Journal of Research in Weed Science

Journal homepage: www.jrweedsci.com

Original Research Article

Germination and growth of some summer crops as affected by allelopathicity of different waste-land weeds

Muhammad Ehsan Safdar [a,*], Ahsan Aziz [a], Umer Farooq [a], Muhammad Sikander Hayat [a], Abdul Rehman [a], Rafi Qamar [a], Amjed Ali [a], Tahir Hussain Awan [b]

a Department of Agronomy, College of Agriculture, University of Sargodha, Sargodha, Pakistan.

b Agronomy Department, Rice Research Institute, Kala Shah Kaku, Punjab, Pakistan.

ARTICLE INFORMATION

Received: 11 May 2019

Revised: 12 June 2019

Accepted: 12 June 2019

Available online: 13 June 2019

DOI: 10.26655/JRWEEDSCI.2019.4.6

KEYWORDS

Crop seeds

Emergence

Leachates

Phytotoxicity

Seedling

Weeds

ABSTRACT

Studies were conducted to ascertain the phytotoxic action of aqueous extracts and rhizospheric soils of wasteland weeds such as *Parthenium hysterophorus* L., *Withania somnifera* L., *Lantana camara* L., and *Achyranthes aspera* L. against four summer crops viz., *Gossypium hirsutum* L., *Helianthus annuus* L., *Oryza sativa* L. and *Zea mays* L. Experiment was carried out in Agronomy Laboratory, College of Agriculture, University of Sargodha, Punjab-Pakistan. In first experiment, the 5% (w/v) aqueous extract prepared from whole plant of each weed was applied to germinating crop seeds sown in petri plates. In the second experiment soils collected from rhizosphere of these weeds were filled in plastic pots and used as germination medium for seeds of these crops. A constant temperature of 30°C was maintained in germinator throughout the germination period of 12 days. In first experiment, significantly lower germination percentages (31.7 and 38.3%) and germination indices (4.4 and 6.4) of crops were noted with application of *A. aspera* and *P. hysterophorus* extracts, respectively. All weed extracts except *L. camara* caused significant reduction in shoot length, root length, seedling length and seedling biomass of crops. Root growth of the crop seedlings was influenced more than their shoot growth. In second experiment, germination percentage, shoot dry weight, seedling biomass and seedling vigor index of crops were significantly inhibited by rhizospheric soil of all weeds. Among crops, *H. annuus* was more susceptible to the deleterious effect of the aqueous extracts as well as rhizospheric soils of weeds. It can be concluded that wasteland weeds especially *P. hysterophorus* and *A. aspera* imparted more negative impact on the germination and seedling growth of test crops. Therefore, crop fields and their surroundings should be kept free from these weeds by clean cultivation.

Introduction

Weeds are plants that germinate and grow vigorously in abundance and not required because they interfere with land and water resources and human welfare. According to habitat, weeds are of

Corresponding author, email: ehsan_safdar2002@yahoo.com (Muhammad Ehsan Safdar).

two type i.e. crop-land weeds and wasteland weeds. Crop-land weeds mostly grow in crop fields or along with the crop plants and compete with them for light, nutrient, space and water. Most of the crop-land weeds are annuals that germinate and produce seed within one season. Waste-land weeds in contrast to crop-land weeds can't directly interfere with the crop growth. Waste-land weeds are seen growing near road sides, railways track and near crop fields and also have phytotoxic chemicals that cause hindrance in the germination and growth of nearby plants. Weeds of all types release chemicals known as allelochemicals and term used for this mechanism is called allelopathy. Allelochemicals are manufactured by plants as secondary metabolic products that are subsequently discharged into the environment as leachates, root exudates, volatilization products, and residues in soil (Khalaj et al. 2013). Allelochemicals are not supposed to have any straight way function in plant's reproduction and development (Bertin et al. 2003).

Parthenium hysterophorus L., also known as parthenium weed or whitehead belongs to family Asteraceae. In Pakistan, it is known as *gajar booti* or *chatak chandni* and considered as invasive weed (Shabbir and Bajwa, 2006). It is an annual and due to environmental conditions sometime behaves as perennial wasteland weed that usually germinates in spring season (Shabbir and Bajwa, 2006). However, prevalence of stressful conditions especially drought, curtails life cycle of this plant to only 4 weeks. This plant is highly allelopathic in nature due to presence of parthenin, a major sesquiterpene lactone, and phenolics like vanillic, caffeic, chlorogenic, ferulic, and anisic acids (Kanchan and Jayachandra, 1980; Singh et al. 2003). *Withania somnifera* L. is a perennial plant belongs to family Solanaceae and commonly called winter cherry. It is used as medicinal plant, both of traditional and modern therapeutic agents. Conservatively, it has been used for number of important medicinal resolutions in the Indian subcontinent. In the recent years there has been increasing interest in *W. somnifera* for its efficiency in a number of diseased conditions, as adaptogenic, immune modulator and other health benefits (DerMarderosian and Beutler, 2001; Duke, 2002). Preceding researchers have documented many pharmacological properties of *W. somnifera* against animal and human diseases. *Lantana camara* L. belong to family Verbenaceae, locally known as white sag, big sag and tick-berry and also known to be toxic weed plant (Binggeli and Desalegn, 2002). Itis a quickly growing woody thicket-forming shrub, native to tropical and sub-tropical South and Central America and now distributed in number of countries (Binggeli and Desalegn, 2002; Zalucki et al., 2007). Tickberry is among top ten deceptive weeds on earth (Sharma et al. 2005). It germinates and grows under a wide range of climatic conditions and occurs on a variety of soil types reflecting its wide ecological tolerance range (Baars and Neser, 1999; Day et al., 2003). *Achyranthes aspera* L. belongs to family Amaranthaceae and commonly known as prickly-

