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EFFICACY OF AQUEOUS EXTRACTS OF DIFFERENT ALLELOPATHIC PLANTS ON GERMINATION AND GROWTH OF WHEAT AND WILD OAT

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Abstract

To analyze the efficacy of aqueous extracts of different allelopathic plants on germination and growth of wheat and wild oat seeds, a lab experiment was conducted in the Department of Weed Science, The University of Agriculture, Peshawar, Khyber Pakhtunkhwa- Pakistan in 2013. The experiment was laid out in a Completely Randomized (CRD) design with three repetitions. Seeds of wheat (*Triticum aestivum* L.) and wild oat (*Avena fatua* L.) were soaked with the exact concentration of their respective water extract (WE) for 24 hours before placing in the petri dishes for germination. Afterwards only distilled water was applied to keep the seed moist. There were eight treatments viz. sorghum WE, sunflower WE, parthenium WE, sorghum+sunflower WE, sorghum+parthenium WE, sunflower+parthenium WE, sorghum+sunflower+ parthenium WE @ 1:10 (w/v) each and a control treatment (distilled water only) for comparison. Data were recorded on germination (%), shoot length (cm), shoot weight (mg), root length (cm) and root weight (mg) at the 20th day of the experiment. All parameters were significantly affected by the all applied treatments. The data showed that highest wheat germination (100%) was recorded in sorghum+parthenium WE and lowest germination (80%) in sorghum+sunflower+parthenium WE. Lowest wild oat germination (60%) was noticed for sunflower+parthenium WE. In conclusion, the application of sorghum+parthenium WE was the most effective and economical treatment in reducing the germination and growth of wild oat.

Key words: Wild oat, Wheat, Allelopathy

Introduction

Weed competition has become a major constraint in limiting yield of any crop. Weeds compete with crop for space, light, moisture and nutrients and reduce the crop yield (Shehzad *et al*., 2013). Wild oat is a noxious grassy weed of wheat in many countries including Pakistan, reducing yield by about 30% (Hobbs *et al.*, 1998). Among the broad leaf weeds in wheat are *Chenopodium album*, *Convolvulus arvensis*, *Rumex crispus, Sinapis arvense*, *Lathyrus aphaca* and *Melilotus indica* while the grassy weeds other than wild oat comprise of *Phalaris minor* and *Lolium tenulentum* etc. Broad leaf weed control is easier than grassy weeds in wheat, however, grasses are the major culprits of yield losses in wheat and more difficult to manage.

Though efficient chemical weed control methods are available; however, constant use of similar herbicides also leads to the development of herbicides resistant bio-types (Bhowmik, 2003). Many reports show the resistance of wild oat to clodinafop-propargyl, diclofop-methyl, fenoxaprop-p-ethyl, isoproturon, fluazifop-p-butyl, haloxyfop-methyl, sethoxidim and tralkoxydim in various countries. In addition, herbicides contaminate the soil, water and environment and may increase the disease risks (Ronald, 2000).

Hence, the international concern regarding the herbicide use is increasing. Similarly, the demand for organic products is also increasing day by day. The area under organic crops is more than 24 million ha in 100 countries, with a global market value of more than $ 23billion year^{-1} and still it is rising up speedily (Roseboro, 2006). Scientists are working to develop innovative, ecological and natural techniques for weeds and other pest management. There are several chemical and cultural methods to control weeds. However, each method has both merits and demerits depending upon the prevailing weeds flora, soil type and cropping system (Usman *et al*., 2013). In this regard, the use of allelopathic plants for weed suppression offers a promising option.

Allelopathy is the mutual adverse effect of two plants on each other through the release of allelochemicals. It is a chemical warfare among the community of plants. Allelochemicals released by one plant have an effect on another plant/weed in the closer surrounding zone. The fact is also established as the biochemical interaction among plants. The word allelopathy was for the first time used by Molisch (1937) to refer to both the harmful and useful biochemical associations among plants and even microorganisms. Rice (1984) modified that definition as any injurious/beneficial influence by producing and release of chemical compounds into the rhizosphere; with a direct or indirect effect. The study of allelopathy has shown that weeds produce certain phytotoxic compounds which hinder seed germination and growth of other plants. Allelopathic evaluation is an emerging research discipline that can be applied as an important tool in the assessment of environmental threats due to bio-invasion in different parts of the world (Shinwari *et al.*, 2013).

