ALLELOPATHIC EFFECTS OF PLANT PARTS OF TWO INVASIVE WEEDS ON SEED GERMINATION AND SEEDLING GROWTH OF OPEN POLLINATED MAIZE VARIETIES

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ABSTRACT

Allelopathic effects of plant parts of two invasive weeds on seed germination and seedling growth of open pollinated maize varieties was investigated at the Agriculture Graduate Laboratory of the Bacha Khan University Charsadda Pakistan during summer, 2018. The experiment was carried out in CRD design with factorial arrangements repeated thrice. Five maize varieties viz., 'Azam', 'Babar',s Pahari', 'Iqbal', and 'Jalal' comprised factor A while, Factor B consisted of water extracts from root, stem and leaf of invasive weeds; Parthenium hysterophorus and Xanthium strumarium. Distilled water was used as control for comparison. Data were recorded for germination (%), seedlings length (cm), shoot weight (g) and root weight (g). It was evident from the results that maximum germination (100 %), Seedling length (7.6 cm), shoot weight (164.88 g) and root weight (163.8 g) was recorded for control (water) treatments. However, among the tested extracts the minimum germination (85.0 %) of maize varieties were achieved under P. hysterophorus stem extract. Maize variety "Pharri" revealed highest sensitivity towards allelopathic potential of different extract, giving minimum (87.5 %) germination. On the other hand, the maize variety Babar showed strong resistance against all applied extracts (treatments) and showed 100% seed germination. In the light of the current results it is recommended that the farmer should discourage the growth of P. hysterophorus weed in their filed as it has strong allelopathic effects on maize crop. Moreover, the farmers should grow maize variety Babar instead of others as this variety showed strong resistant towards the allelopathic effects of both the tested invasive weeds.

Keywords: Open pollinated varieties, *Parthenium hysterophorus*, *Xanthium strumarium.* maize.

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INTRODUCTION

Maize (*Zea mays* L.) is ranked third most important cereal crop after wheat and rice in respect of area and production. In Pakistan it was planted at 65% irrigated and 35% rainfed area with total of 1.12 million hectares (ha) resulting with an average production of 4.53 million tons. (Anonymous, 2010-11). Maize grain is rich source of dietary nutrients. It has 72%, 10 %, 4.8% 5.8%, 3% and 1.8% of starch, protein, oil, fiber, sugar and ash, respectively (Chaudhry,1983).Low yield causing factors such as poor crop management and inappropriate soil fertility inhibit the farmer from getting high yield although the idealsoil and climatic conditions of Pakistan made it fit for maize production. By contributing 21 percent to GDP and employing 43.7 percent of the labor force, agriculture proved to be a vital economic sector of Pakistan. More than 59% percent of the rural population derived their livelihood directly from agriculture (GoP, 2014). The rapidly increasing population in developing country like Pakistan has significantly increased the importance of maize as a cereal crop, to meet the increasing demand of food for growing population. (Memon *et al*., 2011; Durrishahwarn *et al.*, 2008).

One of the biggest challenges in increasing maize yield under limited conditions in crop producing area was yield loss due to weed competition. Economic constraints such as cost of labor, high price of herbicide and hybrids are generally faced by farmers in Pakistan, where corn (*Zea mays* L.) is mostly grown for edible purpose. Increase in crop density to capture more light and covers more soil surface is one of the most efficient weed management strategies to compete with weeds. This may resulted change innumber of grains ear^{-1} and grain weight (Dastfal *et al*., 1999). Rajcan and Swanton, (2001) concluded that the ability of particular weed species to compete for water and nutrient availability and light quality determine its impacts of on corn growth and yield.

One of the worst and most competitive summer weed in cotton, soybean, peanut and maize field is common cocklebur (*Xanthium strumarium* L.). It is aannually grown summer weed having large and broad leaves.(Miller, 2003;Charudattan& Walker 1982). The problems faced in controlling this weed across Balkan area including Macedonia using different chemicals showed the problematic nature of this weed. Barrentine (1974) found the reduction in soybean yield by 10, 28, 43 and 52% during peak season competition by common cocklebur at densities of 3300, 6600, 13 000 and 26 000 plants ha^{-1}. Similarly he observed that during drought stress conditions and cocklebur plant densities of 2000 to 64000 per hectare, reduction in soybean seed yields was from 15% to 100%. Up to 90% decrease in cotton yield, resulted from reductions in boll and seed weight, was observed when common cocklebur weed density was increased from 24 weeds/ 7 m row to 48 weeds / 31 m row length. Similarly Snipes et al. (1987) demonstrated that a single common cocklebur plant, allowed to compete for a full season over an area of 15 m^2, has a potential to decrease the cotton seed yield from 72 kg to 115kg ha^{-1}. Reduction in peanut crop yield up to 16% was reported by Rawson (1964)if a single weed plant of common cocklebur was allowed to grow to maturity over an area of 0.836 m^2 in a peanut field. The competition of common cocklebur in maize is less than in soybean, yet it can cause significant loss in maize crop yield (Weaver, 2001).