chaff flower. In Pakistan, it is mostly supposed to be a flora of waste lands and roadsides but most often has been reported to be among dominant weeds in maize (Shah et al. 2006; Marwat et al. 2010), sugarcane (Qureshi et al. 2002) and wheat (Malik and Khan, 2012). The plant has a variety of allelochemicals like alkaloids, phenolics, oleonolic acid, saponins, dihydroxy ketones, and long chain compounds which have been isolated from its various parts (Neogi et al. 1970; Ali, 1993; Srivastav et al. 2011). Due to its spiny fruits with inverted orientation, this weed caused hindrances in field operations. Weed scientists have been focused on crop-land weeds because they directly influence the crop. However, very little research has been carried out to investigate the harmful effects of waste-land weeds. This research was therefore, conducted to ascertain whether waste-land weeds such as *P. hysterophorus, A. aspera, L. camara* and *W. somnifera* exert phytotoxic effects on nearby crops by various means.

Materials and Methods

Laboratory experiments were conducted to evaluate the allelopathic effect of aqueous extracts and rhizospheric soils of four wasteland weeds viz., lantana (*Lantana camara* L.), parthenium (*Parthenium hysterophorus* L.), prickly chaff flower (*Achyranthes aspera* L.) and winter cherry (*Withania somnifera* L.) against four summer crops viz. sunflower (*Helianthus annuus* L.), cotton (*Gossypium hirsutum* L.), maize (*Zea mays* L.) and rice (*Oryza sativa* L.). Studies were conducted in Agronomic Laboratory, College of agriculture, University of Sargodha, Punjab-Pakistan during the year 2015. In aqueous extract bioassay studies, 5% (w/v) aqueous extracts prepared from entire plant of each weed was applied to crop seeds sown in Petri plates whereas in soil bioassay experiments, rhizospheric soils collected adjacent to roots of wasteland weeds were filled in pots that were used for sowing crop seeds. Both the experiments were laid out in completely randomized design (CRD) with factorial arrangement having 3 replications.

Preparation of aqueous extracts

Weeds growing around cropped area were uprooted at their active growth phase form research area of College of Agriculture, University of Sargodha, Punjab-Pakistan during the year 2015. Initially, collected plants were subjected to drying at room temperature (25^{o}C) and then dried in electric oven at 70^{o}C for 48 h. After drying, plants were cut into small pieces and were soaked in distilled water with ratio of 1:20 w/v for 24 h at room temperature (Hussain and Gadoon, 1981). Then, after shaking well, to obtain 5% w/v aqueous extract of each weed, solution was sieved through muslin cloth. After sieving, extracts were filled in labeled plastic bottles and stored at room temperature.

Collection of rhizospheric soils

Rhizospheric soils of wasteland weeds were collected from experimental area of College of Agriculture, University of Sargodha-Punjab, Pakistan during the year 2015. Weeds were uprooted and soil adjacent to the roots of each weed plant was collected in separate plastic bags and kept in laboratory. After sieving 300 g of soil was filled in each pot (6 cm depth and 12 cm diameter) which were used for sowing the seeds of crops.

Growing conditions

In plant bioassay, 10 seeds of each crop were placed in Petri plates lined with double layer of filter paper and 3 ml aqueous extract of each weed was applied to each Petri plate that was then sealed with para film. In soil bioassay, 10 seeds of each crop were sown in plastic pot filled with rhizospheric soil of each weed. The pots were frequently irrigated with equal quantity of distilled water as and when required. Both the Petri plates and pots were kept in germinator supplied with light at constant temperature of 30^{o}C for 12 days.

