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ALLELOPATHIC EFFECT OF *FICUS BENJAMINA* LEAF EXTRACT, LITTER, AND MULCH ON GERMINATION AND GROWTH OF SUNFLOWER

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ABSTRACT. Allelopathy is an important biological process, which has direct or indirect effects on the germination and growth potentials of plants. Awareness about the allelopathic properties of plants which prevail in agricultural systems can help growers to amend crop cultivation patterns accordingly. In this study, we evaluated the allelopathic effects of *Ficus benjamina* on germination and early seedling growth of four hybrids of sunflower (Oliver, Parsun-3, SFH-80 and NK- S- 278). Ethanolic and hot-water aqueous extracts from leaves, while litter and mulches of the test allelopathic plant significantly reduced germination, radicle and hypocotyle growth of sunflower. Germination percentage was drastically reduced in all the four sunflower hybrids by ethanolic, hot-water and litter extracts; however, compared to control, mulching assay significantly increased germination in hybrids Oliver (76%), Parsun-3 (42%), SFH-80 (78%) and NK-S-278 (30%) at 2, 4, 8 and 12g extract concentration, respectively. Hypocotyle and radicle length of test hybrids were significantly reduced in each assay type. Among tested assays, ethanolic extracts revealed more drastic effects on the studied parameters than hot-water, litter, and mulching. Sunflower hybrid NK-S-278 was more severely affected, while Parsun-3 exhibited resistance to the allelopathic stress. Inhibitory effects were more prominent with increasing concentration of the extracts. The order of the phytotoxic effects of tested bioassays was ethanolic extract> hot-water> litter> mulching. The study suggested that *Ficus* leaves may possess potent allelochemicals with growth inhibitory effects on sunflower seedlings. It is suggested that further study might be required to check the allelopathic effect of *Ficus benjamina* on germination and growth of these sunflower hybrids in field conditions.

Keywords: allelopathy; weed control; growth inhibition; weeping fig; secondary metabolites; agroecosystem.

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INTRODUCTION

Allelopathy is a multifaceted biological process, which runs along with competition in the natural ecosystem to suppress or stimulate the growth of plants through a diverse mechanism (Majeed *et al.,* 2012; Muhammad and Majeed, 2014; Majeed *et al.,* 2017). It has been frequently observed that different chemicals with allelopathic potentials are present almost in all plant parts, which are released into the habitat under specific environmental conditions and exhibits either inhibitory or promotory activities against other plants (Hussain *et al.,* 2010; Muhammad and Majeed, 2014). Allelopathy is widely perceived to play an important role in agroecosystem, in the commercial plantation, environmental impact on soil degradation and modification of productivity and biodiversity (Inderjit *et al.,* 2011). The allelopathic impact relies greatly on different environmental factors, such as temperature, light, water availability, soil nutrients, understory vegetation, individually or together (Cimmino *et al.,* 2014).

Allelopathy is an ecological phenomenon, which affects directly or indirectly the normal activities of neighboring plants through the release of allelochemicals in the environment. The allelopathic activity of donor plants on receiving flora depends on the nature of allelochemicals, their concentration and tolerance level of recipient plants, which generally involve a diverse mechanism of action resulting in affecting the growth of target plants (Majeed *et al.,* 2012; Elisante *et al.,* 2013).

Sunflower is an important oil crop cultivated throughout the country for oil production. Likewise, *Ficus* is a multipurpose plant, generally planted as shelter belt in cultivated fields or for ornamental purposes.

In previous studies, allelopathic activities of *Ficus benghalensis* and *Ficus microcarpa* on different plants have been investigated (Jiang *et al.,* 2014; Mohsin *et al.,* 2016); however, studies of the allelopathic potential of *Ficus benjamina* against sunflower is lacking in the literature.

Therefore, this study was carried out to evaluate the allelopathic effect of *Ficus benjamina* on germination and early seedling growth of four sunflower hybrids.

MATERIALS AND METHODS

Fresh and mature leaves of *Ficus benjamina* were collected from the vicinity of University of Peshawar and were dried at room temperature (25-30˚C), powdered and stored in sterile polythene bags. Sterile Petri dishes were taken for seed bioassay.

