

EFFECTS OF AQUOUS EXTRACTS OF SUNFLOWER (*HELIANTHUS ANNUUS* L.) ON GERMINATION AND SEEDLING GROWTH OF THE SELECTED WHEAT (*TRITICUM AESTIVUM* L.) VARIETIES

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Keywords: Allelopathy, Genotypes, Sunflower, Wheat

Abstract

Farmers generally incorporate the sunflower (*Helianthus annuus* L.) residue in the soil without taking into account the ill effects of sunflower allelopathy on germination and growth of subsequent crop. Since crop response to allelopathy varies with the genotype, the present study was carried out to evaluate the germination and seedling growth response of four varieties of wheat (*Triticum aestivum* L.) viz. MH 97, Inqalab 91, Punjab 96 and Pasban to aqueous extracts of sunflower var. Hysun 33, an allelopathic crop of family Asteraceae. In laboratory bioassays, the effect of different concentrations (5, 10 and 15% on dry weight bases) of aqueous extracts of fresh and dried leaf, stem and roots of sunflower were studied on germination and seedling growth of the selected wheat varieties. Aqueous extract of fresh stem exhibited the highest inhibitory effect on germination of wheat seeds. The highest concentration 15% of this extract significantly reduced germination of various wheat varieties by 21 - 67%. With respect to germination, Inqalab 91 was found the most tolerant to sunflower phytotoxicity followed by MH 97. Fresh stem extract significantly enhanced shoot length and/or shoot dry weight in different wheat varieties. In contrast, 15% dry leaf and fresh root extracts significantly reduced shoot length and shoot dry weight, respectively, in Inqalab 91. Study showed that sunflower extracts stimulated root dry weight in MH 97 and adversely affected this parameter in Pasban.

Introduction

Cultivated sunflower (*Helianthus annuus* L.) is increasing in importance as an agro-economic crops. It is drought resistant, produces crop in short growing seasons and is excellent protein and oil source of premium quality. Sunflower seems to be the crop which can bridge the ever-increasing gap between domestic edible oil production and consumption.

Sunflower crop is also well known for its allelopathic effects and more than 200 natural allelopathic compounds have been isolated from different cultivars of sunflower. (Ashrafi *et al.* 2008). These chemical compounds (allelochemicals) are released into the environment in appropriate quantities via root exudation, as leachates during litter decomposition and volatilization (Reigosa *et al.* 2000). When susceptible plants are exposed to allelochemicals, germination, growth and development may be affected (Xuan *et al.* 2004). Autumn sown sunflower is cultivated during August-September and is harvested in November followed by wheat cultivation in Pakistan. Wheat is the most widely grown cereal grain and in Pakistan it is grown on an area of 8900.7 thousand hectares with total production of 25213.8 thousand tons, making an average of 2833 kg/ha, which is very low as compared to some other wheat producing countries of the world (Agriculture statistics of Pakistan 2011).

Sunflower is a short duration crop, and not strictly season bounded, therefore can be cultivated successfully twice a year without causing displacement of any major economic crop (Ghaffar 1999). After picking up its seeds remaining part of plant is generally mixed in the soil with the idea that it will increase the fertility of the soil as manure. These residues released in the

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soil, are more likely to cause adverse effects on the proceeding crops, and such detrimental interactions cannot be over looked in sunflower based cropping system. The present study was conducted to evaluate the allelopathic effects of water extracts of different parts of sunflower on germination and seedling growth of wheat varieties *viz.*, Iqbal 91, Punjab 96, MH 97 and Pasban.

Materials and Methods

Seeds of sunflower variety Hysun 33 were sown in 2×2 m field plots at a depth of 1 cm. All the agronomic conditions were applied as recommended by Punjab Agricultural Department. After 90 days of sowing, the mature sunflower plants were uprooted, washed thoroughly under tap water, dried with blotting paper, and different parts were separated.