Allelopathy is going to be exploited for weed management in various ways like stubble mulches, the use of allelopathic crops in crop rotation and intercropping systems (Cheema *et al*., 1988; Majeed *et al*., 2012). Now a days allelochemicals are being used as a foliar sprays on different sensitive weeds in several crops (Cheema & Ahmad, 1992; Iqbal, 2007). By using the

Sorghum halepense water extracts weed biomass was reduced by 33-53% which enhanced wheat crop yield (7-14%). Similarly sunflower water extracts has been reported to have positive effects on the crop yield (Cheema *et al*., 1997). Similar results have been reported in other crops too (Bhatti *et al*., 2000).

Sometimes the combine effects of two allelochemicals are more powerful than the sole effect of the water extract of an allelopathic plant (Einhellig & Rasmussen, 1978). For example equal concentration of ferulic and vanillic acids worked synergistically in inhibiting sorghum seed germination. Similarly, any phenolic compound used alone at 10-5 mM have a little effect on the target weed, but when used with other(s) at the same concentration the effect is enhanced and then strongly inhibits the seed germination of the test crop and weed species (Williams, 1984). Further comprehensive investigations are needed on using mixtures of different allelopathic water extracts for wild oat management in wheat. For this purpose, the present experiment was designed to compare the effectiveness of different allelopathic crop/weed extracts alone and in mixtures for wild oat control in wheat under laboratory conditions and to evaluate their effect on the germination and growth of wheat growth alone or in combination.

Materials and Methods

A lab experiment was carried out at the Department of Weed Science, the University of Agriculture Peshawar-Pakistan during November 2013, to evaluate the "Efficacy of aqueous extracts of different allelopathic plants on the germination and growth of wheat and wild oat seeds". The experiment was laid out in a completely randomized design (CRD) having three replications. The seeds of test species viz. wheat and wild oat were soaked with their respective concentrations for 24 hours before placing in the petri dishes. After placing in petri dish on blotting papers distilled water was applied as per requirements of the seed germination under laboratory conditions. There were eight treatments including a control for comparison. The details of the treatments are given below:

Factor A. Treatments detail

Treatment	WE Source Species	WE Conc. @ (w/v)
T1	Sorghum	1: 10 (10 % Conc.)
T2	Sunflower	1: 10
T3	Parthenium	1: 10
T4	Sorghum + Sunflower	1: 10
T5	Sorghum + Parthenium	1: 10
T6	Sunflower + Parthenium	1: 10
T7	Sorghum +Sunflower + Parthenium	1: 10
T8	Control (10 ml Distilled water only)	0: 10

Factor B.

Test Species

1. Wheat (*Triticum aestivum* L.)
2. Wild oat (*Avena fatua* L.)

After 20 days the data was recorded on the parameters of germination (%) by counting the number of germinated seeds in each treatment, shoot length plant^{-1} (cm) by a measuring tape root length plant^{-1} (cm) by a measuring tape, fresh root weight plant^{-1} (mg) with the help of an electric balance, and fresh shoot weight plant^{-1} (mg) with the help of an electric balance.

Statistical Analysis: The data recorded for all the individual parameters were statistically analyzed using the appropriate ANOVA suitable for Completely Randomized Design (CRD). Means were separated by using LSD test at 0.05 probability, where P-values were less than 0.05 (Steel *et al*., 1997).

Results and Discussion

Germination (%): The statistical analysis of the data showed that various plant extracts had significantly affected the germination of both the wheat and wild oat seeds (Table 1). The recorded data showed the highest germination (100 %) in control (distilled water) treatments which was statistically at par with parthenium (WE), sorghum+ sunflower (WE), sunflower+parthenium (WE) and sorghum+parthenium (WEs). Lowest germination (80 %) was achieved in the treatments of sorghum + sunflower + parthenium (WE). Furthermore, highest germination (100 %) of wild oat was observed for sorghum (WE) followed by sunflower (WE) (90 %) while the lowest (60 %) for sunflower + parthenium (WE) plant extracts. that the application of sorghum and sunflower extracts were more effective that reduced the wild oat dry matter by 42-62% in the study of Jamil *et al.,* (2009). By using the water extracts of sorghum and sunflower @ of at 6Lha^{-1} in combination enhanced the grain yield of wheat by almost 90%.

Table 1. Germination (%) as affected by allelopathic effect of different plant extracts on wheat and wild oat.

