Korean J. Ecol., 22(2): 85~88, 1999

Allelopathic Effects of *Parthenium hysterophorus* on Crop and Weed Plants

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ABSTRACT: Aqueous and dichloromethane (DCM) extracts of leaves, root bark and inflorescences of *Parthenium hysterophorus* L. at various concentrations were used to quantify its allelopathic potential against *Indigofera tinctoria, Amaranthus viridis, A. gangeticus, Phaseolus mungo* (cv. CO 1), *Sorghum vulgare* (cv. SPT- 462), *Pennisetum typhoideus* (cv. WCC-75) and *Eleusine corocana* (cv. CO 1). The aqueous extracts were more inhibitory than the DCM extracts to the germination and seedling growth of the plants studied. The relative rate of inhibition increased in the order of inflorescences, leaves and root bark in the aqueous extracts, whereas DCM root bark and inflorescences extracts were promoted at lower concentrations.

Key Words: Allelopathic effect, Aqueous extracts, *Parthenium hysterophorus*.

INTRODUCTION

Allelochemicals are a class of chemicals through which an organism of one species affect the growth, health and behavior in population biology of another species (Whittaker and Feeny 1971). An increased knowledge of this type of interaction (allelopathy) can aid in the development of suitable agricultural system enabling farmers to use the natural habitats against weeds (Narwal 1994). Aliotta *et al.* (1996) have suggested that poisonous plants are neglected sources of natural herbicides and may also play an allelopathic role in the plant-plant interaction.

Parthenium hysterophorus is a major annual weed, Compositae, and widespread around the fields in India. Other plants do not grow well in its proximity. Thus it was hypothesized that *P. hysterophorus* contains phytotoxic substances which have harmful allelopathic effects on other plants.

The allelopathic potential of *Parthenium hysterophorus* has been assessed by using its aqueous extracts for measuring percent seed germination in legumes (Kohli and Rani 1994) and for growth measurement in mulberry (Kanchan and Jeyachandra 1980). This paper reports the effect of the aqueous and dichloromethane extracts of *Parthenium* tissues on seed germination and seedling growth of some crop plants and weeds.

MATERIALS AND METHODS

Parthenium tissues were collected when the plants were in the blooming stage. Leaf, root bark, and inflorescence tissues were segregated. Tissues not used immediately after collection were dried (≤55℃) and stored. *Parthenium* tissues were extracted with dichloromethane (DCM) in a soxhlet apparatus for 24 hrs or more with solvent cycling every 15-25 min. The extracted tissues were dried for 45 hr or more at 55℃ to remove all DCM. Aqueous extracts were prepared by the method of Heisey (1990). Extracted and nonextracted *Parthenium* tissues (1 g) were steeped in 100 ml of distilled water for 24 hr at 4±2℃ with occasional swirling followed by filtration through What-man No. 2 or 4 paper. The extracts were considered to have a concentration of 10 g tissues/l and were diluted with distilled water to produce lower concentrations ranging from 2.5 to 10 g/l.

The dose response to aqueous extracts of *P. hysterophorus* was quantified with bioassay on seeds of *Indigofera tinctoria, Amaranthus gangeticus* and *A. viridis*. The standard consisted of 7-20 seeds of the various plants (Number of seeds used: *Indigofera tinctoria* - 7, *Amaranthus viridis* - 20, *Amaranthus gangeticus* - 20) placed on Whatman No. 1 paper in 6×1.5 cm plastic Petri dishes. Bioassays were done with 2 ml/dish of *P. hysterophorus* extracts or distilled water for controls and incubated in darkness at room temperature (28±2℃). The experimental disign was randomized complete block with three or four replicate Petri dishes for each treatment

or control. Percent seed germination was calculated on the third day by measuring radicle growth and used as an index of allelechemical activity.

Preemergence treatment

The aqueous extracts of different tissues of *Parthenium* were applied preemergence to seeds in 16×11×6 cm flats containing 900 g air dried and sieved (2 mm mesh) garden soil as described by Heisey (1990). *Phaseolus mungo* (15), *Eleusine coracana* (20), *Pennisetum typhoideus* (25) and *Sorghum vulgare* (15) seeds were sown in rows in the trays. Planting depth was 2-3 mm for the millets and 5-10 mm for black gram and sorghum. In preparation for spraying the DCM extract was dissolved in distilled water containing 0.1% triton ×100 surfactant to give a stock containing 10 g/l. This was diluted to the desired concentration (2.5, 5 and 10 g/l). Four replicate flats grouped together were sprayed with total of 12 ml with a glass TLC reagent sprayer. The four control flats received 12 ml of deionized water containing 0.1% triton×100. The sprayed flats were arranged in a randomized complete block design in the laboratory. The treatments were misted with 13 ml of water immediately before spraying to initiate germination and carry the toxin into the soil. The treatments were not watered again until 3 days after spraying and there after were watered from above as needed. Emergence was observed and the emerged shoots