Fresh leaves, stems and roots of sunflower were separately crushed thoroughly in sterilized pestle and mortar and soaked in sterilized water at 20 g/100 ml for 24 hr at room temperature. The same amounts of these plant materials were air dried and soaked in distilled water in a similar way. Materials were filtered through double layered thin muslin cloth and finally through filter paper. The 20% v/w (on fresh weight bases) stock extract was further diluted to lower concentrations of 5, 10 and 15% by adding appropriate amount of distilled water. The extracts were stored at 4°C and generally used within a week (Bashir *et al.* 2011).

Double layered sterilized filter papers were placed in sterilized Petri plates and moistened with 3 ml extracts of various concentrations (5, 10 and 15%). For control treatment, 3 mL of distilled water was used. Ten surface sterilized seeds (using 1% sodium hypochlorite solution) of each of the four test wheat varieties namely MH 97, Inqalab 91, Punjab 96 and Pasban, were placed in these Petri plates at equal distances. Each treatment was replicated three times. Per cent seed germination and early growth in terms of root/shoot length and dry weight was recorded after ten days (Bashir *et al.* 2011). All the data were analyzed by ANOVA followed by DMR Test (Steel and Torrie 1980).

Results and Discussion

Analysis of variance shows that there was significant effect of different parts of sunflower (P), wheat varieties (V) and extract concentration (C) in germination of wheat seeds. However, the effect of fresh or dry plant materials (M) of sunflower was insignificant for this studied parameter. Interactive effect of $M \times P$, $P \times C$, $V \times C$, $M \times P \times V$, $M \times P \times C$, $M \times V \times C$ and $M \times P \times V \times C$ was also significant for germination (Table 1).

Among the different parts of sunflower, extract of fresh stem exhibited the highest inhibitory effect on germination of wheat seeds. The highest concentration of 15% of this extract significantly reduced germination of wheat varieties MH 97, Inqalab 91, Punjab 96 and Pasban by 21, 59, 67 and 47%, respectively. Similarly, 15% extract of dry stem significantly reduced germination of all the wheat varieties except Inqalab 91. There was 41, 37 and 25% reduction in germination of wheat varieties MH 97, Punjab 96 and Pasban, respectively, due to 15% extract of dry stem. Leaf extract was found comparatively less toxic to germination than the stem extract. The highest concentration of 15% of dry leaf significantly reduced germination in Punjab 96 and Pasban by 37 and 32%, respectively. Root extract showed the least toxicity. Only 15% extract of dry root significantly reduced germination by 28% in Pasban (Fig. 1). Similar variable effects of aqueous extracts of different parts of sunflower have also been reported on germination of different varieties of rice (Bashir *et al.* 2011). Likewise, Sedigheh *et al.* (2010) found significant reduction in germination of *Solanum nigrum* seeds due to sunflower extracts. A variety of phytotoxic compounds *viz.*, phenolic, sesquiterpene lactones, annuionones, heliaspirones,

heliannuols and helibisabonols have been identified in sunflower (Macias *et al.* 2003, Anjum and Bajwa 2005, Mehmood *et al.* 2010), which could be responsible for suppression in seed germination (Kamal and Bano 2009).

Among the four test wheat varieties, seed germination in Pasban found to be the most susceptible to sunflower toxicity. The highest concentration of 15% of all the parts of sunflower except fresh root significantly reduced germination in these wheat varieties by 25 - 49%. With respect to germination, Inqalab 91 was found the most tolerant to sunflower phytotoxicity followed by MH 97 (Fig. 1). Varietal variation in germination response to extracts of allelopathic plants has also been reported in rice, maize and other crops (Noor and Khan 1994, Javaid *et al.* 2007). The variable susceptibility of different varieties to the allelopathic plants extracts may be due to inherent differences in morphological and physiological characteristics of different genotypes involved (Macias *et al.* 1992).

Table 1. Analysis of variance for germination and early seedling growth of different wheat varieties as affected by different concentrations of aqueous fresh and dry root, stem and leaf extracts of sunflower.

