TOLERANCE OF CHICKPEA VARIETIES AGAINST ALLELOPATHIC POTENTIAL OF TWO INVASIVE WEEDS COLLECTED FROM THREE LOCATIONS OF KHYBER PAKHTUNKHWA PAKISTAN

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ABSTRACT

Phytotoxicity of two invasive weed species Parthenium hysterophorus L. and Xanthium strumarium L. collected from three different sites viz., Charsadda, Mardan and Peshawar districts of Khyber Pakhtunkhwa were tested against five chickpea varieties in completely randomized design having three replications. The weed species extract revealed highly significant inhibitory effect on chickpea varieties. Among the applied extracts; extract prepared from Parthenium weed collected from Charsadda proved to be more toxic as compared to extracts prepared from other areas, by inhibiting the germination of chickpea to the extent of 91.4%. Maximum and minimum average root weight of 0.56 g and 0.15g among different chickpea varieties was recorded for Peshawar Xanthium and Charsadda Parthenium, respectively. Maximum mean shoot length of 0.29 cm was evident for the control treatment (no extract) whereas minimum mean shoot length of 0.09 cm was observed for chickpea varieties treated involving Charsadda Xanthium. Maximum and minimum mean shoot weight of 2.40 g and 0.77 g were manifested by different chickpea varieties treated by Control (no treatment) and Charsadda Parthenium, respectively. Similarly maximum mean seed vigour index (SVI) of (225.13) was evident for control treatment whereas Extracts from Charsadda Parthenium manifested minimum mean seed vigour index (69.63) in different chickpea varieties under test. It is evident from the results of varietal response of chickpea to common cocklebur (Xanthium strumarium) and parthenium (Parthenium hysterphorus) treatment that chickpea varieties showed tolerance against the phytotoxcity of these invasive weeds. Therefore, it could be used as bio herbicide if it is effective in controlling weeds of chickpea.

Keywords: Allelochemicals, *Cicer arietinum*, cultivars, genetic tolerance, invasive weeds, *Parthenium hysterophorus*, *Xanthium strumarium*.

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INTRODUCTION

Enormous importance of chickpea (*Cicer arietinum* L.) as a vegetable and pulse crop has been demonstrated in Pakistan and Khyber Pakhtunkhwa (KPK). The prevailing severe edaphic and ecological conditions such as inadequate moisture, poor soil and weed management and inadequate or even no fertilizer are the main factors responsible for lower chickpea yield in Pakistan than in the developed countries (Hassan *et al.,* 2006). Allelochemicals released by weeds in the crop growing environment affects the crop growth in the same manner as by competing for nutrients, light and moisture (Kadioglue *et al.,* 2005). The efficacy of allelopathic prospective of different weed's parts such as leaf, stem, root and fruit on crop germination and seedling growth varied (Safdar *et al*., 2019). Although the allelopathic behavior of various weed plant parts was different on crops (Veenapani, 2004). Yet seed crop germination and initial growth are effected differently by the allelopathic effects of different parts of same weed (Aziz *et al*., 2008). Water soluble compounds released by the weeds into the soil also exerted allelopathic effect on crop seed growth and germination. (Batish *et al*., 2007).

The presence of allelo-chemicals in buds, flowers, leaves, stems and seeds are confirmed by many studies. Under field conditions, the suppression of harmful weeds by the field crop was reported by many researchers. Ata and Jamil (2001) have reported the genotypes of rice, oat, sorghum, pearl millet, soybean, sunflower, cucumber and *Brassica campestris* having superior weed suppressing quality. The problems associated with the use of present day pesticides offered a great potential for allelochemicals to be used as pesticides.

The inexpensive and environment friendly use of allelopathic water extracts of weeds helps in reduction in weed biomass as well as reduces the cost on herbicides and hand weeding. Weed management may be carried out in the field. Application of the weed residues having allelopathic effect may be utilized for weed management. Similarly the water extracts of crop plants such as mulches in the field may be employed in weed controlling practices (Matloob *et al*., 2010). Likewise Shikha and Jha (2019) reported that the aqueous extracts of stem of *Parthenium* was more phytotoxic than root extract on germination and growth of *Cicer aeritinum*.