Parthenium, a prolific herbaceous weed, belongs to family Asteraceae, was first introduced in Indiaalong with edible grain PL-480. Chippandale and Panetta (1994) reported health issues in farmers and livestock who came in contact with Parthenium weed. Also its competition with desirable crop and pasture species is evident from studies. Allelopathic effects of leaf and stem extract and dry biomass of *Parthinum hystoraphorus*L. at different concentration on germination and seedling growth and its population density on productivity of corn (*Zea mays* L.) were examined at Manipur University. At 10% (w/v) of leaf and stem extract, cent percent and 91.6% inhibition of seed germination were observed respectively. Parthenium dry biomass incorporated in soil significantly reduced germination and seedling growth of maize with 50 g to 400 g per 10 kg of soil. The population of Parthenium also affects plant height, dry biomass and productivity of corn length, weight and grain weight per corn with increase in population ratio. The presence of different phytochemicals like flavonoids, terpenoids, tannins, alkaloids, steroids etc, from methanol extracts were evident from the qualitative tests of phytochemical constituents of Parthenium. However saponin, tannin, glycoside and cardiac glycoside were found to be absent in the aqueous extracts.Parthenium in the form of extract or residue or growing weed can affect the germination, growth and productivity of maize/ corn. So there is an urgent need of integrated Parthenium management strategy to stop further spread of this alien weed. It posed a serious threat to theviability of human being and natural agro-ecosystems across the continents (Adkins and Navie, 2006). The ability to develop large monoculture strands, even in the absence of other plants in the nearby areas, revealed the vastly spreading nature of this weed. (Riaz and Javaid, 2009).Therefore keeping in view the importance of maize crop and the alleopathic potential of invasive weeds; *Parthenum hystoraphorus* and *Xanthium strumarium* a study was conducted with the following objective.

1. To assess the allelopathic potential of invasive *P. hysteraphorus* and *X. strumarium* weed on maize crop.
2. To test the levels of phytotoxicity of different plant parts of *P. hysteroaphorus* and *X. strumarium*
3. To examine different maize varieties against the allelopathic effects of *P. hystraphorus* and *X. strumarium*.

MATERIALS AND METHODS

An experiment was conducted at the Graduated laboratory of Agriculture department, Bacha Khan University Charsadda Pakistan during summer, 2018. The experiment was designed in completely randomized design with two factor factorial arrangements repeated thrice. The two factors in the experiment are.

Factor A: Maize varieties

'Azam', 'Babar', 'Pahari', 'Iqbal' and 'Jalal'

Factor B: Invasive weeds extracts of plant parts

1) Leaf extract of *P. hysterophorus*
2) Stem extract of *P. hysterophorus*
3) Root extract of *P. hysterophorus*
4) Leaf extract of *X. strumarium*.
5) Stem extract of *X. strumarium*.
6) Root extract of *X. strumarium*

Sample collection and extract preparation

Sample of *P. hysterophorus* and *X. Strumarium* were collected from the research fields of Bacha Khan Agriculture Research Farm (BARF), Bacha Khan University, Charsadda. Whole plants along with the roots were pulled from moist soil before flower setting. 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 roots, leaves and stem were separated, chopped and grinded with the help of grindingmachine. 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.

Treatment Application

The trial was carried out in petri plates replicated four times. Each petri plate contained ten seed of each maize 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. The data were recorded for germination %, root weight (g), shoot length (cm) and shoot weight (g)

Statistical analyses

The recorded data were statistically analyzed and least significant difference (LSD) were computed through the procedure mentioned by Steel and Torrie (1980).

RESULTS AND DISCUSSION

Germination (%)

Significant effect of aqueous extract of weeds on germination of maize varieties was observed when the data was analyzed for germination percentage (Table-1). The means separation data of weed extracts revealed that control treatment gave maximum (100%) germination, whereas minimum (85.0 %) germination was observed for *P. hysterophorus* stem extract that was statistically at par with *P. hysterophorus* leaf extract. On the other hand, significant differences among the performance of different maize varieties against the tested weed extracts were observed for germination percentage. Maximum (100%) germination was recorded in maize variety Babar and minimum (87.5 %) was noted for maize variety Pahari. Similarly, the interaction of tested maize varieties and weed extracts revealed that the highest germination (100%) was recorded for the maize variety Babar in combination with all the applied extracts, while minimum (80.6%) germination was noted in maize variety Iqbal in combination with several extracts. The presence of allelopathins in various parts of plants as explored by many researchers, can affect the receiver plants to varying degrees.The plants synthesize these allelochemicals as secondary metabolites in certain specialized organs located in donor plants. Hence, it is concluded that the allelochemicals found in *P. hysterophorus* disturbed the normal functioning in maize plants that leads to the retardation of maize plant height. Similarly, Jabeen and Ahamd (2009) also found inhibitory effect of different weeds extract on growth of maize varieties. Kumar and Kumar (2010) also declared Parthenium weed as the worst invasive weeds which affects the summer crops plant through its allelopathy as well as adversely affects the biodiversity.

