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Synergistic effect of weeds extracts on growth parameters of three different cultivars of wheat crop (*Triticum aestivum* L.)

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Abstract

This study was designed to evaluate the synergistic effect of 6 different weeds (*Chenopodium album*, *Avena sativa*, *Lathyrus sativus*, *Cirsium arvense*, Rumex dentatus, and *Phalarus minor*) on the growth and related attributes of three cultivars (Faisalabad1, Sahar6 and Galaxy) of wheat (*Triticum aestivum* L.). Current study aims to exploit the allopathic potential of weeds on germination efficiency, growth dynamics and biomass accumulation. Aqueous extracts of weeds roots and shoots were prepared in different concentrations. Experiment was carried out in sterilized petri dishes and also in field (control environment). Roots and shoots extracts exhibited unalike effects on the same cultivar at same concentration. Roots extract (5%) promoted the radical length of 2 weeks old seedling (Sahar6 cultivar) 1.5 times (8.64 cm) as compared to the control. Plumule lengths of sahar6 and galaxy cultivars were positively effected by 5% of both extracts. Fresh weight of Sahar6 cultivar has been increased 1.4 folds (0.82 g) while dry weight has been increased 7 folds (0.78 g) as compared to control by treating with 5% of roots extract. Weed extracts supported the plant height and leaves number in first 2 weeks while a decline have been observed in both height and leaves number from week 3 onward. Based on current study, it can be suggested that phytochemicals in weed extracts contains the allelopathic potential and can promote the growth parameters of wheat crop when used in optimum concentration.

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Introduction

Weeds are the redundant plant species growing among the cultivated plants (Dangwal *et al.,* 2010). Plant families especially like Poaceae, Fabaceae, Brassicaceae and Asteraceae may contain most of the weeds flora (Marwat *et al.,* 2009). Weeds cause cultivar of negative effects, for example, reduces water in the soil and cause competition with crops. Among the various negative effects, allelopathy is one of the most important. The word allelopathy is derived from two Greek words *allelon* "of each other" and *pathon* "to suffer". Plants affect each other in a cultivar of different ways e.g. through allelochemicals, competition etc, which may be mostly negative or sometime positive. Several species of weeds have been reported which have allelopathic affect including creeping thistle, chick weed and couch grass (Kruse *et al.,* 2000) these weeds have synergistic negative effect on crops when they occur together (Putnam and Duke, 1974).

These are different weeds in wheat field and they may be affecting the wheat crop in many ways including by producing various toxic chemicals.

It includes *Chenopodium album, Avena sativa, Lathyrus sativus, Cirsium arvense, Rumex dentatus, Phalarus minor*, *Convolvulus arvensis, Medicago denticulata* and mustard plants.

Majeed *et al.* (2012) carried out field experiments to evaluate the effects of *Chenopodium album* L. on yield and growth of wheat (*Triticum aestivum* L.) (Majeed *et al.,* 2012). At different concentrations the results showed that highly concentrated extracts had inhibitory effect however the extract of lower concentration (25%) had stimulatory effect on different parameters of wheat. Marwat *et al.,* 2013 investigated in Dera Ismail khan, KPK, Pakistan different weeds species which includes *Lathyrus sativus* L. *Phalarus minor* Retz., *Rumex dentatus* L. (Marwat *et al.,* 2013) and *Chenopodium album* (L.) which show competition with wheat crop for different necessities including moisture, nutrition and light which effect wheat production negatively.

Chenopodium album (L.) belongs to the family *Chenopodiaceae* commonly known as goosefoot family (Singh *et al.,* 2007). *Avena sativa* commonly called oats. *Phalarus minor* and *A. sativa* belongs to family graminaceae (Chatuevedi *et al.,* 2011). *Lathyrus sativus* belongs to family Fabaceae. *C. arvense* belongs to the family Asteraceae and is a toxic weed (Khan *et al.,* 2011). *Rumex dentatus* is commonly known as Indian Dock, belongs to polygonaceae (Fatima *et al.,* 2009).

In Pakistan, wheat is an important crop and it is infected by various weeds (Abbas *et al.,* 2007). The expected losses in wheat yield because of weed ranges from 20% to 40% (Ahmad & Shaikh, 2003). Wheat yield losses is more than 10 million $ at provincial level in KP and 20 million $ at national level due to weeds (Hassan *et al.,* 2003). From first 30 days to 60 days is the critical period of weeds competition after wheat sowing (Ahmad and Shaikh, 2003).

