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ALLELOPATHIC EFFECTS OF SOME WEED SPECIES ON THE GROWTH OF TOMATO PLANTS (SOLANUM LYCOPERSICUM L.)

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ABSTRACT

The experiment was designed to observe the growth of tomato plants exposed to different concentration (i.e. 2.5%, 5% and 10%) of the allelopathic plant extract i.e. Clerodendrum viscosum, Ipomea carnea, Chromolaena odorata and Parthenium hysterophorus. In the pot culture experiment it is observed that as the concentration increased of the above mentioned extracts greater inhibition was observed on the different parameter of the experimental plants such as height, number of leaf, biomass as well as the Chlorophyll content. Among the allelopathic plants higher inhibition was observed in the Parthenium hysterophorus treated pots followed by Clerodendrum viscosum, Chromolaena odorata and Ipomea carnea as compared to control. Phytochemical analyses of those selected allelopathic plants revealed that some of them contain Tannin, steroids, phenol and coumarins while some contain flavonoids also.

KEYWORDS: Allelopathy, Chromolaena Odorata, Ipomea Carnea, Clerodendrum Viscosum, Parthenium Hysterophorus And Solanum Lycopersicum L.

INTRODUCTION

The term “allelopathy” was coined to describe the effect of one plant on the neighbouring plants. The word allelopathy has been derived from the two Greek words ’Allelon’ meaning ‘each other’ and ‘Pathos’ meaning ‘to suffer’ i.e. the injurious effects of one plant upon another. However, Molisch (1937) used this term to mean all the biochemical interactions (stimulatory and inhibitory) among the plants. The term Allelopathy generally refers to the detrimental effects of higher plants of one species (the donor) on the germination, growth and development of another species (the recipient). However, allelochemicals which inhibit the growth of some species at certain concentrations may stimulate the growth of the same or different species at a lower concentration. Allelopathy is generally associated with the interactions between living plants and has been observed in the agricultural fields. Some crops also exert allelopathic effects on other crops and weeds. They

may inhibit (-ve effect) or stimulate (+ve effect) the germination and growth of weeds in agro ecosystems. Weeds are the plants which grow where they are not wanted and they interfere with seed germination, growth, productivity and yield of the cultivated crops. Weeds are an important factor in the management of all land and water resources but their effect is greatest on agriculture (Rao 1992 & 2000).

Keeping the above in view in the present work some observations were made on the allelopathic potential of some locally available weed species (i.e. Clerodendrum viscosum, Ipomea carnea, Chromolaena odorata and Parthenium hysterophorus) on the growth of Solanum lycopersicum L., which is an economically important crop plant.

Material and methods

Pot culture experiment.

Methodology suggested by Weng (1964)

The leaf of the allelopathic plants (Chromolaena odorata, Ipomea carnea, Parthenium hysterophorus and Clerodendrum viscosum) were collected from the neighbouring area of the agricultural fields of the study site.

These allelopathy plants were weighed out separately in the quantity of 50, 100 and 200gm. For each weed species three replicates and four treatments including control were used. The leaf of each weed with above mentioned quantity was thoroughly mixed with 2 kg of soil separately and sufficient quantity of water was added to all the pots and they were kept for 15 days in the green house to develop any microbial activity. Then sufficient quantity of the healthy seeds of tomato were taken and sterilized with 3 percent sodium hypochlorite solution and then thoroughly washed with water, several times.

Three healthy seeds of the tomato were sown to all the treated (Control, 50, 100, 200gm) pots. Each treatment has three replicated and kept in RCD (Randomized Complete Design). After the germination of the seed at and interval of 15 days, Observation was taken for 5 times at15 days interval.

For the estimation of chlorophyll content (mg/ml) of leaf grown in the allelopathic plant material treated plots and control was done according to Mahadevan and Sridhar (1986). Leaf sample of 0.02 g was put into test tubes having 5 ml Dimethyl sulfoxide (DMSO). Then the tubes were kept in boiling water bath at 65˚C for half an hour. Absorbance was taken at the wavelength of 645 and 663nm.

Following calculation was used to determine the chlorophyll content with different treatments.

Chl a = (12.7 × OD 663) – (2.69 × OD 645) × V/ a × 1000 × W

Chl b = (22.9 × OD 645) - (4.68 × OD 663) × V/ a × 1000 × W

Total Chl = (20.2 × OD 645) + (8.02 × OD 663) × V/ a × 1000 × W

Where, a = absorbance path = 1 cm

V= solution amount

W = weight of the leaf

Preparation of extract for the phytochemical screening

Ten gram of fresh leaves of allelopathic plants were ground, mixed with 100ml distilled water and filtered. The filtrate was used for the phytochemical analysis.