Data recording

In both experiments, germination data were recorded on daily basis for 12 days. After germination completion, root and shoot lengths of crop seedlings were measured. Seedlings were separated into shoots and roots and weighed after oven drying at 70^{o}C for 24 h. Data of germination and vigor parameter were calculated by using their formulae given below:

Germination / emergence percentage (GP/EP)

Germination/emergence percentage was measured by using following formula:

$$GP/EP = [NT \times 100]/N$$

Where, N: total no. of seeds sown, NT: No. of germinated / emerged seeds

Germination / emergence index (GI/EI)

Germination / emergence index was calculated by formula as defined by Scott et al. (1984):

$$GI / EI = N1 / D1 + \cdots \ldots \ldots \ldots \ldots \ldots + NL / DL$$

Where, N_1: No. of seeds germinated / emerged on 1st count, N_L: No. of seeds germinated / emerged on last count, D_1: Days to 1st count, and D_L: Days to last count

Mean germination / emergence time (MGT/MET)

Mean germination / emergence time was calculated by using the equation as assumed by (Moradi Dezfuli et al. 2008):

$$MGT/MET = \Sigma Dn/ \Sigma n$$

Where, n: Number of seeds which were germinated / emerged on day D, D: Number of days counted from the start of germination / emergence.

Time to 50% germination / emergence (T50)

Time to 50% germination / emergence was intended according to the formula modified by (Farooq et al. 2005):

$$T50 = ti + \{(N/2) - ni\} (tj - ti) /nj - n$$

Where, N: Final number of germination / emerged, n_i, n_j: cumulative number of seeds germinated / emerged by adjacent counts at times t_i and t_j when $n_i<N/2<n_j$.

Seedling vigor index (SVI)

Seedling vigor index was computed by the following formula as described by (Orchard, 1977):

$$SVI = \text{seedling length (cm)} \times \text{germination/emergence percentage}$$

Data Analysis

Recorded data were analyzed statistically according to Fisher's analysis of variance technique by using Statistix 8.1 software. Treatment means were compared by least significant difference test at the 0.05 (5%) probability level (Steel et al. 1997).

Results and Discussion

Aqueous extract bioassay studies

The data regarding germination percentage (GP), mean germination time (MGT), germination index (GI) and time to 50% germination (T_{50}) are presented in Table 1. All the weed extracts significantly influenced the germination and growth traits of crops and theses influences were species specific. Among weed species, *A. aspera* and *P. hysterophorus* caused maximum reductions in germination percentage of crop seeds. Among crops, *H. annuus* showed maximum sensitivity towards aqueous extracts while least was shown by *O. sativa*. Our results are similar to those of (Rashid et al. 2008) who reported that seed germination and seedling growth of crops was reduced

by the application of parthenium extract. Oudhia and Tripathi (2001) also reported significant negative allelopathic effect of parthenium on germination and growth of crops. Time to 50% germination was significantly increased due to wasteland weeds extract. *Gossypium hirsutum* seeds took maximum days (4.8) to attain 50% germination when treated with *W. somnifera* aqueous extract. Among crop seeds time taken to attain 50% germination was not significantly influenced by the application of different weed extracts. Mishra (2015) also found that allelochemicals of lantana significantly retarded the germination and metabolic processes of crops, weeds, vegetables and bryophytes. Minimum (4.4) GI was observed with the application of *A. aspera* extract ant it was statistically at par with *P. hysterophorus* extract whereas among test crops minimum GI (3.9) was recorded in case of *H. annuus.*

Data regarding shoot length, root length, seedling length, seedling biomass, roots and shoot dry weight and seedling vigor index are presented in Table 2. Seedling length and seedling biomass was significantly reduced by the action of allelopathic effect of wasteland weeds. Among crops, *O. sativa* proved most susceptible to the deleterious effects of wasteland weeds as it showed minimum seedling length (2.6 cm) and seedling biomass (96.4 mg). All weeds except *L. camara* showed significant inhibitory effect on shoot and root lengths, seedling length, and seedling biomass of crops. Our results are similar to the findings of Tanveer et al. (2014) and Safdar et al. (2014) that showed that leaf extract of *A. aspera* and *P. hysterophorus* significantly reduced the seedling length of maize. However our findings are contradictory to the observations of Hossain and Alam (2010), Sharma et al. (2005) and Ahmed et al. (2007) who reported significant inhibitory effect of *L. camara* on the growth of agricultural crops. Parsad and Srivastava (1991) noted phyto-inhibitory effect of *L. camara* on growth of rice. Khan et al. (2012) also found that aqueous extract of parthenium weed significantly reduced the shoot length of four wheat cultivars. Singh and Sangeeta (1991) also showed that extracts of different *P. hysterophorus* plant parts significantly reduced the shoot length of wheat and other cereal crops. Javaid et al. (2009) found that aqueous extract of *W. somnifera* reduced the root length of *Rumex dentatus*.

Soil bioassay studies

Rhizospheric soils of all weeds (*P. hysterophorus, L. camara, A. aspera* and *W. somnifera*) significantly inhibited the emergence percentage, shoot dry weight, seedling biomass and seedling vigor index of crops (Tables 3 and 4). Among crops, *H. annuus* showed maximum sensitivity to deleterious effect of rhizospheric soils of weeds as it attained the lowest emergence percentage (20%) and emergence index (3.4).

