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ALLELOPATHIC EFFECT OF *Parthenium hysterophorus* ON GROWTH AND YIELD OF TOMATO (*Lycopersicon esculentum* L.) PLANTS

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ABSTRACT

The experimental study was conducted to evaluate the allelopathic effects of *Parthenium hysterophorus* on vegetable crops tomato (*Lycopersicon esculentum*). Fresh leaves of *Parthenium hysterophorus* were collected, sundried and soaked for 24 hrs; the filtrate was diluted with tap water to make different concentrations. There were five treatments viz., C0 (tap water); C1 (25% concentration); C2 (50% concentration); C3 (75% concentration); C4 (100% concentration). The experiments were laid out in the Randomized Block Design (RBD) with three replications. Leaf leachates of *Parthenium hysterophorus*, at 25%, 50%, 75% and 100% concentrations were applied to determine their effect on seed germination and growth parameters of test crops in pot culture. Germination was significantly higher in tomato when they were treated with 25% and 50% concentration. Similarly, the gross return, net return and higher cost: benefit ratio was reported maximum when the crops were treated with 25% and 50% concentration. The results showed that allelochemical stress caused by *Parthenium hysterophorus* aqueous was much pronounced in 100% concentration i.e. C4. From this we can predict that *Parthenium hysterophorus* might possess allelochemicals that causes both suppressive and stimulatory ability.

KEYWORDS: Allwlopathy, Germination, Seedlings length, *Parthenium hysterophorus, tomato*

In the present world, various types of ecological and environmental disasters are taking place due to highly use of synthetic chemical compounds in agriculture. These toxic chemicals are damaging the ecological balance to a severe extent and introducing many fatal diseases. Synthetic fertilizers often contain toxins that can be destructive to the soil, and the chemicals in these fertilizers can be poisonous to humans, wildlife, and marine life if they reach the oceans. Fertilizers can also leach through soil into groundwater, making it very harmful to the surrounding environment. That's why the demand of sustainable agriculture and eco-friendly alternatives to chemical compounds has been increased. Allelopathy is a natural ecology process of chemical inhibition of one species by another species, where substances acting as germination or growth inhibitors are released into the environment, influencing the development and growth of nearby plants. The term Allelopathy was introduced by professor Hans Molisch in 1937, which is derived from two separate Greek words allelon which means "of each other" and pathos which means "to suffer" literally meaning 'mutual suffering'. Allelopathic chemicals can be present in any part of the plant. They can be found in leaves, flowers, roots, fruits, or stems.

The phenomenon of allelopathy refers to chemical interactions between all sorts of plants. Durimg this process the chemical exudates or leachates released from leaves, stems or roots of a plant will inhibit the expansion of a neighboring one (Dongre and Singh 2011). Stimulatory and inhibitory allelopathic effect depends upon the concentration of allelochemicals (Hill *et al.*, 2006). Higher concentrations of allelochemicals have been observed to have inhibitory effect (Femina *et al.*, 2012; Singh 2019 and Singh 2021a), while, lower concentrations exert stimulatory allelopathic impact on seed germination and growth of plant (Sahoo *et al.*, 2010).

Parthenium hysterophous L. is native to tropical and subtropical America. This plant species is very invasive invader in large extent and it is threatened grassland ecosystem of Australia and India. This weed possesses many hazardous substances and it is very harmful to the surrounding flora, animals and also to human health. It has been already invaded in most of the useful field areas in urban and village. 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 (Swaminathan *et al.* 1990; Stephen and Sowerby 1996).

Tomato (*Lycopersicon esculentum*) belongs to the large and diverse Solanaceae family also called Nightshades which includes more than three thousand

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species. The species originated in western South America. Tomato is the second most important vegetable crop after Potato (*Solanum tuberosum*).

MATERIALS AND METHODS

The present study was conducted at the laboratory of Department of Botany, Govt. girls Degree College, Saiyadraja, Chandauli, U.P., India in the month of September 2023. The mature fresh plants of *Parthenium hysterophorus* L. were collected from the area of the Saiyadraja, Chandauli (U.P) and brought to laboratory. Tomato fruits were purchased from the market, and their seeds separated, washed, and air-dried.

