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Allelopathic Impact of *Parthenium hysterophorous* Leaf Extract on the Yield-Contributing Traits of *Allium sativum* L.

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Abstract

Allelopathy is a biological phenomenon by which plants release biochemical compounds (allelochemicals) into their surroundings, manipulating the progress and existence of other organisms. The current work aimed to investigate the allelopathic influence of *Parthenium hystyerophrous* extract on garlic genotype. The attentiveness of *Parthenium* extract was applied to the seedling of garlic, and found maximum plant height (82.00cm) for treatment (T3), while the minimum was noted in T1 treatment (24.50). the study investigated the effect of treatments on root length and dry matter reduction. The results showed a significant reduction in root length, averaging 3.50, while it had a minimum reduction at 3.65. Statistical analysis revealed varying correlations between root size and dehydration depth, with R values of 0.767, 0.173, and 0.041. The relationship between treated and control plant root lengths was significant in control and treatment-1, but less so in treatment-3. Although the correlation between weight and root length was significant in control and treatment-1, it was weaker in treatment-3, with an R value of 0.138 and 0.31, respectively. This study aimed to explore various applications of allelopathy, suggesting that effective allelochemicals should be further isolated and investigated.

KEYWORDS

Allelochemicals, *Parthenium*, allelopathy, Plant height, roots

INTRODUCTION

Allelopathic Activity is a normal procedure in which plants and microorganisms affect the progress and growth of each other through the discharge of allelochemicals into the atmosphere, effect in helpful results; the process is referred to as allelopathy. Even though these chemicals are harmful, they generally cause a detrimental effect on other organisms [1]. Allelopathy significantly contributes to the formation of specific plant populations and interactions among various plant types. As [2] confirms, plant species are highly multi-site related and complex with their neighboring plant species; this involves competition for resources such as water and nutrients, reserves, stimuli, and interdependence.

In some of the larger plant species, compounds showing allelopathic influence on other body parts have been reported [3]. In certain conditions, these allelochemicals volatilize into the air as either exudates from living plants or sufficient rotted plant matter to exert an effect on adjacent or successor plants [4]. As per various scientists, rain leachates of certain plants showed variable allelopathic effects on various bioassays, and the aqueous extract of each part of *Lantana camara* showed firm allelopathy on the growth of various test species [5]. *Parthenium hysterophorous* L., or congress weed, carrot weed, or white top, is an alien invasive herbaceous weed that previously only occurred in the tropical and subtropical Americas but is now widespread throughout the tropics [6].

These all are cases of the weed being unintentionally introduced, quickly spreading, and forming monospecific thickets that are harmful to rangeland, agriculture, and the diversity of natural habitats. For instance, the *Parthenium* was initially introduced in India in the 1950s, and it soon spread to virtually all nations on Earth [7]. *Parthenium*, also referred to as *Parthenium* weed or carrot weed, is an invasive plant that has been reported to have allelopathic effects, such that it releases biochemicals that can suppress the growth of other vegetation. In the context of the impacts on garlic, studies indicate that it has adverse effects. To reduce the impact of *Parthenium* on garlic, farmers can use different means of weed management, like manual uprooting, mulching, spraying with herbicides, or crop rotation. Farmers can also choose garlic genotypes that exhibit some degree of resistance to allelopathy effects or competitive stress from *Parthenium* in order to ensure the productivity of garlic in areas where *Parthenium* infestation is serious [8]. One of the world's most widespread medicinal and herbal plants is garlic (*Allium sativum* L.), a member of the Allium genus within the Liliaceae family. It is considered to be a generally honorable earlier crop as it is not only an odious nutrient component but also has the

usual ability to resist a number of microbial illness toxins. Furthermore, garlic's stem is a byproduct of the garlic production process, but it has too many benefits to be an applicable organic substance. But since its location is not known, it has been deemed wild or extra output in the present garlic harvesting production. This leads both to ecological pollution and to a great loss of garlic stems utilized. In order to attain agronomic sustainable development and reduce ecological waste, this reserve should be wisely utilized and utilized properly. Few studies on garlic stem allelopathy have been done to date, but there has been research interest in garlic plant ultrasonic extract [9] and aqueous extracts of garlic straw [10]. Thus, the primary aim of this study was to examine the allelopathic impact of different methods of disintegration of garlic stalks. Here, the field properties and plant enzyme activities of the test lettuce plants and the activities of the soil enzymes with broken-down garlic stem were studied

MATERIALS AND METHODS

Experimental Design

An experiment was carried out in the botany department of the University of Malakand, Lower Dir., in the plant physiology lab to analyze the effect of *Parthenium* extract on garlic under salt stress grievances. Three seeds of each line were sown in every one of the twenty-four pots of the normal garlic genotype selected. Each pot was filled with equal amounts of soil and three centimeters in depth. Three treatments [Well water control]. *Parthenium hysterophorous* extract with salt, 50 mM, 100 mM, and 150 mM. The test was repeated twice in a completely randomized manner. After a 15-day propagation retreatment, two plants per pot were kept. Plants were usually watered up to twenty-eight days before treatment.

