Eco. Env. & Cons. 28 (November Suppl. Issue) : 2022; pp. (S11-S15)
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ISSN 0971–765X

DOI No.: http://doi.org/10.53550/EEC.2022.v28i07s.003

Allelopathic Interference of Weeds on Brown Mustard in Pot Culture

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(Received 27 February, 2022; Accepted 3 April, 2022)

ABSTRACT

A pot culture experiment was conducted at the Department of Botany, K.N. Government Post Graduate College Gyanpur, Uttar Pradesh coinciding with the Kharif season (July-October) of 2009. The treatments for the growth of test plant T-59 of mustard (*Brassica compestris var. dichotoma.*) consisted of Aqueous extracts of 4 weeds, viz., *Amaranthus viridis, Eclipta alba, Parthenium hysterophorus* and *Phyllanthus niruri* in concentration of 2% (C_1), 4%(C_2) and Control (C_0). Observation on root length, shoot length, leaf area, root biomass and shoot biomass were recorded by harvesting method at an interval of 30, 60 and 90 DAT (days after treatment). Result of the pot culture experiment indicate that the leaf extracts of all the four test weed species, viz.; *Amaranthus viridis, Eclipta alba, Parthenium hysterophorus* and *Phyllanthus niruri* had a significant retarding effect on growth of mustard var. T-59 at both C_1 and C_2 treatment level at all sampling dates (30, 60 and 90 days after treatment). All the test parameters considered in the study, viz., root length, shoot length, total plant length, leaf area, root biomass, shoot biomass and total biomass were found to be significantly affected by weed leaf extracts and such effect was found to be concentration dependant. The net primary productivity (NPP) and relative growth rate (RGR) values were found to be affected by treatment of different concentration of weed leaf extracts of all the test weeds.

Key words: *Allelopathic brown mustard, Weeds, NPP, RGR*

Introduction

A detailed survey of allelopathy research in last 6 decades (Tiwari, 2010) indicates that most of the results are based on germination studies and allelopathic effects of only a few weeds have been tested in pot culture, nutrient solution culture, and glasshouse and field experiments. For example: *Ageratum conyzoides* (Kalita *et al.*, 1998; 1999; Xu Tao *et al.*, 1999; Gogoi *et al*., 2002); *Amaranthus retroflexus, A. gracilis* and *A. blitoides* (Qasem, 1995); *Anagallis arvensis* (Velu 1996); *Cyperus rotundus* (Kalita *et al.*, 1998, 1999, Quayyum *et al.*, 2000); *Chenopodium album* (Jafari and Kholdebarin, 2002); *Cynodon dactylon* (-Kalita *et al.* 1999, Oudhia, 1999) *Eleusine indica* (Gogoi *et al.*, 2002); *Pluchea lanceolata* (Inderjit, 1998, 2002; Inderjit and Dakshini, 1994c, 1996); and *Parthenium hysterophorus* (Kohli and Batish, 1994). Tauro (1996) has mentioned that the main bioassay generally followed to establish the presence of allelochemicals in weeds is the germination test. It is further mentioned that the experiments stop at this stage itself in most cases. However, to establish allelopathy it is important to see the effect of allelochemicals throughout the plant growth period, because in many instances, an initial inhibition of germination is followed by growth stimulation and therefore conclusions drawn on the basis of germination studies alone are inadequate to establish allelopathy in real sense. For this, pot culture experiments have to be devised to simulate the field conditions and also to study the effect of allelochemicals

contained in leachates/extracts on the test plants during their entire growth period.

Growth is an essential character of life which brings about permanent changes in size and weight of the organism. Growth is affected by environmental factors as well as genetical set up of the individual. In order to understand the dynamics of net primary production, which brings about the growth of plant structure, and complex interaction between plant and environment, it is essential understand various growth attributes.

The rate of dry matter productivity of green plants is termed as "Gross Primary Productivity" and the rate of storage of organic matter in the body of producer organisms, i.e. green plants, in excess of respiratory breakdown of potential chemical energy is known as "Net Primary Productivity" (Odum, 1971). The organic matter production by green plants depends upon the efficiency of the rate and magnitude of photosynthesis, availability and utilization of minerals and water from soil, rate of dissipation of energy via respiration, net storage of organic matter in the body and finally the genetic set up of the individuals.