Sources of variation	df	Mean squares				
		Germination	Shoot length	Shoot dry weight	Root length	Root dry weight.
Plant material (M)	1	168 ^{NS}	124***	1620 ^{NS}	50.02***	149 ^{NS}
Part (P)	2	1468**	91***	3608**	78.84***	2260**
Variety (V)	3	3799**	31**	5696***	85.17***	611 ^{NS}
Concentrations (C)	3	5171**	54***	1742 ^{NS}	17.73**	432 ^{NS}
M × P	2	972**	43***	4919**	2.59 ^{NS}	742 ^{NS}
M × V	3	180 ^{NS}	48***	1588 ^{NS}	19.76**	339 ^{NS}
M × C	3	52 ^{NS}	20*	3861**	8.97 ^{NS}	371 ^{NS}
P × V	6	178 ^{NS}	5 ^{NS}	196 ^{NS}	22.61***	1335**
P × C	6	628**	38***	679 ^{NS}	20.68***	692 ^{NS}
V × C	9	407**	11*	664 ^{NS}	2.45 ^{NS}	1065**
M × P × V	6	379**	6 ^{NS}	659 ^{NS}	1.82 ^{NS}	557 ^{NS}
M × P × C	6	326*	21**	726 ^{NS}	1.55 ^{NS}	1026*
M × V × C	9	274*	18**	662 ^{NS}	3.06 ^{NS}	499 ^{NS}
P × V × C	18	151 ^{NS}	10*	325 ^{NS}	6.91*	563 ^{NS}
M × P × V × C	18	250**	13**	1520**	0.91 ^{NS}	431 ^{NS}
Error	192	117	5.9	805	3.84	447

NS = Non-significant. *, **, *** Significant at $p \leq 0.05$ and $p \leq 0.01$, $p \leq 0.001$, respectively.

Analysis of variance for the effect of sunflower extracts on shoot growth of different wheat varieties shows that the effect of all the variables *viz.*, M, P, V and C was significant for shoot length. However, for shoot dry biomass, only the effect of P and V was significant. Interactive effect of M × P, M × C, P × C, V × C, M × P × C, M × V × C, P × V × C and M × P × V × C was also significant for shoot length. On the other hand, for shoot dry biomass, only the interactive effect of M × P, M × C and M × P × V × C was significant (Table 1). In general, extracts of different parts of sunflower especially stem extract stimulated shoot length. The effect of 15% dry stem extract was significant on shoot length of MH 97. Similarly, 15% fresh stem extract exhibited the similar significant stimulatory effect on shoot length of Inqalab 91 and Pasban.

Likewise, all the concentrations of fresh stem extract significantly enhanced shoot length of Punjab 96. Shoot dry weight was also significantly increased in MH 97 and Inqalab 91 due to 10% fresh stem extract. The highest concentration of fresh stem extract (15%) significantly enhanced shoot dry weight in Punjab 96. In contrast, 15% dry leaf and 15% fresh root extract significantly suppressed the shoot length and shoot dry weight, respectively, in Inqalab 91. The effect of rest of the treatments on shoot growth of different wheat varieties was insignificant (Figs 2 and 3). Previous literature reveals that generally extracts of allelopathic plants reduced the growth of target plants species (Javaid *et al.* 2010, da Silveira *et al.* 2012, Oliveira *et al.* 2012), however, there are reports where these extracts also stimulated plant growth (Javaid and Shah 2008, Kamal and Alam 2010, Peneva 2007).