Phytochemical screening was performed using standard procedures as follows:

Test for tannins (Aqueous FeCl test) - To 0.5ml of extract solution 2 drops of ferric chloride solution was added. Blue colour was observed for gallic tannins and green black for catecholic tannins. (Iyengar,1995).

Test for flavonoids (Mg/HCl test) - To 5ml of extract was treated with a few drops of conc.2N HCL and Magnesium turnings (0.5g). The presence of Flavonoids was indicated if pink or magenta red colour developed within 3 min (Somolenski et al.,1972).

Test for saponins - To the plant extract 2ml of water was added and shaken well, formation of foam indicates the presence of saponins .

Test for steroids - To 2ml of extract, few drops of chloroform and acetic acid was added and heated, after that few drops of conc.H_2SO_4 solution was added. Development of red brown colour indicated presence of steroids.

Test for Phenol - To 0.5ml of extract was treated with few drops of alcohol and 3-4 drops of FeCl was added to it. The colour change to greenish yellow shows the present of phenol.

Test for Coumarins: In a test tube 5ml of plant extract was placed and covered with filter paper moistened with dil NaOH, then heated on water bath for a few minutes. The filter paper was examined under UV light, yellow fluorescence is indicative for the present of coumarins (EI- Tawil 1983).

Result

In pot culture experiment, it is observed that all the allelopathic plants show the higher inhibition of the height of tomato plants as compared to control, among the allelopathic plant extract Parthenium hysterophorus shows the higher inhibition followed by Clerodendrum viscosum, Chromolaena odorata and Ipomea carnea respectively as shown in the table1.

The average chlorophyll content is found to be decrease as compared to the control in all the allelopathy plant extract, followed by P. hysterophorus, C.odorata, C.viscosum and I.carnea respectively as shown in the table 2.

In case of the average number of leaf, it is observed that higher inhibition in Parthenium hysterophorus leaf extracts followed by Clerodendrum viscosum, Chromolaena odorata and Ipomea carnea as compared to control respectively Table 3.

The data on the biomass production in the different parts i.e., (leaf, stem and root) of the tomato plant shows the decrease in weight as compared to control, in leaf, stem and root biomass higher inhibition was observed in Parthenium hysterophorus followed by the Clerodendrum viscosum, Ipomea carnea and Chromolaena odorata as shown in the table 4.

Phytochemical analysis plays a major source of information on the analytical and instrumental methodology in plant sciences. Some of the phytochemical test showed positive result. Parthenium hysterophorus contain flavonoids, saponins, steroids, phenol, and coumarins whereas tannins have been found to be absent. In case of the Chromolaena odorata saponin, steroid, phenol, and coumarin are present, whereas tannins and flavonoids are found to be absent, and in Clerodendrum viscosum tannins, saponins, phenol and coumarins were found to be present, whereas flavonoid and steroid were absent and in case of the Ipomea carnea, it contain tannins, saponins, phenol flavonoids, steroids and coumarins as shown in the table 5.

Table: 1 Showings the inhibitory effect of the allelopathic plant extract (i.e. Chromolaena odorata, Clerodendrum viscosum, Parthenium hysterophorus and Ipomea carnea).on the height of tomato plants when exposed to different concentration

Treat/ Conc.		1st Days	15th Days	30th Days	45th Days	60th Days
Control		12.22 ± 1.68	31.93 ± 4.93	40.11 ± 6.37	50.11 ± 7.51	67.98 ± 4.54
C. odorata	2.5%	6.8 ± 3.22	22.9 ± 9.42	28.26 ± 11.70	33.26 ± 13.73	43.18 ± 17.45
	5%	5.6 ± 2.68	16.7 ± 7.45	21.57 ± 9.89	30.33 ± 14.62	34.38 ± 15.25
	10%	2.31 ± 1.30	4.02 ± 1.17	8.24 ± 2.04	19.23 ± 5.96	29.23 ± 7.22
C. viscosum	2.5%	2.64 ± 1.69	4.34 ± 1.72	9.85 ± 4.81	9.35 ± 4.19	24.73 ± 9.76
	5%	1.98 ± 0.34	2.37 ± 0.32	2.42 ± 0.33	8.53 ± 2.73	20.03 ± 7.12
	10%	1.17 ± 0.26	1.3 ± 0.32	2.36 ± 0.64	6.27 ± 3.53	7.61 ± 3.42
I. carnea	2.5%	8.48 ± 3.24	17.57 ± 6.31	26.93 ±11.15	41.67 ± 12.53	51.03 ± 11.89
	5%	5.35 ± 3.02	15.57 ± 8.34	23.92 ± 9.04	38.54 ± 12.59	40.5 ± 16.29
	10%	3.2 ± 1.10	4.07 ± 1.72	5.24 ± 2.04	6.73 ± 3.12	10.32 ± 4.37
P. hysterophorus	2.5%	1.61 ± 0.64	3.43 0.92	4.4 1.3	6.56 2.78	18.7 4.21
	5%	1.54 ± 0.07	1.57 ± 0.23	1.7 ± 0.42	5.1 ± 2.28	10.81 ± 2.53
	10%	0.96 ± 0.32	1.01 ± 0.35	1.2 ± 0.43	3.71 ± 1.78	4.89 ± 1.78
F value		9.62	13.72	12.66	12.21	11.37
C.D at 5%		153.87	544.84	673.89	845.54	931.91
C.D at 1%		224.79	795.94	984.46	1235.22	1361.4