Green plants assimilate and transform the light energy into potential chemical energy. A part of this energy is used up by plants themselves during their life time to maintain their metabolic activities. The remaining amount of potential chemical energy goes into structural build up and reserve materials of the plants body. Thus in order to evaluate the dynamic features of an ecosystem including the functional aspects like growth, productivity and turn over, study of the changes in dry weight at short interval of time is very essential tool of ecology. Standing crop biomass gives the static picture of ecosystem providing an estimate of the organic matter that is present per unit area at a particular time. Biomass, thus, is a manifestation of net production.

Narwal (1999) has mentioned that India takes only a middle rank in allelopathic research due to lack of research facilities. He has further mentioned that about 700 research paper (about 10% of world) had been published by Indian scientists up to the end of 1997 and most of these are based on bioassay (germination) studies. In the present study, effects of extracts of selected weeds have been studied under pot-culture on various growth attributes of var. T-59 of brown mustard (*Brasica campestris* var. *dichotoma*) throughout its entire growth period.

Materials and Methods

A pot culture experiment was conducted at the Department of Botany, K.N. Government Post Graduate College Gyanpur, Uttar Pradesh coinciding with the *kharif* season (July-October) of 2009. The treatment consisted of aqueous extracts of *Amaranthus viridis, Eclipta alba, Parthenium hysterophours* and *Phyllanthus niruri.* Experimental pots were prepared by filling 2 kgs of garden soil in polyethylene pots. Five seedling of 15 days age of the test variety T. 59 of brown mustard (*Brassica campestris* var. *dichotoma*) were sown in each pot. 200 ml of leaf extracts of 2% (C_1) and 4% (C_2) aqueous extracts were applied to each pot regularly after an interval of 5 days throughout the experiment. Control (C_0) was maintained by supplying the same amount of tap water to the control post. Five replicates of each treatment were maintained.

Observation on root length, shoot length, leaf areas, root biomass and shoot biomass were recorded by harvesting method at an interval of 30, 60 and 90 DAT (days after treatment). Leaf area per plant was measured by using graph paper. These data were used to calculate net primary productivity (NPP), and relative growth rate (RGR). Experimental results were statistically analyzed by using critical difference (CD at 5%) as a measure of significance of variation.

Results (Table 1-3)

The result shown in Table 4.1-4.6 clearly indicate that the treatment of leaf extracts of all the four test weed species, *viz., Amaranthus viridis, Eclipta alba, Parthenium hysterophorus* and *Phyllanthus niruri* in general had a significant retarding effect on growth of brown mustard (*Brassica campestris* var. *dichotoma*) var. T. 59 at either C_1 or both C_1 and C_2 treatment levels at all sampling dates (30, 60 and 90 days). All the test parameters considered in the study, *viz.* root length, shoot length, total plant length, leaf area root biomass, shoot biomass and total biomass were found to be significantly affected by weed leaf extracts and such effect was found to be concentration dependant.

Table 1-3 indicate the effect of leaf extracts of selected weed species on root length, shoot length and total plant length of brown mustard at 90 DAT as compared to control (Co).

At 90 DAT (Table 1) *P. hysterophorus* caused maximum (19.7%) inhibition of root length at C_1 followed by *E. alba* (16.6%), *A. viridis* (11.9%) and *P. niruri* (10.9%). Maximum inhibition of shoot length was also caused by *P. hysterophorus* (6.0%) followed by *E. alba* (4.5%), *A. viridis* (2.6) and *P. niruri* (1.9%). The total length of mustard plants was also most severely inhibited by *P. hysterophorus* (8.2%) followed by *E. alba* (6.5%), *A. viridis* (4.1%) and *P. niruri* (3.4%). Maximum inhibition of leaf area also exhibited similar trend with *P. hysterophorus* causing highest (21.7%) reduction followed by *E. alba* (18.4%), *A viridis* (-13.4%) and *P. niruri* (9.0%).