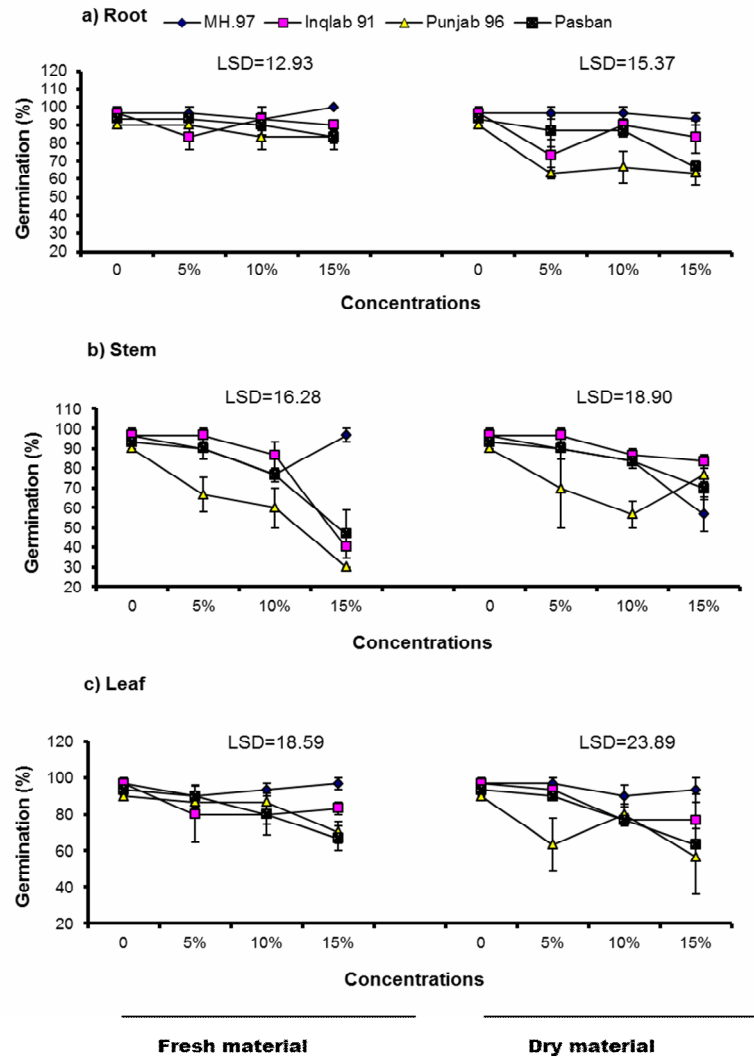


Fig. 1. Effect of aqueous extract of fresh and dry root, stem and leaf of sunflower on percentage germination of different wheat varieties after ten days of incubation. Vertical bars show standard error of means of three replications.