Table-1. Effects of the water extracts of *P. hysterophorus*and *X. Strumarium* on germination (%) of different Maize verities.

Weeds Extracts	Maize Varieties					
	Azam	Pahari	Jalal	Iqbal	Babar	Mean
X. strumarium leaf	100.0 a	90.60 ab	90.00 ab	90.6 ab	100.0 a	**95.0 ab**
X. strumarium stem	90.33ab	90.30 ab	90.00 ab	80.6 ab	100.0 a	**90.1 b**
X. strumarium root	90.66ab	90.30 ab	80.00 b	100.0 a	100.0 a	**92.4 ab**
P. hysterophorus leaf	80.66ab	80.60 ab	90.00 ab	80.6 ab	100.0 a	**86.3 c**
P. hysterophorus stem	80.66ab	80.60 ab	80.66 ab	80.6 ab	100.0 a	**85.0 c**
P. hysterophoru sroot	90.33ab	80.60 ab	90.00 ab	80.6 ab	100.0 a	**88.3 c**
Water (control)	100.00a	100.0 a	100.00 a	100.0 a	100.0 a	**100.0 a**
Extract means	**90.37 b**	**87.50 c**	**88.66 c**	**90.14 b**	**100.0 a**	

LSD Value for varieties = 1.3538
LSD Value for Extract = 0.7736
LSD Value for varieties Extract = 1.7298

Shoot length (cm)

The analysis of variance revealed significant differences among the aqueous extract of weeds on shoot length (cm) of different maize varieties (Table-2). The weed extract means showed that maximum shoot length (7.6 cm) was observed for control treatment (no extract), and minimum shoot length of 1.1 cm was evident for both *X. Strumarium* stem and *P.hysterophorus* stem extract. However, the data for the maize varieties means revealed that the differences were non-significant among the performance of different weed extracts for shoot length. However, the minimum (2.11 cm) numerical value noted for maize variety Jalal, while maize variety Pahari gave the maximum (2.71 cm) shoot length (Table-2). The interaction between maize varieties and weed extracts revealed that maximum shoot length (9.82 cm) was observed for control treatment (no extract) x Azam whereas, minimum (0.81 cm) shoot length was recorded under the combination of variety Iqbal and leaf extracts of *X. strumarium*. Plants express their allelopathic capability through production of allelochemicals and their exudation into the environment by either leaching, volatilization or decomposition which affect the germination and shoot length other plant (Farooq *et al*., 2011). Allelopathic effects of various weeds on germination, radicle and plumule extension of field crops have also been reported earlier by Singh *et al*., 2005.

Table-2. Effects of the water extracts of *P. hysterophorus*and *X. strumarium*on shoot length (cm) of different Maize verities.

Weeds Extracts	Maize Varieties					
	Azam	Pahari	Jalal	Iqbal	Babar	**Mean**
X. strumarium leaf	1.24 c	1.00 c	1.99 c	0.81 d	0.95 d	**1.19 c**
X. strumarium stem	1.92 c	1.69 c	1.41 c	1.61 c	1.92 c	**1.1 bc**
X. strumarium root	1.93 c	2.05 c	1.51 c	2.24 c	1.72 c	**1.9 b**
P. hysterophorus leaf	1.5 c	1.33 c	1.29 c	1.67 c	1.19 c	**1.4 bc**
P. hysterophorus stem	2.15 c	1.04 c	1.31 c	1.95 c	1.12 c	**1.1 bc**
P. hysterophorus root	2.01 c	2.09 c	1.88 c	1.96 c	1.72 c	**1.3 b**
Water (control)	7.23 ab	9.82 a	6.41 b	6.78 b	6.63 b	**7.6 a**
Extract means	**2.57 NS**	**2.71**	**2.11**	**2.43**	**2.18**	

LSD value for varieties = NS
LSD value for Extract = 0.8595
LSD value for Extracts x varieties = 0.7321

Shoot weight (g)

Like the previous studied parameter significant differences among different maize varieties were also observed regarding the shoot weight (Table-3). Among the different plant parts extracts the maximum (164.8g) was observed for control treatment while, the minimum (2.63g) shoot weight was observed for *X. strumarium* leaf extract. For the tested maize varieties, the lowest (30.39 g) shoot weight was recorded for maize variety Jalal and the highest (41.7 g) was observed for maize variety Iqbal. The interaction among the aqueous extracts of weed and tested maize varieties showed that the shoot weight of the all maize varieties was significantly affected by the applied weed extracts. However, minimum shoot weight of 2.15 g was recorded in *X. strumarium* leaf extract x maize variety Pahari, whereas maximum (187g) shoot weight was noted for the same variety (Pahari) under the control treatment. Weeds compete for moisture, light, space and nutrients and cause yield losses in crop yield. Beside, the allelopathic effects of weeds also affect the seed germination and early crop growth (Kadioglue *et al*., 2005).

