ALLELOPATHIC POTENTIAL OF AQUEOUS LEAF EXTRACTS OF PEARL MILLET *(Pennisetum typhoides* S. & H.*)* ON GERMINATION AND GROWTH OF SOME SELECTED WEEDS

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https://doi.org/10.28941/25-3(2019)-1

ABSTRACT

An experiment was carried out in the Postgraduate Laboratory of Department of Agronomy, Faculty of Agriculture, Gomal University, Dera Ismail Khan, Khyber Pakhtunkhwa, Pakistan to investigate the allelopathic effect of millet (Pennisetum typhoides S. & H.) *leaves on germination and growth indices of weed species viz. signal grass, common lambsquarters, field bindweed, broad leaved dock, slender amaranth, wild melon, annual sowthistle and wild jute. Various concentrations [20 g/L (2%) and 40 g/L (4%)] of aqueous leaf extracts of pearl millet along with untreated control were tested. The data revealed that fresh root/shoot weight, fresh plant weight and root/shoot length of different weeds were significantly influenced by aqueous extracts. It was also observed that extract application comparatively showed more inhibited root growth as compared to shoots. It is concluded that aqueous leaf extracts have some allelochemicals, which showed inhibitory effects on germination and growth of weeds, but the inhibition was variable in different weed species tested. It was also found that higher concentration of aqueous extract (40 g/L) had more inhibitory effects on weeds growth and germination than the lower concentration used in this experiment. Further studies are suggested to be undertaken to confirm these findings.*

Keywords: Allelopathy; millet; aqueous extracts; weed species

Citation:
Khan, A., M. W. I. Mallik, I. Hussain, M. H. Malik, M. A. Nadim and M. S. Baloch. 2019. Allelopathic potential of aqueous leaf extracts of pearl millet *(Pennisetum typhoides* S. & H.*)* on germination and growth of some selected weeds. Pak. J. Weed Sci. Res., 25 (3):223-233

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INTRODUCTION

In plant kingdom, certain plants release chemicals which play an important role in their physiological functions and affect the neighboring flora. This process is known as allelopathy. The allelopathic effects of various weeds has been reported to reduce 25-35% yield in wheat (Marwat *et al*., 2008), 20-40% in sugarcane (Khan *et al*., 2004) and 35-80% in maize (Dangwal *et al*., 2010) depending upon the duration of competition, type and density of weeds. For proper weed management, various control measures are adopted including manual, cultural, mechanical and chemical however allelopathy appears to be cost-effective and eco-friendly approach. It is useful tool in managing weeds and pests in a sustainable way (Batish *et al*., 2001). Pearl millet (*Pennisetum glaucum* L.) is an important cereal which contributes to food and nutrition (Shah *et al.*, 2018; Chaudhary *et al.*, 2016). It can grow on marginal and low fertile land and provide livelihood to resource-poor farmers. It has low hydrocyanic acid therefore a good source of fodder (Zhan *et al*., 2003). It is popular in countries where gluten-free foods and beverages are used and among people with coeliac disease (Kasarda, 2001). It is a photo-synthetically efficient (C4), salinity and drought resistant crop well adopted to arid and semi-arid areas. It has been also evaluated for its allelopathic effects as it secretes allelo-chemicals (Radhouane, 2014). Pearl millet shoot and root contain autotoxic compounds (Sexena *et al*., 1996) which restricts the growth of different crops. Radhouane *et al*. (2013) reported that millet leaves contain phenolic compounds, which cause slow germination. A highly weeds infested field was evaluated for allelopathic effects of pearl millet and considerable suppression in weeds growth was observed (Narwal, 2001). Since it is one of the eco-friendly techniques therefore it was felt imperative to apply aqueous leaves extract of pearl millet in order to assess its efficacy against various weeds in the area.

