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STUDY THE ALLELOPATHIC EFFECT OF RADISH BY INCORPORATE INTO SOIL ON SOME POACEAE SPECIES

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Abstract

Previous studies showed that radish (*Raphanus sativus* L.) has significant effect on various plants species due to its allelochemical compounds. This study aimed to evaluate the allelopathic effects of radish (*Raphanus sativus* L.) root incorporated with soil on growth and yield components of some poaceae plants, bread wheat (*Triticum aesitivum* L.), durum wheat (*Triticum durum* L.), wild oat (*Avena fatua*) and wild barley (*Hordeum spontaneum*). Used radish concentrations (wt. /wt.) were (0%, 10%, 20%, 30% and 40%). A greenhouse experiment using 5 kg pots where each pot were sowed with ten seed in 2 cm depth then it was thinned to 5 seedlings.The experimental units were arranged in randomized complete design. In each pot ten seeds were planted in 2 cm depth and each pot was thinned to 5 germinated seedlings. The results of this study showed that all plant species were sensitive to radish root and the degree of sensitivity was concentration dependent. Grain yield (g/pot) sharply reduced by 60% at (40%) concentration compared to control. Furthermore, plant height, biological yield, total tellering and harvest index recorded lowest values (53.67 cm, 15.29 g/pot, 2.55 No./pot and 22.10%) respectively at (40%) concentration. The combination between plants species and concentrations indicate the totally supersession in wild oat and (40%) concentration. The results obtained from the study radish root incorporated with soil can be recommended as bioherbicide ecofriendly methods to weed management.

Keywords: *Raphanus sativus*, Allelopathy, Poaceae, plant residues, weed control.

Introduction

The term allelopathy is defined as direct and indirect beneficial or harmful effect of one plant on another via the production of chemical substance that release into the environment (Rice, 1984). IAS (International Allelopathy Society) defined allelochemicals as chemical compounds including secondary metabolites produced by plants, microorganisms, viruses and fungi that affect the growth and development of agricultural and biological systems (Al-Rejaboo and Jalaluldeen., 2019). Allelochemicals liberated into the environment by different mechanisms, leaching of aboveground parts, volatilization, root exudation and decomposition of plant residue (Rice, 1984; Reigosa *et al*., 1999).

The remaining plant parts after harvest including leaves, stalks and roots is known as plant residues. These residues might play a role in the following crop life cycle, this ancient phenomenon have been considered by farmer, in such a way they suggest different solutions. Allelopathic activity has been observed in different plant species that can be used in agro-ecosystems (Rice, 1995).

Various factors may affect the productivity and yield of the plants. (Anisimova *et al*., 2019; Shahreza *et al*., 2019). Weeds is a natural and noxious enemy of wheat that decreases its yield by 20-30% (Turk and Tawaha, 2002). All members of Brassicaceae family contain mustard oil which inhibit seed germination and plant growth (Boydston and Hang, 1995).Previous studies showed that radish (*Raphanus sativus* L.) belong to brassicaceae family influence on various plants species due to its secondary metabolite compounds such as p-hydroxy benzoic acid, and isothiocyanates (isothiocyanate benzyl, Isothiocyanateallyl) (Lawley *et al*., 2012). The allelochemicals may influence the metabolism process of the target plant, the cellular structure, regulation of hormone, protein synthesis; permeability of membrane, nutrient absorption can be affected among other change (Ferreira and Aquila, 2000).

Koseli (1991) showed that regrowth of johnsongrass rhizomes (*Sorghum halepense*) were suppressed by incorporation of above and underground parts of radish (*Raphanus sativus*). Some crops and weeds showed germination sensitivity to wild radish (*Raphanus raphanistrum* L.) and radicle growth of some weeds was inhibited Norsworthy (2003). Krishnan *et al*., 1998 stated that most useful allelopathic cover crop are Mustard and Rapeseed which reduced total weed biomass in soybean (*Glycine max*) by 40 - 49%. Crop residues when left and decomposed in the soil, weed emergence might be reduce by 75% to 90%. The objective of this study was exploring the allelopathic activity of radish (*Raphanus sativus* L.) incorporated into soil on two wheat species and two endemic weeds in Iraq.

Materials and Methods

This study was conducted in the green house at Grdarasha/college of Agricultural Engineering Science /university of Salahaddin-Hawler, to investigate the effect of radish root *Raphanus sativus* incorporate with soil in different rate on growth and yield of bread wheat *Triticum aesitivum* , durum wheat *Triticum durum*, wild barley *Hordeum spontaneum*, wild oat *Avena fatua*. The experiment was completely randomized factorial design (C.R.D) with three replications.

