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INFLUENCE OF COMBINATIONS OF ALLELOPATHIC WATER EXTRACTS OF DIFFERENT PLANTS ON WHEAT AND WILD OAT

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ABSTRACT

Allelopathy is pragmatic approach for sustainable weed management in agro-ecosystems. A laboratory bioassay experiment was conducted to evaluate the allelopathic potential of combinations of water extracts of six plants against wheat (Triticum aestivum L.) and wild oat (Avena fatua L.). In case of Avena fatua L., Cuscuta reflexa (T_3) and C. reflexa+ Parthenium hysterophorus (T_{18}) extracts totally inhibited the germination whereas Salvia moocraftiana (T_2) extract completely inhibited the plumule growth. The rest of the treatments significantly reduced the plumule length of it. All treatments significantly decreased the radical length of Avena fatua L. except Euphorbia helioscopia (T_1) extract. A gradual reduction in fresh and dry weight was observed. In case of Triticum aestivum L., E. helioscopia+ S. moocraftiana (T_8), E. helioscopia+ P. hysterophorus (T_{11}) and S. moocraftiana+ P. hysterophorus (T_{15}) extracts had no effect on germination. But all the treatments significantly reduced the plumule and radical length of Wheat. S. moocraftiana (T_2) extract increased while C. papaya (T_4), C. reflexa+ R. dentatus (T_{17}) and C. papaya+ R. dentatus (T_{19}) extracts decreased the fresh weight of Triticum aestivum L. It is concluded that different combinations of plant extracts can be used as bioherbicide against Avena fatua L. without damaging Triticum aestivum L. Further investigation is proposed to optimize the suitable concentrations of plant extracts in such combinations.

Key words: Allelopathy, wheat, wild oat, weed management, weeds.

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INTRODUCTION

Allelopathy is the suppression of one species by another species due to release of toxic chemicals, both negative and positive aspects are included in this phenomenon (Kabir *et al.*, 2010). Weeds are a cause of serious loses in crop production so there should be management of weeds. Use of synthetic herbicides is alarming for environment safety (Omezzine *et al.,* 2011). So, allelopathic interaction of plants is the need of the hour to be used as potentially safe weedicides (Miri, 2011).

Allelopathic chemicals have the potential use as bioherbicides and pesticides (Khalid *et al.*, 2002). *Rumex dentatus*, a polygonaceous perennial plant, has allelopathic potential against wheat and mustard. *R. dentatus* alongwith *Cassia occidentalis*, *Calotropis procera* and *Withania somnifera* also showed a synergistic inhibitory effect on biochemical activities and mortality percentage of *Parthenium hysterophorus* (Knox *et al.*, 2010). *Cuscuta* species have parasitic plants which suppress the growth, reproduction, other biochemical and physiological processes of the host plants. *Cuscuta australis* showed allelopathic potential against three exotic invasive plants (*Ipomoea cairica*, *Mikania micrantha*, and *Wedelia trilobata*) (Yu *et al.*, 2011). *Cuscuta reflexa* Roxb. belonging to convolvulaceae family is holoparasitic vine. It attacks the aerial parts of shrubs and trees. It is used in ayurvedic system of medicines (Khan *et al.*, 2009).

Euphorbia helioscopia, a commonly growing weed of Pakistan has a strong invasive potential in winter crops and vegetables. Root, stem and leaf water extracts of *E. helioscopia* significantly reduced the germination, vigor and dry weight of wheat, chickpea and lentil (Tanveer *et al.*, 2010). *Parthenium hysterophorus*, a noxious weed of family asteraceae is widely spread in Pakistan. It forms monoculture stands with no other plant in its vicinity and this is the reason for its invasive nature. It releases parthenin which is strongly allelopathic against its associated plant species (Riaz and Javaid, 2011). *Salvia moorcraftiana* Wall. belonging to family Lamiaceae. It has strong phytotoxic activity against *Lemna aequinoctials* (Khan *et al.*, 2002). *Carica papaya*, a perennial plant, belongs to family caricaceae. It is distributed over whole tropical area and has shown hints of allelopathic activity (Otsuki *et al.*, 2010).

The purpose of present study was to evaluate the allelochemical potential of *Euphorbia helioscopia*, *Salvia moorcraftiana*, *Rumex dentatus*, *Carica papaya*, *Cuscuta reflexa* and *Parthenium hysterophorus* extracts as sole and in combinations against wheat and its associated weed *Avena fatua*.