Treatments (10 % conc. of allelopathic plants, except control)	Germination (%) of wheat	Germination (%) of wild oat
Sorghum (WE)	90 ab	100 a
Sunflower (WE)	90 ab	90 ab
Parthenium (WE)	100 a	80 b
Sorghum+Sunflower (WE)	100 a	70 bc
Sorghum+Parthenium (WE)	100 a	80 bc
Sunflower+Parthenium (WE)	100 a	60 c
Sorghum+Sunflower+Parthenium (WE)	80 b	80 b
Control (distilled water)	100 a	70 bc

LSD value at α 0.05 for wheat =12.5 and for wild oat = 12.7

Shoot length (cm): The statistical analysis of the data showed that different plant extracts had significantly affected the shoot length (cm) of wheat and wild oat (Table 2). The observed data showed that highest wheat shoot length (15.50 cm) was recorded in the application of sorghum + parthenium extraxts (WE) which was statistically at par with sorghum + sunflower (WE) (12.70 cm) and parthenium (WE) (11.90 cm) while the lowest shoot length (2.30cm) was there in the sorghum + sunflower + Parthenium (WE). Furthermore, data regarding shoot length (cm) of wild oat revealed that highest shoot length (10.98 cm) was observed for sorghum (WE) followed by control (distilled water) treatment (10.20 cm) while the lowest (3.60 cm) were noticed for sunflower + parthenium (WE). Bajwa *et al*., (2013) also confirmed that different combinations of plant extracts can be used as bioherbicide against wild oat without damaging wheat crop.

Root length (cm): The statistical analysis of the data showed that the varying plant extract significantly affected the root length (cm) of wheat and wild oat (Table 3). Data showed that highest wheat root length (20.90 cm) was recorded in control treatment followed by sorghum + parthenium (WE) (8.60 cm) while the lowest root length (1.00 cm) was obtained in sorghum + sunflower + parthenium (WE) treatments. Furthermore, data regarding root length (cm) of wild oat revealed that highest root length (13.70 cm) was observed for control distilled water while the lowest (1.10 cm) was noticed for sorghum + sunflower + Parthenium (WE). Farooq *et al.,* (2008) also noted similar results and confirmed that the efficacy of sorghum WE was enhanced in combination with WE of other allelopathens derived from other plants. Therefore, the integration of sorghum WE with parthenium and sunflower water extracts could be more potent in mixtures than the sole WEs of sorghum and parthenium in suppressing wild oat in wheat (Cheema *et al.*, 2003).

Table 2. Shoot length (cm) as affected by allelopathic effect of different plant extracts on wheat and wild oat.

Treatments (10 % conc. of allelopathic plants, except control)	Shoot length of wheat (cm)	Shoot length of wild oat (cm)
Sorghum (WE)	11.30 ab	10.98a
Sunflower (WE)	7.200 b	5.60 cd
Parthenium (WE)	11.90 a	8.50 abc
Sorghum+Sunflower (WE)	12.70 a	6.50 bcd
Sorghum+Parthenium (WE)	15.50 a	9.60 ab
Sunflower+Parthenium (WE)	6.90 a	3.60 d
Sorghum+Sunflower+Parthenium (WE)	2.30 c	4.10 d
Control (distilled water)	14.20 a	10.20 a

LSD value at α 0.05 for wheat = 3.63 and for wild oat = 3.57

Table 3. Root length (cm) as affected by allelopathic effect of different plant extracts on wheat and wild oat.

Treatments (10 % conc. of allelopathic plants, except control)	Root length (g) of wheat	Root length (g) of wild oat
Sorghum (WE)	5.70 bc	6.80 bc
Sunflower (WE)	1.50 d	1.40 c
Parthenium (WE)	3.30 cd	3.80 c
Sorghum+Sunflower (WE)	3.30 cd	4.70 bc
Sorghum+Parthenium (WE)	8.60 b	11.00 ab
Sunflower+Parthenium (WE)	2.30 cd	6.80 ab
Sorghum+Sunflower+Parthenium (WE)	1.00 d	1.10 c
Control (distilled water)	20.90 a	13.70 a

LSD value at α 0.05 for wheat = 3.33 and for wild oat = 2.85

Shoot weight (g): The different plant extracts had a significant effect on the shoot weight (g) of wheat and wild oat (Table 4). The data illustrated that highest shoot weight of 0.65 g was recorded for sorghum + parthenium (WE) followed by control i.e. the distilled water resulting in shoot weight of 0.55 g while the lowest shoot weight (0.13 g) was recorded for sorghum + sunflower + parthenium (WE). In addition, data regarding shoot weight (g) of wild oat revealed that highest wild oat shoot weight (0.60 g) was noticed for control distilled water while the lowest (0.14 g) was recorded for sorghum + parthenium (WE). Which proved effective than all the other allelopathic plants perhaps due to the synergistic effect of parthenium with other plants regarding allelopathy (Belz *et al.,* 2007).