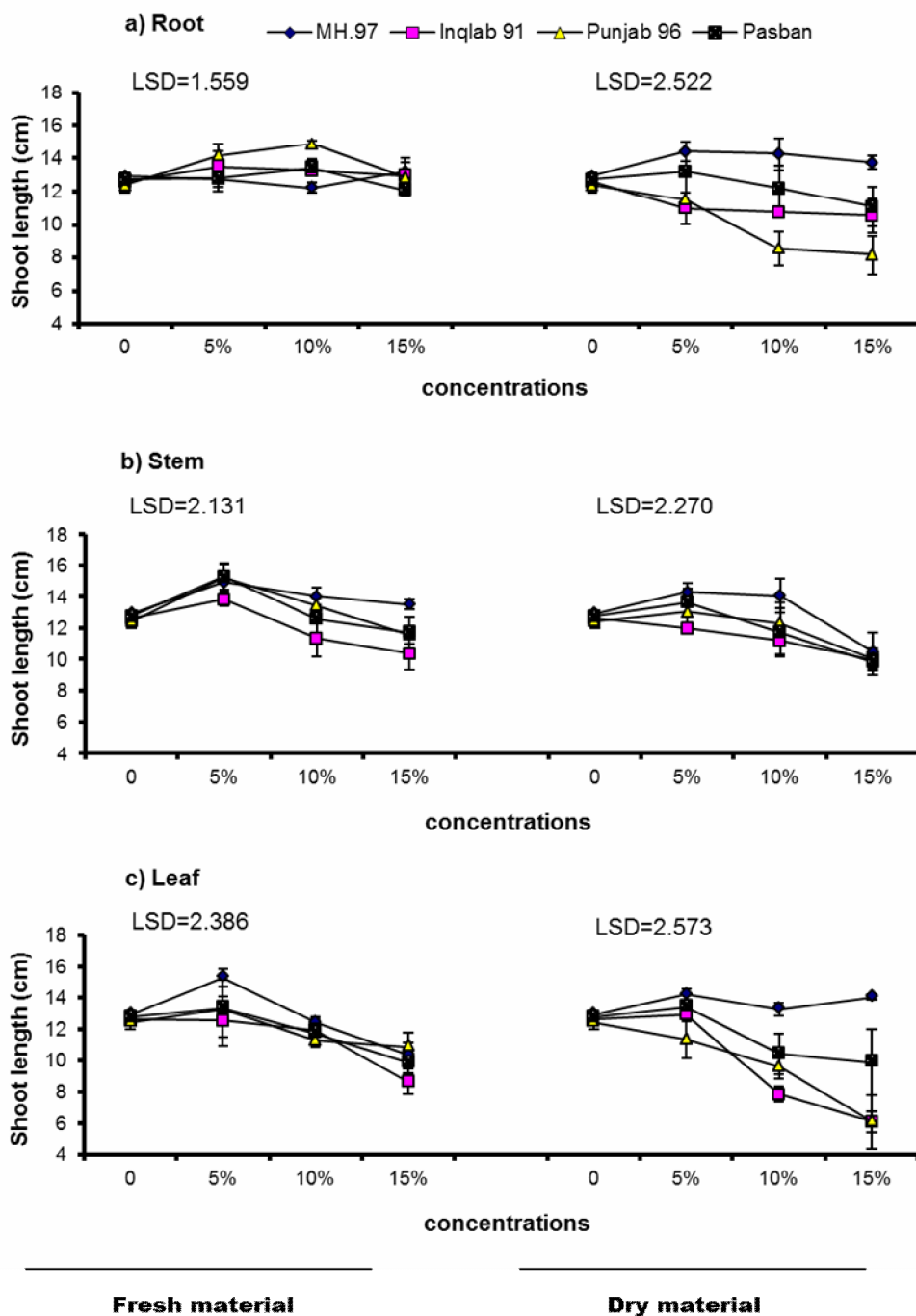


Fig. 2. Effect of aqueous extracts of fresh and dry root, stem and leaf of sunflower on shoot length of different wheat varieties after ten days of incubation. Vertical bars show standard error of means of three replications.