The direct consumption of chickpea for nutritional purpose and its suitability to most of the arid regions of the country ranked it among the mainly grown crops. The main focus of the researchers of the region is to minimize the factors responsible for reducing the chickpea yield. The failure of chickpea seed to germinate in the soil is one of the most important factors among the various responsible for yield reduction. Leaching down of accumulated weed extract/ debris (allelochemicals) present in soil through rain water or ploughing is one of the major reasons for this failure (Khan *et al.* 2012).

In order to determine the impact of harmful chemicals released in the soil by different weeds present in the chickpea filed and to provide precise information for chickpea growers, this study was aimed to investigate the negative effect of parthenium and xanthium weed on different chickpea varieties under laboratory conditions.

MATERIALS AND METHODS

This study was conducted at the Agricultural Graduate Laboratory, Bacha Khan University, Charsadda, Pakistan during January, 2018. The experiment was carried out in Completely Randomized Design with factorial arrangements repeated thrice. The phytotoxcity of 2 invasive weeds species (*Parthenium hysterophorus* and *Xainthium strumarium*) collected from three different locations, Peshawar, Charsadda and Mardan districts was tested against five chickpea varieties. Details of the factors are given below.

Chickpea varieties (Factor-A)

1. 'Karak-I'
2. 'Karak-II'
3. 'Karak-III'

4. 'Chattan'
5. 'Fakhr-e-Thal'

Weeds extract (Factor-B)

1 Peshawar *P. hysterophorus*
2 Peshawar *X. strumarium*
3 Mardan *P. hysterophorus*
4 Mardan *X. strumarium*
5 Charsadda *P. hysterophorus*
6 Charsadda *X. strumarium*

Sample Collection and extract preparation

Three different locations of Peshawar, Mardan and Charsadda, Pakistan were selected randomly for weed samples collection. The whole plant was cut near the ground base with a sharp cutter to collect the sample. Tap water was used to remove the dust and dirt particles. The samples were then dried at room temperature under the shade. The dried plant parts such as leaves and stem were separated, chopped and grinded with the help of grinding machine. Concentrated extract of different parts of weed was made by mixing 120 g of dried powder of individual weed part in one liter of tap water. The solution was kept at room temperature for 24 hours. Filtering process was carried out, using 10 and 60-mesh sieves, to get the final aqueous solution of weeds. Bottling and tagging of the individually weed extracts were carried out for further use in the experimentation. Seedling vigor index was calculated by the following formula

S.V.I = Root length + Shoot length x % Germination

Procedure

The trial was carried out in petri plates replicated three times. Each petri plate contained ten seed of each chickpea variety and three sheets of Whatman No.1 filter paper cut according to size. The petri plates were added with three mL of plant extract as per treatment. Distilled water was used for comparison as a control treatment. Daily observation of the petri plates were carried out. To provide an optimum environment for seed/ seedling growth, an equal amount of aqueous solution was added to each Petri plate as and when needed.

Statistical analysis

The experimental data was subjected to Analysis of Variance (ANOVA) specified for complete randomized design using statistical software Statistix (Version 8.1). The significant means were separated by the Least Significant Differences (LSD) Test at P=0.05 (Montgomery, 2001).

RESULTS AND DISCUSSION

Germination (%)

The aqueous weed extract of *Parthenium* and Xanthium revealed significant differences among germination (%) of different chickpea varieties (Table-1). Maximum germination of 99.3 % was evident for Peshawar *Xanthium*; it was statistically at par with the performance of Charsadda *Xanthium* (98.0%), whereas Charsadda *Parthenium* revealed minimum germination (91.4%). Variety mean data of the tested chickpea varieties for germination percentage showed that the performance of different chickpea varieties was significantly affected by weed extracts. Minimum germination of 90.3% was evident in chickpea variety Karak-III, whereas, chickpea variety Karak-I attained maximum (99.0%) germination against different weed extracts (Table-1). It is evident from the interaction of chickpea varieties and aqueous weed extracts that chickpea variety Karak-I showed maximum (100 %) germination for all treatment except Charsadda Parthenium (93.3%), while minimum seed germination (80.3 %) was noted for the interaction of Karak-III with aqueous weeds extracts especially Charsadda *Parthenium* (80.3%). The allelopathins have the potential to affect the receiver plant in variety of ways and many researchers have explored their presence in various parts of plant. However, in donor plants certain specialized organs synthesize these allelochemicals as secondary metabolites (Kobayashi, 2004). Khan *et al*. (2011) also reported that different concentrations of aqueous extracts of *Silybum marianum* inhibited the chickpea germination by 60 %.

