EFFECTS OF WEED ALLELOPATHY AGAINST MAIZE *(Zea mays* L.*)* VARIETIES

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ABSTRACT

A lab experiment was conducted at Weed Science Research Laboratory, The University of Agriculture Peshawar. The experiment was laid out in Completely Randomized having two factors. Factor "A" was maize varieties including (Burhan, Jalal and Azam) while, factor "B" was different weed water extracts i.e. *Trianthema portulacastrum*, *Xanthium strumarium*, *Convolvulus arvensis* and Distill water treatment was also included for comparison. The results showed that nearly all weeds water extracts significantly affect all the studied parameters of maize varieties. The result revealed that *T. portulacastrum* showed the most toxic effect against all maize varieties as it permit only 76.66% of maize seed to germinate. While, among maize varieties Azam showed high resistance toward the allelopathy of studied weed species and gave 97.50% germination. Maize variety Jalal found susceptible to the phytotoxicity of the studied weeds. As *T. portulacastrum* declared the most problematic weed of maize. Hence, it was recommended that proper measures to be taken for the effective control of *T. portulacastrum* weed to secure the maximum production of maize in Khyber Pakhtunkhwa.

Key words: Allelopathy, horse purslane, maize varieties, growth variables.

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INTRODUCTION

Maize is one of the important cereal crops belonging to family *Poaceae* and stood third in Pakistan after wheat and rice. It is high yielding and short duration crop. It is grown for dual purposes, fodder as well as for grain, throughout Pakistan. At national level, the area under maize cultivation was 1653 thousand hectares having 16.6 percent increase was recorded during 2021-2022 (MNFSR, 2022). The average yield of maize in Pakistan is very low as compared to developed countries, while in Pakistan and especially Khyber Pakhtunkhwa produced less average yield as compared to other provinces. Among the various reasons for low production in maize crop, poor weed management practices, improper planting methods and high weed infestations are common problems (Chikoye *et al*., 2008). Maize is most sensitive to weed competition particularly at early growth stage, as the vegetative and reproductive growth continues for the entire life period because it grows slowly during the first 3 to 4 weeks (Kayode and Ademiluyi, 2004).
Horse purslane (*Trianthema portulacastrum*), a member of family *Aizoaceae*, is common weed of maize. It is well established in Malaya, Western Asia, Africa, Tropical America, Australia, India and several other countries (Mahajan, 1982; Kaur and Kumar, 2017). Out of

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seventy-nine weed species the most violent weed of maize crop is *T. portulacastrum* (Kumar and Singh, 1983). Gupta and Mukerji (2001) also revealed *T. portulacastrum* as a harmful weed posing huge contest with maize crop. Elsewhere in Pakistan, *T. portulacastrum* is a chief weed in maize, cotton, potato, sugarcane, and summer vegetables and blooms from May-October. Due to unpredictable habit, vegetative and reproductive growth continues for the whole life period (Nayyar *et al*., 2001).

Common cocklebur (*Xanthium strumarium* L.) is a harmful weed of maize in Khyber Pukhtunkhwa (Afzal *et al*., 1994). It causes huge crop losses throughout the world (Bloomberg *et al*., 2000; Hussain *et al*., 2022) and this is contributed due to its allelopathic effect (David *et al.,* 2005; Casini, 2004). This weed affects not only the seed germination but also affects the fresh and dry biomass of maize (Inam *et al*., 1987; Bhatt *et al.,* 1994; Hussain *et al*., 2014). *X. strumarium* was first introduced to Pakistan from Afghanistan during the war in the early 1980s due to immigration of Afghan citizens with their farm animals (Hashim and Marwat 2002). The large canopy of *X. strumarium* results in creating more problems in maize production (Karimmojeni *et al*., 2010).

Convolvulus arvensis L. is perennial, noxious weed in Europe and many agricultural areas throughout the world and declared the worst weed of the world (Balicevic *et al.,* 2014). It causes serious problem in maize, grapes and beans (Culhav and Manea, 2011). *Convolvulus arvensis* also provides breeding sites for several insects and reduces the crop production from 20-70% in different crops causing loss of US$ 377 million in United States in 1998 (Teodor, 2006).