Table 1. Effect of aqueous extract of wasteland weeds on germination of summer crops.

Treatment	Crops	GP (%)	GI	MGT	T_{50}
Distilled water (Control)	*G. hirsutum*	76.7	13.9	4.1	2.9 cd
	H. annuus	56.7	6.9	3.4	4.6 ab
	O. sativa	93.3	14.2	4.3	2.7 cd
	Z. mays	53.3	7.5	3.2	3.2 bcd
P. hysterophorus	*G. hirsutum*	33.3	5.9	2.8	3.6 abcd
	H. annuus	16.7	2.2	3.0	2.9 cd
	O. sativa	70.0	13.1	2.8	2.7 cd
	Z. mays	33.3	4.4	3.7	3.4 abcd
W. somnifera.	*G. hirsutum*	43.3	6.4	3.7	4.8 a
	H. annuus	30.0	4.9	3.1	3.1 bcd
	O. sativa	70.0	11.4	3.6	3.3 abcd
	Z. mays	46.7	7.2	3.8	2.6 cde
L. camara.	*G. hirsutum*	46.7	8.2	3.2	2.0 de
	H. annuus	26.7	3.4	3.5	2.0 de
	O. sativa	70.0	12.6	3.1	2.7 cd
	Z. mays	53.3	7.9	3.4	3.6 abc
A. aspera	*G. hirsutum*	33.3	4.3	4.6	2.1 cde
	H. annuus	16.7	1.7	4.0	1.0 e
	O. sativa	46.7	7.3	3.8	2.1 cde
	Z. mays	30.0	4.5	3.6	2.2 cde
LSD		**NS**	**NS**	**NS**	**1.66**
Weed Means		**GP (%)**	**GI**	**MGT**	**T_{50}**
Distilled water (Control)		70 A	10.7 A	3.8	3.3 AB
P. hysterophorus		38.33 CD	6.4 BC	3.1	3.1 AB
W. somnifera		47.5 BC	7.5 B	3.5	3.4 A
L. camara.		49.1 B	8.1 B	3.3	2.6 BC
A. aspera		31.7 D	4.4 C	4.0	1.8 C
LSD		**14.76**	**2.73**	**NS**	**0.83**
Crop Means		**GP (%)**	**GI**	**MGT**	**T50**
G. hirsutum		46.7 B	7.7 B	3.7	3.1
H. annuus		29.3 C	3.9 C	3.4	2.8
O. sativa		70.0 A	11.7 A	3.6	2.7
Z. mays		43.3 B	6.3 **B**	3.6	3.0
LSD		**13.20**	**2.44**	**NS**	**NS**

In a column, values not sharing same letter(s) are significantly different at $P \leq 0.05$, GP = germination percentage, GI = germination index, MGT = mean germination time, T_{50} = time to 50% germination, NS = Non-significan.

Table 2. Growth parameter of crops as influenced by the aqueous extract of different weeds.