Table-1. Effects of different weed extracts on germination (%) of the tested chickpea varieties.

Extract	Chickpea Varieties					Means
	Chattan	**Karak-I**	**Karak-II**	**Karak-III**	**Fakhr-e-Thal**	
Peshawar *P. hysterophorus*	90.0 a-c	100.0 a	96.7 ab	83.7 bc	100.0 a	94.6 a-c
Peshawar *X. strumarium*	100.0 a	100.0 a	100.0 a	96.7 ab	100.0 a	99.3 a
Mardan *P. hysterophorus*	96.7 ab	100.0 a	93.3 a-c	90.3 a-c	100.0 a	96.6 a-c
Mardan *X. strumarium*	90.0 a-c	100.0 a	100.0 a	93.3 a-c	83.3 c	93.3 bc
Charsadda *P. hysterophorus*	96.7 ab	93.3 a-c	100.0 a	80.3 c	86.7 bc	91.4 c
Charsadda *X. strumarium*	100.0 a	100.0 a	93.3 a-c	96.7 ab	100.0 a	98.0 ab
Control (no extract)	100.0 a	100.0 a	100.0 a	100.0 a	100.0 a	100.0 a
Means	96.2 ab	99.0 a	97.6 a	90.3 c	95.7 ab	

$LSD_{0.05}$for weed extract= 2.435
$LSD_{0.05}$for varieties= 2.6703
$LSD_{0.05}$ for varieties x extracts= 3.20

Seed Vigour Index (SVI)

The ANOVA for seed vigour index revealed highly significant differences for weed extracts and interaction of weeds extracts with chickpea varieties whereas the differences among the performance of chickpea varieties were non-significant (Table-2). It is evident from the data that control treatment (no extract) attained maximum SVI value (225), while minimum seed vigour index (70) was calculated for Charsadda *Parthenium*. The present study revealed non-significant differences among the varieties mean. The highest (163) and lowest (125) SVI mean value for varieties was recorded for Karak-II and Chattan, respectively. The mean data of the interaction of chickpea varieties with aqueous weeds extract revealed that maximum (268) value of SVI was attained by variety Karak-III x control treatment (no extract) followed by Karak-II x Peshawar Parthenium, while minimum value of 35 each was observed for the interaction of Charsadda Parthenium and variety Chattan. Mubeen *et al*. (2011) also reported the significant reduction in SVI of rice by the application of *Trianthima portulacastrum* leaf extracts

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Table-2. Effect of different weed extracts x chickpea varieties on seed vigor index (SVI)

	Chickpea Varieties					
Extract	**Chattan**	**Karak-I**	**Karak-II**	**Karak-III**	**Fakhr-e-Thal**	**Mean**
Peshawar *P. hysterophorus*	105 e-j	85 f-j	265 a	134 c-j	179 a-h	154 b
Peshawar *X. strumarium*	215 a-d	180 a-h	248 a-c	134 c-j	253 ab	202 a
Mardan *P. hysterophorus*	139 c-j	185a-g	46 ij	153b-i	87 f-j	122 b
Mardan *X. strumarium*	86 f-j	121 c-j	191 a-f	134 c-j	70 ij	120 b
Charsadda *P. hysterophorus*	35 j	81 g-j	76 h-j	82 g-j	74 h-j	70 c
Charsadda *X. strumarium*	92 f-j	131 c-j	124 c-j	114 d-j	112 d-j	115 bc
Control (no extract)	200 a-e	248 ab	207 a-e	268 a	202 a-e	225 a
Mean	125	147	163	146	140	

$LSD_{0.05}$ for extracts= 47.564
$LSD_{0.05}$ for varieties x extracts=106.36

Shoot length (cm)