A biological phenomenon in which live or dead plant material release chemical substances i.e. allelochemicals is known as allelopathy, which inhibits the associated plant growth however, allelopathy is considered to be one of the possible alternatives for achieving sustainable weed management (Farooq *et al.,* 2008). Because of producing and releasing allelochemicals into the atmosphere in different ways such as leaching, volatilization and disintegration plants show their allelopathic activity (Farooq *et al*., 2011). Crop plants like sorghum, sunflower and rice contain water soluble allelochemicals which possess the capability to inhibit germination and growth of different weeds (Cheema *et al*., 2004). In controlling weeds several workers reported the probability of using allelochemicals in weed management (El-Rokiek *et al*., 2006). In allelopathic studies, the interest is increasing day by day among the agricultural scientists to concentrate on finding such herbicides which play a significant role in weed managements and herbs control and to fascinate the global attention for the allelopathic crop plants (Khan *et al*., 2016).

MATERIAL AND METHODS

Location

The laboratory experiment was carried out at the Department of Weed Science, The University of Agriculture Peshawar Pakistan.

Experimental procedure

Experiment was carried out with Completely Randomized Design (CRD) having factorial arrangement with three replications. Maize varieties (Burhan, Jalal and Azam) were assigned to Factor A while, different weed water extracts i.e. *Trianthema portulacastrum*, *Xanthium strumarium* and *Convolvulus arvensis* and untreated control treatment (distilled water) for comparison were kept in Factor B. Mature and healthy plants of *Trianthema portulacastrum* L., *Xanthium strumarium* L. and *Convolvulus arvensis* L. were collected, washed and then collected plants were dried at $65C^0$ for 24 hr. To prepare extract of the collected weeds first the dried samples of each species were powdered by mechanical grinder, soaked in distilled water for 15 hr and then filtered to make a stock solution of $120g\ L^{-1}$. During the investigation, three maize varieties (*Zea mays* L.) comprising Burhan, Jalal and Azam were used. The seeds of all maize varieties were obtained from the New Developmental Farm of Agronomy, The University of Agriculture, Peshawar and tested against allelopathic potential of *T. portulacastrum* L. *X.*

strumarium L. and *C. arvensis* L. Ten seeds of each test maize cultivar were placed in a 9cm dia. petri-plate and soaked with required concentration of the extract. Experiment was performed in three replicate. The seeds were kept mist in the petri dishes till the termination of the experiment.

Statistical analysis

The germination (%) data were taken on daily basis while, the shoot and root length (cm), root and shoot weight (mg) were recorded at the end of the experiment. Finally all the observed data were analyzed using Statistics 8.1 for each parameter individually using the statistical techniques as suggested by Steel *et al*. (1997).

RESULTS AND DISCUSSION

Germination %

The allelopathic effect of *T. portulacastrum*, *X. strumarium* and *C. arvensis* on germination % of different varieties of maize is presented in Table-1. The extracts mean data revealed that highest germination (93.33 %) was recorded for the untreated check, while the lowest (76.66 %) seed germination was resulted in *T. portulacastrum* followed by *C. arvensis*. The varieties mean showed that maximum (97.50 %) germination was recorded in maize variety Burhan which was however, statistically at par with Azam variety (95.83 %) while, the lowest (54.16 %) germination was recorded in maize variety Jalal. Similarly the interaction showed that highest germination percentage was recorded for Burhan in all treatments except involving *T. portulacastrum*, whereas the lowest (36.67 %) germination was noted in Jalal x *Convolvulus arvensis*. In similar studies Hussain *et al.* (2014) and Gricher *et al.* (2008) reported that *T. portulacastrum* L. contains different phenolic compounds i.e. caffeic, chlorogenic, p-hydroxybenzoic, p-coumaric and ferulic acids which negatively affect the germination and growth of maize. The allelopathic effect of *T. portulacastrum*, *X. strumarium* and *C. arvensis* on germination % of different varieties of maize is presented in Table 1.

Table 1. Germination (%) of maize varieties as affected by different weeds extracts.

Extracts	Varieties			Mean
	Burhan	Jalal	Azam	
Trianthema portulacastrum	10.00 ab	36.67 c	93.33 ab	76.66 b
Xanthium strumarium	100.00 a	50.00 c	93.33 ab	81.11 b
Convolvulus arvensis	90.00 a	50.00 c	96.67 ab	78.88 b
Control	100.00 a	80.00 b	100.00 a	93.33 a
Mean	**97.50 a**	**54.16 b**	**95.83 a**	

LSD for varieties = 9.55, LSD for treatment = 11.02, LSD for interaction = 19.10

Root length (cm)

Data regarding root length of maize varieties as affected by different plant extracts is given in Table-2. The data revealed that all the extracts significantly affected root length of maize varieties. The extract means showed that the maximum (16.24 cm) root length was recorded in control plots; being statistically at par with *X. strumarium* (13.39 cm). While the minimum (2.90 cm) root length was documented in *T. portulacastrum* extract application. The root length of maize varieties (Burhan, Jalal and Azam) were found non-significant for their tolerance against weed extracts.