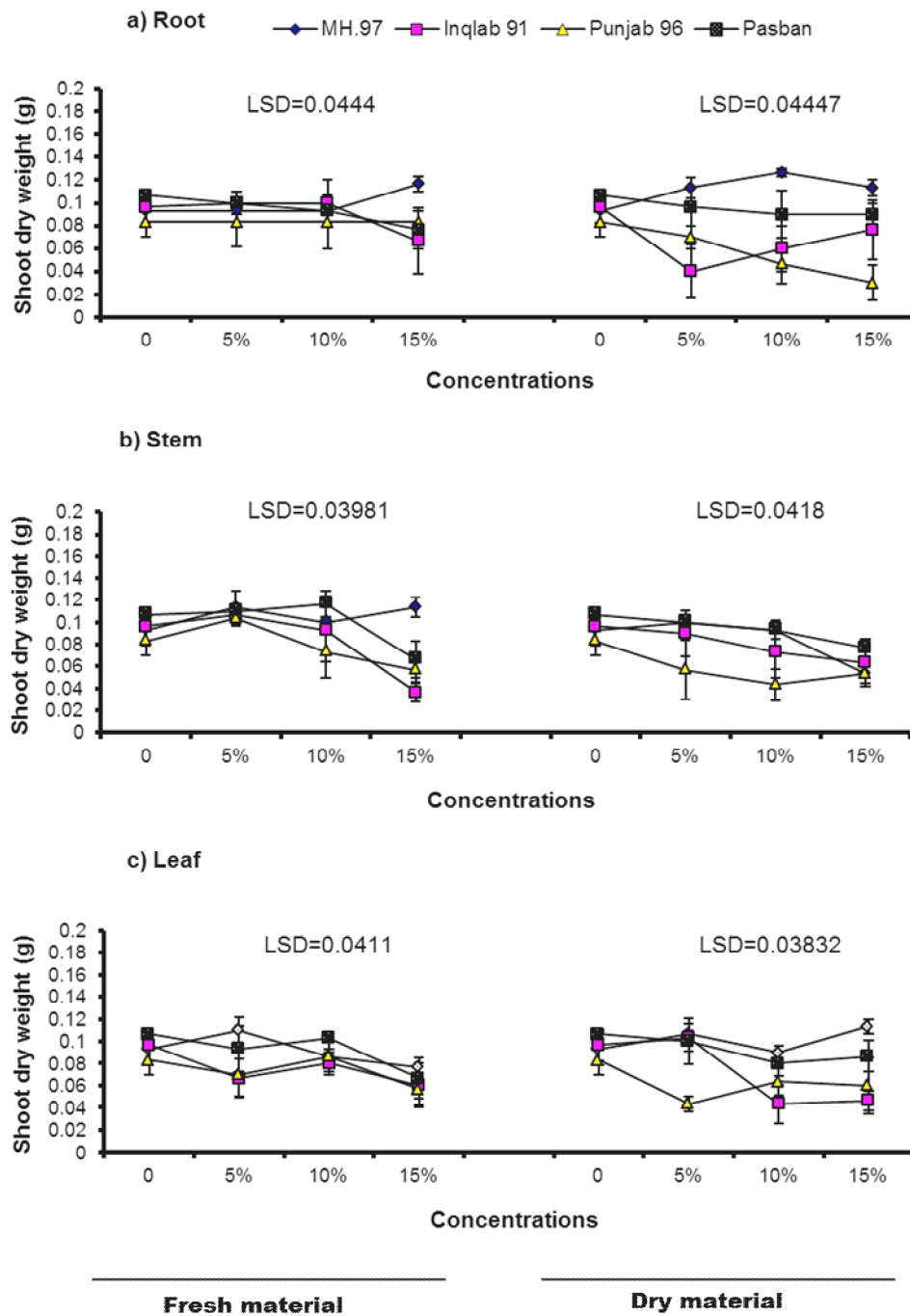


Fig. 3. Effect of aqueous extracts of fresh and dry root, stem and leaf of sunflower on shoot dry weight of different wheat varieties after ten days of incubation. Vertical bars show standard error of means of three replications.

