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ALLELOPATHIC EFFECT OF *Parthenium hysterophorus* ON GROWTH AND YIELD OF TOMATO AND POTATO

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ABSTRACT

The present investigation evaluated the allelopathic effect of *Parthenium hysterophorus* leaf leachate on germination, growth and yield of Tomato (*Solanum lycopersicum*) and Potato (*Solanum tuberosum*). Aqueous leaf leachates at 0 (control), 25, 50 and 100% concentrations were applied under controlled conditions. Results revealed a concentration-dependent inhibitory effect on all growth and yield parameters. At 30 DAS, tomato plant height was reduced by 11.1–15.1%, while potato showed a higher reduction of 18.7–56.2%. At 60 DAS, inhibition reached up to 23.4% in tomato and 54.5% in potato. Germination percentage declined sharply at higher concentrations, with maximum inhibition of 70% in tomato and 34.4% in potato at 100% concentration. Yield per plant was severely reduced, showing 47.5% inhibition in tomato and 73.2% in potato at the highest concentration. The study confirms the strong allelopathic potential of *Parthenium hysterophorus* and highlights the necessity of its effective management in agricultural fields.

KEYWORDS: Allelopathy, *Parthenium hysterophorus*, Tomato, Potato, Inhibition percentage

Allelopathy refers to the chemical interaction among plants, in which one plant releases biologically active compounds that influence the growth and development of neighboring plants (Molisch, 1937; Rice, 1984). These allelochemicals adversely affect seed germination, seedling growth, nutrient uptake and ultimately crop yield (Narwal, 1994). *Parthenium hysterophorus* L. is one of the most aggressive invasive weeds in India, infesting agricultural lands, roadsides and wastelands. The weed releases toxic compounds such as parthenin and phenolic acids, which exert strong inhibitory effects on crop plants (Rajan, 1973; Kanchan and Jayachandra, 1980). Several studies have documented the allelopathic impact of *P. hysterophorus* on cereals, legumes, vegetables and tree species (Swaminathan *et al.*, 1990; Stephen and Sowerby, 1996; Maharjan *et al.*, 2007).

Tomato and potato are economically important vegetable crops and are sensitive to allelopathic stress (Hill *et al.*, 2006; Sangtam *et al.*, 2019). However, information regarding the quantitative inhibition percentages of growth and yield parameters due to *Parthenium hysterophorus* leaf leachate is limited. Earlier researchers have reported significant reductions in germination and seedling growth of crops due to weed leachates (Bhatt *et al.*, 1994; Dongre and Singh, 2007; Singh, 2021b).

In agricultural ecosystems, the invasion of aggressive weeds such as *Parthenium hysterophorus* poses a serious threat to crop productivity by altering soil chemistry and releasing phytotoxic substances into the rhizosphere. The accumulation of allelochemicals in soil may lead to reduced crop performance, particularly when crop plants are grown in close association with weed residues. Although several studies have reported the allelopathic effects of *P. hysterophorus* on different crops, information regarding the quantitative inhibition percentages of growth and yield parameters, especially under controlled conditions, remains limited.

Therefore, the present study was undertaken to evaluate the allelopathic effect of *Parthenium hysterophorus* leaf leachate on germination, growth and yield of tomato and potato with special emphasis on concentration-dependent inhibition percentages, so as to better understand the potential risk posed by this weed to vegetable crop production.

MATERIALS AND METHODS

The experiment was conducted during 2024 in the laboratory of the Department of Botany, Government Girls Degree College, Saiyadraja, Chandauli (U.P.), India. Mature plants of *Parthenium hysterophorus* were collected locally. Healthy tomato seeds and potato tubers were used.

Preparation of Leaf Leachate

Fresh leaves were washed, shade-dried and soaked in tap water (1:10 w/v) for 24 hours. The leachate

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was filtered and diluted to obtain 25, 50 and 100% concentrations. Tap water served as control (0%). Thus, there were four treatments including Control water as follows:

C0 - Control water (Tap water), C1- Leachates of 25% Concentration, C2 - Leachates of 50% Concentration, C3– Leachates of 100% Concentration.

Experimental Design

Polyethylene bags (10 kg capacity) were filled with 5 kg loamy soil. Ten seeds or tubers were sown per bag. Each treatment received 250 ml of leaf leachate initially and was maintained under controlled conditions (25±2°C, 70% RH, 12 h photoperiod) in a completely randomized design with three replications.