Highly significant differences of aqueous extracts of different weeds and interaction of chickpea varieties by weed extracts were observed for shoot length of chickpea varieties, whereas the performance of different chickpea varieties had a non-significant effect on shoot length of chickpea (Table-3). The results of the study revealed that the maximum and minimum shoot length of 0.29cm and 0.09 cm was noticed in control treatment (no extract) and extract of *Xanthium* collected from Charsadda, respectively. Among the chickpea cultivars, Karak-II attained maximum shoot length of 0.16 cm followed by Karak-I (0.16 cm) while the lowest value was evident for Karak-III (0.13 cm). The interaction of chickpea variety by weed extract mean values showed that Peshawar Xanthium x "Chattan attained the maximum value of shoot length (0.43 cm), while the least value (0.02 cm) was observed for Mardan *Xanthium* x variety Fakhr-e-Thal (Table-3). Our results are in line with the findings of Khan *et al.* (2012b) who observed decrease in the length of root and shoot length of wheat seeds upon the application of extracts of Parthenium hysterophorus L. plant parts. Veenapani (2004) also concluded that the seed germination and development in different crops was inhibited due to allelopathic behavior of various parts of weeds

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Table-3. Effect of different weed extracts x chickpea varieties on shoot length (cm) of chickpea varieties.

	Chickpea Varieties					
Extract	**Chattan**	**Karak I**	**Karak II**	**Karak III**	**Fakhr-e-Thal**	**Mean**
Peshawar *P.hysterophorus*	0.14 e-h	0.06 f-h	0.15 e-h	0.11 e-h	0.08 f-h	0.11 b
Peshawar *X. strumarium*	0.43 a	0.25 a-f	0.19 c-h	0.16 d-h	0.37 a-c	0.28 a
Mardan *P.hysterophorus*	0.07 f-h	0.11 e-h	0.20 c-h	0.06 f-h	0.07 f-h	0.10 b
Mardan *X. strumarium*	0.05 gh	0.14 e-h	0.19 c-h	0.08 f-h	0.02 h	0.09 b
Charsadda *P.hysterophorus*	0.03 h	0.18 c-h	0.17 d-h	0.05 gh	0.08 fgh	0.10 b
Charsadda *X. strumarium*	0.11 e-h	0.08 f-h	0.05 gh	0.09 f-h	0.09 f-h	0.09 b
Control (no extract)	0.23 b-g	0.30 a-e	0.19 c-h	0.34 a-d	0.39 ab	0.29 a
Mean	0.15	0.16	0.1	0.13	0.16	

$LSD_{0.05}$ for extracts=0.0845
$LSD_{0.05}$for varieties x extracts=0.1889

Root weight (g)

Highly significant differences among different weed extracts were observed when data was analyzed for root weight, significant differences among chickpea varieties were observed whereas the interaction of varieties by extract showed non-significant differences for root weight parameter. The data for weed extract means revealed that maximum (0.56 g) root weight was noted for *Xanthium*, followed by control treatment (no extract)(0.46 g), whereas Charsadda *Parthenium* revealed minimum root weight (0.15 g). Similarly, the mean data of chickpea varieties showed that weed extracts had significant effect on the root weight. It is evident from the Table-5 that chickpea variety Karak-I gave minimum (0.31 g) root weight whereas chickpea variety Karak-III yielded the highest (0.42 g) weight against different weed extracts. Maximum (0.73 g) root weight for the interaction of chickpea variety and weed extracts was recorded for Peshawar *Xanthium* x variety Fakhr-e-Thal, while minimum root weight (0.09 g) was noted for Charsadda *Parthenium* x variety Chattan (Table-4). Many researchers have explored the presence of allelochemicals in different parts of the plant. They are of the view that the receiver plants are affected in certain ways due to the presence of allelopathins. Kobayashi, 2004) is of the view that the presence of allelopathins in different parts of plants can greatly affect the receiver plants in many ways. Whereas, in donor plants, certain specialized organs are involved in synthesizing these allelochemicals as secondary metabolites.

Table-4. Effect of different weed extracts x chickpea varieties on root weight (g) of chickpea varieties.