Root biomass, shoot biomass and total biomass values of mustard in pot culture were found to exhibit a decreasing trend when treated with different concentrations (C_1 and C_2) of leaf extracts of weeds namely *A. viridis*, *E. alba*, *P. hysterophorus*, and *P. niruri*.

At 90 DAT, maximum inhibition of root biomass was caused by *P. hysterophorus* (13.6%) followed by *E. alba* (10.4%), *A. viridis* (9.4%) and *P. niruri* (9.1%). Most severe inhibitory effect on shoot biomass was also exhibited by *P. hysterophorus* (23.2%) followed by *E. alba* (22.2%), *A viridis* (18.0%) and *P. niruri* (17.6%). Total biomass values were also found to show a similar trend with *P. hysterophorus* causing maximum (21.8%) inhibition followed by *E. alba* (-20.4%), *A. viridis* (16.7%) and *P. niruri* (16.3%). Increasing extract concentration (C_2) caused further inhibition of all the test parameters irrespective of weed species and dates of sampling.

The net primary productivity (NPP) and relative growth rate (RGR) values were found to be affected by treatment of different concentrations of weed leaf extracts (Table 3). In general, treatment by leaf extracts of all the four test weed species usually resulted in decrease in the values of NPP and RGR and this effect was more pronounced in case of treatment by extracts of higher (4%) concentration.

Overall, all the four weeds caused severe inhibition of mustard in this pot culture study and such an inhibitory response was found to be dose dependent. On average, these weeds caused about 15 and 38% inhibition of root length at C_1 and C_2 at 30 DAT, 7 and 15% at 60 DAT and 15 and 24% inhibition at 90 DAT, respectively. The shoot length was inhibited by about 7 and 24, 3 and 17 and 4 and 19% at C_1 and C_2, respectively at 30, 60 and 90 DAT, respectively. The average inhibition of total plant length at 30, 60 and 90 DAT at C_1 and C_2 was noted as 9, and 27, 4 and 17 and 5 and 19%, respectively.

Table 1. Effect of weed leaf extracts on morphological characteristics of (*Brassica campestris* var. dichotoma) var. T-59 in pot culture at 90 DAT.

Treatment	Root length (cm.)	Shoot length (cm)	Total (cm)	Leaf area/ Plant (cm^2)	No. of flowers and fruits/Plant	Weight of 100 seeds (g)
Amaranthus viridis						
Control	19.20	97.90	117.10	939.3	89.4	0.430
C_1	16.90 (-11.9)	95.30 (-2.6)	112.2 (-4.1)	793.6 (-)15.5	77.4 (-13.4)	0.408 (-5.1)
C_2	15.10 (-21.3)	81.40 (-16.8)	96.5 (-17.5)	567.4 (-39.5)	64.6 (-27.7)	0.388 (-9.7)
CD at 5%	1.12	1.62	2.74	43.68	21.0	0.041
Eclipta alba						
Control	19.20	97.90	117.10	939.3	89.4	0.430
C_1	16.0 (-16.6)	93.40 (-4.5)	109.4 (-6.5)	693.8 (-26.1)	72.9 (-18.4)	0.401 (-6.7)
C_2	14.10 (-26.5)	78.20 (-20.1)	92.3 (-21.1)	537.3 (-42.7)	61.7 (-30.9)	0.383 (-10.9)
CD at 5%	1.26	1.23	2.49	52.4	20.4	0.038
Parthenium hysterophorus						
Control	19.20	97.90	117.10	939.3	89.4	0.430
C_1	15.40 (-19.7)	92.0 (-6.0)	107.4 (-8.2)	678.1 (-27.8)	70.0 (-21.7)	0.393 (-8.6)
C_2	13.10 (-31.7)	77.10 (-21.2)	90.2 (-22.9)	508.6 (-45.8)	67.5(-24.4)	0.376 (-12.6)
CD at 5%	0.98	1.52	2.5	48.6	20.8	0.035
Phyllanthus niruri						
Control	19.20	97.90	117.10	939.3	89.4	0.430
C_1	17.10 (-10.9)	96.0 (-1.9)	113.10 (-3.4)	821.9 (-12.4)	81.3 (-9.0)	0.410 (-4.6)
C_2	15.80 (-17.7)	82.10 (-16.1)	97.9 (-16.3)	631.6 (-32.7)	58.4 (-24.4)	0.391 (-9.0)
CD at 5%	1.32	1.46	2.78	5.51	19.6	0.037