Ethanolic extract bioassay. Dried powder of *Ficus benjamina* leaves (10, 20, 40, and 60 g) was soaked in 250 ml of ethanol for 48 hrs at room temperature. After 48 hrs, the extract was filtered. The filtrate was placed in a water bath. Ethanol was evaporated and only a sticky extract was left behind. To the sticky extract 250 ml, distilled water was added and filtered. All extracts were used against seeds of four different sunflower hybrids (Oliver, Parsun-3, SFH-80, and NKS- 278), placed on twice folded filter paper in Petri dishes, which were incubated at 25˚C for 72 hrs. After 72 hrs, data for germination %, hypocotyle and radicle growth were recorded.

Hot-water bioassay. Leave powder of concentration (10, 20, 40 and 60 g) of *Ficus benjamina* were boiled separately for 5 min cooled and filtered. The extract was applied to four sunflower hybrids seeds and processed in the same way as mention before in the ethanolic extract bioassay.

Litter bioassay. Dried powdered concentration (control, 2, 4, 8 and 12 g) of *Ficus benjamina* leaves were placed in Petri dishes with a twice fold of filter paper in them. To each Petri dish, 8 ml of distilled water was applied to moisten the filter paper. For control treatments, fine pieces of filter papers were used without wetting it. Each treatment was replicated five times, each having 10 seeds and was preceded in the same way as mentioned earlier.

Mulching bioassay. *Ficus benjamina* leaves powder of different concentration (control, 2, 4, 8 and 12 g) were placed in plastic glasses of equal sizes, which contained a mixture of sterilized soil and sand. Simple sterilized soil/sand without mulch was used as a control. In every plastic glass, 10 seeds were placed. To moisten the soil/sand, 8 ml of distilled water was applied in each replicate and was preceded in the same way as mentioned before.

RESULTS

Ethanolic extract bioassay

Germination percentage.

Analysis of variance (ANOVA) revealed that germination % for hybrids, concentration, and interaction between hybrids × concentration were significant. Means values for ethanol concentration depicted that germination % age was maximum (57%) at 10 g extract concentration, followed by 20 g (49%), when compared to control (29%). Among the hybrids, Oliver and SFH-80 exhibited maximum germination (82% and 80%), while minimum germination (20% and 16%) was recorded in Parsun-3 and NK-S-278, which were statistically similar.

Concentration × hybrids mean exhibited maximum germination (99%) at the control level, followed by 10, 20 and 40 g, which resulted in 96, 94 and 74% germination, respectively, in Oliver; while, no germination was recorded in Parsun-3 and SFH-80 at the control level (*Table 1*).

Hypocotyle and radicle growth

Results indicated that hypocotyle growth for different hybrids and concentration showed significant differences, while hybrids × concentration means were non-significant. Means values for concentration illustrated that maximum hypocotyle length (0.536 cm) at control, followed by 20, 10, 40 and 60 g, which yielded 0.375, 0.374, 0.251 and 0.320 cm hypocotyle length, respectively.

Among hybrid means, SFH-80 exhibited maximum hypocotyle growth (0.502 cm), followed by Oliver (0.498 cm), Parsun-3 (0.320 cm) and NK-S-278 (0.166 cm). The interaction between hybrids and concentration exhibited maximum hypocotyle length (0.702 cm) under control condition in Oliver. Minimum growth was found in NK-S-278 (0.040 cm and 0.078 cm) at 60 and 40 g, respectively (*Table 2*). Data demonstrated that radicle length varied significantly between concentration means and hybrids. However, the interaction between hybrids and concentration was non-significant.

Concentration means revealed that radicle length was maximum at control (0.631cm) and 10 g concentration (0.628 cm), respectively, which were closely, followed by 60 g (0.226 cm), 20 g (0.407 cm) and 40 g (0.183 cm). Hybrids means revealed that maximum radicle growth was observed in Oliver (0.748 cm), followed by SFH-80 (0.464 cm), Parsun-3 (0.387 cm) and NK-S-278 (0.062 cm).

The interaction between hybrids and concentration showed that radicle growth was maximum in Oliver (1.469 cm) at concentration 10 g, which was statistically similar to SFH-80 (1.060 cm) under control condition, while no radicle growth was observed in NK-S-278 at 40 g and 60 g (*Table 3*).

