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ALLELOPATHIC EFFECTS OF POPLAR LEAF EXTRACTS ON WHEAT: SEASONAL INFLUENCE ON THE ALLELOPATHIC POTENTIALS OF LEAVES

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ABSTRACT

In the present study, leaf extracts of poplar (*Populus nigra*) obtained in aqueous medium were tested in the laboratory conditions against four wheat varieties (Ghaznavi, Siran, Atta Habib and Janbaz) and were found inhibitory to the growth of these plants. Specific focus was given to the effects of allelopathic activity and allelopathic substances in leaves which were collected in different seasons (March, July and November). Results demonstrated that all extracts of leaves collected during March, July and November inhibited the root and shoot growth of Ghaznavi, Siran, Atta Habib and Janbaz in a concentration-dependent manner. However, the inhibitory activity of leaves collected in March was greater than those collected in July and November. The results conclude that poplar leaves collected during March possess greater allelopathic activity than those collected in July and November. It is possible that *P. nigra* could be useful for a weed suppressive residue in the variety of agricultural settings to develop sustainable agriculture options. The effectiveness of *P. nigra* of March as a suppressive agent may be greater than that of July.

Keywords: allelopathy, *Populus nigra*, growth inhibitor, phytochemical substances, residues.

1. INTRODUCTION

Plants have developed various mechanisms to fully adopt them to grow and compete with other plants within the same niche. One such strategy is allelopathy [1], in which chemical compounds produced by secondary metabolism can promote the growth of beneficial species or inhibit the growth of competing plants or microorganisms [2]. Plants contain several secondary metabolites, and some of those compounds possess strong allelopathic activity such as germination and growth inhibitory effects on other plants [3,4]. Knowledge of these substances, termed as allelochemicals [5], may be important for bioprospecting new growth-regulating compounds. Intercropping of allelopathic plants with crop plants can also be manipulated as 'weed suppressors' owing to their allelopathic properties [6,7].

Triticum aestivum, common or bread wheat, is an annual grass in the Poaceae (grass family) native to the Mediterranean region and southwest Asia, which is one of the several species of cultivated wheat, now grown worldwide. It is one of the most important winter cereal crops of Pakistan. It has been cultivated in an area of 8.414 million hectares with an annual production of 21.749 million tons and an average yield of 2.585 tons per hectare. [8]. Poplar (*Populus nigra*) is frequently cultivated in boundary plantation with crops in Pakistan. The genus *Populus* is well known for possessing allelopathy and wide spectrum biological activities against other plants and organisms since different secondary compounds have been reported to be synthesized in leaves, buds and floral parts in *Populus* [9-11]. In the present study, the allelopathic activity of the aqueous extracts of *P. nigra* leaves collected during three different seasons (March, July, and November) was determined using wheat as a test species.

2. MATERIALS AND METHODS

2.1 Extraction of leaves of *Populus nigra*

Clones of *P. nigra* were grown in the agro-forestry with crops in district Charsadda. Leaves of the plant were collected in the month of March, July and November 2014, and stored at room temperature until extraction. *Triticum aestivum* was used as test plant due to the major crop grown in the area. Fresh leaves were selected, washed in running tap water for removing the surface contaminants and dust and was dried at room temperature for two weeks in shade. After drying the leaves were crushed to powdered materials using an electric blender. A sample of 10, 20, 40 and 80g powder materials was taken and soaked for the different soaking duration in tap water. After relative time-periods (24hr, 48hr, 72hr and 96hr) the extracts were filtered through Whatman filter paper. The filtrate obtained was further used in the bioassay.

2.2 Applications of extracts

Ten seeds of *Triticum aestivum* (cv Siran, Atta Habib, Ghaznavi and Janbaz) were placed on two folds of filter paper in Petri dishes and moistened with the respective extracts to make the test. Tap water was used as a control. Three replicates were designed for each extract. The randomized block design was used. Seed germination was recorded after 96 hrs.

2.3 Bioassay comparison

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After germination in the darkness at 25 °C after 96 hours the germination (%), plumule and radical lengths (mm) were measured for each replicate. Three factorial experimental designs were used and all the results were statistically analyzed by using MSTATC program.

3. RESULTS

3.1 Percent germination

Three extracts obtained from 10, 20, 40 and 80g powder of *P. nigra* leaves which were collected in March, June and November significantly inhibited the germination percentage of all the four varieties of wheat showing significant differences between the three seasons (Table 1-3). The inhibitory activity of the March extract was maximum in control (100%), followed by 10g (89.38%), 20g (83.13 %), 40g (42.92%) and 80g (0%) concentrations with a gradual decrease in germination percentage as concentration increased. Among different varieties maximum mean germination (70.67%) was noted in Atta Habib, followed by Siran (68.92%), Janbaz (37.93 %) and Ghaznavi (34.94 %). The effect of soaking duration on the seed germination of various varieties was noted as 24 hours (52.70 %), 48 hours (44.50 %), 72 hours (33.20 %) and 96 hours (30.80 %) (Table-4).

Extracts obtained from leaves which were collected during July revealed that germination percentage was maximum in control (100%), followed by 10g (96.67%), 20g (100%), 40g (100%) and 80g (93.33%). Among various varieties maximum mean germination (97.50%) was noted in Siran, followed by Atta Habib (96.33%), Janbaz (93.50%) and Ghaznavi (84.50%). The effect of soaking duration on the seed germination of various varieties was noted as 24 hours (94.50%), 48 hours (92.00%), 72 hours (96.83%) and 96 hours (85.83%) respectively (Table-5).

The effect of leaf extracts prepared from leaves collected during November on the germination percentage was maximum in control (95.21%), followed by 10g (85.42%), 20g (80.42%), 40g (73.72%) and 80g (55.42%). Varietal means exhibited maximum germination (94.87%) in Atta Habib, followed by Siran (81.86%), Janbaz (80.03%) and Ghaznavi (56.43%). The effect of soaking duration on the seed germination of various varieties was noted as 24 hours (74.17%), 48 hours (85.17%), 72 hours (80.67%) and 96 hours (72.17%) (Table-6).

3.2 Radical length (cm)

Inhibitory activity of P. nigra leaves extracts obtained from March, July and November were determined by root growth of wheat varieties viz Ghaznavi, Siran, Atta Habib, and Janbaz. All extracts significantly inhibited the growth of the roots of all these test plants with extract concentration and soaking duration dependent.