Plastic pots 5 kg capacities were used in this study. Radish root *(Raphanus sativus* L.*)* cut into small piece 0.5-1 cm. The pots filled with soil incorporated and radish (*Raphanus sativus's*) root at five concentrations (wt. /wt.): 0,10,20,30 and 40%. Then the pots planted with tested plant species mentioned above. In each pot ten seeds were planted in 2 cm depth. Each pot was thinned to 5 germinated

seedlings. Also, there was a plastic dish under each pot to recycle the residual water that comes out from each pot to obtain the consistency of residual influence. Finally, the studied plants were harvested, and then the following parameters were investigated; flag leaf area was calculated according to the following formula:

Leaf area (cm^2) = leaf length(cm) × leaf width(cm) × index factor 0.905(Hunt, 1982), total tellering (No./pot) , plant height (cm), biological yield (gm/pot), grain yield (gm/pot), harvest index was estimated by expressing the ratio of grain yield to biological yield (Donald and Hamblin, 1983).

Whereas No. /pot = number per pot, cm= centimeter, gm/pot= gram per pot

Statistical analysis: prior to statistical analysis the normality and homogeneity were checked for all data then the data were subjected to statistical analysis of variance (ANOVA) using SPSS version 20 at the 1% significance level later Tukey's test was applied for mean separation (Weinberg and Abramowitz, 2008).

Results and Discussion

Effect of radish root incorporation with soil on wheat crops and weeds

Root radish incorporated with soil has significant variations on all studied characters of all plant species (Table 1).

Table 1 : The effect of plant species on yield and some parameters of wheat and weeds.

Plant species	grain yield (gm/pot)	plant height(cm)	flag leaf area(cm^2)	biological yield (gm/pot)	total tillering No./pot	harvest index %
bread wheat	8.64ab ±0.41	83.43a ±1.76	43.007a ±2.50	22.90b ±0.60	3.95b ±0.26	37.58b ±1.22
durum wheat	8.35b ±0.31	76.42c ±1.21	35.50b ±0.93	22.58b ±0.73	5.11a ±0.42	37.08b ±0.98
wild barley	6.87c ±0.48	80.35b ±3.16	7.48d ±1.13	24.91a ±0.49	5.53a ±0.90	27.48c ±1.77
wild oat	9.26a ±1.33	65.27d ±8.92	15.41c ±2.81	17.19c ±2.34	3.45b ±0.62	43.21a ±6.08

Common letter means there are no significant different at probability level (1%) by Tukey's-test.

Grain yield and harvest index of wild oat recorded highest values (9.26 gm/pot, 43.21%), while the lowest values were (6.87gm/pot, 27.48%) respectively. Mansoor *et al*. (2004) reported that water extracts incorporated with soil of eucalyptus, sorghum and acacia were significantly influenced grain weight of (*Vigna radiata*). The highest value of plant height was observed in bread wheat (83.43 cm), whereas the lowest was in wild oat (65.27 cm). With regarded to flag leaf area the highest value (43.07 cm^2) was recorded in bread wheat and the lowest (7.48 cm^2) was with wild barley. Plant height and weight of wild barley significantly decrease when grown in soil incorporated with black mustard compared with control treatments. (Turk and Tawaha, 2003). Biological yield (24.91 gm/pot) and total tellering (5.53 No. /pot) in wild barley documented highest value and the lowest were (17.19 gm/pot) and (3.45 No. /pot). According to a study conducted in Nebraska incorporated mustard species into soil, weed biomass decreased by 49% in soybean (*Glycine max* L.) (Krishnan *et al*. 1998). Allelopathic potential of residues of some brassicaceae family when incorporate with soil has suppression impact on johnsongrass (Uremis *et al*.2009). Also, Boydston (2008) reported that cover crops of some brassica species suppress weeds due to allelopathic compounds which released during degradation of residues.

Effect of concentrations on studied plant species

Significant differences among parameters were strongly observed by increasing concentrations of radish root (*Raphanus sativus* L.). Seedling growth declined sharply as the concentrations of radish root increased. Grain yield, biological yield and total tellering recorded highest values (10.99 gm/pot, 25.03 gm/pot and 7.98 No. /pot) respectively in control treatment (0%); however, the lowest values were (4.37 g/pot, 15.29 gm/pot and 2.55 No. /pot) respectively with concentration (40%). The highest value in flag leaf area was recorded (33.17 cm^2) at concentration (30%), but the lowest (21.27cm^2) was with (20%) concentration (Figure1).