MATERIALS AND METHODS

Experiment was conducted in the Weed Management Programme, Institute of Plant and Environmental Protection at National Agriculture Research Centre Islamabad. Experiment had a completely randomized design with five repeats of following the treatments:

T_o = Pure water as control, T_1 = *Euphorbia helioscopia*, T_2 = *Salvia moocraftiana*, T_3= *Cuscuta reflexa*, T_4 = *Carica papaya*, T_5 = *Rumex dentatus*, T_6 = *Parthenium hysterophorus*, T_7 = *E. helioscopia* + *C. reflexa*, T_8 = *E. helioscopia* + *S. moocraftiana*, T_9 = *E. helioscopia* +*C. papaya*, T_{10} = *E. helioscopia* + *R. dentatus*, T_{11} = *E. helioscopia* + *P. hysterophorus*, T_{12} = *S. moocraftiana* + *C. reflexa*, T_{13} = *S. moocraftiana* + *C. papaya*, T_{14} = *S. moocraftiana* + *R. dentatus*, T_{15} = *S. moocraftiana* + *P. hysterophorus*, T_{16} = *C. reflexa* + *C. papaya*, T_{17} = *C. reflexa* + *R. dentatus*, T_{18} = *C. reflexa* + *P. hysterophorus*, T_{19} = *C. papaya* + *R. dentatus*, T_{20} = *C. papaya* + *P. hysterophorus*, T_{21} = *R. dentatus* + *P. hysterophorus*.

Collection of Plant Materials

Mature green leaves were collected from naturally growing populations of these plants from NARC and different areas. Fresh leaves were brought into laboratory and thoroughly washed with distilled water and then placed in paper bags separately which were subjected to oven drying. After appropriate drying, the dried plant material was crushed and was kept in plastic zip lock bags separately then in glass bottles for further use.

Preparation of Aqueous Extracts

Aqueous extract method was used to investigate the growth inhibitory effects of water soluble constituents (Nasir *et al.*, 2005). Ten grams of oven dried leaves were soaked in 100ml of distilled water in a flask and were agitated for 24h on orbital shaker at room temperature. The extracts were stained through two layer of cheese cloth and then filtered with Watman's No. 2 filter paper. Those filtrates were considered as a stock solution. Further combinations were prepared by mixing those extracts in equal proportion i.e. 1:1 (Chotsaeng *et al.,* 2012).

Bioassay

A filter paper was placed in each glass petri dish (9cm size). Seeds of test plants were added to each glass petri dish and 5ml of different combinations of extracts were added per dish. The distilled water was used as control. The petri dishes were sealed with scotch tape and were placed in growth chamber for 15 days. Data of final germination, radical length (cm), plumule length (cm), fresh weight (g) and dry weight (g) were recorded and percentage reduction for

these was calculated.

Statistical Analysis

Data were statistically analyzed using Multiple Comparison Tests for means applied for those variables that showed statistically significant difference in the ANOVA.

RESULTS AND DISCUSSION

Final germination

Cuscuta reflexa (T_3) and *C. reflexa*+ *P. hysterophorus* (T_{18}) extracts totally inhibited the germination of *A. fatua* L. In addition to these treatments seven other treatments viz. extracts of *C. reflexa*+ *R. dentatus* (T_{17}) followed by *P. hysterophorus* (T_6)*, E. helioscopia*+ *C. reflexa* (T_7), *S. moocraftiana*+ *C. reflexa* (T_{12}), *R. dentatus* (T_5), *S. moocraftiana*+ *P. hysterophorus* (T_{15}) and *S. moocraftiana* (T_2) showed significant reduction in germination. It is observed that *C. reflexa* and *P. hysterophorus* (T_2) extracts are more effective both as single treatment and in combination with other plant extracts among all the applied plant extracts (Table-1). 100 % reduction was observed in *C. reflexa* (T_3) and *C. reflexa*+ *P. hysterophorus* (T_{18}) extracts.

In case of *T. aestivum* L., *E. helioscopia*+ *S. moocraftiana* (T_8), *E. helioscopia*+ *P. hysterophorus* (T_{11}) and *S. moocraftiana*+ *P. hysterophorus* (T_{15}) extracts, showed almost same germination percentage as control. Wheat showed minimum germination in *C. reflexa* (T_3) and maximum germination in control and *E. helioscopia*+ *S. moocraftiana* (T_8) extract (Table-2). So these treatments are not recommended to be used in wheat fields. Strong germination inhibition is due to the presence of allelocemicals in high concentrations.