Concentration means of March extracts indicated that radical length was maximum in control (4.68cm), followed by 10g (1.99cm), 20g (1.20cm), 40g (0.37cm) showing a significant decrease under various concentrations. Moreover, varieties mean indicated that highest radical length was observed in variety Siran (2.02cm), followed by Atta Habib (1.83cm), Ghaznavi (1.49cm) and Janbaz (1.24cm). The effect of soaking duration on radical length was maximum (1.74cm) at 24 hours soaking duration with a significant decrease in radical length as the soaking duration increases i.e. 48 hours (1.65cm), 72 hours (1.71cm) and 96 hours (1.49cm) respectively. Besides this, no germination was seen in all varieties at concentration 80g in all four soaking duration (Table-7).

Data obtained for leaf extracts for the month of July revealed that according to concentration means radical length was maximum in control (5.09cm), followed by 10g (3.07cm), 20g (2.08cm), 40g (1.40cm) showing a significant decrease under various concentrations to a minimum of (1.13cm) at 80g concentration. Moreover, varieties mean indicated that highest radical length was observed in Variety *Siran* (2.99cm) followed by *Ghaznavi* (2.54cm), *Atta Habib* (2.29cm) and *Janbaz* (2.39cm). The effect of soaking duration on radical length was maximum (2.78cm) at 24 hours soaking duration followed by 48 hours (2.49cm), 72 hours (2.33cm) and 96 hours (2.61cm) respectively (Table 8).

Results documented that extracts of leaves collected in November showed differential effects on radical length which was maximum in control (2.78cm), followed by 10g (1.99cm), 20g (1.65cm), 40g (1.31cm) showing a significant decrease under various concentrations to a minimum of (0.48cm) at 80g concentration. Moreover, varietal response to various concentrations indicated that highest radical length was observed in variety Atta Habib (1.95cm) followed by Janbaz (1.69cm), Ghaznavi (1.50cm) and Siran (1.43cm). The effect of soaking duration on radical length was 24 hours soaking duration (1.43cm), 48 hours (1.65cm), 72 hours (1.86cm) and 96 hours (1.64cm) respectively (Table-9).

3.3 Plumule length (cm)

All extracts of the *Populus nigra* leaves inhibited plumule growth of wheat varieties viz Ghaznavi, Siran, Atta Habib and Janbaz. The sensitivity of plumule growth against the extracts was concentration and soaking duration dependent. However, the inhibitory activity differed with the month. The inhibitory activity of March extract was significantly greater than that of July and November extracts. Concentration means of March extracts indicated that plumule length was maximum in control (5.25cm), followed by 10g (1.77cm), 20g (1.12cm), 40g (0.45cm) showing a significant decrease. Moreover, the varietal response indicated that highest plumule length was observed in variety Atta Habib (2.14cm), followed by Siran (2.05cm) Ghaznavi (1.46cm) and Janbaz (1.22cm). The effect of soaking duration on plumule length was maximum (1.86cm) at 24 hours soaking duration, followed by 48 hours (1.80cm), 72 hours (1.82cm) and 96 hours (1.39cm) respectively (Table 10).

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Extracts obtained from leaves collected during July indicated that plumule length was maximum in control (4.52cm), followed by 10g (2.83cm), 20g (2.06cm), 40g (1.16cm) showing a significant decrease under various concentrations which reached to a minimum of (0.83cm) at 80g concentration. Moreover, varieties mean indicated that highest plumule length was observed in Variety *Atta Habib* (2.14cm) followed by *Siran* (2.05cm) Ghaznavi (1.46cm) and Janbaz (1.22cm). The effect of soaking duration on plumule length was maximum (2.49cm) at 24 hours and 96 hours soaking duration with a significant decrease in plumule length as the soaking duration increases i.e. 48 hours (2.32cm), 72 hours (1.80cm) respectively (Table-11)

Concentration means of November extracts indicated that plumule length was maximum in control (1.13cm), followed by 10g (0.82cm), 20g (0.49cm), 40g (0.37cm) showing a significant decrease. Moreover, the varietal response indicated that highest plumule length was observed in Variety Ghaznavi (1.21cm) followed by Siran (1.09cm), Janbaz (1.02cm) and Atta Habib (0.95cm). The effect of soaking duration on plumule length was 24 hours soaking duration (1.01cm), 48 hours (1.47cm), 72 hours (1.16cm) and 96 hours (0.64cm) respectively (Table-12).

4. DISCUSSIONS

The inhibitory activity of *P. nigra* leaves differed with leaves collected in different seasons but not with plant parts i.e., root and shoot extracts revealed similar patterns in allelopathic activity. It was observed that the inhibitory activity of leaves collected in March was significantly greater than those collected in July. These results generally coincide with the findings of Kimura and Kato-Noguchi [12] and Ai Kobayashi and Kato Noguchi [13] who observed similar tendency in their results. Cooper-Driver *et al*. [14], Ohmae *et al*. [15], and Riipi *et al*. [16] reported that the concentrations of some substances, such as phenolic acids, in plant leaves were high at the beginning of the growing season and decreased when the season progressed towards the maturity of the leaves. This indicates that age of leaves and the corresponding seasons influence the concentration and/or composition of those allelopathic substances in the extracts. This might be one of the possible reasons to explain the changes in the allelopathic activity of *Populus nigra* leaves against four different wheat varieties throughout a year. At the same time, the effectiveness of those allelopathic substances might be different in their effects due to differential tolerance responses of target wheat cultivars. Ai Kobayashi and Kato Noguchi [13] demonstrated that shoots of *B. brizantha* separated from the plant in June, October and January possessed different concentration of allelochemicals. They recorded that concentrations in the January shoots were significantly lower than those in the June and October shoots. Thus, it was observed that young leaves were inhibitorier than mature leaves.

The present study demonstrated that aqueous extracts from leaves obtained by soaking for various durations invariably reduced germination and seedling growth. A gradual decrease in germination percentage and seedling growth was recorded with increasing concentrations. The toxicity of the aqueous extract and the release of phytoxins, however, were dependent upon the soaking duration. Enhancing the soaking duration from 24 to 96 hrs might have aided either the release of more quantity or more types of phytotoxins or both. The poor and delayed germination of the wheat varieties under allelopathic stress might be due to either death of embryo or imposition of dormancy or inactivity of seeds [17]. Nandal and Dhillon [18] also reported that the aqueous extracts of poplar (*Populus deltoids*) leaves adversely affected the germination and seedling growth of some wheat varieties at high extract concentrations. According to them the harmful effect of poplar leaf extracts at higher concentration might be due to excess of inhibitory allelochemicals present in the extract. The present study suggested that different varieties i.e. Ghaznavi, Siran, Atta Habib and Janbaz responded differently to the same extract. These findings are similar to Hussain and Khan [19] who reported that 25 different species respond differently against same extracts from each other in inhibation of germination and seedling growth. Various other studies [20-24] have also reported differential inhibition of seedling growth and germination in different species.