MATERIALS AND METHODS

A lab experiment was carried out to investigate the allelopathic effect of aqueous leaf extracts of pearl millet on nine weeds at the Department of Agronomy, Faculty of Agriculture, Gomal University, Dera Ismail Khan, Pakistan during 2018-2019. The trial was laid out in a 2 factor completely randomized design having three replications. The factors included 3 different concentrations of aqueous leaf extracts of millet and 9 weed species. The experiment had 27 treatments and two factors i.e. weeds including signal grass *(Brachiaria reptans)*, common lambsquarters *(Chenopodium album* L.*)*, field bindweed *(Convolvulus arvensis* L,*)*, broad leaved dock *(Rumex dentatus* L.*)*, jungle rice *(Echinochloa colona* L.*)*, slender amaranth (*Amaranthus viridis* L.), wild melon *(Cucumus melo var. agrostis)*, annual sowthistle (*Sonchus oleraceus* L.) and wild jute *(Corchorus* sp.) and three pearl millet leaf extracts concentrations (0, 20 and 40g/L) were tested. The leaves of *Pennisetum typhoides* were taken, dried in shade and powdered. Distilled water was added to the required millet leaves powder and left for three days and subsequently the extract through was through whattman filter paper. The filtrate was collected and stored in bottles. Six seeds were sown in each disposable glass containing sandy loam soil. After sowing, 90 mL of extract was applied in 3-folds. Data recorded on various physiological attributes were subjected to ANOVA technique (Steel *et al*., 1997) using "Statistix 8.1" computer software. The appraisal of allelopathy was further deciphered by computing the percentage of each treatment as compared to untreated check.

RESULTS AND DISCUSSION

Fresh root weight (g)

The data aon weight of fresh roots are presented in Table-1a. Equal reduction in weight (0.01 g) was recorded by applying both 40 g/L and 20 g/L aqueous leaf extract of pearl millet as compared to untreated contro. The mean values of species revealed that common lambsquarters and broad-leaved dock had maximum fresh root weight (0.10 g each), while all other weed species had lower fresh root weight. Interaction indicated that common lambsquarters had higher root weight (0.20 g) in control treatment while all other weed species at 40 g/L aqueous leaf extract of millet had lowest fresh root weight as compared to 20 g/L. These values revealed that 40 g/L aqueous extract solution was more effective to reduce the root weight of various weed species. The perusal of data in Table-1b exhibits that the inhibitory effect of the extract at 20 and 40 g/L was potent enough to cease the growth of roots. Similar study (Paul and Begum, 2007) indicated that leaf extract of A. *mexicana* decreased significantly blackgram (*Vigna mungo*) and rapeseed (*Brassica napus*) root weight.

Fresh shoot weight (g)

The data regarding fresh shoot weight (Table-2a) that the main effects of extracts and weed species were statistically significant, while their interaction was non-significant for shoot weight. The inhibitory effect extracts show that higher reduction in weight (0.09 g) was witnessed by applying 40 g/L as compared to 0.21g another leaf extract (20 g/L) (Table-2a). Among the weed species, wild melon weed had maximum fresh shoot weight (0.50 g), while Jungle rice had the lowest fresh shoot weight (0.03 g), which was statistically at par with broad leaved dock (0.04), as compared to other weed species in the test. The interaction revealed highest fresh shoot weight (0.70 g) in untreated control, which was followed by the wild melon x control (0.60g), while other weeds had the lower fresh shoot weight by applying 40 g/L aqueous leaf extract. The quantification of inhibition relative to check shows jungle rice as the most susceptible species to extracts as compared the other species included in the test, while wild melon with a mean value of 83.3% emerged as the most tolerant species to the millet extrats (Table-2b). This might be due to some allelochemicals in aqueous extract of millet. These results are supported with Burhan and Shaukat (1999) and Paul and Begum (2007).

Root length (cm)

The main effects of both variables (aqueous extracts and weed species) were statistically significant while their interaction was non-significant statistically (Table-3a). The dose related inhibition was witnessed by the application of extracts. The lowest root length (3.67 m) was recorded in 40 g/L extract of millet, followed by another extract (20 g/L) with a root length of 6.07 cm, whereas the control showing root length of 4.66 cm (Table-3a). The mean values of various weed species revealed that common lambsquarters and field bindweed had the maximum root length (7.78 and 5.94 cm), while Signal grass had lowest root length (2.73 cm) as compared to the other weed species. Interaction of these two factors indicated that common lambsquarters had longest roots involving untreated control, while signal grass weed had lower root length (1.70 cm) by applying 40 g/L aqueous leaf extract solution of millet. It is clear that better suppression was related to higher concentration i.e. 40 g/L of aqueous leaf extract of millet. The data in Table-3b show that least inhibition was registered in signal grass (87.7%), followed by wild melon (87.5&) and common lambsquarters (86.4). The susceptible species identified based on root length were wild jute (67.9%) and broad leaved dock (73.4%). Earlier findings of Radhouane (2014) also reported that root length of weeds was harmfully affected by higher concentrations of aqueous extract of neem.