Observations on germination were recorded on the 15th day, while plant height, yield attributes and yield per plant were recorded at 30 and 60 DAS. Data were statistically analyzed and CD was calculated at 5% significance.

RESULTS AND DISCUSSION

Effect on Plant Height

Plant height of both tomato and potato was significantly reduced with increasing concentration of *Parthenium hysterophorus* leaf leachate (Table 1). In tomato, plant height at 30 DAS decreased by 11.1%, 8.1% and 15.1% at 25, 50 and 100% concentrations, respectively, compared to control. At 60 DAS, inhibition reached up to 23.4% at 100% concentration.

Potato showed greater sensitivity than tomato. At 30 DAS, plant height was reduced by 18.7%, 31.2% and 56.2% at 25, 50 and 100% concentrations, respectively. At 60 DAS, inhibition ranged from 18.1% at 25% concentration to 54.5% at 100% concentration. The pronounced reduction in plant height clearly indicates concentration-dependent allelopathic inhibition. Similar growth suppression due to weed leachates has been reported earlier (Dongre and Singh, 2007; Singh, 2019; Singh, 2024).

The results of the present study clearly demonstrate the strong allelopathic potential of *Parthenium hysterophorus* leaf leachate on tomato and potato. The reduction in plant height observed in both crops may be attributed to the presence of allelochemicals such as parthenin and phenolic compounds, which interfere with cell division and elongation processes (Rajan, 1973; Kanchan and Jayachandra, 1980).

Effect on Germination

Germination percentage declined significantly with increasing concentration of leaf leachate (Table 2 and Table 3). In tomato, germination was reduced marginally (1.5%) at 25% concentration, but inhibition increased sharply to 20% at 50% and 70% at 100% concentration.

In potato, germination was unaffected at 25% concentration; however, inhibition of 13.5% and 34.4% was recorded at 50% and 100% concentrations, respectively. These results confirm that higher concentrations of allelochemicals severely interfere with enzymatic activities essential for germination. Similar inhibitory effects have been reported by Swaminathan *et al.* (1990), Dongre *et al.* (2004), Maharjan *et al.* (2007) and Singh, (2021b).

Germination percentage of both crops declined progressively with increasing concentration of leaf leachate (Fig.1). The reduction was more pronounced in tomato, indicating higher sensitivity to allelopathic stress as compared to potato. The highest germination percentage was recorded in the control treatment, whereas the lowest germination was observed at 100% concentration, reflecting severe inhibitory effects of leaf leachate at higher doses.

Effect on Yield Attributes and Yield

Yield attributes of tomato such as number of clusters per plant, fruits per cluster and fruits per plant showed progressive inhibition with increasing concentration (Table 2). At 100% concentration, number of clusters per plant declined by 43.6%, fruits per cluster by 47.3% and fruits per plant by 63.1% compared to control. Tomato yield per plant showed 3.2%, 33.8% and 47.5% inhibition at 25, 50 and 100% concentrations, respectively. Tomato yield per plant decreased significantly with increasing concentration of leaf leachate (Fig.2).

In potato, number of sprouts per tuber decreased by 16.7%, 41.4% and 56.1%, while number of tubers per plant declined by 14.7%, 40.3% and 65.9% at 25, 50 and 100% concentrations, respectively (Table 3). Potato yield per plant was severely affected, showing inhibition of 7.2% at 25%, 42.0% at 50% and a maximum of 73.2% at 100% concentration. A marked reduction in potato yield was observed at higher concentrations of leaf extract.

The sharp reduction in yield attributes and final yield at higher concentrations suggests prolonged physiological stress, reduced photosynthetic efficiency and poor assimilate translocation. These findings are in

close agreement with earlier reports on allelopathic stress in vegetable and pulse crops (Dongre *et al.*, 2010; Sangtam *et al.*, 2019; Singh, 2021a; Singh, 2024).

The stronger inhibitory response observed in potato compared to tomato may be attributed to differences in physiological sensitivity and nutrient uptake efficiency of the two crops under allelopathic stress. Root and tuber crops are known to be more vulnerable to soil-borne allelochemicals, which may directly affect root growth, metabolic activities and assimilate partitioning (Rice, 1984; Narwal, 1994). The allelochemicals released from *Parthenium hysterophorus,* particularly parthenin and various phenolic compounds, have been reported to inhibit cell division, membrane permeability and enzymatic activity, leading to suppressed growth and yield (Rajan, 1973; Kanchan and Jayachandra, 1980).