Following the normal growth of the plants for 28 days, salt stress and *Parthenium* extract were applied. The experiment was conducted under fully natural ecological conditions. Throughout the growth period, the day temperature was 28±2°C, the night temperature was 20±7 °C, and the day and night durations were noted at 10 and 12 hours and 12 and 14 hours, respectively. Varying concentrations of salt solution were added to each pot (T1 (20mM), T2 (20mM), and T3 (20mM). 1 liter of distal water was used to dissolve 1 mole of NaCl for the solution, and 25ml of salt solution was added to each pot. The control was irrigated in the same concentration of distal water. In a control setting, the morphological traits of the specified groupings have been established. Plant length, leaf, branch, and root sizes, and the proportion of propagation and overall number of leaves were all measured. Grams per plant were utilized to obtain the FW and DW values. Centimeters was the unit of measurement used to express the plant's length, which was obtained by utilizing a metric scale. Ten days later after spreading, the roots and shoots length was measured in centimeters with a ruler at the end of the study. Shoots of each plant were collected and weighed using an electronic digital

balance in grams (g). Following drying for 72 hours at 800 degrees Celsius in a hot air oven, the dry weight of the shoots and the roots was measured with the same digital balance [11, 12].

RESULTS AND DISCUSSIONS

The abiotic factors are more apparent and limiting, and as a result, they can render plants unproductive [13, 14]. The present research aimed to screen the chosen varieties of *Allium sativum* under different concentrations of Parthenium leaf extract at the University of Malakand. Five replicate pots were employed for the study, and in each pot, there was a different group of seeds. Five different varieties of garlic were collected from adjacent regions for this experiment. The experiment was repeated five times in pots, with a single seed in each pot. After the removal of the rest of the plants, the surviving seedlings were selected for further research.

Table 1. Descriptive statistics for quantitative traits of garlic genotype under leaf extract.

Traits	Mean	Standard Error	Standard Deviation	Sample Variance	Minimum	Maximum	CV %
Plant height	53.00	7.81	20.66	426.83	24.50	82.00	6.79
leaf length	9.79	1.92	5.09	25.90	5.50	20.50	5.09
leaf width	1.62	0.06	0.16	0.03	1.50	1.83	27.02
no. of leaves	3.38	0.15	0.40	0.16	3.00	4.00	22.09
root length	3.67	0.17	0.44	0.19	3.33	4.50	22.00
no.of root	11.33	0.67	1.78	3.19	8.33	14.00	16.80
Fresh weight	2.70	0.31	0.83	0.69	1.90	4.20	8.60
Dry weight	0.51	0.10	0.27	0.07	0.20	0.80	4.98

Table 1 presents the results of an expressive statistical analysis that showed a significant difference between treated and control plants. The lowest value was 0.34, while the highest mean value for plant biomass under control was 79.3, with a standard error and CV of 16.80.

Plant height

One of the significant features that enhances a plant's surface area for transpiration is height; in addition, plant height is related to the production of agricultural yields. The table presents a statistical analysis of recent studies for total plant measurement. There was a significant difference between the treated and control plants. Documented were the lowest value (1.50) and the highest mean value (25.6) and CV (27.6). Similarly, in stress complaint, the mean value of height (11.33±2.8613) was recorded for treatment 1, with CV (17.44) and the maximum mean value was (18±1.7)m, followed by treatment 2 with CV (12.6), and the minimum mean value (13cm) was recorded. ANOVA for total plant height was set up showing that genotype treatment and their evolution are highly significant and positive outcomes on total plant size at alpha 0.05%.

