Tropical Science
45(4): 159–162 (2005)
DOI: 10.1002/ts.21

Allelopathic effects of *Parthenium hysterophorus* extracts on seed germination and seedling growth of lettuce

Mulatu Wakjira, Gezahegn Berecha and Befekadu Bulti
Department of Horticulture and Plant Sciences, Jimma University, PO Box 307, Jimma, Ethiopia
(mulwak2000@yahoo.com)

Abstract *Aqueous extracts of* Parthenium hysterophorus *leaf and flower seriously inhibited seed germination and seedling growth (root and shoot length) of lettuce. Extracts of the root and stem had much less effect. Lettuce roots were more sensitive to the allelopathic effect than shoots. It appears that early removal of Parthenium weed from lettuce fields is essential to avoid poor germination and seedling growth.*

Keywords: allelopathy, aqueous extracts, lettuce, *Parthenium hysterophorus*.

Introduction

Parthenium (*Parthenium hysterophorus*) is an aggressive weed, native to the Americas but now widely spread in Asia, Africa and Australia (Evans 1997). It was introduced accidentally into Ethiopia in the 1970s and it spread rapidly in all regions of the country, along roads and railways, through grazing areas and arable lands, adversely affecting crop production and animal husbandry (Tefera 2002). It has an allergic effect which makes the weeding usually used by subsistence farmers more difficult. The successful spread of Parthenium in so many parts of the world has been attributed to its allelopathic properties, which enable it to compete effectively with otherwise strong crop or pasture species (Mersie and Singh 1987; Swaminathan et al. 1990; Stephen and Sowerby 1996).

Lettuce is an important cash and food crop in Ethiopia, the area grown in the 2001/02 cropping season being 128 ha, with an average yield of 89 q/ha (CSA 2002). A major threat to good lettuce production is competition from annual grasses and broad-leaved weeds against which it is not a good competitor. The rapid spread of Parthenium in Ethiopia is a bigger threat to the expansion and sustainable production of lettuce. Little is known of the allelopathic potential of Parthenium weed on lettuce seed germination and seedling growth, the subject of this paper.

Materials and methods

Naturally growing Parthenium plants around the university campus were randomly uprooted and collected at their flowering stage in September. The plants were brought into the laboratory and immediately separated into root, stem, leaf and flower parts. Each part of the fresh plant was cut into 2–3 cm pieces, dried at 70ºC for 24 h and ground separately in a mill.

Accepted 19 April 2005

Five, 10 and 15 g of each of the ground materials were put in 100 ml of distilled water, left to soak for 24 h at room temperature (21–22ºC) and strained through cheesecloth. Lettuce seed imported from The Netherlands was purchased locally.

Root, stem, leaf and flower extracts at four concentration levels, 0, 5, 10 and 15%, were used. Lettuce seeds were placed on Whatman No 42 filter papers in Petri dishes and moistened with 10 ml of the 5, 10 or 15% aqueous extracts, and with 10 ml of distilled water as the controls. The treatments were laid down in a completely randomized design with factorial arrangement and four replications and kept at room temperature (21–22ºC) in a laminar flow cabinet with 24 h fluorescent light. The experiment was repeated once.

Data on germinated seeds (number of seedlings with visible shoot and root growth) were collected daily from the third to seventh day after planting. Shoot and root length (mm) were recorded on the seventh day by taking ten seedlings at random. If the germination percentage was less than 10, all the seedlings were used as the sample. The rate of germination was calculated by as proposed by Maguire (1962), as:

$$\frac{\text{Number of normal seedlings}}{\text{Days of first count}} + \dots + \frac{\text{Number of normal seedlings}}{\text{Days of final count}}$$

The average data obtained from the two experiments were subjected to analysis of variance using MSTAT-C software. Least Significance Difference was tested for all the means at $P < 0.01$.

Results

All the aqueous extracts of Parthenium flower inhibited germination, so with these root and shoot lengths were zero. With the 5% leaf extract, there was a very low level of germination and shoot length, but no root growth, while with the 10 and 15% extracts there was no germination. The 5% stem extract had little effect on germination or shoot length, but root length was greatly reduced; the stronger stem extracts substantially reduced germination and there was no root or shoot growth. The Parthenium root extracts had a progressive effect, with little effect at 5% but much less germination and little root or shoot growth at 15% (Table 1).

The analysis of variance for germination percentage, rate of germination, root length and shoot length confirmed that there were significant differences between the plant parts, concentration levels and their interaction (Table 2).

Discussion

The aqueous extracts from Parthenium exhibit allelopathic activity on lettuce seed germination and seedling growth, especially the leaf and flower. The 5% aqueous extract of the stem greatly reduced root length but it had less effect on shoot length. Lettuce roots appeared more sensitive to the allelopathic effect than the shoots. Tefera (2002) and Kanchan and Jayachandra (1980) found that Parthenium extracts of the leaf and flower parts had more effect on other crops than the stem and roots. Lettuce roots appeared to be more sensitive to

Table 1. The effect of aqueous extracts of Parthenium plant parts on lettuce

Plant parts	Concentration (%)	Germination (%)	Rate of germination (seeds per day)	Root length (mm)	Shoot length (mm)
Control	0	98a	80a	75a	16a
Root	5	98a	67a	53b	15a
	10	96a	73a	33c	10b
	15	34b	25b	1d	5c
Stem	5	97a	71a	28c	16a
	10	20c	10c	0d	2cd
	15	0d	0c	0d	0d
Leaf	5	4d	1c	0d	1d
	10	0d	0c	0d	0d
	15	0d	0c	0d	0d
Flower	5	0d	0c	0d	0d
	10	0d	0c	0d	0d
	15	0d	0c	0d	0d
LSD (1 %)		7.15	14.50	10.64	4.12

Means in the same column with different letters differ significantly at $P < 0.01$.