Table 1 - Effect of different concentrations of ethanolic extracts of *Ficus benjamina* on germination % of four sunflower hybrids

Concentration	Oliver	Parsun-3	SFH-80	NK-S-278	Concentration means
Control	99^{a}	0^{i}	0^{i}	18^{ghi}	29^{c}
10 g	96^{ab}	38^{efg}	70^{cd}	26^{fgh}	57^{a}
20 g	94^{ab}	24^{gh}	62^{cd}	18^{ghi}	49^{ab}
40 g	74^{bc}	18^{ghi}	50^{de}	16^{ghi}	39^{bc}
60 g	48^{def}	20^{ghi}	74^{bc}	06^{hi}	37^{c}
Hybrids mean	82^{a}	20^{c}	51^{b}	16^{c}	

LSD value for Hybrids =10.70; Concentration =11.96; Interaction =23.92 at α value 5%.

Table 2 - Effect of different concentrations of ethanolic extracts of *Ficus benjamina* on hypocotyle length of four sunflower hybrids

Concentration	Oliver	Parsun-3	SFH-80	NK-S-278	Concentration means
Control	0.702	0.456	0.608	0.380	0.536^{a}
10 g	0.685	0.298	0.302	0.213	0.374^{b}
20 g	0.502	0.348	0.529	0.120	0.375^{b}
40 g	0.236	0.213	0.476	0.078	0.251^{b}
60 g	0.363	0.283	0.593	0.040	0.320^{b}
Hybrids mean	0.498^{a}	0.320^{b}	0.502^{a}	0.166^{c}	

LSD value for Hybrids = 0.1112; Concentration = 0.1244 at α value 5%.

Hot-water bioassay

Germination percentage

ANOVA for germination % showed significant differences between different concentration and hybrids. Means value for interaction between concentration × hybrids were non- significant. Different concentration means revealed that germination was maximum (70%) at the control level, followed by 10, 20 and 60 g (55%, 49%, and 29%, respectively). Among hybrids, Oliver exhibited maximum germination % (77%), followed by SFH-80 (63%), Parsun-3 and NK-S-278 (30% and 26%), which were statistically similar.

Concentration × hybrid means showed a decrease in germination % with an increase in concentration. Maximum germination % was recorded in Oliver (92%) and SFH-80 (88%) at the control level. Moreover, minimum germination % was recorded in NK-S-278 (14%) at 60 g (*Table 4*).

Table 3 - Effect of different concentrations of ethanolic extracts of *Ficus benjamina* radicle length of four sunflower hybrids

Concentration	Oliver	Parsun-3	SFH-80	NK-S-278	Concentration means
Control	0.772^{bcd}	0.510^{cdef}	1.060^{ab}	0.184^{ef}	0.631^{a}
10 g	1.469^{a}	0.533^{cde}	0.430^{cdef}	0.080^{ef}	0.628^{a}
20 g	0.922^{bc}	0.350^{def}	0.312^{def}	0.046^{ef}	0.407^{ab}
40 g	0.342^{def}	0.160^{ef}	0.231^{ef}	0^{f}	0.183^{b}
60 g	0.235^{ef}	0.380^{def}	0.287^{def}	0^{f}	0.226^{b}
Hybrids mean	0.748^{a}	0.387^{b}	0.464^{b}	0.062^{c}	

LSD value for Hybrids = 0.2302; Concentration = 0.2574; Interaction = 0.5148 at α value 5%.

Table 4 - Effect of different concentrations of hot-water extracts of *Ficus benjamina* on germination % of sunflower

Concentration	Oliver	Parsun-3	SFH-80	NK-S-278	Concentration means
Control	92	56	88	42	70^{a}
10 g	78	38	72	32	55^{b}
20 g	86	18	66	26	49^{bc}
40 g	78	24	58	20	45^{c}
60 g	52	16	32	14	29^{d}
Hybrids mean	77^{a}	30^{c}	63^{b}	26^{c}	

LSD value for Hybrids = 8.636; Concentration = 9.655 at α value 5%.

Hypocotyle and radicle growth

It was observed that maximum hypocotyle growth was found under control condition (0.504 cm), followed by 10, 20, 40 and 60 g extract concentration, which exhibited 0.285, 0.176, 0.177 and 0.124 cm, respectively. Among hybrids means maximum hypocotyle growth was recorded in Oliver (0.380 cm), followed by SFH-80 (0.286 cm), NK-S-278 (0.142 cm) and Parsun-3 (0.204 cm). However, hybrids × concentration means revealed that maximum hypocotyle growth was found in Oliver (0.694 cm) at control level, followed by SFH-80 (0.608 cm) at control level, Oliver (0.488 cm) at 10 g, NK-S-278 (0.090 cm) at 40 g and (0.060 cm) at 60 g (*Table 5*).