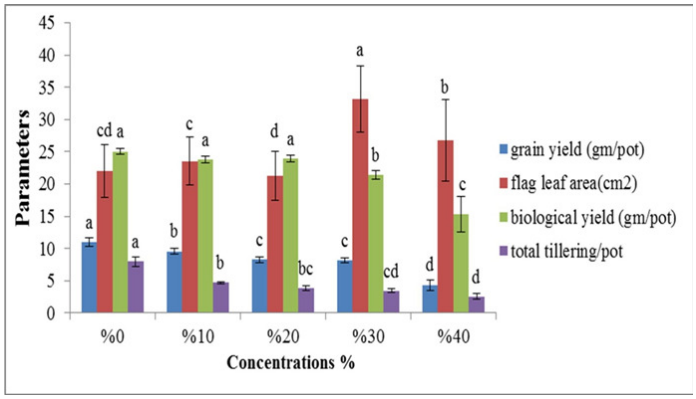

Fig. 1: The effect of radish concentrations (wt. /wt.) on some parameters of wheat and weeds. Common letter means there are no significant different at probability level (1%) by Tukey's-test.

Harvest index reported the highest values (44.54%) at control treatment and the lowest (22.10%) was with (40%) concentrations (Figure2).

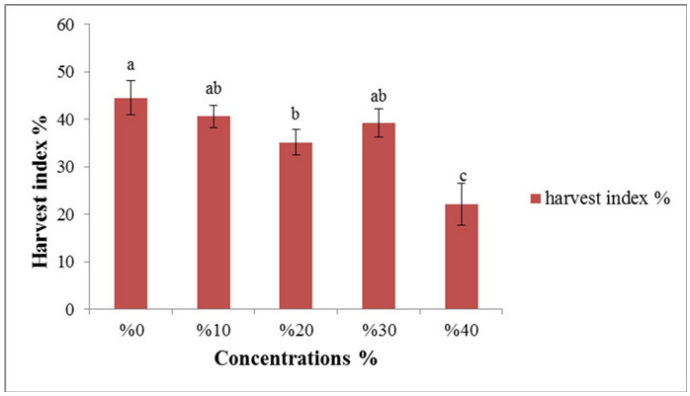

Fig. 2: The effect of radish concentrations (wt. /wt.) on harvest index%.

Common letter means there are no significant different at probability level (1%) by Tukey's-test.

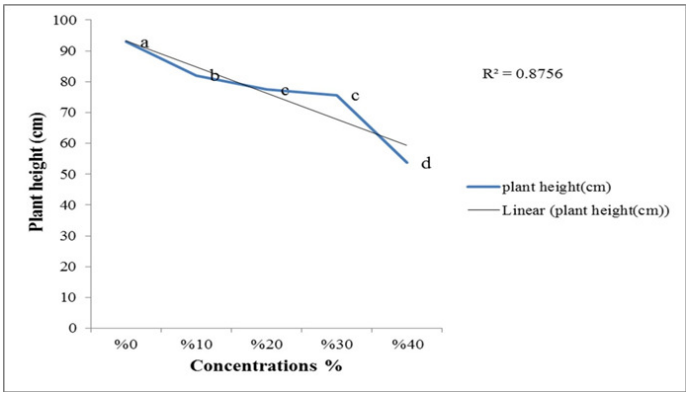

Fig. 3 : The effect of radish concentrations (wt. /wt.) on Plant height (cm).

Increased amount of crop residue decrease emergence and growth of some plant species (Buhler *et al.*1996; Vidal and Bauman, 1996). Norsworthy (2003) stated that emergence and fresh weight of sicklepod and prickly were reduced by wild radish (*Raphanus raphanistrum*) residues incorporated into soil, the level of suppression reliant on the amount of residue.

Effect of the combination between plant species and different concentrations of radish root on some studied characteristics.

The interaction of radish root (*Raphanus sativus*) and different concentration(wt/wt) incorporation with soil showed significant variations of studied characteristics(Table 2).

Table 2: The effect of interaction between plant species and concentrations of radish on some parameters of wheat and weeds.

