EXPLORING THE ALLELOPATHIC EFFECT OF AQUEOUS EXTRACT OF WILD RADISH (*Raphanus raphanistrum* L.) ON TURNIP (*Brassica rapa* subsp. Rapa)

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ABSTRACT

The present study was designed to investigate the allelopathic effect of aqueous extract of wild radish (*Raphanus raphanistrum L.*) on seed germination and seedling growth of turnip (*Brassica rapa* subsp. *rapa*). The experiments were conducted in a lab with completely randomized design (CRD). All analysis were run in four replicates. Different concentrations of aqueous extract of wild radish (0%, 3%, 6%, 9% and 12%) were applied on ten turnip seeds. Results showed that under control conditions, the range of emergence percentage, shoot length, root length, fresh biomass, dry biomass minimum time to start emergence, mean emergence time, and time to complete 50% emergence was 20% - 91%, 1.84 cm - 6.10 cm, 1.59 cm - 7.13 cm, 0.21 g - 1.43 g, 0.07 g - 0.48 g, 6.19 days - 2.86 days, 21.26 days - 8.24 days, 10.93 days - 4.10 days respectively. Hence, it is concluded that the wild radish extract put destructive effects on the emergence and seedling development of turnip.

Keywords: Allelopathy, bioherbicide, emergence, seedling growth and environment.

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INTRODUCTION

Weeds cause massive reductions in crop yield because they compete in parallel with crops for space, light, nutrition, water and other resources (Maqbool *et al.,* 2022a; Khan *et al.,* 2022a and Khan *et al.,* 2022b). Nadeem *et al.,* (2021b) reported that worldwide destruction caused by the pests and weeds was 35%, 28% and 29% in wheat, vegetables and fruits, respectively. There is large number of allelopathic weeds that affect plants from development to maturity and cause substantial financial losses (Nadeem *et al*., 2021b, Nadeem *et al*., 2021c and Khan *et al*., 2022a) Some weeds possess the ability to destroy other weeds and crops by the release of toxic chemicals (Bhadoria, 2011; Nadeem *et al.,* 2021a and Nadeem *et al.,* 2020a). Any useful or destructive effect of competing organisms on other organisms by releasing chemicals into the surrounding environment is called allelopathy. These chemical compounds are called allelochemicals (Eichorn *et al.,* 2014; Nadeem *et al*., 2022 and Maqbool *et al*., 2022d). 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.

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These chemical substances exist in all plant parts like in leaves, rhizomes, seeds, pollens, flowers, stems, roots (Khan *et al.,* 2018; Ferdosi *et al.,* 2021 and Nadeem et al., 2021d). 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.,* 2021a; Maqbool *et al*., 2021 and Maqbool *et al*., 2021c).

These compounds (allelochemicals) effect the germination and development process of associated sensitive plants. Allelochemicals usually affect the respiration, nutrition, division, expansion of cells, photosynthesis, transpiration, protein production, metabolic and enzymes activities of concerned plants (Peng *et al.,* 2004; Khan *et al.,* 2022a). Some other negative effects include inhibition of seed germination, stem elongation and shoot as well as root development (Ravinder *et al.,* 2001; Maqbool *et al.,* 2022d). Appropriate utilization of the allelopathy chemicals towards the improvement of environment and crops productivity through ecological control of insects, pests (Ahmad *et al.,* 2022a, 2022b), crop diseases (Javaid and Khan, 2016; Jabeen *et al.,* 2021) and weeds (Javaid and Khan, 2020; Javaid *et al.,* 2020) as well as the synthesis of unique agrochemicals based on natural products have gained scientists attention all around the globe (Sang-UK *et al.,* 2005; Nadeem *et al.,* 2021a).

Usually, wild radish is a troublesome weed in wheat fields (Webster and Macdonald, 2001). It is commonly known as jointed radish or charlock, jointed wild radish or white charlock (Darbyshire *et al.,* 2000), Like other Brassicaceae plants, wild radish produces allelochemicals such as glucosinolates which can be transformed to isothyocyanates by myrosinase activity (Malik *et al.,* 2008). These isothyocyanates may show a major part in weed destruction (Norsworthy and Meehan, 2005). Due to the presence of glucinolate in summer vegetables wild radish might be used as a shelter crop (Norsworthy, 2003).

