Research Article

Allelopathic Effect of Aqueous Extract of Wild Radish on Pea Seedling Emergence and Growth

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Abstract | The present study was designed to check the allelopathic effects of aqueous extract of wild radish on pea seedling emergence and growth at Department of Agronomy, College of Agriculture, the University of Sargodha in 2021. The experiment was run in four replicates to avoid variance. Different concentrations of aqueous extract of wild radish (0.0 %, 3.0 %, 6%, 9.0% and 12.0 %) were applied on ten seed of pea. It was observed that maximum emergence percentage (94.25 %), shoot length (5.52 cm), root length (6.20 cm), fresh biomass (0.95 g), dry biomass (0.32 g), minimum time to start emergence (2.56 days), mean emergence time (4.51 days), time to complete 50% emergence (3.62 days), was observed under control while minimum emergence percentage (22.50 %), shoot length (0.95 cm), root length (1.11 cm), fresh biomass (0.18 cm), dry biomass (0.06 cm), maximum time to start emergence (6.08 days), mean emergence time (21.55 days), time complete 50% emergence (10.78 days) was observed with 12.0% aqueous extract concentration wild radish. The results revealed that wild radish extract put destructive effects on the emergence and seedling development of tested vegetables. It was observed that inhibitory effect depends on the level of concentration.

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Introduction

Weeds are the unwanted plants that usually grows in association with other crops or sometimes alone and cause massive reduction in crop yields. Since, they compete for place, light, nutrition and water therefore considered to be problematic (Aziz *et al.*, 2022a; Javaid *et al.*, 2022). FAO reported that pests and weeds destroy 35%, 28% and 29% wheat, vegetables and fruits worldwide, respectively

(Tariq *et al*., 2022; Arooj *et al*., 2021). A vast variety of allelopathic weeds have been reported that affect plants from development to maturity and cause significant losses (Nadeem *et al*., 2021a, b). Some weeds destroy other weeds and crops by their toxic chemicals and get attention as an herbicidal resistant (Bhadoria, 2011).

Any useful or destructive effect of competing organisms on other organisms by releasing chemical compounds into surroundings is called allelopathy and these chemical compounds are called allelochemicals (Maqbool *et al*., 2021a). It is a chemical interfering mechanism in which dead or live plant resources released chemical compounds which prevent or arouse the growth of their own members or other species. These chemical substances exist in all plant parts like in leaves, rhizomes, seeds, pollens, flowers, stems, roots. These chemical compounds can be discharged into the surroundings through the process of decomposition of plant remains, leaching, volatilization and root exudation (Maqbool *et al*., 2021b, c). Allelochemicals may effect on different stages of germination, as well as on plant's respiration, nutrition, division, expansion of cells, photosynthesis, transpiration, protein production, metabolic and enzymes activities. The most prominent negative allelopathic impacts are the inhibition of seed gemination, stem elongation and shoot as well as root development (Ravinder *et al*., 2001).

Scientists are now utilizing the allelopathy phenomenon in synthesizing new natural based agrochemicals that help towards the improvement of environmental protection and crops productivity through ecological control of pests, crop diseases, and weeds (Kadioglu *et al*., 2005). Wild radish is the hardest weed in slight grains like wheat crops throughout the Southeast (Webster and Macdonald, 2001). It is also referred to as white charlock, fused wild radish, and assembled radish or charlock (Darbyshire *et al*., 2000). Similar to other Brassicaceae crops, wild radish also contains compounds (allelochemicals), including glucosinolates, which can be converted to isothyocyanates by the enzyme that acts as myrosinase (Malik *et al*., 2008). These isothyocyanates may play a significant role in destroying weeds (Norsworthy and Meehan, 2005). Due to presence of glucinolate in summer vegetables wild radish might be used as a shelter crop (Norsworthy, 2003). The allelochemical relations and their possessions on vegetables are significant aspects to be considered in root vegetable production. While, study on allelopathy in vegetable harvests have been done worldwide, however, no work has been reported on allelopathic effect of natural radish on winter vegetables. Consequently, this study was planned to look at the allelopathic effects of natural radish on pea seedling emergence and growth.