It was observed from this study that the leaves extract of *Populus nigra* significantly affected the radical and plumule length of all the four varieties i.e. *Ghaznavi, Siran, Atta Habib and Janbaz* invariably by causing a reduction in their elongation ($P< 0.05$). The inhibition rate of the radical and plumule length of wheat seedlings showed linear relation to both concentration and soaking duration. These observations agree with Barkatullah *et al.* [25] who also observed that aqueous extracts from leaves of *Dodonae aviscosa* significantly reduced the plumule and radical growth of the tested species with increasing concentration. Increasing soaking duration and concentration generally enhanced inhibition. The enhanced phytotoxicity with increasing concentration and soaking duration in *Azadirachta indica* [26], *Tamarindus indica* [27], *Broussonetia papyrifera* [28] and *Lactuca sativa* [29] supports our findings. The presence of allelochemicals was not limited to germination inhibition alone, it also brings about impairment in the metabolic activities of the targeted plants, leading to a decrease in their root and shoot length [30]. Reduction in the root and shoot length of wheat varieties might be due to the presence of allelochemicals such as phenolic compounds, alkaloids and saponins [31].In the present study march collection, all soaking duration viz 24, 48, 72 and 96 hrs soaking durations of the maximum concentration of the part used (80g) completely inhibited the germination in all the four varieties. The same effect was observed by Araniti *et al.* [32] and Akhtar *et al.* [33] who documented complete inhibition of Lettuce seeds by aqueous extract obtained from in *H. hircinum, C. nepeta*, *A. arborescens,* and *C. sativa*. Sher *et al.* [34] evaluated the phytotoxic effect of *Populus euphratica* that completely inhibited the germination of *Triticum aestivum*.

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CONCLUSIONS

The extracts of *Populus nigra* leaves collected in March and July inhibited root and shoot growth of all four different wheat varieties i.e., Ghaznavi, Siran, Atta Habib and Janbaz in a concentration-dependent manner. However, the inhibitory activity of leaves collected in March (young leaves) was greater than those collected in July (mature leaves) and November (senescenced leaves).

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Table-1. Mean squares of the ANOVA for Germination (%), Radical and Plumule Growth (mm) of aqueous extract Season 1.

Sources	d.f	Germination (%)	Radical Growth(mm)	Plumule Growth(mm)
Concentrations (C)	4	82103.542*	166.283*	208.878*
Soaking duration (H)	3	175.000*	0.741*	2.923*
HxC	12	212.153*	0.721*	3.001*
Varieties (V)	3	3669.444*	7.304*	12.064*
CxV	12	814.931*	0.945*	1.526*
HxV	9	116.852*	0.633*	2.263*
HxVxC	36	85.023NS	0.374*	1.047*
Error	160	62.083	0.265	0.250
Coefficient of Variation (%)		12.49%	31.22%	29.10%

d.f= degree of freedom, *= significant and NS= non-significant

Table-2. Mean squares of the ANOVA for Germination (%), Radical and Plumule Growth (cm) of aqueous extract Season 2.

Sources	d.f	Germination (%)	Radical Growth(cm)	Plumule Growth(cm)
Concentrations (C)	4	1392.083*	123.473*	104.859 *
Soaking duration (H)	3	763.750*	2.153*	6.443*
HxC	12	87.361*	1.341*	2.068*
Varieties (V)	3	2077.083*	5.704*	3.309*
CxV	12	203.472*	0.656*	0.521 NS
HxV	9	184.861	0.465 *	0.555 NS
HxVxC	36	56.157NS	0.485*	0.618*
Error	160	48.333	0.246	0.343
Coefficient of Variation (%)		7.48%	19.41%	25.69%

d.f= degree of freedom, *= significant and NS= non-significant

Table-3. Mean squares of the ANOVA for Germination (%), Radical and Plumule Growth (cm) of aqueous Extract Season 3.

Sources	d.f	Germination (%)	Radical Growth(cm)	Plumule Growth(cm)
Varieties (V)	4	2143.750*	1.788*	7.035*
Soaking duration (H)	3	15659.306*	3.392*	0.706NS
HxC	12	504.861*	1.810*	0.575NS
Concentrations (C)	3	10620.417*	34.633*	36.39*
CxV	12	775.694*	3.027*	0.627NS
HxV	9	3410.694*	3.520*	4.153*
HxVxC	36	343.750*	1.318*	0.629NS
Error	160	179.583	0.363	0.487
Coefficient of Variation (%)		17.17%	36.69%	65.37%

d.f= degree of freedom, *= significant and NS= non-significant

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Table-4. Effect of *Populus nigra* leaves aqueous extract of season 1 on percent germination of wheat seeds. Each value is a mean of 3 replicates, each with 10 seedlings.