Root Weight (g): The plant extracts had a significant effect on the root weight (g) of wheat and wild oat (Table 5) after statistically analyzing the data. Highest root weight of 0.7060 g was recorded for control distilled water followed by sorghum + parthenium (WE) and sunflower + parthenium (WE) (0.3430 g) while the lowest root weight (0.0380 g) was noticed for sorghum + sunflower + parthenium (WE). In addition, data regarding to root weight (g) of wild oat revealed that highest root weight (0.2270 g) was noticed for control distilled water while the lowest (0.0120 g) was resulted by sorghum + sunflower + parthenium (WE).

Conclusion

Although all plants extracts were effective up to some extent but the combination of *Parthenium hysterophorus* L. and sunflower water extracts proved the best among all water extracts used in controlling wild oat seed germination and growth without affecting wheat seed germination and development. It is worth mentioning that the sole effect was less than the dual combination effect and that the impact of the triple combination of parthenium, sorghum and sunflower was the best.

Table 4. Shoot weight (g) as affected by allelopathic effect of different Plant extracts on wheat and wild oat.

Treatments (10 % conc. of allelopathic plants, except control)	Shoot weight (g) of wheat	Shoot weight (g) of wild oat
Sorghum (WE)	0.46 ab	0.42 ab
Sunflower (WE)	0.31 bc	0.24 b
Parthenium (WE)	0.44 ab	0.30 ab
Sorghum+Sunflower (WE)	0.47 ab	0.24 b
Sorghum+Parthenium (WE)	0.65 a	0.14 ab
Sunflower+Parthenium (WE)	0.23 b	0.17 b
Sorghum+Sunflower+Parthenium (WE)	0.13 c	0.25 ab
Control (distilled water)	0.55 a	0.60 a

LSD value at α 0.05 for wheat = 0.32 and for wild oat = 0.29

Table 5. Root weight (g) as affected by allelopathic effect of different plant extracts on wheat and wild oat.

Treatments (10% conc. of allelopathic plants, except control)	Root weight (g) of wheat	Root weight (g) of wild oat
Sorgham	0.0745 c	0.0715 bc
Sorghum (WE)	0.0615 c	0.0265 c
Sunflower (WE)	0.1180 c	0.0600 c
Parthenium (WE)	0.1215 c	0.0410 c
Sorghum+Sunflower (WE)	0.3430 b	0.1595 ab
Sorghum+Parthenium (WE)	0.3430 b	0.0135 c
Sunflower+Parthenium (WE)	0.0380 c	0.0120 c
Sorghum+Sunflower+Parthenium (WE)	0.7060 a	0.2270 a

LSD value at α 0.05 for wheat = 0.31 and for wild oat = 0.28

References

Alam, S.M. 1991. Weed Science Problem in Pakistan. *Pak. Gulf. Eco.,* 3-9: 25-29.

Alam, S.M., A.R. Azami, S.S.M. Naqvi, M.A. Khan and B. Khanzada. 1997. Effect of leaf aqueous extract of common lambsquarter and NaCl on germination and seedling growth of rice. *Acta Physiologia Plantarum,* 19: 91-94.

An, M., J.E. Pratley and T. Haig. 1998**.** Allelopathy: from concept to reality. *In*: Proc. 9th Australian Agron. Conf. Wagga Wagga, NSW, Australia, pp. 563-566.

Bajwa, A.A., S. Khalid, S. Sadia, M. Nabeel and W. Nafees. 2013. Influence of combinations of allelopathic water extracts of different plants on wheat and wild oat. *Pak. J. Weed Sci. Res.,* 19(2): 157-166.

Batish, D.R., P. Tung, H.P. Singh and R.K. Kohli. 2007. Phytotoxicity of sun- flower residues against some summer season crops. *J. Agron. Crop Sci.,* 188: 19-24.

Begum, M.K., K.M. Hasan, M. Salim, M.A. Hossain and M.K. Rahman. 2003. Effect of herbicides on different crop characters used in controlling weeds of Aman rice grown under wet seeded culture. *J. Agron.,* 2: 44-51.

Bell, A.R. and J.D. Nalewaja. 1968. Competition of wild oat in wheat and barley. *Weed Sci*., 16: 505-508.