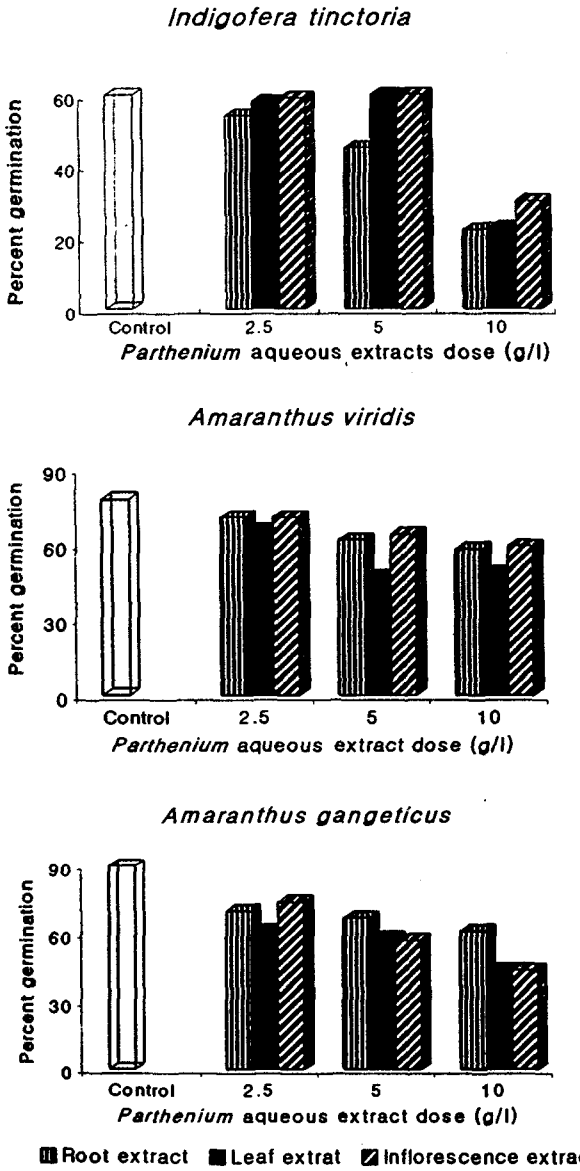

Fig. 1. Bioassay of three plant species with aqueous extracts of *Parthenium hysterophorus* tissues.

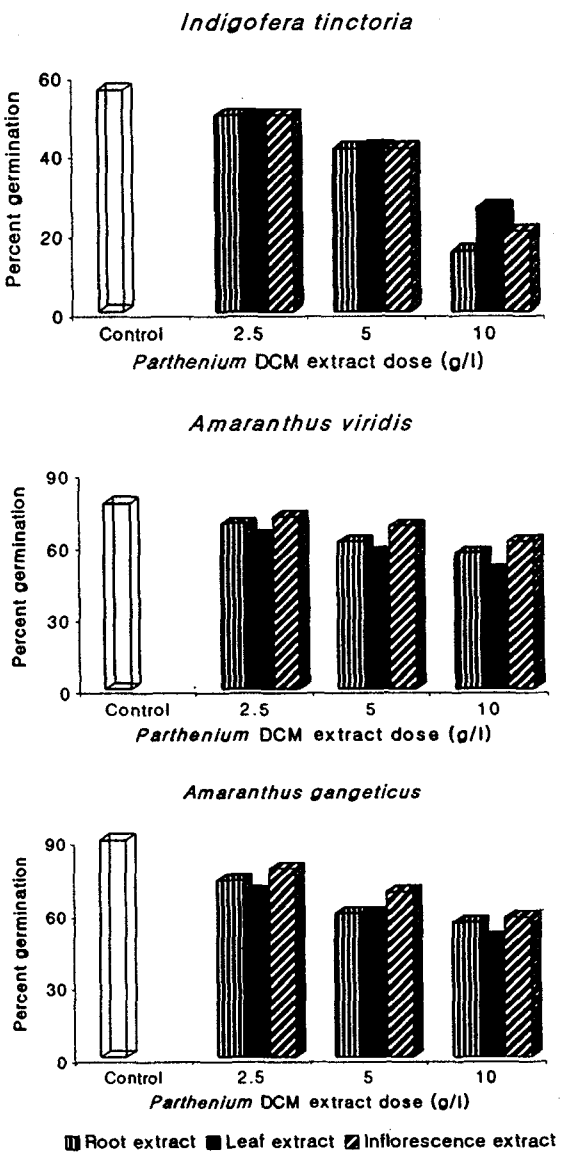

Fig. 2. Bioassay of three plant species with dichloromethane (DCM) extracts of *Parthenium hysterophorus* tissues.