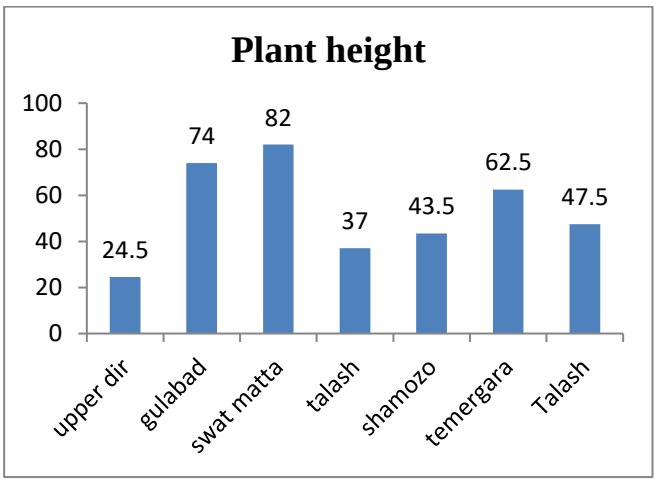

Figure 1. Graphical representation of the plant height of garlic under the allelopathic condition of *Parthenium*.

Leaf length

In the current research of garlic genotype under stress conditions, the maximum shoot length was established in R3 (12.2) and the highest shoot length was found in R2 with slight variation (12.66). The lowermost shoot length was also found in genotype R4, which is (7.6). Moreover, all genotype shows momentous differences in length, the highest length was recorded for the control with a mean value (18.5±1.0692) and CV (8.1795), while the minimum value (6.5cm) was noted.

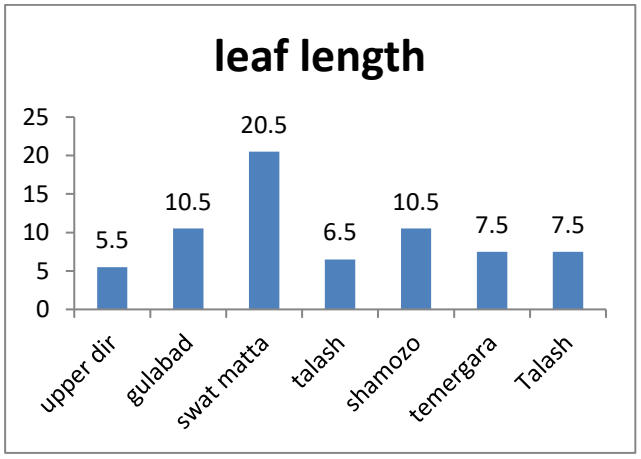

Figure 2. Graphical representation of leaf length of garlic under allelopathic condition of *Parthenium*.

Root length

The root size was expressively changed the highest root length was found in R5 (4.5cm), which show confident variation. The genotype R3 had the minimum root length. The simplest way to reach underground trace rudiments is through roots, which are also crucial to hyper accumulation. The table presents an expressive statistical analysis of root length. Root hair number had the highest mean value (5.5) with standard error (1.2168) and CV (23.5334), while genotype R2 had the lowest mean value (7.8) with standard error (1.333). The mean square for root length confirmed that the values are really significant and reflect the positive effects on root length in the present study.

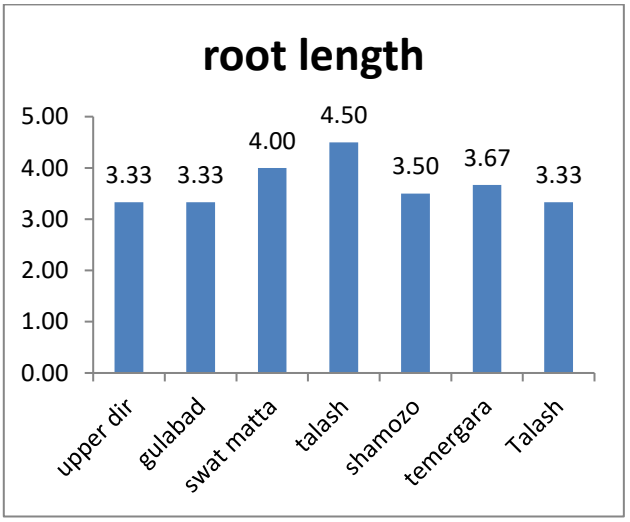

Figure 3. Graphical representation of root length of garlic under allelopathic condition of *Parthenium*.

Fresh weight

In this study, a major reduction in the genotype of garlic was observed in stressed plants of *Parthenium.* The lowest fresh weight was found in the genotype 3 treatment (20ml) and showed a significant reduction with an increase in the level of extract, whereas the highest fresh weight was recorded in T1 treatment (20ml). The table provides a descriptive statistical summary of the existing study on fresh weight, indicating clearly the marked difference between the control and extract. The mean value of the height of the control plant (2.768) was measured with a normal error of 0.0.5143.

Dry weight

The shoot dry mass in control plants increases in all genotypes of garlic as compared to other treatments, like R2 and R5. The findings suggest that the treated

plants are significantly affected by salt solution and *Parthenium* extract.