Treatments	Crops	SL	RL	SDW	RDW	SDL	SB	SVI
Distilled water (Control)	*G. hirsutum*	5.3 cde	5.7 bcd	77.67	40.1	11.1 bc	864.0 b	534.6
	H. annuus	5.4 cd	3.9 def	257.0	30.4	9.3 cde	871.3 b	373.0
	O. sativa	3.3 cdefgh	6.6 bc	15.67	202.0	10.0 bcd	11.3 f	584.1
	Z. mays	9.1 b	9.7 a	76.67	116.7	18.8 a	1384.3 a	436.1
P. hysterophorus	*G. hirsutum*	4.0 cdefgh	2.0 fgh	156.33	56.3	6.0 efgh	89.3 f	270.5
	H. annuus	2.9 defgh	1.4 gh	120.33	36.3	4.3 fgh	91.7 f	164.6
	O. sativa	2.1 gh	3.4 efg	13.33	33.3	5.5 efgh	92.7 f	515.7
	Z. mays	10.0 b	3.4 efg	37.0	73.0	13.4 b	556.7 bcd	626.3
W. somnifera.	*G. hirsutum*	4.0 cdefgh	2.2 fgh	208.33	138.3	6.3 defgh	118.7 f	346.4
	H. annuus	3.0 cdefgh	2.1 fgh	292.0	11.7	5.2 fgh	374.3 def	227.5
	O. sativa	2.7 efgh	2.4 fgh	33.33	23.3	5.2 fgh	91.3 f	572.9
	Z. mays	5.4 cd	2.3 fgh	47.0	192.3	7.8 cdef	762.3 bc	810.2
L. camara.	*G. hirsutum*	4.9 cdef	5.1 cde	70.63	250.3	10.0 bcd	748.7 bc	424.3
	H. annuus	4.6 cdefgh	2.9 fgh	17.33	12.0	7.5 cdefg	459.3 cde	178.2
	O. sativa	2.9 defgh	7.5 b	30.00	90.0	10.5 bc	128.0 ef	456.3
	Z. mays	13.3 a	7.2 b	76.67	303.3	21.0 a	1236.0 a	722.5
A. aspera	*G. hirsutum*	4.0 cdefgh	1.9 fgh	43.0	8.6	6.0 efgh	103.0 f	221.6
	H. annuus	2.6 fgh	1.2 h	150.43	45.6	3.8 gh	45.0 f	84.5
	O. sativa	1.8 h	1.3 gh	20.0	43.3	3.2 h	59.0 f	289.3
	Z. mays	5.7 c	2.2 fgh	63.33	81.0	7.9 cdef	691.7 bcd	304.7
LSD		**2.67**	**2.09**	**NS**	**NS**	**0.23**	**338.16**	**NS**
Weed means		**SL**	**RL**	**SDW**	**RDW**	**SDL**	**SB**	**SVI**
Distilled water (Control)		5.8 AB	6.5 A	106.8	97.3 AB	12.3 A	807.7 A	482.0
P. hysterophorus		4.7 BC	2.5 B	81.8	49.7 B	7.3 B	207.5 B	394.3
W. somnifera		3.8 C	2.2 B	145.2	91.5 AB	6.1 BC	334.1 B	489.3
L. camara.		6.5 A	5.7 A	48.7	163.9 A	12.2 A	643.0 A	445.3
A. aspera		3.5 C	1.6 B	69.2	44.6 B	5.2 C	224.7 B	225.0
LSD		**1.33**	**1.04**	**NS**	**83.28**	**1.3**	**169.08**	**NS**
Crop Means		**SL**	**RL**	**SDW**	**RDW**	**SDL**	**SB**	**SVI**
G. hirsutum		4.4 B	3.4 B	11.2 AB	98.8 AB	7.9 B	382.7 B	359.4 B
H. annuus		3.7 BC	2.3 C	167.4 A	27.2 B	6.0 C	368.3 B	205.5 C
O. sativa		2.6 C	4.3 AB	22.5 B	78.4 B	6.9 BC	96.4 C	483.6 AB
Z. mays		8.8 A	4.9 A	60.1 B	153.2 A	13.8 A	926.2 A	579.9 A
LSD		**1.19**	**0.93**	**107.2**	**74.49**	**0.12**	**151.23**	**151.4**

Value having different letters show significant difference (P≤0.05), SL=shoot length, RL=root lenght, SFW=shoot fresh weight, RFW=root fresh weight, SDW=shoot dry weight, RDW=root dry weight, SDL=seedling length, SVI=seedling vigor index, SB=seedling biomass, NS= Non-significant.

Table 3. Germination of crops as influenced by rhizospheric soil of different weeds.

Treatment	Crops	EP(%)	EI	MET	T50
Distilled water (Control)	*G. hirsutum*	66.7 abc	9.0	4.2	3.2
	H. annuus	50.0 bcde	2.3	3.1	2.8
	O. sativa	70.0 ab	10.4	4.3	3.8
	Z. mays	53.3 bcd	6.8	4.4	4.2
P. hysterophorus	*G. hirsutum*	63.3 abcd	8.2	4.1	3.9
	H. annuus	6.7 f	2.8	4.3	4.1
	O. sativa	83.3 a	10.0	4.1	3.6
	Z. mays	26.7 ef	4.7	3.6	3.4
W. somnifera	*G. hirsutum*	43.33 cde	4.5	3.7	3.8
	H. annuus	13.3 f	4.1	3.6	3.1
	O. sativa	66.6 abc	7.1	4.0	3.5
	Z. mays	26.6 ef	6.0	4.6	3.6
L. camara	*G. hirsutum*	43.33 cde	7.3	3.4	2.7
	H. annuus	3.4 f	1.4	3.0	3.0
	O. sativa	83.3 a	10.5	4.5	3.5
	Z. mays	40.0 de	3.7	3.3	3.3
A. aspera	*G. hirsutum*	13.3 f	8.8	3.3	2.4
	H. annuus	26.6 ef	6.6	1.3	0.4
	O. sativa	60.0 abcd	9.3	4.9	4.1
	Z. mays	40.0 de	6.4	4.0	2.5
LSD		**32.58**	**NS**	**NS**	**NS**
Weed means		**EP (%)**	**EI**	**MET**	**T50**
Distilled water (Control)		60.0 A	7.2	4.0	3.5 A
P. hysterophorus		45.0 B	6.4	4.0	3.7 A
W. somnifera		37.5 B	5.4	4.0	3.5 A
L. camara.		42.5 B	5.7	3.5	3.1 AB
A. aspera		35.0 B	7.8	3.4	2.4 B
LSD		**14.29**	**NS**	**NS**	**0.9**
Crop Means		**EP (%)**	**EI**	**MET**	**T50**
G. hirsutum		46.0 B	7.7 AB	3.8 AB	3.2
H. annuus		20.0 C	3.4 C	3.1 B	2.7
O. sativa		72.6 A	9.5 A	4.3 A	3.7
Z. mays		37.3 B	5.5 BC	4.0 AB	3.4
LSD		**11.3**	**2.8**	**0.9**	**NS**

In a column, value with different letters show significant difference (P≤0.05), EP= emergence percentage, GI= emergence index, MGT= mean emergence time, T_{50} = time to 50% emergence.