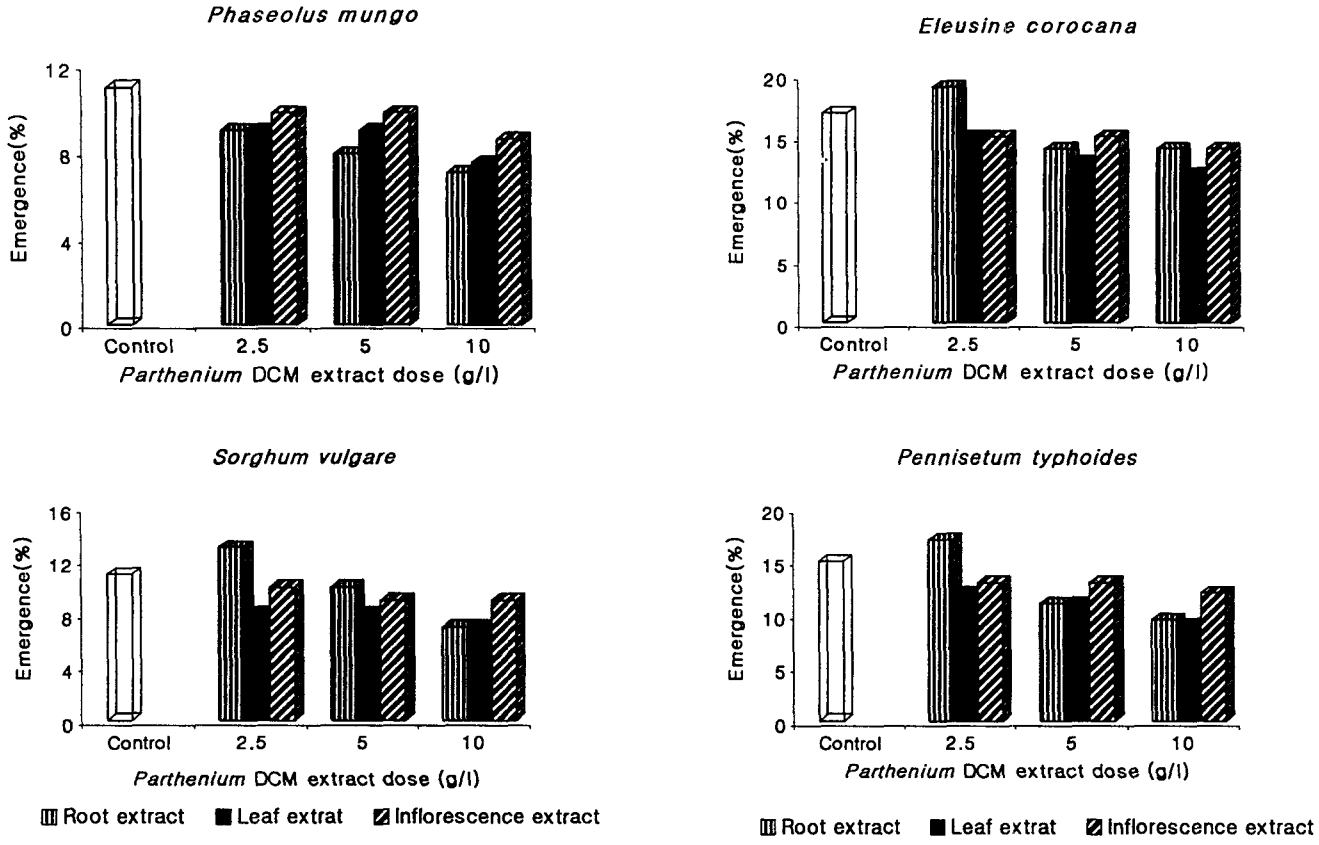

Fig. 3. Emergence of four plant species seven days after preemergence spray with dichloromethane (DCM) extracts of *Parthenium hysterophorus* tissues.

were harvested 7 days after spraying. They were dried at 55℃ and weighed.

RESULTS AND DISCUSSION

Aqueous extracts of *Parthenium* roots, leaves and inflorescences inhibited germination of all plants studied. The maximum inhibition (30-40% from control) was observed in *Amaranthus gangeticus* (Fig. 1).

DCM extraction appreciably increased the phytotoxicity of all extracts at 10 g/l on *Indigofera tinctoria* as against the aqueous extracts (Fig. 2).

Heisey (1990) reported that DCM extract did not appreciably reduce the toxicity of *Ailanthus* tissues.

DCM extract of *Parthenium* leaves were more inhibitory for the germination of seeds of *Amaranthus* spp. than the DCM extract of roots and inflorescences.

Emergence of *Eleusine corocana* and *Pennisetum typhoideus* was most affected by 10 g/l of DCM leaf extract while that of *P. mungo* was affected most by 10 g/l root bark extract (Fig. 3).