The interaction of varieties and extracts indicated that minimum (1.14 cm) root length was computed for the combination of maize variety Jalal x *T. portulacastrum* and the maximum (17.04 cm) root length was noted for the combination of maize "variety Azam x Control. Suppression of maize root in response to *T. portulacastrum* water extracts (Muhammad *et al.,* 2015).

Table 2. Root length (cm) of maize varieties as affected by different weeds extracts

Extracts	Varieties			Mean
	Burhan	Jalal	Azam	
Trianthema portulacastrum	2.94 de	1.14 e	4.64 de	**2.90 c**
Xanthium strumarium	14.34 abc	9.74 abcd	16.10 ab	**13.39 a**
Convolvulus arvensis	7.42 cde	8.55 bcde	9.74 abcd	**8.57 b**
Control	16.72 a	14.97 abc	17.04 a	**16.24 a**
Mean	**10.35**	**8.60**	**11.88**	

LSD for Varieties = NS, LSD for Treatments = 4.63, LSD for Interaction = 8.02

Root Weight (mg)

Data regarding root weight of different varieties of maize are presented in Table-3. The data revealed that all the extracts used have significantly affected the root weight of maize varieties. The extracts means data showed that the maximum (43.3 mg) root weight was recorded in control while minimum (6.0 mg) root weight was recorded in *T. portulacastrum*. The varieties means were non-significant. The interaction of varieties x extracts treatments was also found significant. The interaction means showed that maximum (45.0 mg) root weight was recorded for Burhan x control, however minimum (1.00 mg) was observed for Jalal x *T. portulacastrum*. Similar results were shown by (Mubeen *et al.,* 2011).

Table 3. Root weight (mg) of maize varieties as affected by different plants extracts.

Extracts	Varieties			Mean
	Burhan	Jalal	Azam	
Trianthema portulacastrum	5.00 de	1.00 e	12.0 cde	6.0 c
Xanthium strumarium	26.0 abcd	23.0 abcd	31.0 abc	26.6 b
Convolvulus arvenis	17.00 bcde	36.0 ab	24.0 abcd	25.6 b
Control	45.00 a	42.0 a	43.0 a	43.3 a
Mean	**23.25**	**25.5**	**27.5**	

LSD for varieties = NS, LSD for treatments = 0.12, LSD for interaction = 0.22

Shoot length (cm)

The allelopathic effect of *T. portulacastrum*, *X. strumarium* and *C. arvensis* on shoot length of different varieties of maize is presented in Table 4.The result indicated that all the extracts significantly affected shoot length of maize varieties. The extracts means showed that the maximum (10.72 cm) shoot length was observed in *X. strumarium* however it was statistically par with *C. arvensis* and Control. While, the minimum (2.96 cm) shoot length was obtained with *T. portulacastrum* extract application. Maize varieties (Burhan, Jalal and Azam) were also found significant for shoot length. Azam produced highest (10.31 cm) shoot length, being at par with Burhan (8.55 cm). The minimum (6.36 cm) shoot length was recorded in Jalal variety.

The interaction of varieties and extracts indicated that shoot length of all maize varieties was increased in control plots. Minimum shoot length of all three verities was observed with *T. portulacastrum* application. Our results are also in strong agreement with (Khan *et al*., 2016) that showed that various phenolic compounds in *T. portucalastrum* inhibit cell division.

Table 4. Shoot length (cm) of maize varieties as affected by different plants extracts.

Extracts	Varieties			Mean
	Burhan	Jalal	Azam	
Trianthema portulacastrum	2.84 d	1.34 d	4.70 cd	2.96 b
Xanthium strumarium	11.74 a	8.34 abc	12.08 a	10.72 a
Convolvulus arvensis	9.22 abc	6.02 bcd	13.01 a	9.42 a
Control	10.42 ab	9.74 ab	11.46 a	10.54 a
Mean	**8.55 ab**	**6.36 b**	**10.31 a**	

LSD for varieties = 2.4031, LSD for treatments =2.7749, LSD for interaction =4.8063