Materials and Methods

The research was conducted at the Department of Agronomy, College of Agriculture, University of Sargodha, Pakistan during 2021. In this study allelopathic capacity of wild radish on the development and sprout development of pea was studied. The experiments were run in four replicates. The whole plant of wild radish was collected from the Agronomic Research farm, the Department of Agronomy, College of Agriculture, University of Sargodha, Pakistan. Fresh plant parts were cut into small pieces, shade dried and chopped. Aqueous extract was prepared by 100 g of plants mixture with 1000 ml of condensed water (1:10 w/v) at ambient temperature for 24 hours and then filtered. Different concentrations of 0.0 %, 3.0 %, 6.0 %, 9.0 % and 12.0 % were prepared from the standard solution. Ten seeds of pea were placed in a petri dish and extract of known concentrations were applied.

Emergence percentage (%) was calculated daily from the second day of sprout according to the formula of Time to start emergence (days):

$$\textit{Emergence Percentage (\%)} = \textit{Number of emerge seed/ Total number of seeds} \times 100$$

Time to 50% emergence (days) was documented by applying the method purposed by Coolbear *et al*. (1984). Shoot length and root length was calculated by using measuring scale. The fresh and dry biomass (g) was calculated of all the sprouts. For dry biomass, each seedling was dried at 600 °C in an oven.

Statistical analysis

Data examined statistically by Fisher's analysis of variance (ANOVA) techniques and the consequence of treatments will be compared by applying least significance difference (LSD) test at 5% possibility level.

Results and Discussion

Allelopathic effect of wild radish on the emergence of pea

Emergence percentage is a dynamic index which has significant role in growth of crop plants. Data regarding the emergence percentage of pea presented in Table 1 showed that different concentrations of wild radish extract affected the emergence percentage of peas. The maximum germination percentage (94.25 %) was recorded under control. However, with an increase in the concentration of aqueous extract of wild radish resulted in a reduction in emergence percentage. The minimum (22.50%) emergence percentage was examined with a 12.0 % aqueous extract concentration of wild radish. The variability in germination percentage among various concentrations of wild radish might be due to allelochemicals present in wild radish. The data confirmed Golubinova and Ilieva (2015) statement that Melissa officinalis extract residual inhibited the germination of pea seedlings. The quantity of allelopathic substances in saturated extract is higher and prevents germinating of seeds as also reported by (Khan *et al*., 2022a, b).

Table 1: *Allelopathic effect of different concentrations of aqueous extract of wild radish on the emergence of Pea.*

Concentration	Germination (%)	Time to start emergence (Days)	Time to T50% emergence (Days)	Mean emergence time (%)
0.0 %	94.25 A	2.56C	3.62 C	4.51 C
3.0 %	73.00 B	3.33C	6.17 C	6.17 C
6.0 %	50.00 C	4.72B	8.25 B	16.50 C
9.0 %	37.00 D	5.06B	8.88 B	17.76 B
12.0%	22.50 E	6.08 A	10.78 A	21.55 A
LSD at 5%	6.79	0.92	0.76	1.43

Mean not sharing a letter in common differ significantly at 5% level of significant.

The significant effect of wild radish extract was observed on time to start germination. Maximum time to start germination with 12.0 % concentration of wild radish extract was 6.08 days. Similarly, the minimum time to start germination with 0.0% concentration of wild radish extract was 2.56 days. this variability in time may be due to the presence of allelochemicals. Our results are in accordance with those of Rebaz *et al*. (2001) who reported that Anagallis arvensis L. extracts suppressed gem millet, canola, grain, maize, carrots, and turnips root and shoot development. Similar allelopathic effects of several vegetation types on the seed germination of various crops was also observed by Khan *et al*. (2023).

The maximum time (10.78 days) to complete 50% germination was taken by 12.0 % concentration of wild radish extract. Whereas the minimum time (3.62 days) to complete 50% germination was taken by control. Uremis *et al*. (2009) study supported our results. The different concentrations of wild radish extract import a significant effect on the mean emergence of pea. Maximum mean germination time (21.55 days) was observed with 12.0 % concentration. Whereas the minimum mean emergence (3.62 days) of pea was recorded under control. Vegetables differ in reacting to allelochemicals due to genetic variation properties. The consequences are in accord with those of Ali *et al*. (2021) who described that saturated extract of species badly prevented the growth and germination of ground crops.