Coefficient of correlation of morphological traits

The correlation association (person) among the calculated morphological traits was carried out as given in Table 2. The studied morphological traits were found to be important, significant among different traits. A strong correlation between the number of leaves with leaf width at r value 0.041. Similarly, root length was found to correlate with the number of leaves at 0.051.

Table 2: Correlation of quantitative traits of garlic genotype under allelopathic stress conditions.

Traits	Plant Height	Leaf Length	Leaf Width	No. of Leaves	Root Length	No. of Root	Fresh Weight	Dry Weight
Plant Height	1							
Leaf Length	0.767	1						
Leaf Width	0.173	0.432	1					
No. of Leaves	0.262	0.531	0.041	1				
Root Length	0.041	0.198	0.794	0.051	1			
No. of Root	0.318	-0.061	0.065	-0.230	-0.329	1		
Fresh Weight	-0.287	0.1143	0.232	-0.214	0.204	-0.588	1	
Dry Weight	-0.644	-0.542	-0.622	0.143	-0.483	-0.296	0.220	1

In a similar technique, the correlation between the number of roots and leaf width was significant at 0.065, while the dry weight and number of leaves were found least significant at 0.143. Likewise, there is a significant, less significant, positive, or negative correlation among various features as shown in Table 2.

Parthenium leaf extract stress results were tested on garlic genotypes during the present study. Seven selected lines of improved garlic were collected from local locations in the lower and upper Dir for these findings. *Parthenium* affected the different morphological traits of the selected genotype, including dry mass, fresh weight, total biomass, root length, number of secondary roots, shoot length, and plant length. Similarly, they are active in processes of growth such as flowering, fruiting, vegetative growth, seed germination, and seedling vigor and growth. Under growing *Parthenium* leaf extract scrutiny, [15] recorded a greater amount of dry matter partitioning to the leaf in terms of the stem.

A number of studies have shown a direct correlation between the status of soil moisture and the potential of plant growth [16, 17]. The difference in dry weight of the control and *Parthenium* leaf extract-treated plants was recorded in the present experimental study. For dry weight, the minimum value (0.09m) was accounted for, whereas the mean value (1grm) under unstressed conditions was recorded. Similarly, treatment one possessed the highest mean value (1.5 gm) and the lowest mean value (0.02) subjected to salt stress conditions, then treatment two (R2), which possessed the highest mean value (0.9 gm) and the lowest mean value (0.75 gm), and treatment three (R3), which possessed the highest mean value (1 gm) and the lowest mean value (0.03 gm).

Some studies have revealed an evident relationship between soil moisture availability and the potential for plant growth. Differences in dry weight among control and *Parthenium* leaf extract-treated plants

were recorded in the present experimental study. The smallest value (0.09m) for dry weight was described, whereas the mean value (1grm) under unstressed was recorded. Similarly, treatment one possessed the highest value (1.5 gm) and lowest value (0.02) under salt stress conditions, followed by treatment two (R2), which possessed the highest value (0.9 gm) and the lowest value (0.75 gm), and treatment three (R3), which possessed the highest value (1 gm) and the lowest value (0.03 gm). The components of the root system are the root system topology, the subordinate root number and length, and the topographical distribution of the main and proximal roots.

The physical structures of soil discriminate against the morphological adaptability of roots [18-19]. Even though plants can have a range of characteristics during the most adaptive stage of salt tolerance, including the root hair strength, the architecture of their root system is the most critical aspect in withstanding the extreme environmental conditions [20, 21]. There is a considerable difference in root length, which is among the most vital growth and stress reaction limits, according to the existing findings. Because roots are now the only means of accessing trace elements, they are vitally important to fast growth [22].

Besides lowering the endosperm concentration in germination and yield reduction, [23, 24] ascertained that the overtone with higher tolerance to salinity in the species inhibits food seed propagation, which is harmful to embryos and suppresses photosynthesis in *Allium sativum* leaves by reducing stomatal and mesophyll conductance to carbon dioxide diffusion. As per the findings, *Allium sativum* may be considered a better choice for the bioactive secondary metabolites due to the fact that it is highly tolerant to extracts and exhibits higher osmotic change [25].

Conclusions

Parthenium has a variety of allelopathic compounds that could inhibit or improve the growth and morphological features of the garlic genotype. Equally fresh and dried leaves extract indicated inhibitory properties on selected varieties, in contrast to the control; however, inhibitory properties showed by dry leaves extract on all test species were expressively higher than fresh leaves extract.

Conflict of interest

The authors have declared no conflict of interest.

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