Plumule Length

Salvia moocraftiana (T_2) extract totally inhibited the plumule growth of *A. fatua* L. The rest of the treatments significantly reduced the plumule length of *A. fatua* L. (Table-1). 100 % reduction of plumule length was shown by *S. moocraftiana* (T_2), *C. reflexa* (T_3) *and C. reflexa*+ *P. hysterophorus* (T_{18}) extracts (Table 1). In an experiment same sort of technique was used in which allelopathic potential of *Sorghum bicolor* and *Helianthus annuus* extracts applied sole and in combinations was observed against *Euphorbia dracunculoides* germination, radical and plumule length. 100% combinatiom of both plant extracts was more effective in reducing germination and seedling length as compared to sole treatments (Khaliq *et al.*, 2012).

All the treatments significantly decreased the plumule length of Wheat. Maximum percentage reduction of plumule length was observed in *C. reflexa* (T_3) and minimum percentage reduction was observed in *S. moocraftiana*+ *P. hysterophorus* (T_{15}) (Table-2).

Radical length

All treatments significantly decreased the radical length of *A. fatua* L. (Table-1). 100% reduction in radical length was shown by *C. reflexa* (T_3) and *C. reflexa*+ *P. hysterophorus* (T_{18}) extracts (Table-1). Previously extract of *Sorghum bicolor* as a sole and in combination with extracts of eucalyptus, sunflower, brassica, tobacco and sesame was analyzed to control wild oat growth in wheat fields. After sowing water extracts were applied with an interval of 30-40 days. Combination of sorghum and sunflower extract was more effective as compared to other combinations (Jamil *et al.*, 2009). All the treatments showed significant reduction of radical length of wheat seedlings in the range of 75-100% (Table-2). Reduction in radical length is attributed to high concentration of allelochemicals in respective plants.

Fresh and dry weight of seedlings

Only one treatment (*E. helioscopia* (T_1) extract) significantly increased the fresh weight of *A. fatua* seedlings followed by a gradual decline in all treatments. Maximum fresh weight inhibition was seen in *C. reflexa*+ *R. dentatus* (T_{17}) extracts (29.56%) whereas minimum reduction was shown by *C. reflexa*+ *C. papaya* (T_{16}) and *C. papaya*+ *P. hysterophorus* (T_{20}) extracts (13.49%) (Fig. 1). *S. moocraftiana* (T_2) extract was the only treatment which significantly increased the fresh weight of wheat. Minimum fresh weight was recorded in *C. reflexa*+ *R. dentatus* (T_{17}) extract and maximum fresh weight was recorded in *S. moocraftiana* (T_2) extract (Fig. 2).

Keeping dry weight in view there was an increase in dry weight of *A. fatua* seedlings in all the treatments. 34.17%, 28.33%, 25% and 20.83% increase in dry weight of seedlings of *A. fatua L*. was shown by *E. helioscopia*+ *R. dentatus* (T_{10}), *S. moocraftiana* (T_2), *C. papaya*+ *R. dentatus* (T_{19}) and *C. reflexa* (T_3) extracts respectively (Fig. 1). Kanaga *et al.* (2012) carried out a study to evaluate the effect of leaf extract of Neem on Cow pea and Horse gram observed similar trends in dry weight. In wheat most of the treatments significantly increased the dry weight (Fig. 2). Fluctuations in fresh and dry weights of seedlings can be attributed to the possible synergistic and antagonistic effects of allelochemicals present in plant water extracts used.

Overall suppressing potential of the extracts might be due to presence of strong inhibitory allelochemicals. And the treatments which did not significantly affect the growth and germination of wild oat and wheat might not have potentially strong allelochemicals. Germination inhibition and growth reduction in some treatments may render towards the hormonal activity suppression, reduction of mitotic activity in hypocotyle and roots, alteration of cell division and tissue elongation, imbalance of ion uptake, inhibition of protein formation,

photosynthesis, respiration and nucleic acid formation, effect on the cell membrane permeability and all these effects are due to the presence of allelochemicals.

CONCLUSION

All these plants have allelopathic potential of varying degree and the use of combinations of their plant water extracts can offer a good control of wild oat in wheat crop. *C. reflexa* alone and in combination with *P. hysterophorus* totally inhibited the germination of wild oat. In case of wheat, *E. helioscopia*+ *S. moocraftiana*, *E. helioscopia*+ *P. hysterophorus* and *S. moocraftiana*+ *P. hysterophorus* extracts should be focused for their promotory effects on germination and growth of wheat. Further studies are proposed to set the right combinations and suitable concentrations of water extracts.