The aims and objectives of this study are, to evaluate synergistic effects of selected weeds on different wheat cultivars (Faisalabad1, Sahar6 and Galaxy). How the weed affect different growth parameters of wheat both in fields and laboratory conditions. To assess the weed tolerance in wheat cultivars.

Materials and methods

Weed collection

All the 6 species of weed i.e. *Chenopodium album, Avena sativa, Lathyrus sativus, Cirsium arvense, Rumex dentatus,* and *Phalarus minor*were collected from the wheat fields of Charsadda (34.1682° N, 71.7504° E) Khyber Pakhtukhwa, Pakistan.

Preparation of extract

Shoots and roots were separated from the collected samples. Fresh shoots and roots were gently washed with distilled water and dried at room temperature. The shoots and roots were grinded thoroughly separately but collectively of 5 collected weed species. Three different concentration extracts were prepared from each roots and shoots materials. Five, ten and fifteen grams of ground weeds material (shoots and

roots separately) were added into 100 ml of distilled water, to make 5%, 10% and 15% w/v aqueous fresh extracts. All the mixtures were sonicated for 30 minutes and vortexed for 2 minutes. The resultant mixtures were then kept at room temperature for 48 hours. The mixtures were sonicated and vortexed again and finally filtered.

Test specie and varities

Triticum aestivum L. (wheat) was used as test specie. Wheat cultivars Faisalabad1, Sahar6 and Galaxy were used to check the Allelopathic effects of selected weeds.

Laboratory work

Petri dishes were sterilized by autoclaving (121°C, 20 min). Two sterilized folded filter papers were placed in each Petri dish and 5 seeds of each wheat cultivar (Faisalabad1, Sahar6 and Galaxy) were placed. Ten milliliter extract of each concentration of both roots and shoots were poured on each petri dishes. The prepared petri dishes were kept at 25±2°C in incubator and data was recorded after 3 days. The experiment was executed in triplicates.

Field work

In field, soil (4 kg) of similar composition was used in pots. For each treatment, 5 pots, each with 5 seeds of wheat cultivars and 10 ml of root and shoot extract separately were used. The pots were placed at 25±2°C in net house. All the experiments were carried out in a synchronized manner. Each treatment was consisted of triplicates. Graphs were generated using Microsoft Excel (2013).

Results

Laboratory work

Effect of root and shoots extract on radical length

The effect of the roots and shoots extracts on the growth of the radical length was studied by measuring the length of radical of 3-days old seedlings.All the 3 concentrations (5%, 10% and 15%) of both the roots and shoots have affected the radical length of all wheat cultivars. Increasing the concentration of the weeds extracts has resulted in decreasing the radical length. Moreover, 5% extracts resulted in increased radical length. Highest radical length i.e. 1.5 times higher as compared to control, was recorded for Sahar6 cultivar treated with 5% roots extract while the same concentration of the shoots extract did not affect the radical length of the same wheat cultivar as shown in Fig. 1 (A). Furthermore, weed extracts showed no positive response on radical length of Galaxy and Faisalabad1 cultivars except for 5% roots and shoot extract respectively as shown in Fig. 1.

Table 1. Effect of weed extracts on height of wheat cultivars.

	Cultivars	5 grams extract			10 grams extract		15 grams extract	
		Control	Root	Shoot	Root	Shoot	Root	Shoot
Week 1	Faisalabad 1	4.55	6.61	6.83	4.5	4.66	3.5	3.5
	Sahar 6	4.63	6.5	7.33	5	6.83	3.66	5.5
	Galaxy	4.52	6.5	7.25	3.83	4.5	3.16	3.5
Week 2	Faisalabad 1	6.8	7.66	8.66	5.66	6.83	4.83	4.8
	Sahar 6	6.91	7.57	8.5	6	8	4.5	4.87
	Galaxy	6.83	7.5	7.5	4.5	5.5	4.16	4.83
Week 3	Faisalabad 1	30	25.31	25.5	24.16	24.16	23.66	21.6
	Sahar 6	27.83	26.33	26.5	24.83	25.5	23	21.76
	Galaxy	30.2	25.82	26.16	24.8	24.83	23.83	21.66
Week 4	Faisalabad 1	33.73	25.66	34.33	24.66	32.5	24.16	21.66
	Sahar 6	34.63	26.5	35.16	25.33	34.83	21.83	21.62
	Galaxy	33.73	26.16	34.83	25.16	30	24.33	21.66
Week 5	Faisalabad 1	34.2	35.5	33.33	33.33	33.3	32.33	21.6
	Sahar 6	35.16	35.66	35.66	35.66	35.66	34.83	21.66
	Galaxy	34.2	35.5	35.5	33.5	33.31	32.35	32.3