Result of the pot culture experiment indicate that the leaf extracts of all the four test weed species, viz.; *Amaranthus viridis, Eclipta alba, Parthenium hysterophorus* and *Phyllanthus niruri* had a significant retarding effect on growth of mustard var. T-59 at both C_1 and C_2 treatment level at all sampling dates (30, 60 and 90 days after treatment). All the test parameters considered in the study, viz., root length, shoot length, total plant length, leaf area, root biomass, shoot biomass and total biomass were found to be significantly affected by weed leaf extracts and such effect was found to be concentration dependant.

The net primary productivity (NPP) and relative growth rate (RGR) values were found to be affected by treatment of different concentration of weed leaf extracts of all the test weeds.

The study supports the idea that the weeds growing in crop fields area able to retard the germination, establishment, growth, productivity and yield of

Table 2. Effect of weed leaf extracts on dry matter accumulation in brown mustard (*B. campestris* var. *dichotoma*) var. T-59 in pot culture at 90 DAT.

Biomass (g plant^{-1}) Treatment	Root	Shoot	Total
Amaranthus viridis			
Control	1.346	7.496	8.842
C_1	1.219 (-9.4)	6.141 (-18.0)	7.36 (-16.7)
C_2	1.160 (-13.8)	5.973 (-20.3)	7.133 (-19.3)
CD at 5%	0.122	1.353	1.475
Eclipta alba			
Control	1.346	7.496	8.842
C_1	1.206 (-10.4)	5.831 (-22.2)	7.037 (-20.4)
C_2	1.146 (-14.8)	4.937 (-34.1)	6.083 (-31.2)
CD at 5%	0.134	1.361	1.495
Parthenium hysterophorus			
Control	1.346	7.496	8.842
C_1	1.162 (-13.6)	5.750 (-23.2)	6.912 (-21.8)
C_2	1.110 (-17.5)	4.694 (-37.3)	5.804 (-34.3)
CD at 5%	0.153	1.745	1.898
Phyllanthus niruri			
Control	1.346	7.496	8.842
C_1	1.223 (-9.1)	6.173 (-17.6)	7.396 (-16.3)
C_2	1.163 (-13.5)	5.986 (-20.1)	7.149 (-19.1)
CD at 5%	0.121	1.316	1.437

Table 3. Effect of weed leaf extracts Net Primary Productivity (NPP) Relative Growth Rate (RGR) of brown mustard (*B. campestris* var. dichotoma) var. T- 59 in pot culture experiment.

Weed	Treatment level	NPPg.day^{-1}		RGRg.g.$^{-1}$ day^{-1}	
		60 days	90 days	60 days	90 days
A. viridis	C_0	0.1526	0.0568	0.0148	0.0031
	C_1	0.1485	0.0467	0.0199	0.0030
	C_2	0.1270	0.0659	0.0194	0.0047
E. alba	C_0	0.1526	0.0568	0.0148	0.0031
	C_1	0.1450	0.0424	0.0203	0.0028
	C_2	0.0172	0.0339	0.0202	0.0026
P. hysterophorus	C_0	0.1526	0.0568	0.0148	0.0031
	C_1	0.1369	0.0483	0.0202	0.0034
	C_2	0.1239	0.0298	0.0204	0.0024
P. niruri	C_0	0.1526	0.0568	0.0148	0.0031
	C_1	0.1611	0.0316	0.0200	0.0019
	C_2	0.1345	0.0564	0.0194	0.0039

crops through involvement of allelopathy and thus allelopathy as such constitutes an important aspect of crop interference by weeds.

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