Table-1. Influence of allelopathic plant extracts on germination and growth of Wild oat

Treatments		Final germination	Plumule length (cm)	Radical length (cm)
T_o	Pure water (Control)	34 abcde	15.024 a	18.497 a
T_1	*E. helioscopia*	52 a	12.892 b	10.992 b
T_2	*S. moocraftiana*	14 fghi	0 h	0.66 fg
T_3	*C. reflexa*	0 i	0 h	0 g
T_4	*C. papaya*	20 defgh	2.14 defg	1.254 fg
T_5	*R. dentatus*	12 fghi	0.35 fgh	0.52 fg
T_6	*P. hysterophorus*	8 ghi	0.01 h	0.12 g
T_7	*E. helioscopia+ C. reflexa*	8 ghi	0.32 fgh	0.68 fg
T_8	*E. helioscopia+ S. moocraftiana*	42 abc	3.576 d	4.2134 c
T_9	*E. helioscopia+ C. papaya*	40 abc	8.65 c	3.376 cd
T_{10}	*E. helioscopia+ R. dentatus*	30 bcdef	6.814 c	4.184 c
T_{11}	*E. helioscopia+ P. hysterophorus*	46 ab	2.549 de	2.329 def
T_{12}	*S. moocraftiana+ C. reflexa*	8 ghi	0.64 efgh	1.38 efg
T_{13}	*S. moocraftiana+ C. papaya*	40 abc	1.637 defgh	2.162 def
T_{14}	*S. moocraftiana+ R. dentatus*	34 abcde	0.985 efgh	1.999 def
T_{15}	*S. moocraftiana+ P. hysterophorus*	12 fghi	0.015 h	0.825 fg
T_{16}	*C. reflexa+ C. papaya*	38 abcd	2.208 def	3.2174 cde
T_{17}	*C. reflexa+ R. dentatus*	6 hi	0.1 gh	0.7 fg
T_{18}	*C. reflexa+ P. hysterophorus*	0 i	0 h	0 g
T_{19}	*C. papaya+ R. dentatus*	36 abcde	1.68 defgh	1.116 fg
T_{20}	*C. papaya+ P. hysterophorus*	26 cdefg	0.888 efgh	0.839 fg
T_{21}	*R. dentatus+ P. hysterophorus*	18 efghi	1.03 efgh	0.62 fg

❖ Treatments sharing similar letters are statistically non significant to each other.

Table-2. Influence of allelopathic plant extracts on germination and growth of Wheat

Treatments		Final germination	Plumule length (cm)	Radical length (cm)
T_o	Pure water (Control)	98 a	11.946 a	17.566 a
T_1	*E. helioscopia*	74 bcde	2.428 jkl	1.498 hij
T_2	*S. moocraftiana*	88 abc	6.622 cde	2.088 efgh
T_3	*C. reflexa*	10 h	0.316 l	0.135 k
T_4	*C. papaya*	54 fg	2.96 hijk	0.998 ijk
T_5	*R. dentatus*	76 bcde	1.806 kl	0.874 jk
T_6	*P. hysterophorus*	96 a	5.194 defgh	3.03 cde
T_7	*E. helioscopia+ C. reflexa*	82 abcd	3.986 fghijk	2.566 defg
T_8	*E. helioscopia+ S. moocraftiana*	98 a	9.158 b	4.39 b
T_9	*E. helioscopia+ C. papaya*	86 abc	5.546 defg	2.892 def
T_{10}	*E. helioscopia+ R. dentatus*	90 ab	7.314 bcd	3.132 cde
T_{11}	*E. helioscopia+ P. hysterophorus*	96 a	6.21 def	4.078 bc
T_{12}	*S. moocraftiana+ C. reflexa*	84 abcd	8.894 bc	3.384 bcd
T_{13}	*S. moocraftiana+ C. papaya*	72 bcdef	3.862 ghijk	1.948 fghi
T_{14}	*S. moocraftiana+ R. dentatus*	76 dcde	5.698 defg	1.946 fghi
T_{15}	*S. moocraftiana+ P. hysterophorus*	96 a	9.512 b	3.968 bc
T_{16}	*C. reflexa+ C. papaya*	60 efg	3.046 hijk	1.742 ghij
T_{17}	*C. reflexa+ R. dentatus*	42 g	2.732 ijk	1.074 hijk
T_{18}	*C. reflexa+ P. hysterophorus*	58 efg	3.936 ghijk	1.966 fghi
T_{19}	*C. papaya+ R. dentatus*	54 fg	2.55 jkl	0.976 ijk
T_{20}	*C. papaya+ P. hysterophorus*	70 cdef	4.19 fghij	2.084 efgh
T_{21}	*R. dentatus+ P. hysterophorus*	66 def	4.914 efghi	1.824 ghij

- Treatments sharing similar letters are statistically non significant to each other.