Effect of root and shoot extracts on plumule length

The effects of roots and shoots extracts on all the 3 wheat cultivars are almost similar. Both extracts initially (5%) enhanced the growth of plumule, 10% extracts have no significant effect while 15% inhibited the plumule growth. Highest growths were recorded for Galaxy and Sahar6 cultivars treated with 5% of both roots and shoots extracts (Fig. 2).

Nonetheless, effects of roots and shoots extracts were also studied for root numbers but no differences were observed (Data not showed).

Table 2. Effect of weed extracts on number of leaves of wheat cultivars.

Cultivars			5 grams extract		10 grams extract		15 grams extract	
		Control	Root	Shoot	Root	Shoot	Root	Shoot
Week1	Faisalabad 1	7.96	11.16	9.5	10.66	8.83	9.33	8
	Sahar 6	7.96	11.33	9.66	9.16	9.5	8.83	8.5
	Galaxy	8.2	11	9	9.66	8.16	9.33	7.5
Week2	Faisalabad 1	8.83	12	10.33	11.33	9.83	10.83	13.5
	Sahar 6	8.83	12.33	10.83	10.16	10.5	9.83	9.16
	Galaxy	8.83	12	10.83	10.83	10.6	10.33	8.83
Week3	Faisalabad 1	10.63	18.83	13.5	12.5	10.1	11.33	9
	Sahar 6	11.96	16.16	14	14.83	11.5	12.33	9.83
	Galaxy	10.63	Table	13.83	12.83	11.8	11.66	8.16
Week4	Faisalabad 1	11.03	12	10.5	11.16	10.5	9.33	9.33
	Sahar 6	12.43	12.83	11	10.16	9	8.5	10
	Galaxy	12.43	12	9.66	9.16	8.16	7.33	4.83
Week5	Faisalabad 1	11.03	12	10.5	11.16	10.5	9.33	9.33
	Sahar 6	12.43	12.83	11	10.16	9	8.5	10
	Galaxy	12.43	12	9.66	9.16	8.16	7.33	4.83

Effect of roots and shoots extracts on biomass

The effect of roots and shoots extracts was evaluated on biomass (fresh weight & dry weight) of wheat cultivars. A similar trend was observed, 5% extracts resulted in enhanced biomass accumulation except for 5% shoots extract has no significant effect on Faisalbad1 cultivar. Although, the biomass accumulation in Sahar6 cultivar has been positively improved by treatment with roots extract (5% &10%) and shoots extract (5%). Highest fresh weight accumulation was recorded for Sahar6 cultivar which increased 1.5 folds (0.82 g) while dry weight has been increased 7 folds (0.78 g) as compared to control by treating with 5% of roots extract (Fig 3).

Furthermore, Germination percentage was also recorded but the effect was inhibitory and no significant differences were observed as compared to control (Data not showed).

Field work

Effect weed extracts on plant height

Effect of all three concentrations i.e. 5%, 10% and 15% weed extracts (roots and shoots) on height of all three cultivars (Faisalabad1, Sahar6 and Galaxy) were observed. Height data of plantlets treated with weed extract was recorded from week1 to week5. According to the recorded data, in the first two weeks inhibition was found for both the weed extracts at the concentration of 10% and 15% while 5% of both roots and shoots extract has improved the plant height of the tested wheat cultivars (Table 1). In week 3 the 5% of both the roots and shoots extracts produced similar results and has improved the plant height up to 6 cm. Although 10% of both the extracts also improved the plant height up to 4 cm. Nonetheless, in third week 15% of extracts produced no significant effect and did not inhibit the plant height of wheat cultivars as compared to controls.