Shoot length (cm)

ANOVA revealed main effects of both variables (aqueous extracts and weed species) were statistically significant (P<0.05), while their interaction for shoot length was non-significant statistically

(P>0.05) (Table-4a). The data showed maximum reduction in shoot length (7.46 cm) by applying aqueous extract (40 g/L) of millet leaves, while the other extract (20 g/L) of millet showed the higher shoot length (9.30 cm) of weeds. Control treatment had the longest shoots, while averaged across the species. Mean values of various weeds revealed that field bindweed had maximum shoot length (15.39 cm), which was statistically at par with wild melon (14.44 cm), while broad-leaved dock had the shortest shoot length (6.56 cm) which was statistically comparable with three other species in the test (Table-4a). The interaction of these two factors revealed that weed Jungle rice had the longest shoots (16.00 cm) under control treatment while signal grass weed had the lower shoot length (3.00 cm) by applying 40 g/L aqueous leaf extract solution. The percentage of check data (Table-4b) emerged as the most tolerant weed with a mean value of 98.3% followed by slender amaranth (82.3). The most susceptible species with respect to shoot length were signal grass (57.3) and jungle rice (64.6). The data in Table-4b further exhibit that about 13% more inhibition was recorded in 40g/L as compared to 20g/L (Table-4b). It is concluded that high concentration of extract showed inhibitory effects on shoot length of the tested weed species. Earlier research showed that leaf and seed extracts significantly reduced shoot length of *B*. *dictyoneura* and *C*. *ternatea* seedlings (Namkeleja *et al*., 2013). Similar results were communicated by Anisimov *et al*. (2013) who reported that shoot length of seaweed was negatively affected by applying higher level of aqueous extracts of various crops. Afridi and Khan (2015) have also reported the varying allelopathy of different weed species on wheat and rice.

Fresh weight of plant (g)

Like most of the above other parameters the differences were significant for the extract rates and the weed species, but their interaction was non-significant statistically. (Table-5a). Among the pearl millet leaf extracts, the higher inhibition in fresh weight of plant (0.12 g) was evaluated by applying aqueous leaf extract @ 40 g/L, but it was statistically at par with the untreated check, while the other extract i.e. 20 g/L showed the higher fresh weight of plant (0.43 g) as compared to 40g/L as well as it was statistically significant from the check. Mean values of weed species revealed that common lambsquarters and field bindweed showed highest fresh plant weight (0.98 and 0.51 g), while wild jute had the lowest plant fresh weight of only 0.10 g. The interaction showed that common lambsquarters had the highest plant fresh weight (1.27 g) in control, while broad-leaved dock and wild jute had the lowest plant fresh weight (0.00 g) by applying 40 g/L aqueous extract. The percent of check data (Table-5b) show that the signal grass manifested immense tolerance to the inhibition (112.3%), even higher than the untreated check. Earlier conclusions of Vaithiyanathan *et al*. (2014) reveal that weight of several crop plants was inhibited by the application of neem extract. Yazdani and Bagheri (2011) also reported that tobacco plant extracts reduced fresh weight of soybean.

CONCLUSION

It is concluded from findings that aqueous extract of millet leaves contain allelochemicals, which inhibit the germination and growth of different weeds. However, higher concentrations of extract resulted in increased inhibition of weed growth as compared to lower doses. Differences existed among the test species regarding tolerance to the aqueous extracts.

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Table-1a. Effect of aqueous leaf extracts of pearl millet on fresh root weight (g) of various weeds.