Table-3. **Effects of the water extracts of *P. hysterophorus*and *X. strumarium* on shoot weight (g) of different Maize verities.**

Weeds Extracts	Maize Varieties					
	Azam	Pahhari	Jalal	Iqbal	Babar	Mean
X. strumarium leaf	2.68 c	2.15 c	2.68 c	2.61 c	2.68 c	**2.63 e**
X. strumarium stem	13.53c	26.90 c	28.57 c	40.17 c	12.81c	**24.40 bc**
X. strumarium root	16.11c	16.56 c	19.03 c	19.67 c	15.57 c	**17.39 c**
*P. hysterophorus*leaf	5.46 c	7.34 c	3.14 c	4.22 c	4.11c	**4.85 e**
P. hysterophorus stem	.500 c	4.99 c	25.27 c	21.37 c	15.12 c	**14.36 d**
*P. hysterophorus*root	12.23 c	11.80 c	15.50 c	27.37 c	18.83 c	**17.15 c**
Water (control)	159.17 ab	187.00 a	118.57 b	176.50 ab	183.17 a	**164.88 a**
Extract means	**30.59 b**	**36.72 b**	**30.39 b**	**41.70 a**	**36.05 ab**	

LSD value for extracts = 7.588
LSD value for varieties = 5.763
LSD value for varieties x Extracts = 22.727

Root weight (g)

ANOVA revealed significant effect of the aqueous extract of weeds on root weight (g) of different maize varieties (Table-4). The extracts means revealed that the maximum and minimum root weight of 163.8g and 43.22 g was noted for control treatment (no extract), and *Xanthium strumarium* root extract, respectively. On the other hand, the data for the maize varieties means showed non-significant differences for root weight, however, numerically the minimum root weight (59.29 g) was recorded for maize variety Babar while, maize variety Pahari gave maximum root weight of 77.63 g. (Table-4). The interaction of weed extracts and tested Maize varieties also revealed significant differences among the performance of maize varieties across different weed extracts. Maximum (188.3 g) and minimum (31.2 g) was recorded for the maize variety Baber interacting with control treatment (no extract) and *Xanthium strumarium root* extract, respectively.

Table-4. Effects of the water extracts of *P. hysterophorus* and *X. strumarium* on root weight (g) of different Maize varieties.

Weeds Extracts	Maize Varieties					
	Azam	**Pahhari**	**Jalal**	**Iqbal**	**Babar**	**Mean**
X. strumarium leaf	56.2 de	35.8 e	41.3 e	66.2cde	33.2 e	**46.59 c**
X. strumarium stem	41.6 e	78.1 cde	56.7 de	81.7cde	37.4 e	**59.12 b**
X. strumarium root	39.5 e	42.7 e	52.6 de	50.2 d	31.2 e	**43.22 c**
P. hysterophorus leaf	49.9 de	52.4 d	46.2 de	60.3 de	44.8 de	**50.77 c**
P. hysterophorus stem	58.0 de	47.0 de	62.2 de	98.8 cd	40.30 e	**61.30 b**
*P. hysterophorus*root	33.9 e	32.7 e	48.8 de	64.1 de	39.7 e	**43.89 c**
Water (control)	166.1ab	183.0 a	160.0 ab	121.9 bc	188.3 a	**163.8 a**
Extract means	**63.64 NS**	**67.39**	**66.86**	**77.63**	**59.29**	

LSD value for extracts = 25.057
LSD value for varieties = NS
LSD value for varieties x Extracts = 56.029

CONCLUSIONS AND RECOMMENDATIONS

In the light of the above results, it has been concluded that all the plant parts extracts of both the studied weeds significantly affect the germination and seedlings growth of maize varieties, however among the extract *P. hysterophorus* leaf showed highest toxic effect on maize varieties. Further, among the maize varieties, the Babar was more resistant to the toxic effects of applied extracts while, the maize variety Paharri was more sensitive towards tested extracts. Farmers should discourage the growth of *P. hysterophorus* weed in their filed as it has strong alleopathic effect on maize crop. Moreover, farmers must grow maize variety Babar instead of others as this variety showed strong resistant to the phytotoxic effects of invasive weed extracts. Moreover, keeping the phytotoxic properties of these weeds they can be utilized as a tool for controlling weed in summer crops after laboratory tests.

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