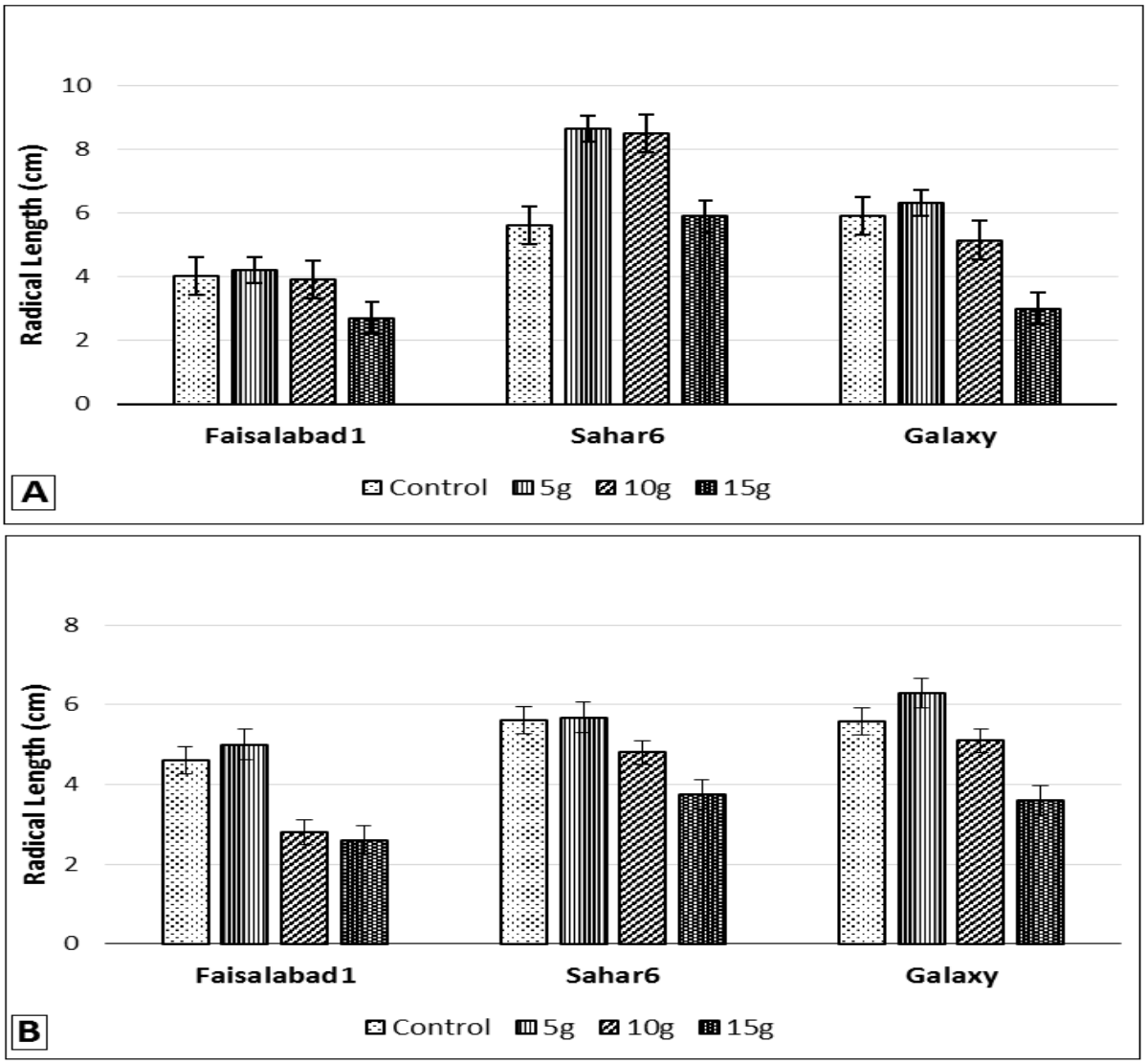

Fig. 1. A-Effect of roots extract on radical length of wheat cultivars, B-Effect of shoots extract on radical length of wheat cultivars. Values are mean of triplicates ±SE.

The highest height (35.16 cm) was recorded in week 4 for the Sahar6 cultivar treated with 5% shoots extract. Furthermore, the highest heights for the Galaxy and Faisalabad1 cultivars were also recorded in week 4 treated with 5% shoots extract (Table 1). Surprisingly, in week 4 the 10% shoots extract improved the plant height of all the three wheat cultivars. In week 5 the 5% and 10% extracts (both) produced no significant effect on the plant height while 15% inhibited the plant height of wheat cultivars.