Table 2: *Allelopathic effect of different concentrations of aqueous extract of wild radish on seedling growth of Pea.*

Concentration	Shoot length (cm)	Root length (cm)	Fresh biomass (g)	Dry biomass (g)
0.0 %	5.52 A	6.20 A	0.95 A	0.32 A
3.0 %	3.73 B	4.57 B	0.61 B	0.20 B
6.0 %	2.13 C	2.69 C	0.41 C	0.13 C
9.0 %	1.35 D	1.69 D	0.31 D	0.10 D
12.0%	0.95 E	1.11 E	0.18 E	0.06 E
LSD at 5%	0.32	0.47	0.19	0.05

Mean not sharing a letter in common differ significantly at 5% level of significant.

Allelopathic effect of wild radish on seedling growth of pea

Data about the shoot length of pea as affected by various amounts of wild radish extracts is presented in Table 2. The maximum shoot length (5.52 cm) was recorded with 0.0 % concentration of aqueous extract of wild radish. The minimum shoot length (0.95 cm) was recorded with 12.0 % concentration of aqueous extract of wild radish. Influence of aqueous extract of wild radish on shoot length of different tested vegetables showed that extract of different concentrations had stimulated effects on shoot length of all tested vegetables. Stimulatory effects revealed that low concentration of wild radish extract not affect the germination and development of crops seedling. The results are in accordance with those of Belz (2007) who supported that weed extract of low concentrations had strong triggering (motivated) effects on experienced crops. The longer root length

(6.20 cm) was recorded in pea with 0.0 % concentration aqueous extract of wild radish. The shorter root length (1.11 cm) was recorded in pea in 12.0 % concentration of aqueous extract of wild radish. Results showed that wild radish extract had durable inhibitory belongings on root length than shoot length. High sensitivity of the roots of pea plants to the allelopathic effects of wild radish extract was due to its uninterrupted contact with extract. Root length inhibition possibly affects the water and nutrient absorption and mechanical stabilization in soil.

Table 3: *Chemical analysis of wild radish for the determination of type of phenolic.*

Compound Name	Quantity (ppm)
Qucercetin	1.20
Gallic acid	0.39
M.coumeric acid	0.69
Ferulic acid	3.24
Cimamic acid	0.98

The effect of aqueous extract of wild radish produced a significant effect on the fresh biomass of the targeted vegetable. Maximum fresh biomass (0.92g) was recorded under control and the minimum fresh biomass (0.06 g) was recorded with 12.0% concentration of wild radish extract. It was concluded that tested vegetables showed diverse level of sensitivity toward chemical substances of wild radish. The occurrence of allelochemicals in soil directly affected the growth of recipient plants and significantly reduced the crop's biomass (Kapoor *et al*., 2012). The maximum dry biomass (0.32 g) was recorded under the control. While minimum dry biomass (0.06 g) was recorded with 12.0 % concentration of aqueous extract of wild radish. Results recorded that inhibitory or stimulatory effects of wild radish was concentration dependent. Shoot fresh weight of pea was recorded to improve with an increasing concentration level of extract as compared to distilled water (control). The variability in shoot dry weight might be due to allelopathic result of wild radish extract on vegetables. The Allelochemicals in aqueous in Aqueous extract of Wild radish presented in Table 3.

Conclusions and Recommendations

It is clear from this study that wild radish contains allelochemicals which cause allelopathic effects to surrounding both weeds and crops. Its aqueous extract can be used as herbicide to manage weeds with no hazardous effect to the natural environment.

Novelty Statement

Wild radish has strong allelochemicals in its aqueous extract. We can use it to control weeds without harming the environment.

Author's Contribution

Muhammad Ather Nadeem, Bilal Ahmad Khan, Neelam Yaqoob, Abdullah and Amina Iftikhar plane and conducted the research work Muhammad Irfan, Muhammad Waqas, Syed Saqlain Hussain and Sidra Shakil organized the data and initial draft of the manuscript. All the authors review the manuscript before the submission.

Conflict of interest

The authors have declared no conflict of interest.

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