On the contrary direct use of allelopathy, on a field scale, by plant to plant activity has been documented by Joshi and Mahadevappa 1986). These workers found that the leguminous plant, *Cassia sericea*, could exert effective control of *Parthenium hysterophorus* in the field through allelopathic activity.

But the significance of the work of Joshi and Mahadevappa (1986) lies not only in the application of allelopathy to solving a weed problem but also in the fact that Joshi (1990) attempted a benefit: cost analysis in respect of his finding.

DCM extract of root bark resulted in maximum reduction in biomass in all the three plants tested. The phytotoxicity of the extracts increased in the order of inflorescences < leaves < roots (Fig. 4).

As suggested by Qasem (1995) the plants were found to differ in their sensitivity to the weed extracts. The inhibitory effect of the *Parthenium* tissues especially at higher concentration, may be due to the presence of high quantity of allelochemicals which are water and DCM soluble. Similar observation has been made by Joshi *et al.* (1996).

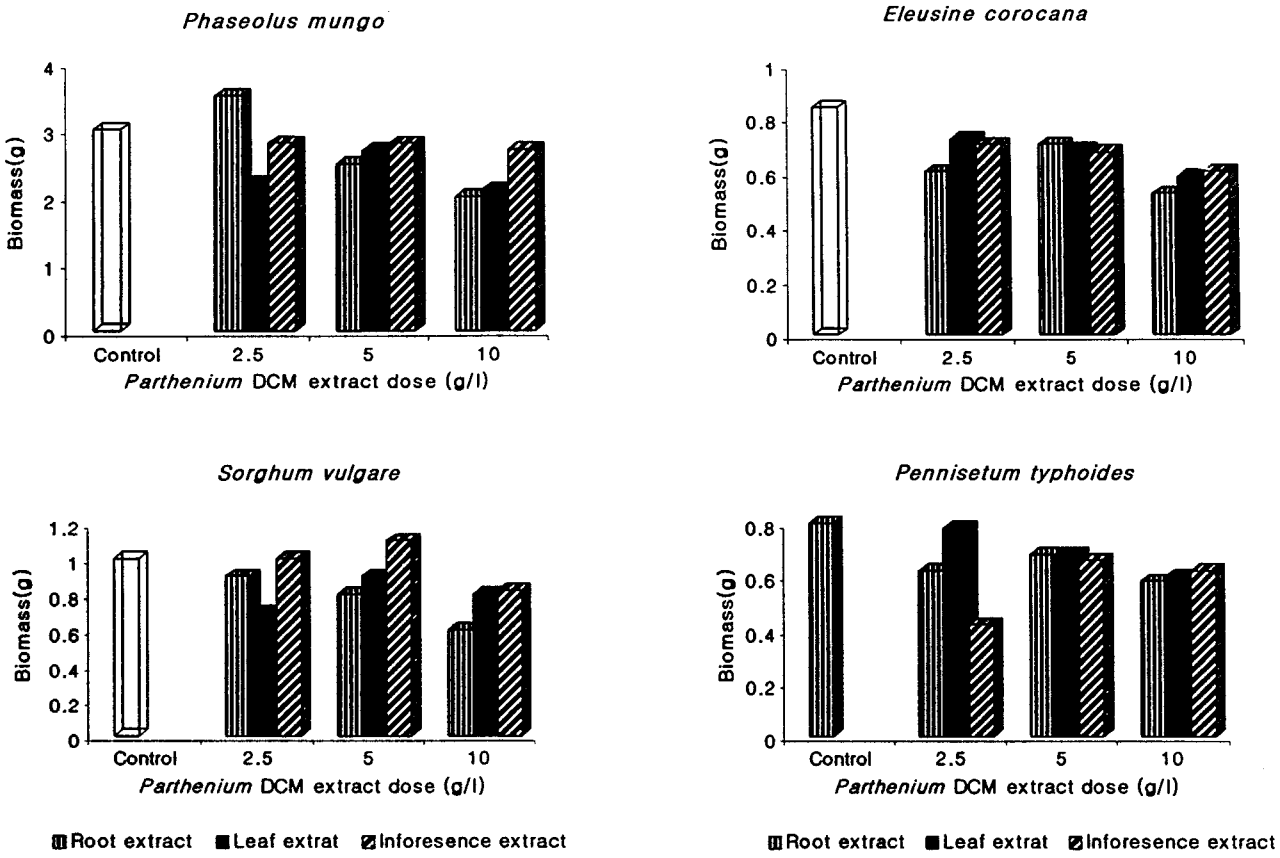

Fig. 4. Biomass of four plant species seven days after preemergence spray with dichloromethane (DCM) extracts of *Parthenium hysterophorus* tissues.

ACKNOWLEDGEMENTS

This work was supported by the grant from UGC, India to ME.

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(*Received December 20, 1998*)