Shoot weight

The allelopathic effect of *T. portulacastrum*, *X. strumarium* and *C. arvensis* on shoot weight of different varieties of maize are presented in Table 5. The result revealed that all the extracts significantly affected shoot weight of maize varieties. The extract means exhibited that the maximum (44.0 mg) shoot weight was recorded with *X. strumarium*. However, it was not significantly different from that of *C. arvensis* and Control. The minimum (10 mg) shoot weight was obtained with *T. portulacastrum* extract application. Maize varieties (Jalal and Azam) were also found significant for shoot weight. Azam produced the maximum (38.7 mg) shoot weight, while the minimum (26.2 mg) shoot weight was recorded in Jalal variety. The interaction of varieties and treatments indicated that shoot weight of all maize varieties was increased in control plots. Minimum shoot weight of all three verities was observed with *T. portulacastrum* application. The phytotoxicity of *T. portulacastrum* in maize is due to restriction of water uptake (Asghar *et al.*, 2013).

Table 5. Shoot weight (mg) of maize varieties as affected by different weeds extracts.

Extracts	Varieties			Mean
	Burhan	Jalal	Azam	
Trianthema portulacastrum	9.00 de	3.00 e	18 cde	**10.0 b**
Xanthium strumarium	49.0 a	37.0 abc	46 a	**44.0 a**
Convolvulus arvensis	38.0 ab	25s.0 bcd	50 a	**37.6 a**
Control	40.0ab	40.0 ab	41 ab	**40.3 a**
Mean	**34.0 ab**	**26.2 b**	**38.7 a**	

LSD for varieties = 0.0990, LSD for treatment = 0.1143, LSD for interaction = 0.1980

CONCLUSION

The results showed that all the weeds extracts negatively affect the seed germination and seedling growth of the tested maize varieties. Moreover among all the weeds extracts, the maximum inhibition was resulted by *Trianthema portulacastrum* extract. Hence, the present study revealed that these weeds affects the agro-ecosystem and needs to be properly managed. Furthermore, the present study recommended that all the weeds especially *Trianthema portulacastrum* should be properly managed for effective germination and growth of major crops including maize crop.

CONFLICT OF THE INTEREST

Authors have no conflict over the submission of the article to this journal.

REFERENCES CITED

Afzal, S., A. Din and M.R. Awan. 1994. Preliminary studies on the distribution of maize Weeds of Abbottabad and Haripur (NWFP). Pak. J. Weed Sci. Res., 7(1): 13-17.

Asghar, M., A. Tanveer, M.A. Nadeem, H. Ali. 2013. Comparative allelopathic potential of two *Aizoaceae* weeds against germination of different crops Pak. J. Weed Sci. Res., 19(4): 377-391.

Balicevic, R., M. Ravlic, M. Knezevic and I. Serezlija. 2014. Allelopathic effect of field bindweed (*Convolvulus arvensis* L.) Water extracts on germination and initial growth of maize. J. Animal Plant Sci., 24(6): 1844-1848.

Bhatt, B.P., D.S. Chauhan and N.P. Todaria. 1994. Effect of weed leachates on germination and radicle extension of some food crops. Indian J. Plant Physiol., 37(3): 177-179.

Bloomberg, J.R., B.L. Kirkpatrick and L.M. Wax. 1982. Competition of common cocklebur with soybean. Weed Sci., 30: 507-513.

Casini, P. 2004. Allelopathic influences of common cocklebur (*Xanthium italicum* Moretti) on maize. Allelopathy J., 13(2): 189-200.

Cheema, Z.A., M. Asim and A. Khaliq. 2004. Sorghum allelopathy for weed control in cotton (*Gossypium arboreum* L.). Int. J. Agric. Biol., 2: 37-4.

Chikoye, D., A.F. Lum, R. Abaidoo, A. Menkir, A. Kamara, F. Ekeleme and N. Sanginga. 2008. Response of corn genotypes to weed interference and nitrogen in Nigeria. Weed Sci., 56(3): 424-433.

Culhav C.D and D. Manea. 2011. Controlling *convolvulus arvensis* L. in grain maize and winter wheat in banat (Romania). Res. J. Agri. Sci., 43 (2).

David, I., V.M. Borbely and L. Radocz. 2005. Changing of amounts of allelochemicals in Italian cocklebur (*X. italicum* Mor.) during the growing season. Novenyvedelem., 41 (9): 397-403.

El-Rokiek, K.G., T.A. El-Shahawy, F.A. Sharara. 2006. New approach to use rice straw waste for weed control. Int. J. Agric. Biol., 8 (2): 26. 75.

Farooq, M., K. Jabran, H. Rehman and M. Hussain. 2008. Allelopathic effects of rice on Seedling development in wheat, oat, barley and berseem. Allelopathy J., 22: 385-390.