Effect of weed extracts on leaves number

Wheat verities were treated with different concentrations (5%, 10% & 15% w/v) of weeds extracts (roots and shoots). Data of leaves count was recorded from week 1 to week 5. According to the results an increasing trend has been observed until week 3. Weeds extracts treatment have produced both the positive and negative results depending on the concentration of the extract. In the very first week all the three concentrations increased the leaves number as compared to control. A regular increase has been observed for the 5% weed extracts onward until week 3. No change has been observed in week 5. Ten percent extracts (both) have also affected the leaves number and caused an increase for all the three wheat cultivars. Fifteen percent weed extract showed an increasing effect on leaves number in 1st 2 weeks on the Faisalbad1 and Sahar6 cultivars while for the galaxy cultivar no significant change has been

observed. Highest leaves number was recorded for the Galaxy and Faisalabad1 cultivars in week 3 which was 19.16 and 18.83 respectively (Table 2).

Effect of weed extracts on nodes number

The effect of roots and shoots extracts on the growth of the nodes after two weeks was observed. Nodes number of Faisalabad1 and Sahar6 cultivars was increased by all the 3 concentrations i.e. 5%, 10% and 15% of roots extract as compared to controls while in galaxy cultivar 10 and 15% roots extract inhibited the nodes number. The nodes number in all three wheat cultivars was increased only by 5% of shoots extract. Unlike the roots extract, 10 and 15% showed inhibitory effect on nodes wheat verities. Highest nodes number (2.33) was observed for Faisalbad1 cultivar by treating with 5% of both roots and shoots extracts. Furthermore, in Galaxy cultivar 5% of shoots extract resulted in highest number of nodes (2.33) as shown in Fig. 4. No clear difference were observed at week 3, 4 and 5 (Data not showed).