Significant at $p \geq 0.05$

Table 2- Chlorophyll content of the leaf of the tomato plants exposed to different concentration of allelopathic plants (i.e. Chromolaena odorata, Clerodendrum viscosum, Parthenium hysterophorus and Ipomea carnea).

Treatment		Chlorophyll a(mg/ml)	Chlorophyll b (mg/ml)	Total Chlorophyll (mg/ml)
Control		4.39	1.61	6.01
P. hysterophorus	2.5%	2.98	1.22	4.41
	5%	1.11	0.69	1.91
	10%	1.08	0.58	1.86
C. odorata	2.5%	3.86	1.52	5.38
	5%	3.49	1.51	4.99
	10%	2.21	0.85	3.05
I. carnea	2.5%	4.10	1.50	5.60
	5%	3.72	1.39	5.11
	10%	3.59	1.23	4.82
C. viscosum	2.5%	3.98	1.44	5.41
	5%	2.11	0.79	2.91
	10%	2.08	0.78	2.86
F value		4.21	4.09	3.54

Significant at $p \geq 0.05$

Table 3 - Showing the inhibitory effect of the allelopathic plants (i.e. Chromolaena odorata, Clerodendrum viscosum, Parthenium hysterophorus and Ipomea carnea) on number of leaf of tomato plants when exposed to different concentration.

Treat/ Conc.		1st Days	15th Days	30th Days	45th Days	60th Days
Control		3.88 ± 0.45	11.4 ± 1.69	13.4 ± 2.10	15.4 ± 1.08	26.6 ± 4.5
C. odorata	2.5%	2.67 ± 1.41	8.22 ± 3.08	9.89 ± 3.71	11.56 ± 4.57	16.33 ± 6.26
	5%	5.56 ± 2.14	6.11 ± 2.29	7.11 ± 2.81	9.11 ± 3.59	11.78 ± 4.79
	10%	3.78 ± 1.22	4.89 ± 0.73	7 ± 0.82	8.56 ± 1.33	11.44 ± 2.04
I. carnea	2.5%	4.56 ± 1.36	6.67 ± 2.35	10.2 ± 1.82	11.78 ± 3.39	18.89 ± 3.13
	5%	6.56 ± 3.83	7.78 ± 1.55	9.77 ± 1.52	12.11 ± 2.71	13.11 ± 4.25
	10%	1.78 ± 1.03	2.44 ± 1.00	3.89 ± 1.77	5.33 ±1.96	5 ± 2.87
C. viscosum	2.5%	1.56 ± 0.51	4.22 ± 1.03	6.11 ± 1.95	7.22 ± 1.58	10.89 ± 2.96
	5%	1.78 ± 0.38	3.44 ± 0.77	3.56 ± 0.77	6.78 ± 1.22	9.22 ± 2.16
	10%	11.4 ± 1.69	2.11 ± 0.61	3.56 ± 1.00	5.78 ± 1.28	6.22 ± 2.39
P. hysterophorus	2.5%	1.56 ± 0.92	3.33 ± 0.87	5.33 ± 1.48	6.56 ± 1.05	8.78 ± 0.95
	5%	1.33 ± 0.58	2.33 ± 0.71	2.88 ± 0.84	5.33 ± 0.58	6.22 ± 0.94
	10%	1.33 ± 0.57	1.56 ± 0.51	2.67 ± 1.29	4.33 ± 1.60	4.11 ± 1.67
F value		4.17	10.97	9.89	6.35	10.56
C.D at 5%		56.44	142.26	156.27	123.67	299.67
C.D at 1%		82.46	207.82	228.29	180.67	437.78

Significant at $p \geq 0.05$

Table 4 – Biomass of the different parts of the tomato plants i.e. leaf. Stem and root