Concentration	Signal grass	Lambs quarters	Field bindweed	Broad-leaved dock	Jungle rice	Slender amaranth	Wild melon	Annual sow thistle	Wild Jute	Mean
Control	0 c	0.20 b	0 d	0.30 a	0 a	0.10 c	0 d	0 d	0. d	0.06 a
20% Sol (20g/L)	0 d	0.10 c	0 d	0 d	0 d	0 c	0 d	0 d	0 d	0.01 b
40% Sol (40g/L)	0 d	0 d	0 d	0 d	0 d	0.10 c	0 d	0 d	0 d	0.01 b
Mean	0 c	0.10 a	0 c	0.10 a	0 c	0 b	0 c	0 c	0 c	

$LSD_{0.05}$ for different concentrations = 0.01, species=0.02 and D×S interaction = 0.032

Table-1b. Effect of aqueous leaf extracts of pearl millet on percent of check on fresh root weight (g) of various weeds.

Concentration	Signal grass	Lamb squarters	Field bindweed	Broad-leaved dock	Jungle rice	Slender amaranth	Wild melon	Annual sow thistle	Wild Jute	Mean
Control	100	100	100	100	100	100	100	100	100	100
20% Sol (20g/L)	0	50.0	0	0	0	0	0	0	0	5.4
40% Sol (40g/L)	0	0	0	0	0	0	0	0	0	-0
Mean	33.3	50.0	33.3	33.3	33.3	33.3	33.3	33.3	33.3	-

Table-2a. Effect of aqueous leaf extracts of millet on fresh shoot weight (g) of various weeds.

Concentration	**Signal grass**	**Lamb squarters**	**Field bindweed**	**Broad-leaved dock**	**Jungle rice**	**Slender amaranth**	**Wild melon**	**Annual sow thistle**	**Wild Jute**	**Mean**
Control	0.100 NS	0.70	0.23	0.13	0.10	0.70	0.60	0.30	0.20	0.31 a
20% Sol (20g/L)	0.00	0.47	0.17	0.00	0.00	0.43	0.43	0.20	0.13	0.21 b
40% Sol (40g/L)	0.13	0.03	0.10	0.00	0.00	0.07	0.47	0.00	0.00	0.09 c
Mean	0.08 cd	0.40 b	0.17 c	0.04 d	0.03 d	0.40 b	0.50 a	0.17 cd	0.11 cd	

$LSD_{0.05}$ for different concentrations = 0.03, species= 0.09 and D×S interaction = 0.09

Table-2b. Effect of aqueous leaf extracts of millet on percent of check for fresh shoot weight (g) of various weeds.

Concentration	**Signal grass**	**Lamb squarters**	**Field bindweed**	**Broad-leaved dock**	**Jungle rice**	**Slender amaranth**	**Wild melon**	**Annual sow thistle**	**Wild Jute**	**Mean**
Control	100	100	100	100	100	100	100	100	100	100
20% Sol (20g/L)	0.0	67.1	73.9	100	0	61.4	71.7	66.7	65.0	56.2
40% Sol (40g/L)	100.0	6.4	43.5	0	0	10.0	78.3	0	0	25.8
Mean	66.7	57.8	72.5	66.7	33.3	57.1	83.3	55.6	55.0	-

Table-3a. Effect of aqueous leaf extracts of millet on root length (cm) of various weeds.

Concentration	**Signal grass**	**Lambs quarters**	**Field bindweed**	**Broad-leaved dock**	**Jungle rice**	**Slender amaranth**	**Wild melon**	**Annual sow thistle**	**Wild Jute**	**Conc. Mean**
Control	3.67[NS]	9.00	6.33	8.10	6.50	6.67	4.00	4.00	6.33	6.07 a
20% Sol (20g/L)	2.83	7.67	4.67	5.73	5.60	4.83	3.50	2.83	4.23	4.66 b
40% Sol (40g/L)	1.70	6.67	4.00	4.00	5.00	4.00	3.00	2.33	2.33	3.67 c
Mean	2.73 d	7.78 a	5.00 bcd	5.94 ab	5.70 abc	5.17 a-d	3.50 bcd	3.06 cd	4.30 bcd	-

$LSD_{0.05}$ for different concentration = 0.56, species= 2.68 and D×S interaction = 1.68

Table-3b. Effect of aqueous leaf extracts of millet on percent of check for root length (cm) of various weeds.