Preparation of Aqueous Leaf and Stem Extract

The collected leaves were sun dried for 4-5 days and later the dried leaves were crushed and soaked in tap water for 24 hours at 1:10 proportion on weight by volume. After 24 hours of soaking the leaf extracts was filtered with the help of muslin cloth and the extracts of different concentration i.e. 25, 50, 75 and 100 per cent was prepared accordingly. Thus, there were five treatments including Control water as follows:

C0 - Control water (Tap water), C1- extracts of 25% Concentration, C2 - extracts of 50% Concentration, C3 - extracts of 75% Concentration and C4– extracts of 100% Concentration.

Phytotoxicity of Parthenium Extract to Tomato

Before seed germination test, empty and undeveloped seeds were discarded by floating 5 min in tap water to remove dirt and dust. The seeds were surfaced sterilized with 0.1% mercuric chloride (HgCl2) solution for 3 min and then washed 6-7 times with distilled water.

Polyethylene bags of 10 kg capacity were half-filled with 5kg of air-dried loamy soil. The ten seeds of tomato were sown in the bags, and 250ml of the leaf exudates were added, while distilled water was used for the control. Subsequently, the bags were watered every other day with 100ml of distilled water. Germination counts were made, and plant height measurement of the seedlings were taken The experiments were carried out under 70% relative humidity at 25 ± 2^0C with a 12 h photoperiod to test the germination under different concentration of extracts in three replicate with completely randomized block design.

The germination of seeds were recorded on the 15^{th} day after showing. Plant height, number of flower, number of cluster, number of tomato per plant were recorded at 30, 60 and 90 DAS. Experimental results were statistically analyzed using critical difference (CD at 5%) as a measure of significance.

RESULTS AND DISCUSSION

Germination Percentage (%)

The highest percentage of germination was found at treatment C0 (95.50%) followed by C2 (90.00%), C4 (75.00%) and C1 (60.00%), respectively. The lowest germination percentage of 58.40% was recorded in C4. The *Parthenium* extract effect on crops showed that the concentrations of *Parthenium* significantly affected the germination of test species. As concentration of plant extract increases, the percentages of seed germination get inhibited as compared to control in tomato. The studies with other species have reported that the response to allelochemicals may be concerning on the concentration dependent (Dongre *et al.,* 2004; Dongre *et al.,* 2010; Dongre and Singh 2011; and Singh, 2021b). Allelochemicals that inhibit the growth of some species at certain concentrations might stimulate the growth of the same or different species at different concentrations (Narwal, 1994). It is therefore necessary to identify concentration at which *Parthenium hysterophorus* aqueous extract would affect the germination and growth of crops.

Plant Height

The plant height was recorded at 30, 60 and 90 DAS respectively as influenced by different percentage of *Parthenium* leaf extracts. At 30 DAS, it was observed that plant height was significantly affected by different concentration of extracts. The maximum plant height was found in treatment C2 (19.40 cm) followed by C3 and C1 both are (18.6 cm) and minimum plant height was observed in C4 (17.30 cm). At 60 DAS, it was observed that plant height was significantly affected by different concentration of extracts. The maximum plant height was found in C2 (28.10 cm) followed by C3 (27.04 cm) and minimum plant height was observed in C4 (19.76 cm). At 90 DAS, it was observed that plant height was significantly affected by different concentration of extracts. The maximum plant height was found in treatment C2 (51.64 cm) followed by C1 (50.32 cm) and minimum plant height was found in C4 (39.00 cm) (Table 1).

Table 1: Effect of different concentration of *Parthenium hysterophorus* leaf extract on Tomato plant height (cm)

Treatment (%)	30 DAS	60 DAS	90 DAS
C0 (Control)	18.20	24.50	47.70
C1	18.60	25.10	50.32
C2	19.40	28.10	51.64
C3	18.60	27.04	50.0
C4	17.30	19.76	39.00
CD at 5%	0.063	0.063	1.13

Different allelochemicals have different sites of action in a plant. Thus, the sensitivity to allelochemicals and the extent of inhibition varied with species and organs (Maharjan *et al.,* 2007). Singh (2017) observed that leaf extracts had more impact on the radicle growth of crops than root extracts. This implies that inhibitory chemicals had higher concentrations in leaves than in the roots. Singh (2021c) found higher phytotoxic effects of aqueous leaf extracts of parthinium on the germination, root and shoot lengths of three crop namely *Zea mays*, *Triticum aestivum* and *Vigna radiate.* Among all the plant species the concentration of extract increases the root and the shoot length reduces as compare to control. Some earlier work have also reported that the *Parthenium hysterophorus* L. reduces root and shoot length of *Zea mays* L. and *Glycine max* L.(Bhatt *et al.*, 1994).