Duration	Concentrations	Varieties				Means Hrs*Conc	Means Var*Conc
		Ghaznavi	Siran	Atta Habib	Janbaz		
24 hrs.	Con	100.00	100.00	100.00	100.00	100.00^{A}	100.00^{A}
	10g	76.67	100.00	100.00	100.00	94.17^{AB}	71.67^{C}
	20g	60.00	93.33	100.00	73.33	81.67^{E}	70.00^{C}
	40g	33.33	50.00	53.33	36.67	43.33^{G}	33.33^{F}
	80g	0.00	0.00	0.00	0.00	0.00^{I}	0.00^{G}
Means hrs.*Var.		54.00^{FG}	68.67^{ABC}	70.67^{ABC}	62.00^{DE}	63.83^{A}	
48 hrs.	Con	100.00	100.00	100.00	100.00	100.00^{A}	100.00^{A}
	10g	73.33	96.67	100.00	90.00	90.00^{BC}	99.17^{A}
	20g	73.33	100.00	96.67	56.67	81.67^{E}	97.50^{A}
	40g	40.00	63.33	70	36.67	52.50^{F}	47.50^{E}
	80g	0.00	0.00	0.00	0.00	0.00^{I}	0.00^{G}
Means hrs.*Var.		57.33^{EFG}	72.00^{AB}	73.33^{A}	56.67^{EFG}	64.83^{A}	
72 hrs.	Con	100.00	100.00	100.00	100.00	100.00^{A}	100.00^{A}
	10g	56.67	100.00	100.00	83.33	85.00^{CDE}	99.17^{A}
	20g	73.33	96.67	100.00	73.33	85.83^{CDE}	98.33^{A}
	40g	30.00	43.33	66.67	33.33	43.33^{G}	55.83^{D}
	80g	0.00	0.00	0.00	0.00	0.00^{I}	0.00^{G}
Means hrs.*Var.		52.00^{G}	68.00^{ABC}	73.33^{A}	58.00^{EF}	62.83^{AB}	
96 hrs.	Con	100.00	100.00	100.00	100.00	100.00^{A}	100.00^{A}
	10g	80.00	100	96.67	76.67	88.33^{BCD}	87.50^{B}
	20g	73.33	100	96.67	63.33	83.33^{BCD}	66.67^{C}
	40g	30.00	33.33	33.33	33.33	32.50^{H}	35.00^{F}
	80g	0.00	0.00	0.00	0.00	0.00^{I}	0.00^{G}
Means hrs.*Var.		56.67^{EFG}	66.67^{BCD}	65.33^{CD}	54.67^{FG}		
Means Varieties		55.00^{B}	68.92^{A}	70.89^{A}	57.97^{B}	60.84^{B}	
Means Concentrations		100.00^{A}	89.38^{B}	83.13^{C}	42.92^{D}	0.00^{E}	

LSD value for Hours = 2.841, varieties = 2.841, Concentration = 3.176, Hours*varieties = 5.682, Hours*concentration = 6.353 and Varieties*concentrations = 6.353 interactions at α 5%

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Table-5. Effect of *Populus nigra* leaves aqueous extract of season 2 on percent germination of wheat seeds. Each value is a mean of 3 replicates, each with 10 seedlings.

Duration	Concentrations	Varieties				Means Hrs*Conc.	Means Var*Conc
		Ghaznavi	Siran	Atta Habib	Janbaz		
24 hrs.	Con	100	100	100	100	100^{A}	100^{A}
	10g	80.00	96.67	100	96.67	93.33^{A}	84.17^{H}
	20g	100	100	93.33	100	98.33^{A}	88.33^{FGH}
	40g	86.67	93.33	93.33	96.67	$92.50^{D.EF}$	76.67^{I}
	80g	76.67	90.00	93.33	93.33	88.33^{FG}	73.33^{I}
Means hrs.*Var.		88.67^{DE}	96.00^{ABC}	96.00^{ABC}	97.33^{AB}	94.50^{AB}	
48 hrs.	Con	100	100	100	100	100^{A}	100^{A}
	10g	83.33	100	100	90.00	93.33^{CDEF}	98.33^{ABC}
	20g	86.67	100	93.33	96.67	94.17^{BCDE}	100^{A}
	40g	70.00	96.67	100	86.67	88.33^{FG}	95.83^{ABCD}
	80g	63.33	100	90.00	83.33	84.17^{FG}	93.33^{CDEF}
Means hrs.*Var.		80.67^{F}	99.33^{A}	96.67^{AB}	91.33^{CDE}	92.00^{B}	
72 hrs.	Con	100	100	100	100	100^{A}	100^{A}
	10g	96.67	100	100	100	99.17^{AB}	99.17^{AB}
	20g	93.33	100	96.67	96.67	96.67^{ABCD}	94.17^{BCDE}
	40g	83.33	100	100	100	95.83^{A-E}	96.67^{ABCD}
	80g	90.00	93.33	93.33	93.33	92.50^{DEF}	91.67^{DEF}
Means hrs.*Var.		92.67^{BCD}	98.67^{A}	98.00^{A}	98.00^{A}	96.83^{A}	
96 hrs.	Con	100	100	100	100	100^{A}	100^{A}
	10g	76.67	96.67	96.67	93.33	90.83^{EF}	95.00^{A-E}
	20g	73.33	100	93.33	96.67	90.83^{EF}	97.50^{ABC}
	40g	66.67	93.33	93.33	76.67	82.50^{HI}	90.00^{EFG}
	80g	63.33	90.00	90.00	70.00	78.33^{I}	85.00^{GH}
Means hrs.*Var.		76.00^{F}	96.00^{ABC}	94.67^{ABC}	87.33^{E}	88.50^{C}	
Means Varieties		84.50^{C}	97.50^{A}	96.33^{A}	93.50^{B}		
Means Conc.		100^{A}	94.17^{B}	95.00^{B}	89.79^{C}	85.83^{D}	

LSD value for Hours =2.507, varieties = 2.507, Concentration = 2.803, Hours*varieties = 5.013, Hours*concentration = 5.605 and Varieties*concentrations = 5.605 interactions at α 5%

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Table-6. Effect of *Populus nigra* leaves aqueous extract of season 3 on percent germination of wheat seeds. Each value is a mean of 3 replicates, each with 10 seedlings.