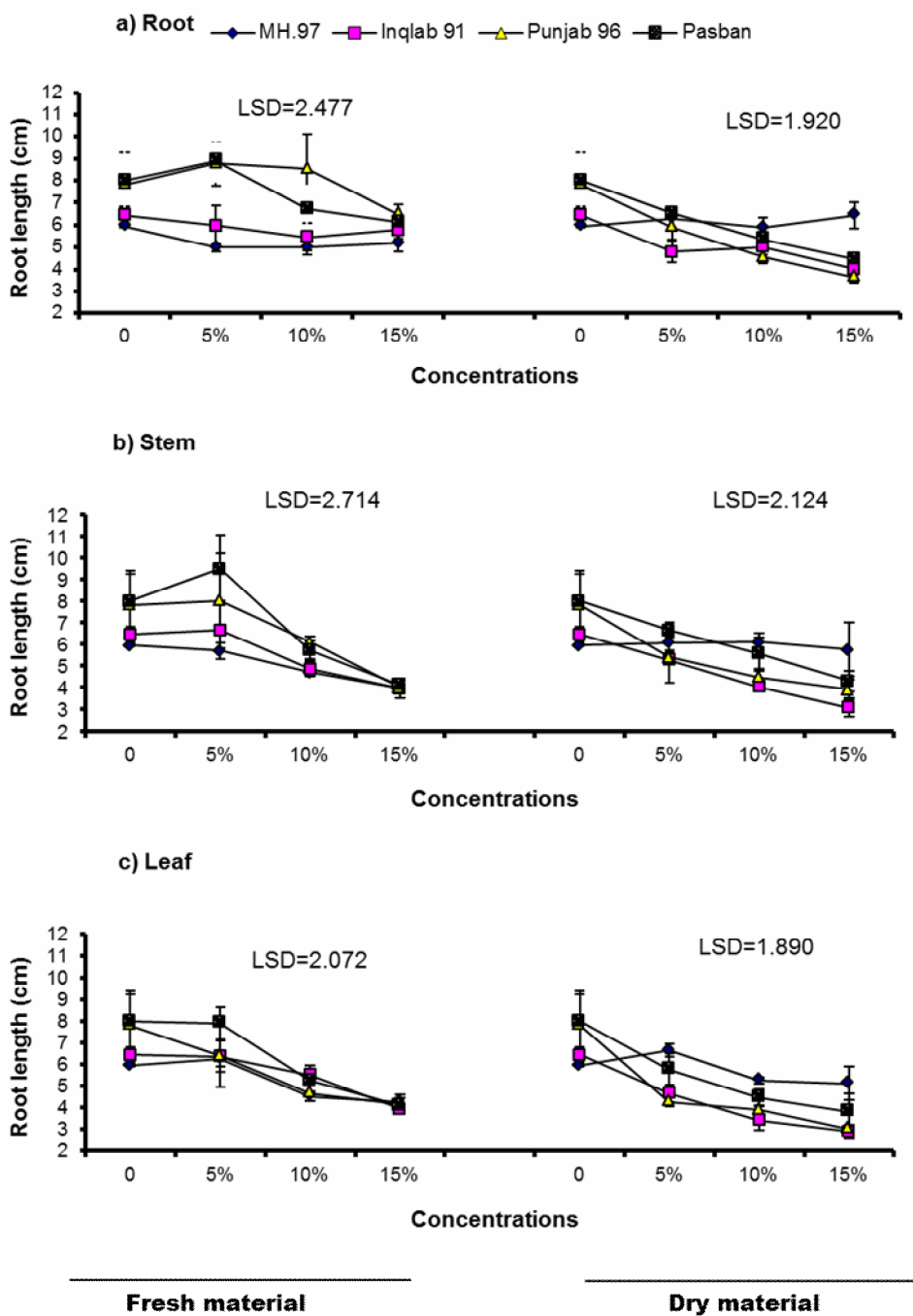


Fig. 4. Effect of aqueous extracts of fresh and dry root, stem and leaf of sunflower on root length of different wheat varieties after ten days of incubation. Vertical bars show standard error of means of three replications.