Belz, R.G., C.F. Reinhardt, L.C. Foxcroft and K. Hurle. 2007. Residue allelopathy in *Parthenium hysterophorus* L. Does parthenin play a leading role?. *Crop Protection*, 26(3): 237-245.

Bhatti, M.Q.L., Z.A. Cheema and T. Mahmood. 2000. Efficacy of sorgaab as natural weed inhibitor in raya. *Pak. J. Biol. Sci*., 3(7): 1128-1130.

Bhowmik, P.C. 2003. Challenges and opportunities in implementing allelopathy for natural weed management. *Crop Protection*, 22(4): 661-671.

Cheema, Z.A., S. Ahmed. S. Majeed and N. Ahmed. 1988. Allelopathic effects of wheat (*Triticum aestivum* L.) straw on germination and seedling growth of two weed species and cotton. *Pak. J. Weed Sci. Res.*, 1(2): 118-122.

Cheema, Z.A. and S. Ahmad. 1992. Allelopathy: A potential tool for weed management. *Proc. Nat. Sem. Plant Health and Care in Agri. Prod*., Dec. 28-29, 1988. Uni. Agr., Faisalabad. pp. 151-156.

Cheema, Z.A., M. Luqman and A. Khaliq. 1997. Use of allelopathic extracts of sorghum and sunflower herbage for weed control in wheat. *J. Animal Plant Sci*., 7: 91-93.

Cheema, Z.A., A. Khaliq and M. Mubeen. 2003. Response of wheat and winter weeds to foliar application of different plant water extracts. *Pak. J. Weed Sci. Res*., 9(1-2): 89-97.

Einhellig, F.A. and J.A. Rasmussen. 1978. Prior cropping with grain sorghum inhibits weeds. *J. Chem. Ecol*., 15: 951-960.

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.

Hobbs, P.R., K.D. Sayre and J.I.O. Monasterio. 1998. Increasing wheat yields sustainably through agronomic means, NRG Paper 98-01, Mexico, DF.

Iqbal, M. 2007. *Response of recent wheat varieties and some rabi weeds to the allelopathic effects of sorghum water exudate*. M.Sc. Thesis, Agron. Dept. Univ. Agric., Faisalabad.

Jamil, M., Z.A. Cheem, M.N. Mushtaq, M. Farooq and M.A. Cheema. 2009. Alternative control of wild oat and canary grass in wheat fields by allelopathic plant water extracts. *Agron. Sustain. Dev.,* 29: 475-482.

Majeed, A., Z. Chaudhry and Z. Muhammad. 2012. Allelopathic assessment of fresh aqueous extracts of *Chenopodium album* L. for growth and yield of wheat (*Triticum aestivum* L.). *Pak. J. Bot.,* 44(1): 165-167.

Molisch, H. 1937. Der Einfluss einer pflanze auf die andere. Allelopathic Fischer, Jena.

Rice, E.L. 1984. *Allelopathy*. 2nd Ed. Academic press, Orlando Florida, USA.

Ronald, E. 2000. Hand book of chemical risk assessment: health haz- ards to humans, plants and animals (Vol. II), Lewis Publishers, Washington DC, USA.

Roseboro, K. 2006. The organic food handbook: a consumer's guide to buying and eating organic food, Basic Health Publications, Laguna Beach, CA, pp. 9.

Shehzad, M., A. Tanveer, M. Ayub, K. Mubeen, M. Ibrahim, I. Qadir and N. Sarwar. 2013. Effect of weed-crop competition on growth and yield of Garden Cress. *Sarhad J. Agric.,* 29(1): 79-82.

Shinwari, M.I., M.I. Shinwari and Y. Fujii. 2013. Allelopathic evaluation of shared invasive plants and weeds of Pakistan and Japan for environmental risk assessment. *Pak. J. Bot.,*45(S.I): 467-474.

Steel, R.G.D., J.H. Torrie and D. Dickey. 1997. Principles and procedures of statistics: a biometrical approach (3rd ed.), McGraw Hill Book Co., Inc. New York.

Usman, K., M.Q. Khan and A.U. Rehman. 2013. Integrated impact of tillage and herbicides on weed control and wheat yield in cotton based cropping system. *Sarhad J. Agric.,* 29(4): 495-501.

Williams, S. 1984. Official methods of analysis. The association of official analytical chemists. Published by the association of Analytical Chemists., Inc. 1111, N19th Street Suite 210. Arlington, Virginia, 22209 USA; 503.

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