustard seed meals offered a high potential as a bio-herbicide in organic production systems.



INTRODUCTION

The need for sustainable agricultural production systems has generated demand for effective non-synthetic alternative weed control strategies. For most vegetable crops there are few herbicide options available, and there is little prospect of new herbicides being registered. More research into the potential of non synthetic herbicides is required that would support sustainable agricultural production. Brassicaceae seed meal, a residue product of the seed oil extraction process, can provide a resource for supplemental nutrients, disease control and weed suppression. Glucosinolate hydrolysis products are thought to be responsible for the weed suppression induced by Brassicaceae residues. The enzyme myrosinase and water are required for glucosinolate hydrolysis. The type, concentration and functionality of glucosinolate hydrolysis products vary among Brassicaceae species. The objective of this study was to evaluate the effect of different Brassicaceae seed meals and application rates on the emergence of wild oat (*Avena fatua*), Italian rye grass (*Lolium multiflorum*), prickly lettuce (*Lactuca serriola*) and pigweed (*Amaranthus retroflex*) which are some of the major weeds in vegetable production systems.

MATERIAL & METHODS

The herbicidal effects of Indian mustard (*B. juncea*), yellow mustard (*S. alba*) and rapeseed (*B. napus*) amended potting compost were examined in the greenhouse. Indian mustard ('Pacific Gold') and yellow mustard ('IdaGold') seed meal used in this study contained about 40% more of total glucosinolate content, compared to the high glucosinolate rapeseed ('Dwarf Essex'). The primary glucosinolate in Pacific Gold is allyl, accounting for over 99% of the 176 µmol g^{-1} of total glucosinolate in the defatted seed meal; while the primary glucosinolate type in IdaGold is 4-hydroxy-benzyl glucosinolate accounting for over 96% of the total glucosinolate content. The major glucosinolate types in Dwarf Essex are 2-hydroxy-3-butenyl and 3-butenyl glucosinolate. .

Figure 1. Grass weed seedling biomass after seed meal amendments.

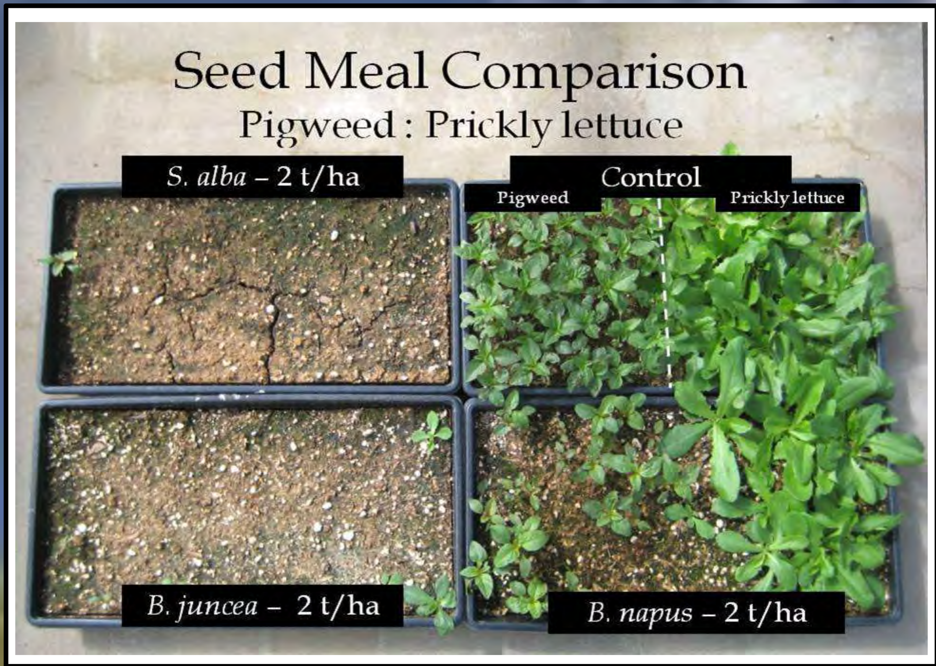


Figure 2. Broadleaf weed biomass after seed meal amendments.