Table 4. Growth parameters of crops as influenced by the rhizospheric soils of different wasteland weeds.

Treatments	Crops	SL	RL	SDW	RDW	SDL	SB	SVI
Distilled water (Control)	*G. hirsutum*	9.1	3.4	268.7	125.3	12.5	2266.3	836.0
	H. annuus	7.9	4.6	58.3	16.3	12.6	239.0	628.0
	O. sativa	8.5	6.3	76.3	60.0	14.8	792.0	1038.5
	Z. mays	23.4	16.1	333.0	203.0	39.4	3188.7	2087.5
P. hysterophorus	*G. hirsutum*	7.1	3.8	96.3	75.6	10.9	1091.1	690.8
	H. annuus	2.6	1.6	40.67	12.0	4.2	25.7	85.3
	O. sativa	7.9	6.2	19.7	76.7	14.0	613.3	1236.5
	Z. mays	21.3	13.6	212.0	170.3	35.0	2266.7	869.0
W. somnifera.	*G. hirsutum*	7.7	3.6	114.3	115.7	11.4	1803.7	489.9
	H. annuus	5.4	2.6	17.0	5.4	8.5	56.3	1700.7
	O. sativa	10.4	6.4	43.3	73.3	16.8	436.7	695.4
	Z. mays	23.9	14.2	179.7	119.0	38.1	1766.7	731.8
L. camara.	*G. hirsutum*	7.5	3.7	160.6	38.9	11.2	1303.0	493.9
	H. annuus	8.7	4.5	67.3	10.40	13.1	256.3	61.2
	O. sativa	7.3	7.7	14.3	86.0	15.0	703.3	1258.7
	Z. mays	21.9	9.5	245.0	125.7	31.5	2093.3	1320.3
A. aspera	*G. hirsutum*	8.7	4.1	117.7	52.7	12.8	1122.7	167.6
	H. annuus	4.6	3.1	41.0	12.2	7.8	207.7	215.6
	O. sativa	7.7	6.6	20.0	42.6	14.4	400.0	824.5
	Z. mays	18.7	10.5	99.67	122.3	29.2	1162.3	1168.9
LSD		**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**
Weed means		**SL**	**RL**	**SDW**	**RDW**	**SDL**	**SB**	**SVI**
Distilled water (Control)		12.2	7.1	184.1 A	101.0	19.8	1621.5 A	1147.5 A
P. hysterophorus		9.7	6.3	92.2 BC	83.7	16.1	1045.7 B	720.4 B
W. somnifera		12.0	6.7	88.58 BC	78.3	18.7	1015.8 B	521.9 B
L. camara.		11.4	6.4	121.83 B	65.2	17.2	1089.0 B	783.5 B
A. aspera		9.9	6.1	69.58 C	57.5	16.0	732.2 B	594 B
LSD		**NS**	**NS**	**96.9**	**NS**	**NS**	**760.1**	**386**
Crop Means		**SL**	**RL**	**SDW**	**RDW**	**SDL**	**SB**	**SVI**
G. hirsutum		8.0 B	3.7 C	151.3 B	81.59 B	11.7 BC	1517.4 B	535.6 B
H. annuus		5.9 B	3.2 C	44.9 C	11.2 C	9.2 C	202.2 D	232.2 B
O. sativa		8.3 B	6.6 B	34.73 C	67.7 B	15.0 B	589.1 C	1010.7 A
Z. mays		21.8 A	12.7 A	213.9 A	148.1 A	34.6 A	2087.5 A	1235.5 A
LSD		**3.4**	**2.9**	**47.9**	**74.9**	**5.7**	**376.1**	**345.2**

Value having different letters show significant difference (P≤0.05), SL=shoot length, RL=root length, SFW=shoot fresh weight, RFW=root fresh weight, SDW=shoot dry weight, RDW=root dry weight, SDL=seedling length, SVI=seedling vigor index, SB=seedling biomass.

Our results are in line with those of Safdar et al. (2014) who investigated that rhizospheric soil of *P. hysterophorus* significantly reduced the germination of maize. In contrast to our results, Hussain et al. (2011) concluded that soil collected underneath *L. camara* had no allelopathic effects on the test species. Paudel et al. (2009) noted that rhizospheric soil of *P. hysterophorus* significantly reduced the germination rate in *Raphanus sativus* L. Parthenium compost along with dung in different ratios showed significant inhibition in growth and emergence index of plant species (Rajiv et al. 2013). Oudhia and Tripathi (2000) found inhibitory effects of parthenium weed on the

germination of rice. Growth of radicle and plumule and its elongation depends upon cell division and in many cases cell division is inhibited by allelopathic compounds (Hussain et al. 1984; Rice, 1984; Putnam and Tang, 1986).