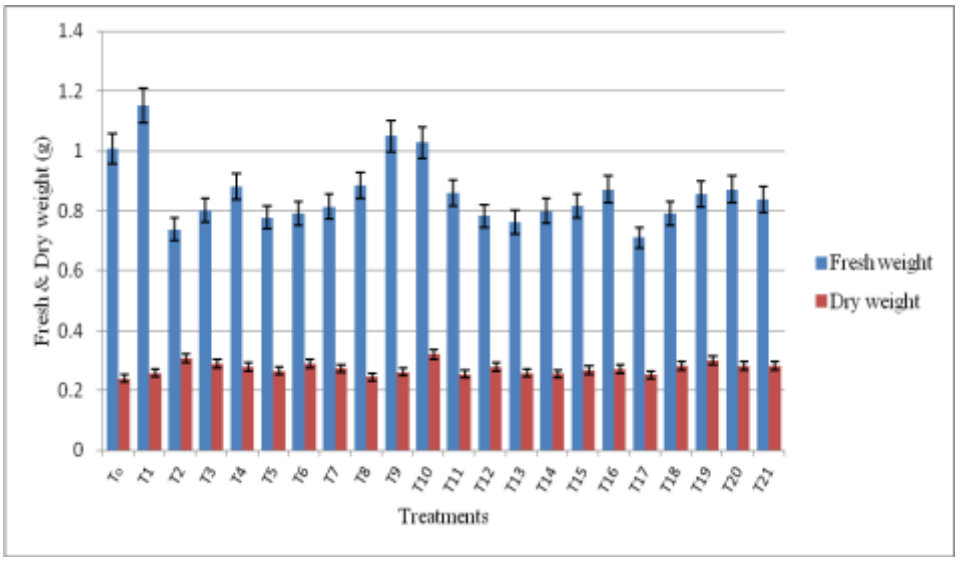

Figure 1. Effect of allelopathic plant extracts on fresh and dry weight of Wild oat

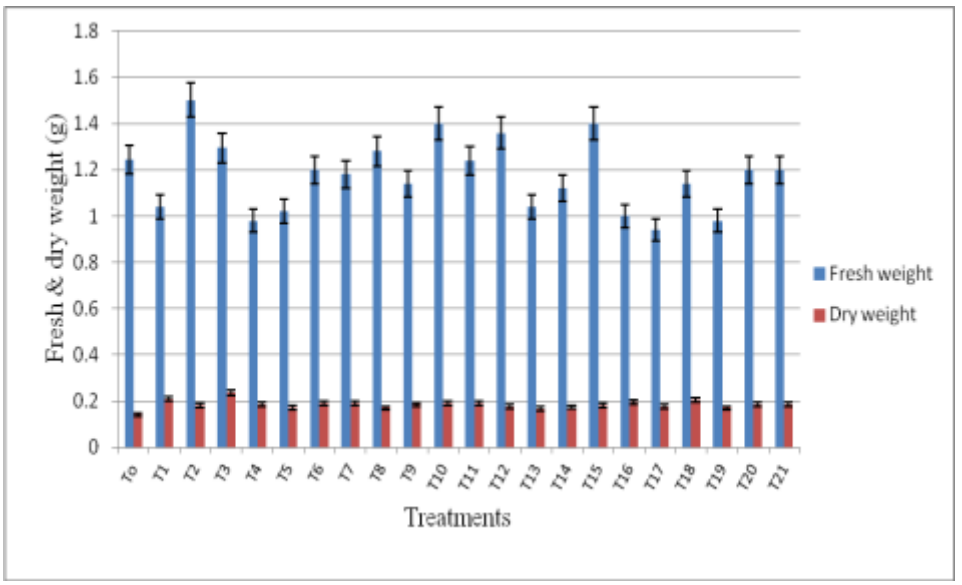

Figure 2. Effect of allelopathic plant extracts on fresh and dry weight of Wheat

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