Days Taken to Flowering

The minimum days taken to flowering was observed in C2 (50% leaf extract) with 40.9 respectively. The maximum days taken to flowering was observed in C4 (100% leaf extract) with 52.56 respectively (Table 2). Allelochemicals affect all functions of plant life including photosynthesis, respiration transpiration and growth (Rice, 1984).

Table 2: Effect of different concentration of leaf extract of *Parthenium hysterophorus* on germination (%), Day taken to flowering, Number of cluster per plant, Number of fruit per cluster, Number of fruit per cluster, Number of tomato per plant and Tomato yield per plant (kg)

Treatment	Germination (%)	Day taken to flowering	Number of cluster per plant	Number of fruit per cluster	Number of tomato per plant	Tomato yield per plant (kg)
Control	95	45.32	6.20	2.71	25.00	1.12
25%	60	44.86	6.00	2.70	25.40	1.66
50%	90	40.9	7.00	2.94	27.00	1.90
75%	75	45.96	6.40	2.82	26.50	1.46
100%	59	52.56	5.60	2.14	19.10	0.76
CD at 5%	0.94	0.38	1.76	0.13	0.26	0.18

Number of Cluster per Plant

The highest number of cluster per plant was observed in treatment C2 (50% leaf extracts) with 7.0 and followed by C3 (75% leaf extracts) with 6.4 and the leased was observed in C4 (100% leaf extracts) with 5.6 respectively. This result conform with the findings of (Oluwafemi, 2014 and Sangtam *et al.,* 2019). The physical and chemical processes important for growth and development of plants are frequently modified by chemicals released from neighboring plants, which can affect the plant negatively or positively in some cases (Iqbal *et al.,* 2013).

Number of Fruit per Cluster

The highest number of fruits per cluster was observed in treatment C2 (50% leaf extracts) with 2.94 and followed by C3 (75% leaf extracts) with 2.82 and the leased was observed in C4 (100% leaf leachates) with 2.14 respectively. This result conform with the findings of (Oluwafemi, 2014 and Sangtam *et al.,* 2019). The physical and chemical processes important for growth and development of plants are frequently modified by chemicals released from neighboring plants, which can affect the plant negatively or positively in some cases (Iqbal *et al.,* 2013).

Number of Tomato per Plant (g)

The highest number of fruits per plant was observed in treatment T2 (50% leaf extracts) with 27.0 and followed by T3 (75% leaf extracts) with 26.0 and the leased was observed in T4 (100% leaf extracts) with 19.0 respectively. The intensity of allelopathic effects depends on the concentration of substances that are present in the extract, what was proven in this work, in which the concentration of 20% showed significant inhibition effect over the aerial part and the root, while the other concentrations did not present the same result, what highlights the specificity of the allelopathic effect (Dongre and Singh 2007).

Tomato Yield per Plant (kg)

The highest number of tomato yield per plant was observed in treatment C2 (50% leaf extracts) with 1.9 kg and followed by C1 (25% leaf extracts) with 1.66 kg and the leased was observed in C4 (100% leaf extracts) with 0.76 kg respectively. Due to the presence of allelochemicals in aqueous extract of *Parthenium hysterophorus* L. showing inhibitory effect of growth and productivity of on different plant species (Rajan 1973 and Singh 2019).

CONCLUSION

The maximum germination percentage, height of plant, growth and yield parameters were recorded at C2 (50% leaf leachates) for Tomato under parthenium leaf leachates.The allelochemicals present in the *Parthenium hysterophorus* can have an allelopathic inhibitory effect on different agricultural crops including vegetables associated with *Parthenium*.It can also be concluded that, the closer the planting of any crop (vegetable) near the *Parthenium hysterophorus* the lesser the performance of the crop and consequently the lower the productivity. The *Parthenium hysterophorus* L. have potential to inhibit the seed germination and seedling emergence of different plants due to the presence of allelochemicals. So, in field condition, the incorporation of parthenium plants to the soil affects the growth and yield of succeeding crops. To decrease the impact of parthenin effect on crop, the removal of Parthenium plants before its flowering or before sowing of crop may be recommended, after further research.

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