Conclusion

Aqueous extracts of P. hysterophorus and A. aspera were proved to be more phytotoxic against test crops. The overall inhibitory effect of aqueous extract was more pronounced than by rhizospheric soils of weeds especially on germination and growth of crops. Among weeds, P. hysterophorus and A. aspera were found to be highly allelopathic against crops. Among crops, H. annuus and O. sativa were more susceptible to phytotoxicity of weeds.

Acknowledgements

Authors of this manuscript greatly acknowledge Faisal Shoukat, Laboratory Assistant for his help and guidance during the entire course of study.

Conflict of Interest

No conflicts of interest have been declared.

References

Ahmed R, Uddin M.B, Khan M.A.S.A, Mukul S.A, Hossain M.K. 2007. Allelopathic effects of *Lantana camara* on germination and growth behavior of some agricultural crops in Bangladesh. J Forestry Res. 18: 301-304.

Ali M. 1993. Chemical Investigation of *Achyranthes aspera* Linn. Oriental J Chem. 9: 84-84.

Baars J.R, Neser S. 1999. Past and present initiatives on the biological control of *Lantana camara* (Verbenaceae) in South Africa. Afr Entomol Memoir. 1: 21-33.

Batish D.R, Singh H.P, Kohli R.K, Saxena D.B, Kaur S. 2002. Allelopathic effects of parthenin against two weedy species, *Avena fatua* and *Bidens pilosa*. Environ Experim Bot. 47: 149-155.

Bertin C, Yang X, Weston L.A. 2003. The role of root exudates and allelochemicals in the rhizosphere. Plant Soil. 256: 67-83.

Binggeli P, Desalegn D. 2002. Lantana camara-the invasive shrub that threatens to drive people out of their land. Newsletter of the Ethiopian Wildlife and Natural History Society, pp. 4-6.

Day M.D, Wiley C.J, Playford J, Zalucki M.P. 2003. *Lantana*: current management status and future prospects (No. 435-2016-33733).

DerMarderosian A, Beutler J.A. 2001. The review of natural products: the most complete source of natural product information (No. Ed. 3): Facts and Comparisons.

Duke J. A. 2002. Handbook of medicinal herbs. CRC press.

Farooq M, Basra S.M.A, Ahmad N, Hafeez K. 2005. Thermal hardening: a new seed vigor enhancement tool in rice. J Integ Plant Biol. 47: 187-193.

Hossain M.K, Alam M.N. 2010. Allelopathic effects of Lantana camara leaf extract on germination and growth behavior of some agricultural and forest crops in Bangladesh. Pak J Weed Sci Res. 16: 217-226.

Hussain F, Gadoon M.A. 1981. Allelopathic effects of *Sorghum vulgare* Pers. Oecologia. 51: 284-288.

Hussain F, Ghulam S, Sher Z, Ahmad B. 2011. Allelopathy by *Lantana camara* L. Pak J Bot. 43: 2373-2378.

Hussain F, Zaidi M.I, Chughtai S.R. 1984. Allelopathic effects of Pakistani weeds: *Eragrostis poaeoides* P*. beauv*. Pak J Sci Indust Res. 27: 159-164.

Javaid A, Shafique S, Shafique S. 2009. Herbicidal activity of *Withania somnifera* and *Datura alba* against Rumex *dentatus*. J Agric Res. 47: 37-45.

Kanchan S, Chandra J. 1980. Pollen allelopathy. A new phenomenon. New Phytol. 84: 739-646.

Khalaj M.A, Amiri M, Azimi M.H. 2013. Allelopathy: physiological and sustainable agriculture important aspects. Int J Agron Plant Prod. 4: 950-962.

Khan N, Naveed K, Hussain Z, Khan A.S. 2012. Assessment of allelopathic effects of parthenium (Parthenium hysterophorus L.) plant parts on seed germination and seedling growth of wheat (*Triticum aestivum* L.) cultivars. Pak. J. Weed Sci. Res. 18: 39-50.

Malik M, Khan A.U.H. 2012. Weed diversity in wheat fields of Upper Indus Plains in Punjab, Pakistan. Pak. J. Weed Sci. Res. 18: 413-421.

Marwat K.B, Hashim S, Ali H. 2010. Weed management: a case study from north-west Pakistan. Pak. J. Bot 42: 341-353.

Mishra A. 2015. Allelopathic properties of *Lantana camara*. Int Res J Basic Clinic Stud. 3: 13-28.