Treatment		Leaf	Stem	Root
Control		8.58 ± 1.26	7.96 ± 0.89	5.56 ± 0.48
C. viscosum	2.5%	2.84 ± 0.35	2.08 ± 0.08	1.97 ± 0.02
	5%	2.65 ± 0.65	1.47 ± 0.02	0.93 ± 0.02
	10%	0.46 ± 0.02	0.19 ± 0.03	0.09 ± 0.00
I.carnea	2.5%	4.68 ± 0.63	6.22 ± 0.61	5.64 ± 1.32
	5%	2.3 ± 0.94	2.49 ± 0.54	2.3 ± 0.02
	10%	0.62 ± 0.02	0.31 ± 0.00	0.24 ± 0.00
C. odorata	2.5%	6.76 ± 0.34	6.54 ± 3.27	4.66 ± 2.36
	5%	4.28 ± 0.27	4.01 ± 0.30	2.39 ± 0.41
	10%	1.24 ± 0.76	1.13 ± 0.70	0.53 ± 0.30
P. hysterophorus	2.5%	1.74 ± 0.39	1.56 ± 0.34	0.92 ± 0.34
	5%	1.42 ± 0.27	1.06 ± 0.1	0.48 ± 00
	10%	0.37 ± 00	0.15 ± 00	0.05 ± 00

Table 5- Preliminary phytochemical test for allelopathic plants

SL.No	Test	C. odorata	C. viscosum	P. hysterophorus	I. carnea
1.	Tannins: Aqueous FeCl test	-ve	+ ve	-ve	+ve
2.	Flavonoids: Mg/HCl test	-ve	- ve	+ve	+ve
3.	Saponin: Faom test	+ve	+ ve	+ve	+ve
4.	Steroids: Salkawaski test:	+ve	-ve	+ve	+ve
5.	Phenol test	+ve	+ve	+ve	+ve
6.	Coumarins test	+ve	+ve	+ve	+ve

Where, - indicate absent, + indicate present.

DISCUSSION

From the present work it was observed that the reduction in height, number of leaf, Chlorophyll content and dry weight of the seedling with increase in the concentration of the allelopathic plant extracts has been observed. It seems to be mainly due to the presence of the inhibitory substances like phenolic acids and flavonoids respectively. Depressive effect on growth of rubber seedlings has been reported earlier in the case of the application of Mikania and it was suggested that growth inhibitory substances like phenolic acid and flavonoids constituents present in Mikania may be responsible for the same (Weng 1964). The allelopathic leaf extract of the test plants (i.e. Parthenium hysterophorus) has been found to have the strongest allelopathic effect on the growth of Solanum lycopersicum .L as compared to the other allelopathic plant extracts i.e. Chromolaena odorata, Clerodendrum viscosum and Ipomea carnea. Earlier workers have also reported that leachates of Parthenium hysterophorus reduced root and shoot elongation of Oryza sativa (Singh and Sangeeta 1991), maize and soyabeans (Bhatt et al. 1994) as well as some common Australian pasture grasses (Alkins and Sowerby 1996).This indicate the presence of inhibitory chemicals in higher concentration in the leaf compared to the stem and root (Kanchan and Jayachandra 1980). According to Kanchan and Jayachandra(1979) and Pandey(1994),Parthenium hysterophorus is one of the best known plant invaders in the world linking allelopathy to exotic invasion. It is known that the unique allelopathic effect of some exotic species on native, 'inexperienced' communities also contribute to invasive success. (Callaway and Aschehoug, 2000).

Allelopathy is expected to be an important mechanism in the plant invasion process. Parthenium hysterophorus, because of its invasive capacity and allelopathic properties, has the potential to distrupt natural ecosystems (Evans 1997). It has been reported earlier for causing a total habitat change in native Australian grasslands, open woodlands, riverbanks and floodplains (McFadyen 1992, Chippendale and Panetta 1994).

In case of the biomass, it is also shown that the dry weight of the leaf, stem and root were higher in control as compared to the seeds/seedling exposed to different concentrations of the leaf, stem and root extracts of the test plants (i.e.2.5%, 5% and 10%) These showed that the aqueous extracts of Chromolaena odorata, Clerodendrum viscosum, Ipomea carnea and Parthenium hysterophorus inhibited the growth of the test crop plant. The result was contrary with the findings of Chengrong et al. (2005) who stated that allelochemicals from Wedelia troblabata reduced germination, and dry weights of root and shoot per plants of rice.

According to Tiwari et al. (2005) Parthenium hysterophorus has not been used for any purpose in Nepal. Therefore this plant may become a high risk posed invasive species in near future. Present results showed that concentrated aqueous leaf extract of Parthenium hysterophorus and Chromolaena odorata inhibited the seed germination and seedling growth of the crop plant, (i.e. Solanum lycopersicum L.). Keeping the above in view it can be suggested that these allelopathic plants should not be allowed to grow in the immediate vicinity of the agricultural field and this should not be used as green manure either, Whether they can be used in the composting or vermin compost preparation needs to be worked-out before they are considered for the same.

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