Concentration	**Signal grass**	**Lambs quarters**	**Field bindweed**	**Broad-leaved dock**	**Jungle rice**	**Slender amaranth**	**Wild melon**	**Annual sow thistle**	**Wild Jute**	**Conc. Mean**
Control	100	100	100	100	100	100	100	100	100	100
20% Sol (20g/L)	77.1	85.2	73.8	70.7	86.2	72.4	87.5	70.8	66.8	76.7
40% Sol (40g/L)	46.3	74.1	63.2	49.4	76.9	60.0	75.0	58.3	36.8	60.0
Mean	74.6	86.4	79.0	73.4	87.7	77.5	87.5	76.4	67.9	-

Table-4a. Effect of aqueous leaf extracts of millet on shoot length (cm) of various weeds.

Concentration	Signal grass	Lambs quarters	Field bindweed	Broad-leaved dock	Jungle rice	Slender amaranth	Wild melon	Annual sow thistle	Wild Jute	Mean
Control	13.00^{NS}	10.00	21.50	6.67	16.00	15.00	16.17	9.33	11.33	13.22 a
20% Sol (20g/L)	6.33	6.00	14.00	7.33	9.00	11.67	14.17	7.67	7.50	9.30 b
40% Sol (40g/L)	3.00	5.17	10.67	5.67	6.00	10.33	13.00	6.00	7.33	7.46 c
Mean	7.44 e	7.06 e	15.39 a	6.56 e	10.33 cd	12.33 bc	14.44 ab	7.67 de	8.72 de	

$LSD_{0.05}$ for different concentration = 0.87, species=2.79 and D×S interaction = 2.59

Table-4b. Effect of aqueous leaf extracts of millet on percent of check for shoot length (cm) of various weeds.

Concentration	Signal grass	Lambs quarters	Field bindweed	Broad-leaved dock	Jungle rice	Slender amaranth	Wild melon	Annual sow thistle	Wild Jute	Mean
Control	100	100	100	100	100	100	100	100	100	100
20% Sol (20g/L)	48.7	60.0	65.1	109.8	56.3	77.8	87.6	67.7	66.2	71.0
40% Sol (40g/L)	23.1	51.7	49.6	85.0	37.5	68.9	80.4	64.3	64.7	58.4
Mean	57.3	70.6	71.6	98.3	64.6	82.3	69.3	77.3	77.0	-

Table-5a. Effect of aqueous leaf extracts of millet on fresh weight of plant (g) of various weeds.

Concentration	Signal grass	Lamb squarters	Field bindweed	Broad-leaved dock	Jungle rice	Slender amaranth	Wild melon	Annual sow thistle	Wild Jute	Mean
Control	0.00^{NS}	1.27	1.10	0.33	0.10	0.50	0.50	0.22	0.13	0.44 a
20% Sol (20g/L)	0.10	1.63	0.23	0.13	0.07	0.77	0.57	0.20	0.17	0.43 a
40% Sol (40g/L)	0.17	0.03	0.20	0.00	0.03	0.10	0.47	0.07	0.00	0.12 b
Mean	0.09c	0.98a	0.51b	0.16c	0.07c	0.46b	0.51b	0.16c	0.10c	-

Table-5b. Effect of aqueous leaf extracts of millet on percent of check for fresh weight of plant (g) of various weeds.

Concentration	Signal grass	Lamb squarters	Field bindweed	Broad-leaved dock	Jungle rice	Slender amaranth	Wild melon	Annual sow thistle	Wild Jute	Mean
Control	100	100	100	100	100	100	100	100	100	100
20% Sol (20g/L)	110	128.3	20.9	39.4	70.0	154.0	114.0	90.9	130.0	95.3
40% Sol (40g/L)	117	3.4	18.2	0	30.0	29.0	94.0	31.8	0	35.9
Mean	112.3	74.6	46.4	46.5	55.7	94.3	102.7	63.7	76.7	-