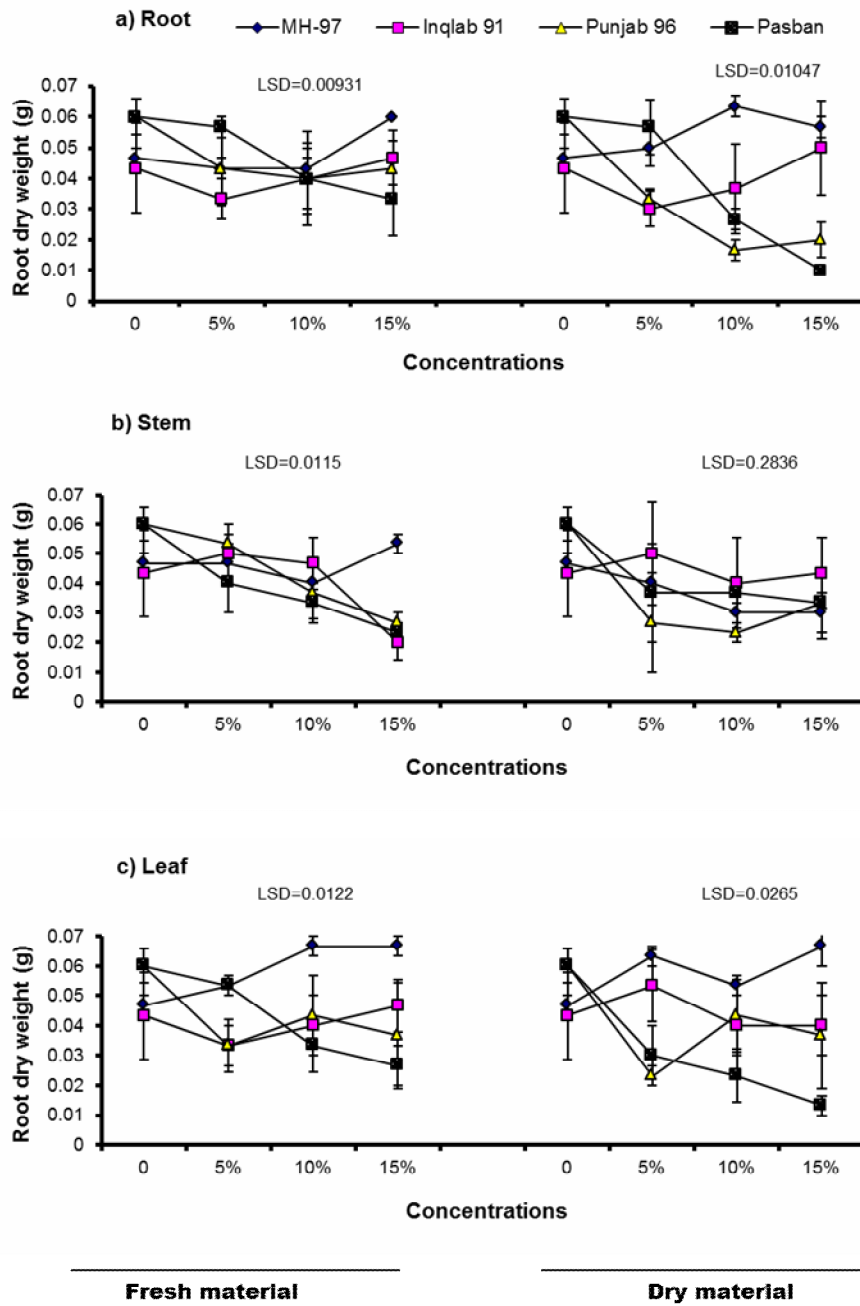


Fig. 5. Effect of aqueous extracts of fresh and dry root, stem and leaf of sunflower on root dry weight of different wheat varieties after ten days of incubation. Vertical bars show standard error of means of three replications.

Analysis of variance for the effect of sunflower extracts on root growth of different wheat varieties shows that the effect of M, P, V as well as C was significant for root length. However, for root dry weight only the effect of P was significant. Among the various interactions, the effects of $M \times V$, $P \times V$, $P \times C$ and $P \times V \times C$ was significant for root length. Similarly, the interactive effect of $P \times V$, $V \times C$ and $M \times P \times C$ was significant for root dry weight (Table 1). Response of root growth in wheat to aqueous extracts of different parts of sunflower was highly variable. Root length in MH 97 was significantly reduced by 10 and 15% fresh leaf and 15% fresh stem extracts. Similarly, 15% extracts of dry leaf and dry root extracts significantly suppressed root dry weight in Pasban. Conversely, all the concentrations of fresh leaf extract, 5% extract of dry leaf and 10% extract of dry root significantly enhanced root dry weight in MH 97. Likewise, 15% fresh and dry stem extracts significantly enhanced root length in Punjab 96 and root dry weight in Inqalab 91, respectively. The effect of rest of the extract treatments on different root growth parameters was insignificant (Figs 4 and 5).

In brief stem extract of sunflower reduced germination in all the four tested wheat varieties. Germination in wheat var. Inqalab 91 showed more tolerance to sunflower phytotoxicity as compared to the other test wheat varieties. The effect of aqueous extracts of various parts of sunflower on shoot and root growth of wheat varieties was highly variable, and with few exceptions was either insignificant or stimulatory.

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(Manuscript received on 29 August, 2016; revised on 10 February, 2017)