	Chickpea Varieties					
Extract	**Chattan**	**Karak I**	**Karak II**	**Karak III**	**Fakhr-e-Thal**	**Mean**
Peshawar *P. hysterophorus*	0.23 g-k	0.20 h-k	0.25 f-k	0.43 b-g	0.34 d-j	0.29 d
Peshawar *X. strumarium*	0.40 b-i	0.45 b-g	0.62ab	0.59 a-c	0.74 a	0.56 a
Mardan *P. hysterophorus*	0.36 d-ij	0.41 b-i	0.34 d-j	0.38 c-j	0.37 d-j	0.37 b-d
Mardan *X. strumarium*	0.37 d-j	0.39 c-j	0.41 b-h	0.47 b-e	0.42 b-h	0.41 bc
Charsadda *P. hysterophorus*	0.09 k	0.09 k	0.19 i-k	0.17 jk	0.21 h-k	0.15 e
Charsadda *X. strumarium*	0.35 d-j	0.29 e-k	0.35 d-j	0.35 d-j	0.35 d-j	0.34 cd
Control (no extract)	0.47 b-e	0.35 d-j	0.52 a-d	0.55 a-d	0.46 b-f	0.47 ab
Mean	0.33 b	0.31 b	0.38 ab	0.42 a	0.41 a	

$LSD_{0.05}$ for varieties= 0.08
$LSD_{0.05}$for extracts= 0.09
$LSD_{0.05}$for varieties x extracts interaction=0.21

Shoot weight (g)

The ANOVA for shoot weight of chickpea varieties revealed highly significant differences among the performance of different weeds extracts and performance of chickpea varieties, whereas non-significant differences for the interaction of varieties by weeds extract was observed (Table-5). These results showed that the highest shoot weight of 2.40 g was noticed in control treatment (no extract), while the lowest shoot length (0.77g) was computed for Charsadda *Parthenium*. Among the chickpea cultivars the maximum (1.65g) shoot weight were recorded for Karak-II fallowed by Karak-III (1.53 g) while the lowest data were recorded for chickpea variety Chattan (1.29g). Maximum value of shoot weight (2.82g) for interaction mean data was noticed in control treatment (no extract) x KarakIII, while the least value for this parameter (0.35g) was evident for Charsadda *Parthenium* x variety "Chattan" (Table-5). Khan *et al.* (2012a) found the inhibition in root and shoot weight of different crop seed when exposed to various plant parts extracts.

Table-5. Effect of different weed extracts x chickpea varieties on shoot weight (g) of chickpea varieties.

	Chickpea Varieties					
Extract	**Chattan**	**Karak I**	**Karak II**	**Karak III**	**Fakhr-e-Thal**	**Mean**
Peshawar *P. hysterophorus*	1.16 f-m	0.85 i-m	2.75 a	1.55 b-k	1.78 a-j	1.62 bc
Peshawar *X. strumarium*	2.15 a-g	1.80 a-j	2.27 a-d	1.38 d-m	2.53 ab	2.03 ab
Mardan *P. hysterophorus*	1.44 c-l	1.85 a-i	0.50 lm	1.60 b-k	0.87 h-m	1.25 c
Mardan *X. strumarium*	0.86 i-m	1.21 f-m	1.91 a-h	1.36 e-m	0.70 k-m	1.21 cd
Charsadda *P. hysterophorus*	0.35 m	0.90 h-m	0.76 j-m	0.94 h-m	0.90 h-m	0.77 d
Charsadda *X. strumarium*	0.92 h-m	1.31 e-m	1.35 e-m	1.17 f-m	1.12 g-m	1.17 cd
Control (no extract)	2.20 a-f	2.48 a-c	2.07 a-g	2.82 a	2.42 a-d	2.40 a
Mean	1.29	1.48	1.65	1.54	1.47	

$LSD_{0.05}$ for varieties= 0.3958
$LSD_{0.05}$for Extracts=0.4683
$LSD_{0.05}$for Varieties x Extracts interaction= 1.0472

CONCLUSIONS AND RECOMMENDATIONS

It is evident from the results of varietal response of chickpea varieties to *Xanthium* and *Parthinium* treatment that chickpea varieties showed resistance against the phytotoxcity of these invasive weeds, so it can be popularized as bio herbicide in chickpea if it gave promising results in controlling chickpea weeds.

More studies are also recommended to search out the allelopathic potential of parthenium weed against other crops and weeds. If this weed showed strong phytotoxic effects on some problematic weeds then this can lead to the synthesis of some ecofriendly bio herbicide in future.

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