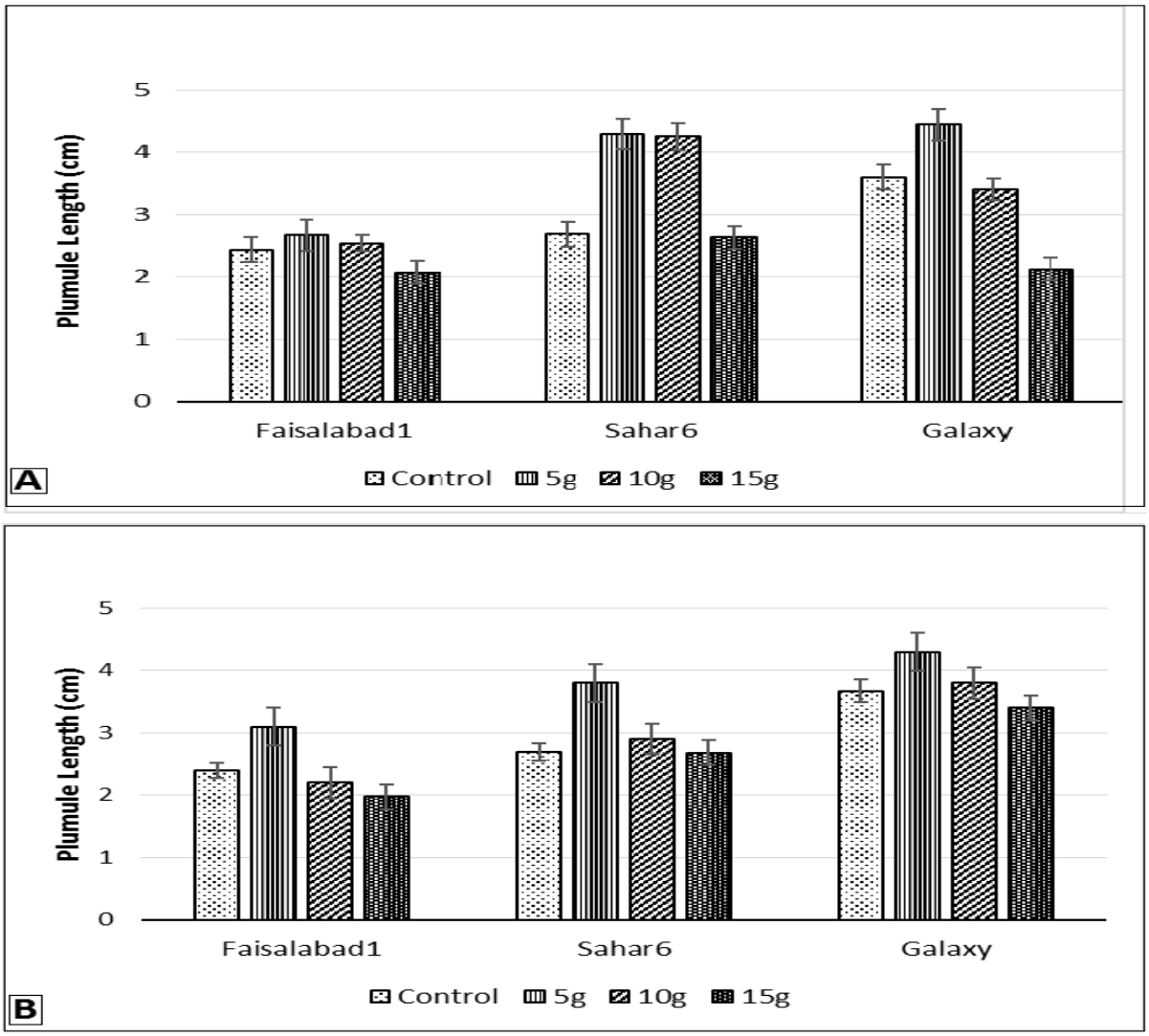

Fig. 2. A-Effect of roots extract on plumule length of wheat cultivars, B-Effect of shoots extract on plumule lengthof wheat cultivars. Values are mean of triplicates ±SE.

Effect of roots and shoots extracts on kernels length

The fresh roots and shoots extracts of the selected weeds of different concentrations (5%, 10% & 15% w/v) were examined for the kernels length in wheat cultivars. The observed effect of both roots and shoots extracts (all three concentrations) has been nearly similar in both Faisalabad1 and Galaxy cultivars, in which 5% and 10% (both roots and shoots extracts)

enhanced the kernels lengths while 15% has no effect as compared to controls. While in Sahar6 cultivar 15% (both roots and shoots extracts) also had some enhancing effect. Highest increase of 2.1 cm and 1.6 cm was observed in Faisalabad1 and Sahar6 by treatment with 5% of roots extracts. Likewise results were also recorded for shoots extract (Fig. 5).