Table 2. Mean squares of lettuce parameters as affected by Parthenium extracts

Sources of variation	DF	Germination (%)	Rate of germination	Root length (mm)	Shoot length (mm)
Plant part (A)	3	11671.04**	6198.24**	1672.56**	196.10**
Concentration (B)	3	23581.50**	16218.27**	18063.52**	708.73**
A ¥ B	9	3315.21**	1883.25**	662.92**	78.94**
Error	48	14.20	58.06	31.44	4.73
CV (%)		8.15	21.51	21.68	30.93

** significant at $P < 0.01$.

the Parthenium extracts than shoots, presumably because the roots are in direct contact with the extracts; again, similar results were reported with other crops by Tefera (2002), Bhowmik and Doll (1984) and Qasem (1995).

The allelopathic chemicals released from Parthenium roots (Guzman 1988), stems (Mersie and Singh 1988), leaves (Stephen and Sowerby 1996) and flowers (Srivastava et al. 1985) affecting a wide range of crops are sesquiterpenes, lactones and phenolics (Picman and Picman 1984; Swaminathan et al. 1990). Kohli et al. (1985) suggested that two allelochemicals acting synergistically were responsible for the significant decrease in seed germination and subsequent growth of cabbage, when placed in extracts of Parthenium leaf and inflorescence. It appears that the early removal of Parthenium from lettuce fields is essential to avoid the losses in terms of poor germination and seedling growth.

Acknowledgements

We thank Fikre Lemessa for his valuable comments, and Solomon Tulu, Elfinesh Leben and Berhanu Tola for their assistance in the laboratory work.

References

Bhowmik PC and Doll JD (1984) Allelopathic effects of annual weed residues on growth and nutrient uptake of corn and soybeans. Agronomy Journal 76: 383–388.

CSA (2002) Agricultural Sample Survey Series, 2001/02: Report on the Preliminary Result of Area, Production and Yield of Temporary crops (Maher Season, Private Peasant Holdings). Part I. Central Statistical Authority. Addis Ababa.

Evans HC (1997) *Parthenium hysterophorus*: a review of its weed status and the possibilities for biological control. Biocontrol News and Information 18: 89–98.

Guzman CD (1988) Allelopathic effects of seven weed species in pumpkin (*Cucurbita moschata*) under greenhouse conditions. Journal of Agriculture 72: 491–493.

Kanchan SD and Jayachandra (1980) Allelopathic effects of *Parthenium hysterophorus* L. II. Leaching of inhibitors from aerial vegetative parts. Plant Soil 55: 61–66.

Kohli RR, Chaudhry P and Saxena DB (1985) Auto- and teletoxicity of *Parthenium hysterophorus* L. Acta Universitatis Agriculturae Brno [Czechoslovakia] 33: 253–263.

Maguire JD (1962) Speed of germination-aid in selection and evaluation for seedling emergence and vigor. Crop Science 2: 176–177.

Mersie W and Singh M (1987) Allelopathic effect of *Parthenium hysterophorus* extract and residue on some agronomic crops and weeds. Journal of Chemical Ecology 13: 1739–1747.

Mersie W and Singh M (1988) Effect of phenolic acids and ragweed *Parthenium hysterophorus* L. extracts on tomato (*Lycopersicum esculentum*) growth and nutrient and chlorophyll content. Weed Science 36: 278–281.

Picman J and Picman AK (1984) Authotoxicity in *Parthenium hysterophorus* and its possible role in control of germination. Biochemical System Ecology 12: 287–297.

Qasem JR (1995) The allelopathic effect of three *Amaranthus* spp. (pigweeds) on wheat (*Triticum durum*). Weed Research 35: 41–49.

Srivastava JN, Shukla JP and Srivastiva RC (1985) Effect of *Parthenium hysterophorus* L. extract on the seed germination and seedling growth of barley, pea and wheat. Acta Botanica Indica 13: 194–197.

Stephen WA and Sowerby MS (1996) Allelopathic potential of the weed *Parthenium hysterophorus* L. in Australia. Plant Protection Quarterly 11: 20–23.

Swaminathan C, Vinaya Rai RS and Sureshi KK (1990) Allelopathic effects of *Parthenium hyterophorus* L. on germination and seedling growth of a few multipurpose tress and arable crops. The International Tree Crops Journal 6: 143–150.

Tefera T (2002) Allelopathic effects of *Parthenium hysterophorus* extracts on seed germination and seedling growth of *Eragrostis tef*. Journal of Agronomy and Crop Science 188: 306–310.