Duration	Concentrations	Varieties				Means Hrs*Conc.	Means Var*Conc
		Ghaznavi	Siran	Atta Habib	Janbaz		
24 hrs.	Con	70.00^{C-G}	100.0^{A}	96.67^{A}	100.0^{A}	91.67^{ABC}	83.33^{CD}
	10g	50.00^{GHIJ}	90.00^{ABC}	100.0^{A}	90.00^{ABC}	82.50^{CDEF}	59.17^{E}
	20g	53.33^{F-J}	90.00^{ABC}	96.67^{A}	63.33^{D-H}	75.83^{FGHI}	52.49^{E}
	40g	23.33^{KLM}	73.33^{B-F}	90.00^{ABC}	66.67^{D-H}	63.33^{IJK}	27.50^{G}
	80g	50.00^{GHIJ}	36.67^{JKL}	93.33^{AB}	50.00^{GHIJ}	57.50^{K}	57.50^{E}
Means hrs.*Var.		49.33^{FG}	78.00^{DE}	95.33^{A}	74.00^{DE}	74.17^{B}	
48 hrs.	Con	90.00^{ABC}	100.0^{A}	93.33^{AB}	100.0^{A}	95.83^{AB}	100.0^{A}
	10g	90.00^{ABC}	96.67^{A}	96.67^{A}	100.0^{A}	95.83^{AB}	90.00^{ABC}
	20g	63.33^{D-H}	100.0^{A}	96.67^{A}	50.00^{GHIJ}	77.50^{D-H}	95.00^{AB}
	40g	50.00^{GHIJ}	100.0^{A}	96.67^{A}	100.0^{A}	86.67^{BCDE}	88.33^{BC}
	80g	66.67^{D-H}	60.00^{E-I}	100.0^{A}	53.33^{F-J}	70.00^{HIJ}	34.17^{FG}
Means hrs.*Var.		72.00^{E}	91.33^{AB}	96.67^{A}	80.67^{CDE}	85.17^{A}	
72 hrs.	Con	80.00^{A-E}	100.0^{A}	100.0^{A}	100.0^{A}	95.00^{AB}	97.50^{AB}
	10g	63.33^{D-H}	83.33^{ABCD}	100.0^{A}	100.0^{A}	86.67^{BCDE}	96.67^{AB}
	20g	60.00^{E-I}	96.67^{A}	93.33^{AB}	100.0^{A}	87.50^{BCD}	96.67^{AB}
	40g	16.67^{LMN}	96.67^{A}	80.00^{A-E}	100.0^{A}	73.34^{FGHI}	91.67^{ABC}
	80g	63.33^{D-H}	40.00^{IJK}	93.33^{AB}	46.67^{HIJ}	60.83^{JK}	91.67^{ABC}
Means hrs.*Var.		56.67^{F}	83.33^{BCD}	93.33^{A}	89.33^{ABC}	80.67^{A}	
96 hrs.	Con	93.33^{AB}	100.0^{A}	100.0^{A}	100.0^{A}	98.33^{A}	100.0^{A}
	10g	33.33^{JKL}	90.00^{ABC}	90.00^{ABC}	93.33^{AB}	76.67^{EFGH}	95.83^{AB}
	20g	33.33^{JKL}	93.33^{AB}	100.0^{A}	96.67^{A}	80.83^{DEFG}	77.50^{D}
	40g	20.00^{KLMN}	83.33^{ABCD}	100.0^{A}	83.33^{ABCD}	71.67^{GHI}	87.50^{BCD}
	80g	50.00^{GHIJ}	0.00^{N}	80.00^{A-E}	3.33^{MN}	33.33^{L}	38.33^{F}
Means hrs.*Var.		46.00^{G}	73.33^{E}	94.00^{A}	75.33^{DE}		
Means Varieties		56.43^{C}	81.86^{B}	94.87^{A}	80.03^{B}	72.17^{B}	
Means Conc.		95.21^{A}	85.42^{B}	80.42^{B}	73.75^{C}	55.42^{D}	

LSD value for Hours = 4.832, varieties = 4.832, Concentration = 5.402, Hours*varieties = 9.664, Hours*concentration = 10.80, varieties*concentration = 10.80 and Hours*varieties*concentration= 21.61 interactions at α 5%

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Table-7. Effect of *Populus nigra* leaves aqueous extract of season 1 on radical length of wheat seeds. Each value is a mean of 3 replicates, each with 10 seedlings.

Duration	Concentrations	Varieties				Means Hrs*Conc.	Means Var*Conc
		Ghaznavi	Siran	Atta Habib	Janbaz		
24 hrs.	Con	5.15	4.92	6.15	4.39	5.15 ^{A}	4.47^{B}
	10g	1.47	2.61	2.66	1.44	2.05^{CD}	1.67^{E}
	20g	1.18	1.32	1.73	0.81	1.26 ^{FG}	1.05^{FG}
	40g	0.23	0.19	0.5	0.13	0.26^{HI}	0.27^{IJ}
	80g	0.00	0.00	0.00	0.00	0.00^{I}	0.00^{J}
Means hrs.*Var.		1.61^{D-H}	1.81^{CDEF}	2.21^{AB}	1.35^{HIJ}	1.74^{A}	
48 hrs.	Con	3.61	5.57	4.03	4.32	4.38^{B}	5.42^{A}
	10g	2.47	2.39	3.17	1.55	2.39^{C}	2.50^{D}
	20g	1.03	1.67	1.05	0.73	1.12^{G}	1.67^{E}
	40g	0.21	0.46	0.43	0.33	0.36^{HI}	0.53^{HI}
	80g	0.00	0.00	0.00	0.00	0.00^{I}	0.00^{J}
Means hrs.*Var.		1.46^{FGHI}	2.02^{ABC}	1.74^{C-G}	1.38^{GHI}	1.65^{AB}	
72 hrs.	Con	4.48	6.41	5.18	3.62	4.92 ^{A}	4.88^{B}
	10g	1.23	2.93	2.11	1.41	1.92^{DE}	2.47^{D}
	20g	0.76	1.73	1.34	0.9	1.18^{G}	1.37^{EF}
	40g	0.44	0.77	0.63	0.18	0.51^{H}	0.45^{HI}
	80g	0.00	0.00	0.00	0.00	0.00^{I}	0.00^{J}
Means hrs.*Var.		1.38^{GHI}	2.37^{A}	1.85^{BCDE}	1.22^{IJ}	1.71 ^{A}	
96 hrs.	Con	4.65	4.78	4.16	3.43	4.25^{B}	3.94^{C}
	10g	1.53	2.07	1.93	0.95	1.62^{EF}	1.34^{EF}
	20g	1.21	1.95	1.38	0.42	1.24^{FG}	0.71^{GH}
	40g	0.22	0.68	0.23	0.23	0.34^{HI}	0.22^{IJ}
	80g	0.00	0.00	0.00	0.00	0.00	0.00^{J}
Means hrs.*Var.		1.52^{E-I}	1.89^{BCD}	1.54^{D-I}	1.01^{J}	1.522	
Means Varieties		1.49^{C}	2.03^{A}	1.85^{B}	1.25^{D}		
Means Conc.		4.68^{A}	1.99^{B}	1.20^{C}	0.37^{D}	0.00^{E}	

LSD value for Hours = 0.1856, varieties = 0.1856, Concentration = 0.2075, Hours*varieties = 0.3712, Hours*concentration = 0.4150 and Varieties*concentrations = 0.4150 interactions at α 5%

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Table-8. Effect of *Populus nigra* leaves aqueous extract of season 2 on radical length of wheat seeds. Each value is a mean of 3 replicates, each with 10 seedlings.