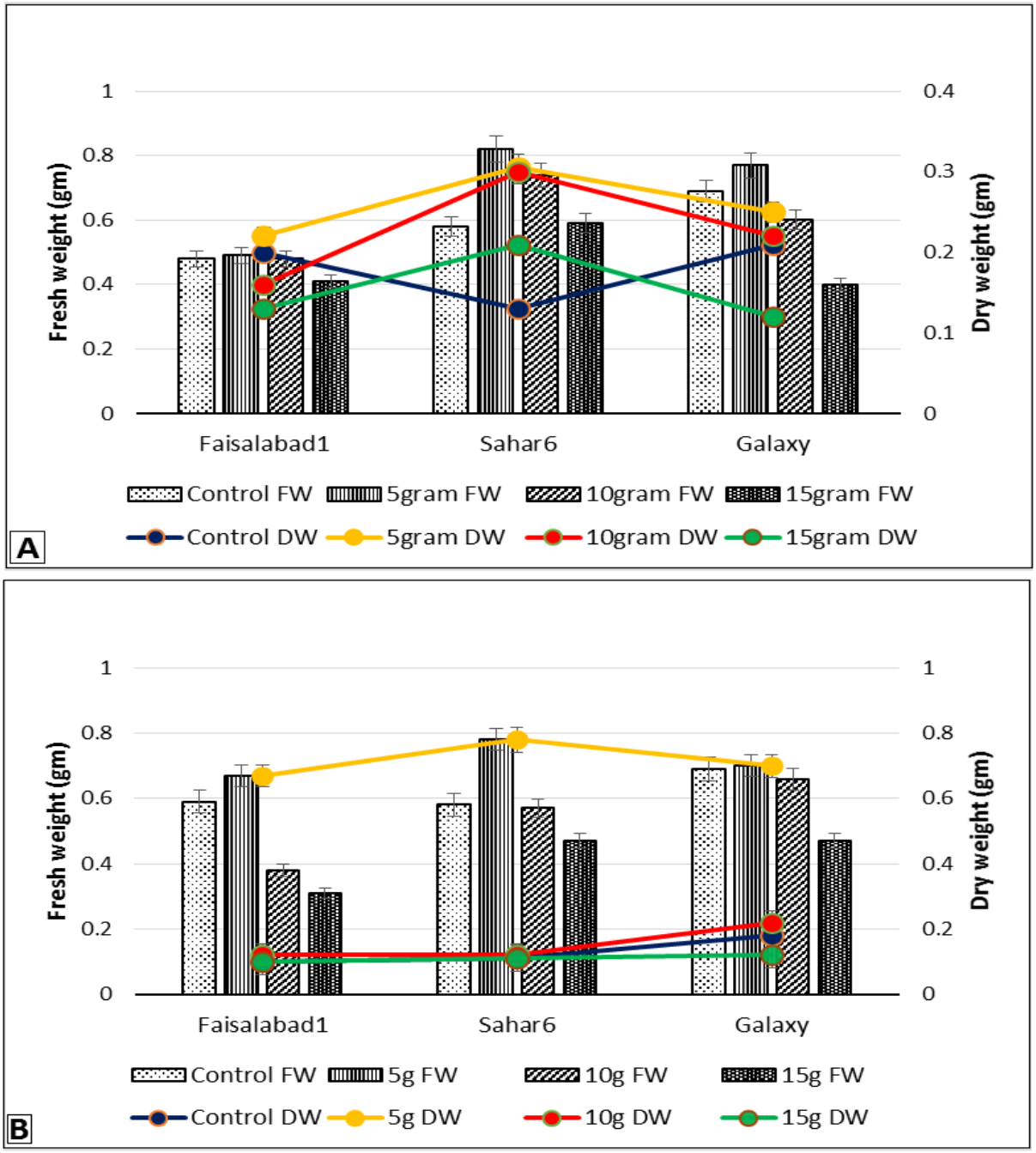

Fig. 3. A-Effect of roots extract on biomass of wheat cultivars, B-Effect of shoots extract on biomassof wheat cultivars. Values are mean of triplicates ±SE.

Discussion

All the extracts from weeds parts increased the radical and plumule growth at 5% concentration as compared to control. However, higher concentrations decreased the radical growth. Effect of shoots extracts on radical was stimulatory on Sahar6 cultivar and roots extract for Galaxy among all. Current results are in agreement with Rather *et al.,* (2006) who reported that *Phalarus minor Retz.* has increased root and shoot length of wheat crop (Rather *et al.,* 2016).