Data for radicle growth showed that it was retarded under increasing concentration. Highest length was recorded in control (0.642 cm), followed by10, 20, 40 and 60 g extract concentration (0.191, 0.169, 0.084 and 0.018 cm, respectively). Radicle growth among hybrids was maximum in Oliver (0.371cm), followed by SFH-80 (0.331cm), Parsun-3 (0.134 cm) and NK-S-278 (0.049 cm).

According to interaction mean between hybrids and concentration maximum radicle growth was recorded in SFH-80 (1.060 cm) at control condition, while no radicle length was noticed in NK-S-278 at 40 and 60 g extract concentration (*Table 6*).

Table 5 - Effect of different concentrations of hot-water extracts of *Ficus benjamina* hypocotyle length of sunflower

Concentration	Oliver	Parsun-3	SFH-80	NK-S-278	Concentration means
Control	0.694	0.456	0.608	0.260	0.504[a]
10 g	0.488	0.168	0.316	0.168	0.285[b]
20 g	0.282	0.142	0.150	0.130	0.176[bc]
40 g	0.272	0.106	0.238	0.090	0.177[bc]
60 g	0.164	0.150	0.120	0.060	0.124[c]
Hybrids mean	0.380[a]	0.204[bc]	0.286[ab]	0.142[c]	

LSD value for Hybrids = 0.09; Concentration = 0.109 at α value 5%

Table 6 - Effect of different concentrations of hot-water extracts of *Ficus benjamina* on the radicle length of sunflower

Concentration	Oliver	Parsun-3	SFH-80	NK-S-278	Concentration means
Control	0.814	0.510	1.060	0.184	0.642[a]
10 g	0.441	0.080	0.224	0.020	0.191[b]
20 g	0.336	0.080	0.220	0.040	0.169[bc]
40 g	0.216	0	0.130	0	0.084[bc]
60 g	0.050	0	0.020	0	0.018[c]
Hybrids mean	0.371[a]	0.134[b]	0.331[a]	0.049[b]	

LSD value for Hybrids = 0.1543; Concentration = 0.1725 at α value 5%.

Litter bioassay

Germination percentage

Significant differences were recorded for germination percentage of different hybrids under different concentrations. In control, germination reached to maximum (55%) at control condition. At different concentrations, germination was 52% at 2 and 4 g, while the lowest percentage (5%) was recorded at the highest concentration 12 g. Hybrids means for germination % was maximum (54%) in SFH-80, followed by 52% in Oliver, 16% in Parsun-3, and 10% in NK-S-278. The interaction between hybrids × concentration means shows maximum germination % (84%) was found in SFH-80 at concentration 2 g, while minimum germination % was noticed in NK-S-278 at 8 g and 12 g, respectively (*Table 7*).

Hypocotyle and radicle growth Both hypocotyle and radicle lengths of different hybrids varied to a significant extent under different treatments. Results revealed that maximum hypocotyle length (0.734 cm) was found at control level, while minimum growth (0.038 cm) occurred at 12 g extract concentration.

Concentration, especially at 12 g, had a remarkable suppressing effect on hypocotyle growth in all hybrids. Among means values for hybrids, SFH-80 exhibited maximum hypocotyle length (0.613 cm), followed by Oliver (0.408 cm), Parsun-3, (0.171 cm) and NK-S-278(0.057 cm). Interaction means for hybrids × concentration showed maximum hypocotyle growth (1.202 cm) in Oliver at the control level. However, the lowest hypocotyle growth (0.00 cm) was recorded in NK-S-278 and Parsun-3 at 8 g and 12 g concentration (*Table 8*).

Table 7 - Effect of different concentrations of litter of *Ficus benjamina* on seed germination of sunflower

Concentration	Oliver	Parsun-3	SFH-80	NK-S-278	Concentration means
Control	68^{a}	40^{b}	80^{a}	30^{bc}	55^{a}
2 g	82^{a}	22^{cde}	84^{a}	22^{cde}	52^{a}
4 g	74^{a}	16^{cdef}	70^{a}	2^{f}	40^{b}
8 g	24^{bcd}	6^{ef}	26^{bcd}	0^{f}	14^{c}
12 g	12^{def}	0^{f}	10^{def}	0^{f}	05^{d}
Hybrids mean	52^{a}	16^{b}	54^{a}	10^{b}	---

LSD value for Interaction = 16.30; Concentration = 8.151; Hybrids = 7.291

Table 8 - Effect of different concentrations of litter of *Ficus benjamina* hypocotyle length of sunflower