Duration	Concentrations	Varieties				Means Hrs*Conc.	Means Var*Conc
		Ghaznavi	Siran	Atta Habib	Janbaz		
24 hrs.	Con	5.28^{CDE}	6.10^{AB}	4.62^{E-I}	4.92^{DEFG}	5.23^{B}	5.03^{B}
	10g	3.39^{LMNO}	3.55^{J-O}	2.91^{OPQR}	3.92^{I-M}	3.44^{D}	3.28^{DE}
	20g	2.54^{PQRS}	2.38^{QRST}	2.28^{RST}	1.79^{ST}	2.25^{F}	2.11^{HI}
	40g	1.60^{B-L}	2.05^{ABCD}	1.75^{B-I}	1.77^{B-H}	1.79^{G}	1.28^{LMNO}
	80g	1.12^{F-M}	1.66^{B-K}	1.07^{G-M}	0.98^{H-M}	1.21^{H}	0.98^{NO}
Means hrs.*Var.		2.78^{BC}	3.14^{A}	2.52^{CDE}	2.68^{BC}	2.78^{A}	
48 hrs.	Con	3.97^{H-M}	6.24^{AB}	3.73^{J-N}	5.76^{BC}	4.93^{B}	5.84^{A}
	10g	3.08^{NOPQ}	4^{H-L}	2.09^{ST}	2.99^{N-R}	3.04^{E}	3.58^{D}
	20g	2.24^{RST}	2.55^{PQRS}	2.07^{ST}	1.73^{T}	2.15^{FQ}	2.43^{GH}
	40g	1.23^{E-M}	0.97^{I-M}	1.63^{B-L}	1.32^{B-M}	1.28^{H}	1.63^{JKL}
	80g	0.95^{I-M}	1.28^{D-M}	0.93^{JKLM}	1.01^{H-M}	1.04^{H}	1.47^{KLM}
Means hrs.*Var.		2.29^{DEFG}	3.01^{AB}	2.09^{G}	2.56^{CD}	2.49^{BC}	
72 hrs.	Con	4.72^{EFGH}	4.25^{G-K}	3.88^{I-M}	4.34^{F-J}	4.30^{C}	4.47^{C}
	10g	3.46^{K-O}	3.21^{L-P}	2.51^{P-T}	2.46^{P-T}	2.91^{E}	2.52^{FG}
	20g	2.09^{ABC}	2.67^{A}	1.97^{A-E}	1.71^{B-J}	2.11^{FG}	2.00^{IJ}
	40g	0.99^{H-M}	1.60^{B-L}	0.89^{KLM}	1.31^{C-M}	1.20^{H}	1.38^{KLMN}
	80g	1.01^{H-M}	1.30^{C-M}	1.31^{C-M}	1.03^{H-M}	1.16^{H}	1.10^{MNO}
Means hrs.*Var.		2.45^{CDEF}	2.61^{CD}	2.11^{FG}	2.17^{EFG}	2.33^{C}	
96 hrs.	Con	6.15^{AB}	6.79^{A}	5.63^{BCD}	5.07^{CDEF}	5.91^{A}	5.02^{B}
	10g	3.18^{MNOP}	3.56^{J-O}	2.56^{PQRS}	2.24^{RST}	2.88^{E}	2.90^{EF}
	20g	1.58^{B-L}	2.12^{AB}	1.68^{B-K}	1.85^{B-G}	1.81^{G}	1.77^{IJK}
	40g	1.29^{C-M}	1.87^{A-F}	1.26^{D-F}	0.93^{JKLM}	1.34^{H}	1.33^{LMNO}
	80g	0.85^{LM}	1.67^{B-K}	1.11^{F-M}	0.77^{M}	1.10^{H}	0.95^{O}
Means hrs.*Var.		2.61^{CD}	3.20^{A}	2.45^{CDEF}	2.17^{EFG}		
Means Varieties		2.54^{B}	2.99^{A}	2.29^{C}	2.39^{BC}	2.61^{AB}	
Means Conc.		5.09^{A}	3.07^{B}	2.08^{C}	1.40^{D}	1.13^{E}	

LSD value for Hours = 0.1788, varieties = 0.1788, Concentration = 0.1999, Hours*varieties = 0.3577, Hours*concentration = 0.3999 and Varieties*concentrations = 0.3999 interactions at α 5%

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Table-9. Effect of *Populus nigra* leaves aqueous extract of season 3 on radical length of wheat seeds. Each value is a mean of 3 replicates, each with 10 seedlings.

Duration	Concentrations	Varieties				Means Hrs*Conc.	Means Var*Conc
		Ghaznavi	Siran	A. Habib	Janbaz		
24 hrs.	Con	3^{CDE}	1.61^{I-W}	2.96^{CDE}	2.43^{E-J}	2.50^{CD}	3.35^{A}
	10g	0.64^{W-Z}	1.15^{P-Z}	1.65^{H-V}	2.44^{E-I}	1.47^{GH}	1.58^{DEFG}
	20g	0.97^{S-Z}	0.9^{T-Z}	1.31^{N-Z}	1.54^{I-Y}	1.18^{HI}	1.14^{FGH}
	40g	2.3^{E-L}	1.11^{O-Z}	1.18^{P-Z}	2.17^{E-O}	1.69^{FG}	1.25^{EFGH}
	80g	0.14	0.7^{V-Z}	0	0.46	0.33^{J}	0.21^{I}
Means hrs.*Var.		1.41^{DEFG}	1.09^{G}	1.42^{DEFG}	1.81^{CD}	1.43^{A}	
48 hrs.	Con	3.72^{BCD}	1.28^{O-Z}	2.82^{DEF}	1.05^{Q-Z}	2.22^{DE}	1.78^{CD}
	10g	1.42^{K-Z}	1.75^{H-U}	1.97^{F-Q}	1.65^{H-V}	1.69^{FG}	1.77^{CD}
	20g	2.26^{E-N}	1.49^{I-Y}	1.38^{K-Z}	5.3^{A}	2.61^{BCD}	1.54^{DEFG}
	40g	0.93^{T-Z}	0.99^{R-Z}	1.82^{G-T}	1.32^{M-Z}	1.27^{GH}	1.11^{GH}
	80g	0.25^{F-S}	0.77^{V-Z}	0.51^{Z}	0.26^{F-S}	0.45^{J}	0.94^{H}
Means hrs.*Var.		1.72^{CDE}	1.26^{FG}	1.70^{CDE}	1.92^{BC}	1.65^{A}	
72 hrs.	Con	2.74^{EFG}	2.28^{E-M}	4.41^{AB}	2.58^{EFGH}	3.00^{AB}	3.80^{A}
	10g	2.61^{EFGH}	1.97^{F-R}	2.79^{DEF}	3.87^{BC}	2.81^{BC}	2.32^{B}
	20g	0.19^{X}	2.32^{E-K}	2.19^{E-O}	1.32^{M-Z}	1.51^{GH}	1.61^{DEF}
	40g	0.95^{T-Z}	1.47^{J-Z}	2.08^{E-P}	0.28^{Z}	1.19^{HI}	1.72^{CDE}
	80g	0.25^{F-S}	1.58^{I-X}	0.59^{YZ}	0.63^{XYZ}	0.76^{IJ}	0.38^{I}
Means hrs.*Var.		1.35^{EFG}	1.92^{BC}	2.41^{A}	1.74^{CDE}	1.86^{A}	
96 hrs.	Con	3.93^{BC}	1.93^{F-S}	5.01^{A}	2.75^{EFG}	3.41^{A}	2.20^{BC}
	10g	1.66^{H-V}	2.19^{E-O}	2.86^{DEF}	1.33^{L-Z}	2.01^{EF}	2.32^{B}
	20g	1.15^{P-Z}	1.46^{K-Z}	1.54^{I-Y}	1.03^{Q-Z}	1.29^{GH}	2.29^{B}
	40g	0.81^{U-Z}	0.87^{T-Z}	1.81^{G-T}	0.87^{T-Z}	1.09^{HI}	1.16^{FGH}
	80g	0.21^{F-S}	0.72^{V-Z}	0.4^{Z}	0.17^{T}	0.38^{J}	0.38^{I}
Means hrs.*Var.		1.552^{CDEF}	1.434^{DEFG}	2.324^{AB}	1.23^{FG}		
Means Varieties		1.50^{BC}	1.43^{C}	1.95^{A}	1.69^{B}	1.64^{A}	
Means Conc.		2.78^{A}	1.99^{B}	1.65^{C}	1.31^{D}	0.48^{E}	