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

Treatment (%)	30 DAS		60 DAS	
	Tomato	Potato	Tomato	Potato
C0 (Control)	19.80	16.00	26.50	22.00
C1	17.60 (-11.1)	13.00 (-18.7)	26.20 (-1.1)	18.02 (-18.1)
C2	18.20 (-8.1)	11.02 (-31.2)	27.60 (+3.7)	13.00 (-40.9)
C3	16.80 (-15.1)	07.00 (-56.2)	20.30 (-23.4)	10.01 (54.5)
CD at 5%	0.246	0.67	13.8	1.02

Data in parentheses indicate percent decrease/increase from control.

Table 2: Effect of different concentration of leaf leachate of *Parthenium hysterophorus* on germination (%), Number of clusters per plant, Number of fruits per cluster, Number of tomatoes per plant and Tomato yield per plant (kg)

Treatment	Germination (%)	Number of clusters per plant	Number of fruits per cluster	Number of tomatoes per plant	Tomato yield per plant (kg)
Control	100	8.7	3.8	27.7	1.24
25%	98.5 (1.5)	7.9 (-9.2)	3.6 (-5.2)	26.2 (-5.4)	1.20 (-3.2)
50%	80.0 (-20.0)	7.5 (-13.8)	2.8 (-26.3)	20.4 (-26.3)	0.82 (-33.8)
100%	30.0 (-70.0)	4.9 (-43.6)	2.0 (-47.3)	10.2 (-63.1)	0.65 (47.5)
CD at 5%	2.92	1.03	0.26	0.45	0.15

Data in parentheses indicate percent decrease from control.

Table 3: Effect of different concentration of leaf leachate of *Parthenium hysterophorus* on germination (%), Number of sprouting per tuber, Number of tuber formation per plant and Potato yield per plant (kg)

Treatment	Germination (%)	Number of sprouting per tuber	Number of tuber formation per plant	Potato yield per plant (kg)
Control	100	4.06	12.9	1.38
25%	100 (0.0)	3.38 (-16.7)	11.0 (-14.7)	1.28 (-7.2)
50%	86.5 (-13.5)	2.38 (-41.4)	7.7 (-40.3)	0.80 (-42.0)
100%	65.6 (-34.4)	1.78 (-56.1)	4.4 (-65.9)	0.37(-73.2)
CD at 5%	4.20	0.38	1.34	0.09

Data in parentheses indicate percent decrease from control.

Earlier workers have also reported that aqueous extracts of *P. hysterophorus* reduce photosynthetic efficiency, nutrient uptake and carbohydrate metabolism in crop plants, resulting in poor growth and productivity (Swaminathan *et al.*, 1990; Maharjan *et al.*, 2007). The concentration-dependent inhibition observed in the present study is in close agreement with the findings of Dongre and Singh (2007), Dongre *et al.* (2010) and Singh (2021b), who reported severe growth and yield reduction in crops exposed to weed leachates. The present findings further substantiate the role of concentration-dependent allelopathic interference of *P. hysterophorus* and emphasize that continuous exposure to higher concentrations may cause cumulative toxic effects, ultimately resulting in severe yield losses (Singh, 2024).