MoradiDezfuli P, Sharif-zadeh F, Janmohammadi M. 2008. Influence of priming techniques on seed germination behavior of maize inbred lines (*Zea mays* L.). ARPN J Agric Biol Sci. 3: 22-25.

Neogi N.C, Garg R.D, Rathor R.S. 1970. Preliminary pharmacological studies on achyranthine. Ind J Pharmacy. 32: 43-46.

Orchard T.J. 1977. Estimating the parameters of plant seedling emergence. Seed Sci Tech. 5: 61-69.

Oudhia P, Tripathi R.S. 2000. Allelopathic effect of *Lantana camara* L. on wheat var. Sujata. Crop Res. 19: 357-360.

Paudel V, Gupta V, Agarwal V. 2009. Effect of diffusates of *Parthenium hysterophorus* L. on seed germination of *Raphanus sativus* L. Scient World 7: 29-32.

Prasad K, Srivastava V.C. 1991. Teletoxic effect of weeds on germination and growth of rice (*Oryza sativa*). Indian J. Agr. Sci. 61: 591-592.

Putnam A.R, Tang C.S. 1986. The science of allelopathy. Wiley.

Qureshi S.A, Madramootoo C.A, Georges D. 2002. Evaluation of irrigation schemes for sugarcane in Sindh, Pakistan, using SWAP93. Agric Water Manag. 54: 37-48.

Rajiv P, Narendhran S, Subhash K.M, Sankar A, Sivaraj R, Venckatesh R. 2013. *Parthenium hysterophorus* L. compost: assessment of its physical properties and allelopathic effect on germination and growth of *Arachis hypogeae* L. Int Res J Environ Sci. 2: 1-5.

Rashid H, Khan M.A, Amin A, Nawab K, Hussain N, Bhowmik P.K. 2008. Effect of *Parthenium hysterophorus* L. root extracts on seed germination and growth of maize and barley. Americas J. Plant Sci. Biotechnol. 2: 51-55.

Rice E.L. 1984. Allelopathy. 2nd Ed. Academic Press, New York. pp. 421.

Safdar M.E, Tanveer A, Khaliq A, Naeem M.S. 2014. Allelopathic action of parthenium and its rhizospheric soil on maize as influenced by growing conditions. Planta Daninha. 32: 243-253.

Scott S.J, Jones R.A, Williams W. 1984. Review of data analysis methods for seed germination1. Crop Sci. 24: 1192-1199.

Shabbir A, Bajwa R. 2006. Distribution of parthenium weed (*Parthenium hysterophorus* L.), an alien invasive weed species threatening the biodiversity of Islamabad. Weed Biol Manag. 6: 89-95.

Shah S.R.U, Muhammad Q, Khan I.A, Shah S.A.U. 2006. Study of medicinal plants among weeds of wheat and maize in Peshawar Region. Pak. J. Weed Sci. Res. 12: 191-197.

Sharma G.P, Raghubanshi A.S, Singh J.S. 2005. Lantana invasion: an overview. Weed Biol Manag. 5: 157-167.

Sharma G.P, Raghubanshi A.S. 2007. Effect of *Lantana camara* L. cover on local depletion of tree population in the Vindhyan tropical dry deciduous forest of India. Appl Ecol Environ Res. 5: 109-121.

Singh H.P, Batish D.R, Pandher J.K, Kohli R.K. 2003. Assessment of allelopathic properties of *Parthenium hysterophorus* residues. Agric Ecosys Environ. 95: 537-541.

Singh S.P, Sangeeta. 1991. Allelopathic potential of *Parthenium hysterophorus* L. J Agron Crop Sci. 167: 201-206.

Srivastav S, Singh P, Mishra G, Jha K.K, Khosa R.L. 2011. *Achyranthes aspera*-An important medicinal plant: A review. J Nat Prod Plant Resour. 1: 1-14.

Steel R.G.D, Torrie J.H, Dickey D.A. 1997. Principles and Procedures of Statistics. A Biometrical Approach 3rd Ed. McGraw Hill Book Co., Inc., Singapore, pp: 172-177.

Tanveer A, Safdar M.E, Tariq M.A, Yasin M, Noorka I.R. 2014. Allelopathic inhibition of germination and seedling vigor of some selected crops by *Achyranthes aspera* L. Herbologia 14: 35-46.

Zalucki M.P, Day M.D, Playford J. 2007. Will biological control of *Lantana camara* ever succeed? Patterns, processes & prospects. Biol Control. 42: 251-261.

Cite this article as: Muhammad Ehsan Safdar, Ahsan Aziz, Umer Farooq, Muhammad Sikander Hayat, Abdul Rehman, Rafi Qamar, Amjed Ali, Tahir Hussain Awan. Germination and growth of some summer crops as affected by allelopathicity of different waste-land weeds. *Journal of Research in Weed Science*, 2019, 2(4), 358-371. DOI: 10.26655/JRWEEDSCI.2019.4.6