Concentration	Oliver	Parsun-3	SFH-80	NK-S-278	Concentration means
Control	1.202^{a}	0.462^{bc}	1.135^{a}	0.138^{cd}	0.734^{a}
2 g	0.320^{cd}	0.275^{cd}	0.782^{ab}	0.126^{cd}	0.376^{b}
4 g	0.317^{cd}	0.080^{cd}	0.983^{a}	0.020^{d}	0.350^{b}
8 g	0.117^{cd}	0.040^{cd}	0.099^{cd}	0.000^{d}	0.064^{c}
12 g	0.086^{cd}	0.000^{d}	0.066^{cd}	0.000^{d}	0.038^{c}
Hybrids mean	0.408^{b}	0.171^{c}	0.613^{c}	0.057^{c}	

LSD value for Hybrids = 0.1976; Concentration = 0.220; Interaction = 0.4418 at α value 5%.

For radicle growth, similar results were observed. Radicle length was maximum (1.242 cm) in control, followed by 2 g (0.361 cm), which decreased to 0.030 cm and 0.005 cm at 8 g and 12 g concentration, respectively. For hybrids means, maximum radicle length (0.840 cm) was noted in SFH-80, followed by Oliver, Parsun-3, and NK-S-278 (2.92 cm, 0.266 cm and 0 cm), respectively. Maximum radicle length (3.248 cm) was recorded in SFH-80 at control, followed by Parsun-3

(1.040 cm), Oliver (0.676 cm) at control level, although minimum radicle growth (0.00 cm) was recorded in Parsun-3 and SFH-80 at 8 g and 12 g concentration, respectively (*Table 9*).

Mulching bioassay

Germination percentage

According to concentration means, maximum germination (57%) was noticed at concentration 12 g, followed by 8 g (53%), 2 g (49%) and 4 g (47%), while minimum germination (42%) was recorded under control condition. According to hybrids means, maximum germination (75%) was shown by Oliver, followed by SFH-80 (56%), Parsun-3 (34%), NK-S-278 (32%). The interaction between concentration × hybrid shows less inhibition in Oliver at 2 g concentration (82%), while highest inhibition was shown at control level (58%) (*Table10*).

Hypocotyle and radicle growth

Results indicated that maximum hypocotyle length (1.093 cm) was found in control, followed by 4 g (0.929 cm), 2 g (0.865 cm), 12 g (0.769 cm) and 8 g (0.748 cm). Gradual decrease occurred with increase in concentration. Maximum hypocotyle growth was recorded in NK-S-278 (0.626 cm), followed by SFH-80 (1.179 cm), Oliver (1.078 cm) and Parsun-3 (0.640 cm). Hybrids × concentration revealed maximum germination in Oliver (1.669 cm) at control, followed by SFH-80 (1.620 cm and 1.412 cm) at 4 and 2 g concentration, respectively. However, minimum means value for interaction was found in NK-S-278 (0.460 cm) at higher concentration of 12 g, followed by Parsun-3 (0.496 cm) at 4 g concentration (*Table 11*). Concentration mean for radicle length was maximum (1.059 cm) under control condition, followed by 4, 8 and 2 g concentration revealing 0.772, 0.720, 0.647 and 0.646 cm, respectively.

Hybrids mean revealed maximum radicle length (1.044 cm) in SFH-80, followed by Oliver (0.894 cm), Parsun-3 (0.436 cm) and NK-S-278 (0.894 cm). Interaction between hybrids × concentration shows maximum radicle length (1.489 cm) in Oliver at control level, while minimum interaction means (0.318 cm) was noted in Parsun-3 at 8 g concentration (*Table 12*).

Table 9 - Effect of different concentrations of litter of *Ficus benjamina* on radicle length of sunflower

Concentration	Oliver	Parsun-3	SFH-80	NK-S-278	Concentration means
Control	0.676[bcd]	1.046[b]	3.248[a]	2.301a	1.242[a]
2 g	0.395[bcd]	0.266[cd]	0.785[bc]	0.60[b]	0.361[b]
4 g	0.248[cd]	0.020[cd]	0.165[cd]	0.54b	0.108[bc]
8 g	0.120[cd]	0.000[d]	0.000[d]	0.21c	0.030[bc]
12 g	0.020[d]	0.000[d]	0.000[d]	0.03[d]	0.005[c]
Hybrids mean	0.292[b]	0.266[b]	0.840[a]	0.00[d]	

LSD value for Hybrids = 0.308; Concentration = 0.3444; Interaction = 0.6888 at α value 5%.