The main aim of this study was to investigate the allelopathic effect of wild radish on the emergence and seedling growth of turnip.

MATERIALS AND METHODS

The research was conducted at the Department of Agronomy, College of Agriculture, University of Sargodha, Pakistan during 2021. In this study, the allelopathic capacity of wild radish on the emergence and seedling growth of turnip was studied. The experiments were carried out in Completely Randomized Design (CRD) having 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 then finely chopped. The aqueous excerpt was prepared by fraternization of 100 g of plant mixture with 1000 mL of condensed water in the proportion of 1:10 (W/V) at ambient temperature for 24 hours. The extract was obtained by filtering it through filter paper. The extract was stored in bottles and tagged. Sub samples of different concentrations were organized from the standard solution, ten seed of turnip were placed in petri dish and extract of known concentration (0%, 3%, 6%, 9% and 12%c) was applied according to treatments.

Observations

Data on the following parameters were recorded during the research work by using standard procedures. Emergence percentage (%) was calculated daily according to the formula of Certified Seed Study (1990). Time to start emergence (days) was counted from the 2nd day of research when initial seed of each trial was sprouted up to 2mm. Time to 50% emergence (days) was documented by applying the method purposed by Coolbear *et al.* (1984). Shoot length and shoot length was calculated by using a measuring scale.

The fresh biomass (g) was calculated of all the sproutsand average biomass was calculated in gram. The dry biomass(g) of all the seedlings from each replicate was taken. and oven dried at 600 °C till the constant weight of each seedling was achieved.

Statistical analysis

Data examined statistically by Fisher's analysis of variance (ANOVA) techniques and the results of treatments will be compared by applying least significance difference (LSD) test at 5% possibility level (Steel *et al.,* 1997).

RESULTS AND DISCUSSION

Allelopathic effect of wild radish (*Raphanus raphanistrum L.)* on the emergence of turnip (Brassica rapa subsp. Rapa)

Emergence percentage (%)

Data regarding the emergence percentage of turnip presented in Table 1 showed that different concentrations of wild radish extract affected the emergence percentage of turnip. The maximum germination percentage (91%) 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 (20%) 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 outcomes are in agreement with those of Pour and Bakhsh, (2012) who described that aqueous extract and residues of Melissa officinalis had retard the germination and growth of wheat and pea sprouts. Nadeem *et al.,* 2020a: Nadeem *et al.,* 2020b; Nadeem *et al.,* 2021a; Maqbool *et al.,* 2022a; Maqbool *et al.,* 2022d reported that concentrated extract contains a higher concentration of allelopathic compounds that inhibits seed germination.

Time to start emergence

Data concerning the period to start emergence of turnip as affected by the aqueous extract of wild radish is resented in Table 1. The significant effect of wild radish extract on time to start germination of tested turnip was observed. Maximum time (6.19 days) and minimum time (2.86 days) to start germination were taken by wild radish extract concentration (12% conc.) and (0% conc.) This variability in time to start germination with different concentrations of wild radish might be due to allelochemicals present in it. Rebaz *et al.,* (2001) revealed that an aqueous extract of *Anagallis arvensis* L., inhibited germination, root and shoot development of gem millet, mustard, wheat, corn, carrot and turnip. Similar findings were reported in previous studies regarding the allelopathic impacts of different weed species on seed propagation of various produces (Nadeem *et al.,* 2020b; and Nadeem *et al.,* 2021a).

Time to start 50% emergence

Statistics concerning the time taken to 50% emergence of turnip as affected by different concentrations of aqueous extract of wild radish accessible in Table 1. Maximum time (10.93 days) to complete 50% germination was taken by pea with 12.0 % concentration of wild radish. Whereas the minimum (4.10 days) is under control. This might be due to the occurrence of different allelochemicals in diverse plant parts of wild radish. The results of Uremis *et al.,* (2009) supported that the allelopathic possibility of Brassica type severely reserved the sprouting and development of Johnson grass.