Plant*	Concentration	grain yield (gm/pot)	plant height (cm)	flag leaf area(cm^2)	biological Yield (gm/pot)	total tillering No./pot	harvest index %
Bread wheat	0%	10.57bc ±0.19	94.87ab ±0.40	38.55bc ±0.83	25.25ab ±0.48	5.53bcd ±0.47	41.89b-e ±1.38
	10%	10.17b-e ±0.41	85.7c ±0.95	35.31b-e ±0.64	24.64ab ±0.62	4.07def ±0.35	41.38b-e ±2.52
	20%	8.03c-fg ±0.15	80.10c-f ±0.72	33.04de ±0.98	24.00abc ±0.29	3.60def ±0.12	33.50def ±1.01
	30%	7.72efg ±0.38	79.78def ±0.78	53.29a ±0.16	20.27cde ±0.39	3.27def ±0.27	38.19c-f ±2.61
	40%	6.70fg ±0.21	76.72fgh ±1.93	55.15a ±1.11	20.33cde ±0.53	3.27def ±0.33	32.96ef ±0.74
Durum wheat	0%	9.73b-e ±0.12	84.4cd ±0.67	30.69e ±1.53	25.3ab ±0.68	7.93b ±0.48	38.54c-f ±1.36
	10%	9.17b-f ±0.52	77.87efg ±0.79	35.35b-e ±1.27	22.73a-d ±0.79	5.00c-f ±0.20	40.46bc-f ±2.96
	20%	8.00c-g ±0.42	72.87gh ±0.63	34.57cde ±1.12	23.83abc ±0.36	3.87def ±0.58	33.63def ±2.23
	30%	8.13c-g ±0.18	73.44gh ±0.75	40.07b ±0.89	23.33abc ±0.67	4.87c-f ±0.07	34.92c-f ±1.38
	40%	6.70fg ±0.21	73.53gh ±1.30	36.83bcd ±0.80	17.73e ±0.64	3.87def ±0.29	37.82c-f ±1.09
Wild barley	0%	9.00bc-g ±0.91	99.73a ±1.30	2.93hi ±0.21	26.50a ±0.71	11.87a ±0.07	34.21def ±4.43
	10%	7.93d-g ±0.30	84.67cd ±0.35	6.64h ±0.64	25.67ab ±0.77	4.67c-f ±0.13	30.97efg ±1.50
	20%	6.57gh ±0.37	74.40fgh ±0.58	5.82h ±0.53	25.93ab ±0.54	5.00c-f ±1.10	25.29fg ±0.89
	30%	6.8fg ±0.06	78.5efg ±1.61	6.67h ±0.53	23.33abc ±0.94	3.07def ±0.44	29.23efg ±1.14
	40%	4.07h ±0.44	64.44i ±0.87	15.36fg ±0.44	23.1abc ±1.02	3.07def ±0.44	17.68g ±2.13
Wild oat	0%	14.67a ±0.63	92.83b ±0.97	15.88fg ±0.51	23.08abc ±0.59	6.60bc ±0.53	63.50a ±1.7
	10%	11.00b ±0.67	79.95c-f ±0.6	16.88f ±0.86	22.30bcd ±0.76	5.13cde ±0.24	49.64abc ±4.68
	20%	10.46bcd ±0.43	82.67cde ±0.43	11.64g ±0.48	21.89bcd ±1.02	2.93ef ±0.13	48.17bcd ±4.37
	30%	10.2b-e ±0.51	70.92h ±1.04	32.65de ±0.39	18.67de ±0.33	2.60f ±0.31	54.75ab ±3.51
	40%	0.00i ±0.00	0.00j ±0.00	0.00i ±0.00	0.00f ±0.00	0.00g ±0.00	0.00h ±0.00

Common letter means there are no significant different at probability level (1%) by Tukey's-test.

Grain yield and harvest index recorded highest values (14.67 gm/pot) and (63.50%) in wild oat and control treatment (0%). The highest values were observed in plant height (99.73 cm), biological yield (26.50 gm/pot) and total tellering (11.87 No. /pot) with wild barley and control treatment (0%). Plant species have different degree of sensitivity toward allelopathic potential due to variation of genetic properties (Ali, 2016). Flag leaf area recorded highest value (55.15cm^2) in bread and (40%) concentrations. The lowest values for all studied characteristics were recorded (0) in wild oat at (40% concentrations).It is known that the plants belong to Brassicaceae family produce glucosinolates that on hydrolysis form several different allelochemicals (Eberlein *et al*. 1998).These allelochemical compounds might be responsible for the detected effects.

Conclusion

According to greenhouse experiment, radish root (*Raphanus sativus*) incorporated with soil has significant effect on growth of studied plant species. The degree of plant growth suppressions were depended on the concentrations level (wt/wt) of radish root residue. So, the greatest effects were in higher a concentration which was 40% concentrations. It is required to isolate and identified allelochemical substance in radish for applying such ecofriendly method of weed management.

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