LSD value for Hours =6.870, varieties = 0.2172, Concentration = 0.2429, Hours*varieties = 0.4345, Hours*concentration = 0.4858 and Varieties*concentrations = 0.4858 and Hours*varieties*concentration=0.9715 interactions at α 5%

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Table-10. Effect of *Populus nigra* leaves aqueous extract of season 1 on plumule length of wheat seeds. Each value is a mean of 3 replicates, each with 10 seedlings.

Duration	Concentrations	Varieties				Means Hrs*Conc.	Means Var*Conc
		Ghaznavi	Siran	Atta Habib	Janbaz		
24 hrs.	Con	5.91^{CD}	4.49^{FG}	7.76^{A}	4.05^{GH}	5.55^{B}	4.79^{B}
	10g	0.74^{M-T}	2.37^{JK}	3.22^{I}	1.23^{L-P}	1.89^{F}	1.27^{EF}
	20g	1.35^{LMNO}	1.42^{LMN}	2.96^{IJ}	0.48^{P-T}	1.55^{FG}	0.98^{FG}
	40g	0.24^{RST}	0.35^{QRST}	0.45^{P-T}	0.11^{T}	0.28^{LM}	0.23^{JK}
	80g	0.00^{T}	0.00^{T}	0.00^{T}	0.00^{T}	0.00^{M}	0.00^{K}
Means hrs.*Var.		1.65^{DEF}	1.73^{CDE}	2.88^{A}	1.17^{HI}	1.86^{A}	
48 hrs.	Con	4.88^{EF}	5.61^{DE}	4.92^{EF}	4.32^{FG}	4.93^{C}	5.76^{A}
	10g	2.40^{JK}	2.90^{IJ}	4.41^{FJ}	1.14^{L-Q}	2.71^{E}	2.21^{D}
	20g	1.11^{L-Q}	1.40^{LMNO}	0.96^{L-S}	0.50^{P-T}	0.99^{HI}	1.51^{E}
	40g	0.26^{RST}	0.37^{QRST}	0.61^{O-T}	0.27^{RST}	0.37^{KLM}	0.79^{GHI}
	80g	0.00^{T}	0.00^{T}	0.00^{T}	0.00^{T}	0.00^{M}	0.00^{K}
Means hrs.*Var.		1.73^{CDE}	2.06^{BC}	2.18^{B}	1.24^{GH}	1.80^{A}	
72 hrs.	Con	4.07^{GH}	7.38^{AB}	6.62^{BC}	6.44^{C}	6.13^{A}	5.92^{A}
	10g	0.73^{M-T}	2.78^{IJ}	1.74^{KL}	0.75^{M-T}	1.50^{FG}	2.68^{C}
	20g	0.48^{P-T}	1.51^{LM}	0.77^{M-T}	0.38^{QRST}	0.78^{HIJ}	1.58^{E}
	40g	0.27^{RST}	1.42^{LMN}	0.67^{N-T}	0.46^{P-T}	0.70^{IJK}	0.51^{HIJ}
	80g	0.00^{T}	0.00^{T}	0.00^{T}	0.00^{T}	0.00^{M}	0.00^{K}
Means hrs.*Var.		1.11^{HI}	2.62^{A}	1.96^{BCD}	1.61^{DEF}	1.82^{A}	
96 hrs.	Con	4.32^{FG}	5.54^{DE}	4.38^{FG}	3.34^{HI}	4.39^{D}	4.54^{B}
	10g	1.21^{L-P}	0.77^{M-T}	1.37^{LMNO}	0.50^{P-T}	0.96^{HI}	0.90^{FGH}
	20g	0.99^{L-S}	1.71^{KL}	1.64^{KL}	0.29^{RST}	1.15^{GH}	0.41^{IJ}
	40g	0.14^{T}	1.04^{L-P}	0.30^{RST}	0.23ST	0.43^{JKL}	0.27^{JK}
	80g	0.00^{T}	0.00^{T}	0.00^{T}	0.00^{T}	0.00^{M}	0.00^{K}
Means hrs.*Var.		1.332	1.812	1.54	0.872	1.39^{B}	
Means Varieties		1.46^{B}	2.06^{A}	2.42^{A}	1.24^{C}		
Means Conc.		5.25^{A}	1.77^{B}	1.12^{C}	0.45^{D}	0.00^{E}	

LSD value for Hours = 0.1803, varieties = 0.1803, Concentration = 0.2016, Hours*varieties = 0.3606, Hours*concentration = 0.4031, Varieties*concentrations = 0.4031 and Hours*variety*concentration = 0.8063 interactions at α 5%

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Table-11. Effect of *Populus nigra* leaves aqueous extract of season 2 on plumule length of wheat seeds. Each value is a mean of 3 replicates, each with 10 seedlings.