Mean emergence time

The effect of various concentrations of aqueous extract of wild radish on the mean germination time of turnip is presented in Table 1. The different concentrations of wild radish extract import a significant effect on the mean emergence of turnip. Maximum mean germination time (21.96 days) was

observed with a 12% concentration. Whereas the minimum mean emergence (8.24 days) of pea was recorded under control. Vegetables differ in reacting to allelochemicals due to genetic variation properties. The consequences are in accordance with those of Channappagoudar et al. (2010) who described that aqueous extract of species badly inhibited the germination and growth of ground crops.

Table 1. Allelopathic effect of different concentrations of aqueous extract of wild radish on the emergence of Turnip

Concentration (%)	Germination (%)	Time to start emergence (Days)	Time to start 50% emergence (Days)	Mean emergence time (%)
0	91.00 A	2.86 C	4.10 D	8.24 D
3	70.750 B	3.62 C	6.39 C	12.79 C
6	48.500 C	4.73 B	8.31 B	16.81 B
9	32.500 D	5.1663 B	8.88 B	17.92 B
12	20.000 E	6.19 A	10.93 A	21.96 A
LSD at 5%	**5.59**	**0.98**	**0.77**	**1.34**

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

Allelopathic effect of wild radish on seedling growth of pea

Shoot length

Data concerning the shoot length of turnip as affected by different concentrations of aqueous extract of wild radish is presented in Table 2. The maximum shoot length (6.10 cm) was recorded with 0.0 % concentration of aqueous extract of wild radish. The minimum shoot length (1.85 cm) was recorded with a 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 not affect the germination and development of crops seedling. The results are in accordance with those of Belz (2001) who supported that weed extract of low concentrations had strong triggering (motivated) effects on the test crops.

Root length

Data regarding the root length of the turnip represented in Table 2 showed that diverse concentrations of wild radish suggestively affected the length of the root of the tested vegetables. The longer root length (7.13 cm) was recorded in pea with 0.0 % concentration of aqueous extract of wild radish. The shorter root length (1.59 cm) was recorded in spinach in 12.0 % concentration of aqueous extract of wild radish. Results showed that wild radish extract had more durable inhibitory belongings on root length than shoot length. High sensitivity of the roots of tested vegetables 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. The variability in root length among different concentrations of wild radish might be due to the allelopathic effect on vegetables. Nadeem *et al.,* (2021a) reported in previous studies regarding

the allelopathic impacts of different weed species on seed root length.

Fresh biomass (g)

The data regarding the fresh weight of pea is presented in Table 2. The maximum fresh biomass (0.21 g) was recorded under control. While, the minimum fresh biomass (1.43 g) was recorded with a 12.0% concentration of wild radish. It was concluded that tested vegetables showed a diverse level of sensitivity toward the chemical substances of wild radish. The occurrence of allelochemicals in the soil directly affected the growth of recipient plants and significantly reduced the crop's biomass (Kapoor *et al.,* 2012).

***Dry biomass* (g)**

The dry biomass of a plant is a dynamic index that has significant involvement in the growth of plants. The dry biomass of turnip with different concentrations of aqueous extract of wild radish (Table 2). The maximum dry biomass (0.48 g) was recorded under the control. While minimum dry biomass (0.7g) was recorded with a 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). While extract inhibitory effect was increased on shoot fresh weight of cauliflower and spinach as the concentration level increased. The variability in shoot dry weight might be due to the allelopathic result of wild radish extract on vegetables.

Table 2. Allelopathic effect of different concentrations of aqueous extract of wild radish on seedling growth of turnip.

Concentration (%)	Shoot length (cm)	Root length (cm)	Fresh biomass (g)	Dry biomass (g)
0	6.10 A	7.13 A	1.43 A	0.48 A
3	4.73 B	5.07 B	0.74 B	0.25 B
6	2.63 C	3.20 C	0.46 BC	0.15 BC
9	1.95 CD	2.19 CD	0.37 C	0.12 C
12	1.85 D	1.59 D	0.21 C	0.07 C
LSD at 5%	**0.76**	**1.08**	**0.30**	**0.10**

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

CONCLUSIONS

It is clear from this study that wild radish contains allelochemicals (toxic chemicals) in their tissues which cause allelopathic effects. The presence of wild radish residues in the soil significantly reduced the germination and seedling growth of succeeding crops, vegetables and weeds.

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