Table 10 - Effect of different concentrations of mulch of *Ficus benjamina* on germination % of sunflower

Concentration	Oliver	Parsun-3	SFH-80	NK-S-278	Concentration means
Control	58	38	38	32	42
2 g	82	32	46	36	49
4 g	80	28	52	28	47
8 g	80	32	66	32	53
12 g	76	42	78	30	57
Hybrids mean	75[a]	34[c]	56[b]	32[c]	

LSD value for Hybrids =10.02 at α value 5%.

Table 11 - Effect of different concentrations of mulch of *Ficus benjamina* on hypocotyle length of sunflower

Concentration	Oliver	Parsun-3	SFH-80	NK-S-278	Concentration means
Control	1.669	0.609	1.065	1.030	1.093
2 g	0.852	0.578	1.412	0.619	0.865
4 g	1.088	0.496	1.620	0.513	0.929
8 g	0.936	0.660	0.886	0.508	0.748
12 g	0.844	0.858	0.914	0.460	0.769
Hybrids mean	1.078[a]	0.640[b]	1.179[a]	0.626[b]	

LSD value for Hybrids = 0.2612 at α value 5%.

Table 12 - Effect of different concentrations of mulch of *Ficus benjamina* on radicle length of sunflower

Concentration	Oliver	Parsun-3	SFH-80	NK278	Concentration means
Control	1.489	0.496	1.188	1.063	1.059
2 g	0.556	0.384	1.060	0.589	0.647
4 g	0.882	0.446	1.210	0.550	0.772
8 g	0.726	0.318	1.074	0.764	0.720
12 g	0.815	0.538	0.690	0.941	0.646
Hybrids mean	0.894[ab]	0.436[c]	1.044[a]	0.701[bc]	

LSD value for Hybrids = 0.3371 at α value 5%.

DISCUSSION

Decreased germination and seedling growth of four sunflower hybrids, as revealed by different extract concentration of methanolic, hot-water, litter and mulching bioassays, in this study indicate the *Ficus* contain potent allelochemicals with phytotoxic potentials. Results of earlier work, conducted by Dejam *et al.* (2014), are also in agreement with results of this study, which revealed that methanolic extracts of *Eucalyptus globules* leaves on germination of eggplant were inhibitory, when compared to control, where maximum germination was recorded (31.67%). Dejam *et al.* (2014) investigated the allelopathic activities of *Eucalyptus globules* methanolic extract on hypocotyle growth of eggplant, which demonstrated that the studied parameter significantly reduced at concentrations 1.25, 2.5, 5, 10 g/L, which are in agreement with our study. Reduced length of different extract treatments may be attributed to reduced water and mineral uptake by the recipient seedlings (Majeed *et al.,* 2017; Siyar *et al.,* 2018). Differential response of different hybrids to different extract concentrations of *Ficus* may be due to different tolerance capacity of test seedlings. It may be suggested that radicle elongation strongly depends on conducive environment required for optimal growth, while allelopathic stress can significantly alter their growth.

In general, our results regarding germination, hypocotyle and radicle length are in accordance with previous studies (Muhammad and Majeed, 2014, Majeed *et al.,* 2017, Siyar *et al.,* 2017a,b and Siyar *et al.,* 2018), which documented that allelopathic stress of different plants, such as sunflower, sugarcane, and some weeds, exhibited inhibitory effects on the germination, hypocotyle and radicle lengths of wheat, maize and target weeds at higher concentration, but slightly stimulated the parameters at lower concentration. They elucidated that allelopathic plants release growth suppressive substances (in a concentration-dependent manner), which create a challenging environment for susceptible plants. These substances can alter absorbency of the cell membranes, hormones secretion, enzyme activities and several other reactions, which control the growth of seedlings.

CONCLUSIONS

Results of this study conclude that germination and seedling growth significantly declined at the applied extract concentration of *Ficus* leaves in different bioassays. Sunflower hybrids also exhibited variation in response the applied allelopathic stress. Among sunflower hybrids, NK-S-278 was more severely affected, while Parsun-3 exhibited resistance to the allelopathic stress. Inhibitory effects on the growth parameters linearly increased with increase in the concentration of extract. Phytotoxicity of the tested bioassays was recorded in the order ethanolic extract> hot-water> litter> mulching.

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