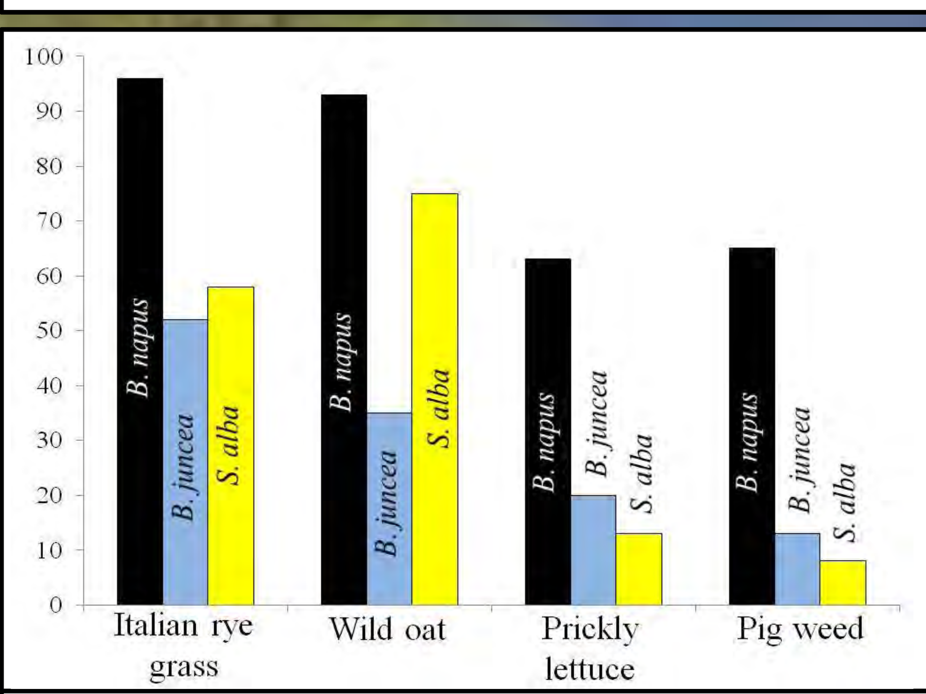


Figure 3. Weed seedling emergence after seed meal amendments.

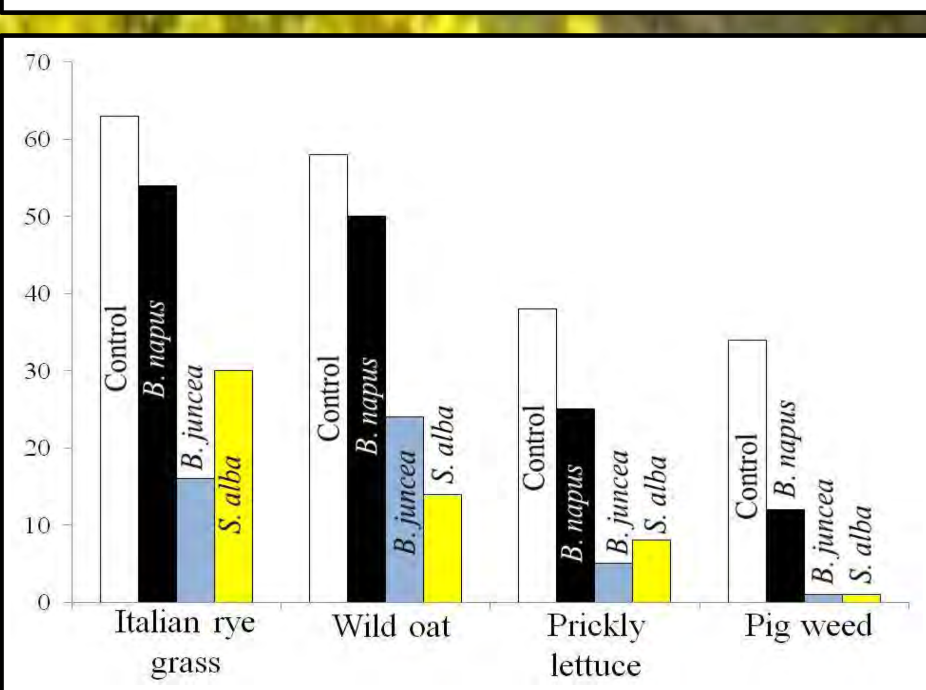


Figure 4. Weed seedling above ground biomass after seed meal amendments.

MATERIAL & METHODS (CONT.)

Five hundred cm^3 of Sunshine® Mix containing 75% peat moss, 15% perlite and 10% vermiculite was mixed with the respective seed meal type equivalent to application rates of 1 Mt ha^{-1} and 2 Mt ha^{-1} and filled in a seedling growing flat (26 cm x 25 cm). Fifty seeds of each weed species were planted in evenly spaced rows in an individual seedling flat. The seedling flats were watered to field capacity immediately after weed seed planting and watered daily thereafter. The experimental design was a split-plot design where seed meal types were assigned as main plots and meal rates assigned as sub-plots (i.e. 1 Mt ha^{-1} or 2 Mt ha^{-1}, plus a no meal treatment control). Data were collected on seedling emergence and dry biomass of the weed species.

RESULTS AND DISCUSSION

Seed meal amendments reduced weed seedling emergence by between 7-19%, 15-22%, 50-65% and 50-64% in Italian rye grass, wild oat, prickly lettuce and pigweed, respectively, at application rates of 1-2 Mt ha^{-1}, when compared to the no treatment control. Dry weed biomass was reduced by between 55-77% and 63-79% for prickly lettuce and pigweed, respectively, at seed meal application rates of 1-2 Mt ha^{-1}. *B. juncea* showed significantly better herbicidal efficacy on the grassy weeds than *S. alba* which was most effective in controlling the broadleaf weeds (Figure 1 & 2). In all instances a 1 Mt ha^{-1} application rate of either *B. juncea* or *S. alba* showed greater herbicidal effect compared to a 2 Mt ha^{-1} application rate of rapeseed meal. These results show that all glucosinolates are not equal in herbicidal effects. The herbicidal effects of the mustard seed meal could offer vegetable growers a new option for weed control, particularly in organic production systems. In a real life practical situation it would perhaps seem feasible to treat soils with a blend or mixture of both *B. juncea* and *S. alba* seed meals so that both grassy and broad leaved weeds , or indeed other pests can be effectively controlled. without synthetic pesticides.