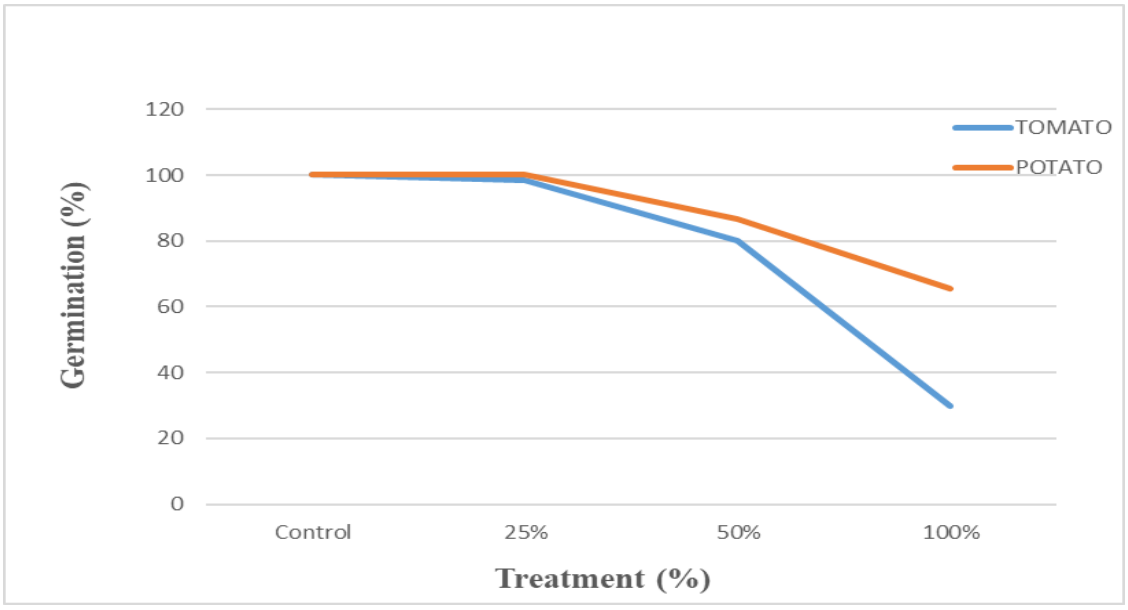

Figure 1: Effect of *Parthenium hysterophorus* Leaf Leachate on Yield per Plant of Tomato and Potato

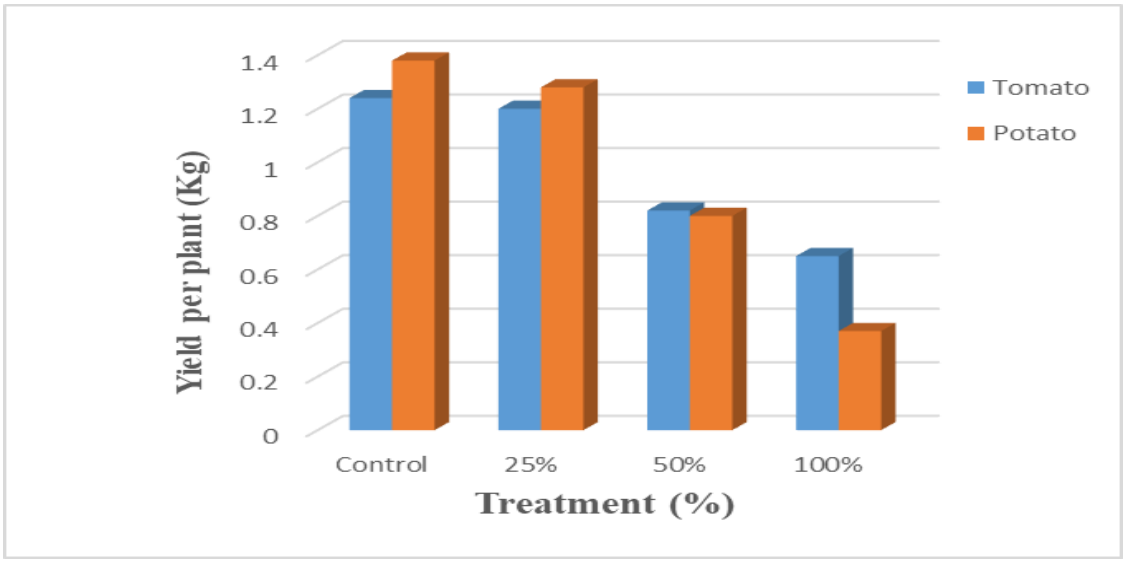

Figure 2: Effect of *Parthenium hysterophorus* Leaf Leachate on Yield per Plant of Tomato and Potato

CONCLUSION

The present study clearly demonstrates that *Parthenium hysterophorus* leaf leachate exerts strong allelopathic effects on germination, growth and yield of tomato and potato. Inhibition percentages increased progressively with concentration, with potato being more sensitive than tomato. Maximum inhibition was observed at 100% concentration, resulting in severe yield losses. The findings highlight the potential threat of *P. hysterophorus* infestation in agricultural fields and emphasize the need for its timely management to minimize crop yield losses.

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