Farooq, M., K. Jabran, Z.A. Cheema, A. Wahid and K.H.M. Siddique. 2011. Exploiting allelopathy for sustainable agriculture. Pest Manag. Sci., 67: 493-506.

Gricher. 2008. Horse pursalane *Trianthema portulacastrum* control in peanut (*Arachis hypogaea*). Weed Techchnol., 7: 570-572.

Gupta, R. and K.G. Mukerji. 2001. Environmental effect on the reoccurrence of *Alternaria alternata* on *Trianthema portulacastrum*. J. Envir. Biol., 22(2): 83-86.

Hashim, S. and K.B. Marwat. 2002. Invasive weeds a threat to biodiversity: a case study from Abbotabad district, N-W Pakistan. Pak. J. Weed. Sci. Res., 8(1-2):1-12.

Hussain, Z., K.B. Marwat, B. Gul, M. Saeed, S. Bibi. 2022. Effect of common cocklebur on biological yield of maize at varying population. Pak. J. Bot., 44(5):1627-1632.

Hussain, Z., K.B. Marwat, J. Cardina, I.A. Khan. 2014. *Xanthium strumarium* L. impact on corn yield and yield components. Turk. J. Agri. For., 38: 39-46.

Inam, B., F. Hussain and F. Bano. 1987. Allelopathic effects of Pakistani weed, *X. strumarium* L. Pak. J. Sci. Indust. Res., 30(7): 530-53.

Karimmojeni, H., H.R. Mashhadi, Hamid, S. Shahbazi, A. Taab, H. Alizadeh. 2010. Competitive interaction between maize, *Xanthium strumarium* and *Datura stramonium* affecting some canopy characteristics. Aus. J. Crop Sci., 4:684-691.

Kaur, M and N. Kumar. 2017. *Trianthema portulacastrum* L. The noxious weed and its control. Adv. Plants. Agric. Res., 6(3): 1-3.

Kayode, J. and B. Ademiluyi. 2004. Effect of tillage methods on weed control and maize performance in southwestern Nigeria location. J. Sustainibility. Agri. 23: 39-45.

Khan, M.I., I. Khan, N. Khan, B. Gul, R. Khan, Hashmatullah, I. Ahmad, I. Khan, M.I.A. Khan, M. Iqbal, H. Bibi. 2016. Varietal response of maize (*Zea mays* L.) Against weeds aqueous extracts. Appl. Ecol. Environ. Res., 14(4): 569-576.

Kumar, S. and V. Singh. 1983. Phytosociological studies on the weeds of maize fields. Indian J. Weed Sci., 15(1): 101-108.

Mahajan, S.K. 1982. Morphology and growth behavior of *Trianthema portulacastrum.* Vijnana Parishad Anusandhan Patrika., 25 (2): 117-124.

Muhammad, N., A. Mahmood, M.Z. Ihsan, I. Daur, S. Hussain, Z. Aslam and S.A. Zamanan. 2015. *Trianthema portulacastrum* and *Cyperus rotundus* interference in maize and application of allelopathic crop extracts for their effective management1. Planta Daninha., 34:10.

MNFSR, 2022. Agricultural Statistics of Pakistan. Ministry of National Food Security and Research (Economic Wing), Government of Pakistan, Islamabad.

Mubeen, K., M.A. Nadeem., A. Tanveer and Z.A. Zahir. 2011. Allelopathic Effect of Aqueous Extracts of Weeds on the Germination and Seedling Growth of Rice (*Oryza sativa* L.). Pak. J. Life. Sci., 9(1): 7-12.

Natarajan, A and P. Elavazhagan. 2014. Allelopathic Influence of *Trianthima Portulacastrum* L. on growth and developmental responses of sesame (*Sesamum indicum* L.). Int. J. Curr. Biotechnol., 2(3):1-5.

Nayyar, M.M., M. Ashiq and J. Ahmad. 2001. Manual on Punjab Weeds. Directorate Agron. Ayub. Agric. Res., 51-52.

Steel, R.G.D., J.H. Torrie and D. Dicky. 1997. Principles and Procedures of Statistics. Multiple comparison. 3rd Ed. Mc Graw Hill Book Co., New York, USA. 178-198.

Teodor, R., P. Gus, I. Bogdan, P. Laura, I. Oroian. 2006. Research regarding to control species *Convolvulus arvensis* L. on relation with soil tillage systems. Journal of Central European Agriculture., 7: 739-742.