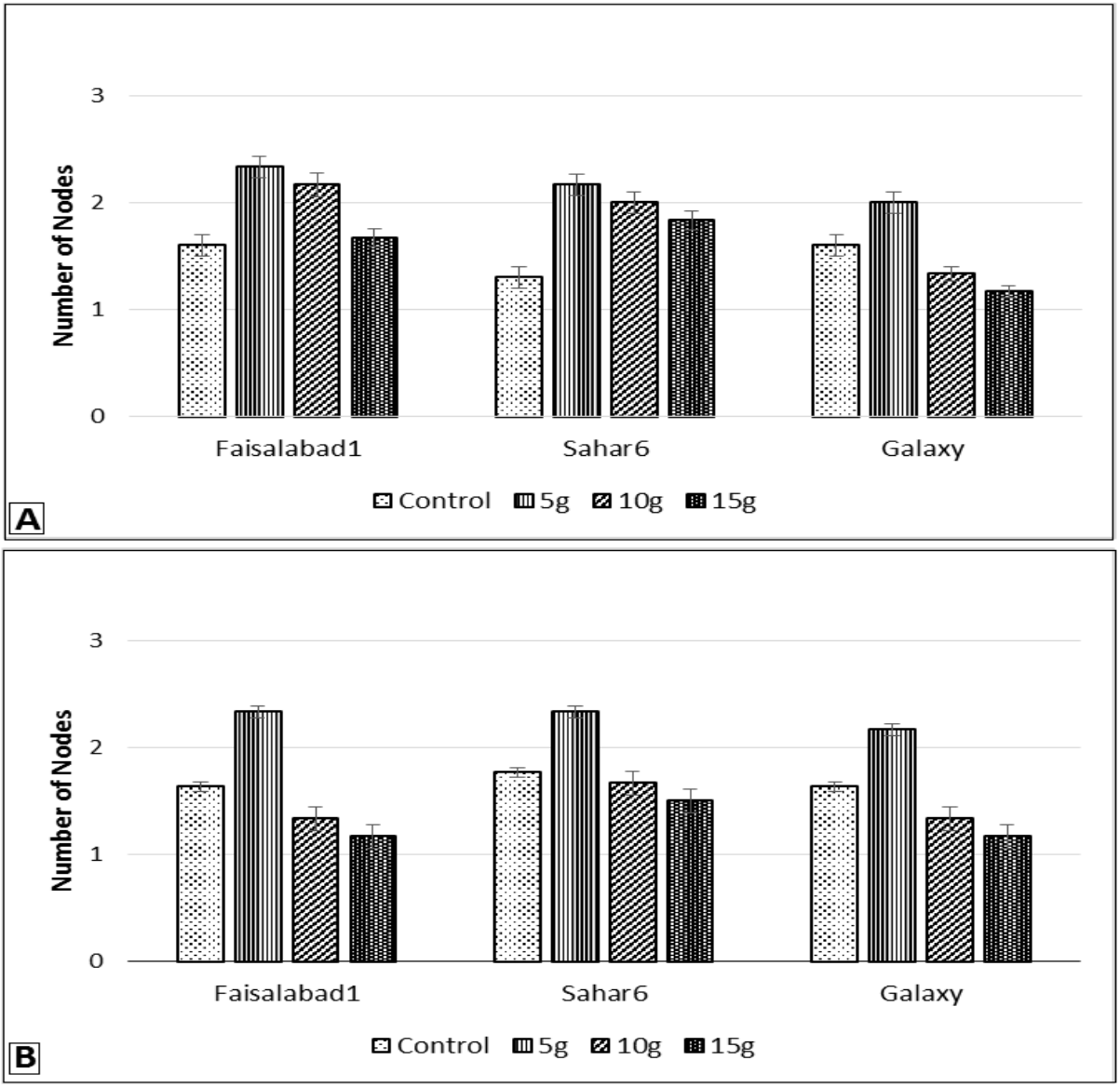

Fig. 4. A-Effect of roots extract on number of nodes of wheat cultivars, B-Effect of shoots extract on number of nodes of wheat cultivars. Values are mean of triplicates ±SE.

In current findings germination percentage was decreased by both shoot and root extracts. The results are supported by Hussain *et al.,* (1997) who reported the inhibitory effect of seed germination when treated with the hot water extract of *R. dentatus* L (Hussain *et al.,* 1997). Furthermore, 14 weeds leaf leachates treatment caused the decline in wheat germination percentage (Dongre and Singh, 2011). Based on the current findings and the reported data most of the weeds negatively affect the wheat germination percentage. Among all the concentrations 5% enhanced the plants height, leaves number and nodes number as compared to control. However, higher concentrations has inhibitory effects on these parameters. Likewise results were reported by Majeed *et al.* (2012) who studied that *Chenopodium album* L. *(Majeed et al., 2012)*. And found that all of the growth parameters of *Triticum aestivum* L. at low concentration caused enhancement, as the concentration increased a decline has been found in growth parameters.

Kernels length increased by 5% concentration but decreased when the concentration increased. Effect of shoots extract was more stimulatory at 5% concentration and inhibitory at 15% concentration than roots. Sunflower residue incorporation or RI+NPK was not important on grain yield of Punjab

96 wheat cultivar (Bashir *et al.,* 2012). In another report, the grain yield of Inqalab91 wheat cultivar was reduced 41% in comparison when NKP was used alone. These results are in agreement with ours.

In current study, majority of the parameters (germination efficiency, growth dynamics and biomass accumulation) studied, were improved by selected weeds when introduced at low concentration. According to the reported data, weeds show either stimulatory or inhibitory effects but in current results the growth parameters were increased at low concentrations and decreased by the higher concentration treatment. This is because we studied the synergistic effect of weeds in combine instead of separately and the synergistic effect was stimulatory at low concentration and inhibitory at higher concentration.

Conclusion

Based on current results, it can be said that selected weeds are allelopathic plants, which are capable of suppressing the germination and growth of test species at high concentrations. Allelopathic effects depended upon the parts assayed and test species. Germination and growth were independently affected. In all wheat cultivars, Sahar6 cultivar was found to be more tolerant to weeds extracts as compared to other cultivars.

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Conflict of Interest

No potential conflict of interest has been declared among authors.

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