Duration	Concentrations	Varieties				Means Hrs*Conc.	Means Var*Conc
		Ghaznavi	Siran	Atta Habib	Janbaz		
24 hrs.	Con	4.27^{DEFG}	3.66^{F-K}	4.04^{EFGH}	4.79^{BCDE}	4.19^{C}	4.67
	10g	2.83^{K-P}	3.66^{F-K}	2.99^{I-O}	3.24^{H-M}	3.18^{DE}	2.80
	20g	3.26^{H-M}	3.29^{H-L}	3.21^{H-M}	1.59^{R-Z}	2.84^{E}	2.02
	40g	1.36^{U-Z}	1.17^{V-Z}	1.47^{T-Z}	1.08^{WXYZ}	1.27^{IJK}	1.18
	80g	0.63	1.39^{T-Z}	0.93^{XYZ}	1.06^{WXYZ}	1.00^{JKL}	0.64
Means hrs.*Var.		2.47	2.64	2.53	2.35	2.49^{A}	
48 hrs.	Con	5.04^{BCD}	5.72^{AB}	4.60^{CDEF}	4.37^{DEFG}	4.93^{B}	4.78
	10g	2.98^{J-O}	3.81^{F-J}	2.48^{L-S}	2.76^{K-Q}	3.01^{E}	3.37
	20g	1.79^{R-Y}	1.93^{P-W}	2.50^{L-R}	1.55^{S-Z}	1.94^{FG}	2.36
	40g	1.16^{V-Z}	0.37	1.32^{U-Z}	1.09^{WXYZ}	0.98^{KL}	1.19
	80g	0.51	0.79^{Z}	0.86^{YZ}	0.78^{Z}	0.74^{L}	1.07
Means hrs.*Var.		2.29	2.52	2.35	2.11	2.32^{A}	
72 hrs.	Con	3.15^{H-M}	3.68^{F-K}	3.45^{G-K}	3.93^{E-I}	3.55^{D}	4.39
	10g	2.14^{N-U}	2.95^{J-O}	2.05^{O-V}	1.66^{R-Z}	2.20^{F}	2.68
	20g	1.43^{T-Z}	2.33^{M-T}	1.98^{P-W}	1.10^{WXYZ}	1.71^{GHI}	2.42
	40g	0.81^{Z}	1.28^{U-Z}	0.57	0.92^{YZ}	0.89^{KL}	1.26
	80g	0.59	0.66	0.69	0.71	0.66^{L}	0.84
Means hrs.*Var.		1.63	2.18	1.75	1.66	1.80^{B}	
96 hrs.	Con	6.21^{A}	6.06^{A}	5.50^{ABC}	3.87^{E-J}	5.41^{A}	4.24
	10g	3.26^{H-M}	3.07^{I-N}	3.21^{H-M}	2.18^{N-U}	2.93^{E}	2.46
	20g	1.58^{R-Z}	1.87^{Q-X}	1.97^{P-W}	1.63^{R-Z}	1.76^{FGH}	1.47
	40g	1.41^{T-Z}	1.94^{P-W}	1.67^{R-Z}	0.86^{YZ}	1.47^{HIJ}	0.99
	80g	0.81^{Z}	1.46^{T-Z}	0.88^{YZ}	0.50	0.91^{KL}	0.76
Means hrs.*Var.		2.65	2.88	2.65	1.81		
Means Varieties		2.26^{B}	2.56^{A}	2.32^{B}	1.98^{C}	2.49^{A}	
Means Conc.		4.52^{A}	2.83^{B}	2.06^{C}	1.16^{D}	0.83^{E}	

LSD value for Hours = 0.2112, varieties = 0.2112, Concentration = 0.2361, Hours*varieties = 0.3712, Hours*concentration = 0.9444 interactions at α 5%

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Table-12. Effect of *Populus nigra* leaves aqueous extract of season 3 on plumule length of wheat seeds. Each value is a mean of 3 replicates, each with 10 seedlings.

Duration	Concentrations	Varieties				Means Hrs*Conc.	Means Var*Conc
		Ghaznavi	Siran	Atta Habib	Janbaz		
24 hrs.	Con	3.12	3.22	1.07	3.28	2.67	3.74^{A}
	10g	0.37	1.2	1.65	0.79	1.00	0.89^{DEFG}
	20g	0.63	0.58	0.77	0.52	0.62	0.53^{GHI}
	40g	0.28	0.61	0.43	0.36	0.42	0.45^{GHI}
	80g	0.46	0.19	0.39	0.18	0.31	0.43^{GHI}
Means hrs.*Var.		0.97	1.16	0.86	1.03	1.01^{B}	
48 hrs.	Con	4.32	3.52	1.22	1.76	2.71	2.56^{B}
	10g	1.87	1.68	3.14	1.09	1.95	1.29^{CD}
	20g	0.77	0.96	1.48	2.22	1.36	0.71^{E-I}
	40g	0.93	0.81	0.95	0.34	0.76	0.63^{FGHI}
	80g	0.54	0.61	1.03	0.13	0.58	0.27^{HI}
Means hrs.*Var.		1.69	1.52	1.56	1.11	1.47^{A}	
72 hrs.	Con	4.84	1.97	1.07	3.41	2.82	1.14^{CDEF}
	10g	1.14	1.62	1.13	0.71	1.15	1.62^{C}
	20g	0.46	0.76	0.63	1.69	0.89	0.83^{D-H}
	40g	0.29	0.83	0.44	0.32	0.47	0.57^{GHI}
	80g	0.53	0.28	0.69	0.24	0.44	0.63FG^{HI}
Means hrs.*Var.		1.45	1.09	0.79	1.27	1.16^{B}	
96 hrs.	Con	2.67	1.53	1.19	2.29	1.92	2.69^{B}
	10g	0.17	0.64	0.56	0.38	0.44	0.75^{D-H}
	20g	0.25	0.54	0.41	0.38	0.39	1.20^{CDE}
	40g	0.29	0.27	0.46	0.27	0.32	0.32^{HI}
	80g	0.16	0.00	0.34	0.07	0.14	0.16^{I}
Means hrs.*Var.		0.71	0.59	0.59	0.68		
Means Varieties		1.21	1.09	0.95	1.02	0.64^{C}	
Means Conc.		1.13^{A}	0.82^{B}	0.49^{C}	0.37^{CD}	0.10^{D}	

LSD value for varieties = 0.2516, Concentration = 0.2813 and Varieties*concentrations = 0.5626 interactions at α 5%