Global Journal of Agriculture and Food Sciences Research
Vol.1, No.1, pp.45-52, March 2014
Published by British Research Institute UK (www.gbjournals.org)

ALLELOPATHIC POTENTIAL OF WHEAT (TRITICUM AESTIVUM)

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ABSTRACT: *Triticum aestivum has been examined for its allelopathic potential against rice seedling under field conditions in the pot experiments. Allelopathic studies has been designed by using aqueous both cold and hot extracts from root and shoot straw, leachates and mulching in various pot experiments, invariably reduced the plant height, length of leaf, width of leaf, number of spike per plant, length of spike, number of seeds per spike and size of internode of the rice plant used as the test species. The aqueous extracts obtained after 48 h were more inhibitory than 24 h. similarly 10 % W/V extracts were more inhibitory than 5 % W/V extracts. It was observed that number of leaves was not affected significantly. Leachates and mulching experiments also proved to be inhibitory. It is suggested that both wheat root and stem straw have strong allelopathic potential against the rice plant. Further studies are required to explore its behavior so as to maximize its potential against weed and minimize against crop plants.*

KEYWORDS: Allelopathic, Wheat, Triticm aestivum, Seedling

INTRODUCTION

Allelopathy, simply defined as "the release of phytotoxins by plants". Or the ability of plants to inhibit germination of other plants. It can enhance the competitive success of the plant invaders, since the release of these phytotoxins in the environment may affect the growth and life processes of other community species (Callaway 2002, Mschado, 2007). It is a complex process that operates along with other competitions in nature to suppress and finally exclude susceptible associated species from the common habitat (Hussain *et al*., 2007). Allelopathy is a biological phenomenon by which an organism produces one or more biochemicals that influence the growth, survival, and reproduction of other organisms.

These biochemicals are known as allelochemicals, which is a subset of secondary metabolites and can have beneficial (positive allelopathy) or detrimental (negative allelopathy) effects on the target organisms (stamp, 2003). Allelochemicals are present in many types of plants and are released into the rhizosphere by a variety of mechanism including decomposition of residues, volatilization, and root exudation. These chemicals are known to affect germination, growth, development, distribution and reproduction of a number of plant species (Inderjit and Malik, 2002) Several allelochemicals and the ability to release these chemicals, indicates that allelopathic potential is a polygenic characteristic weakly correlated with yield or other important agronomic features (Kong *et al* 2005). Similarly a crop plants crop plant also have allelopathic potential and is receiving greater attention as a potential mean that can be exploited in various ways for solving agricultural problems. Wheat possesses allelopathic

potential for weed suppression and disease control through the release of secondary metabolites from its living plants or residues, which could avoid the environmental pollution brought by herbicides and germicides (Alsaadawi *et al*, 2001, Zhang *et al*, 2004). Several categories of allelochemicals for wheat allelopathy have been identified, including phenolic acids, hydroxamic acids, and short-chain fatty acids (Wu *et al*., 2001)

Recent research work done on allelopathic potential of wheat highlighted a variety of studies which includes Wu *et al*, 2000 (Allelochemicals in wheat different parts) , Zhang *et al*, 2004 (allelopathic potential of wheat for weed suppression), Li *et al*, 2005 (Allelopathic effect of wheat residue) Ma, 2005 (allelopathic studies of common wheat) Zuo *et al*, 2005, (allelpathic effect of wheat genotypes), Villagrasa *et al*,2006, Zheng *et al*, 2007, (Allelopathic effect of wheat on weeds), Zuo *et al*, 2007(Allelopathy variation in dryland winter wheat) Labbafy *et al*, 2009 (Allelopathic Interaction of Wheat (*Triticum aestivum* L.) and Rye (*Secale cereal* L.), Yuyan *et al*, 2009 (Allelopathic effects of root exudates from wheat) Labbafi *et al*, 2010 (allelopathic effect of wheat against weeds) Zuo *et al*, 2010 (potential of four winter wheat *Triticum aestivum* L. accessions) Saffari *et al*, 2010 (Allelopathic effects of straw extract wheat varieties on the growth of corn).

The present study was conducted to assay the allelopathic potential of wheat *Triticm aestivum* against rice seedling in pot under field conditions.

MATERIALS AND METHODS

Root and shoot straw of wheat were collected from Peshawar university Garden, Azakhel Nowshehra and were dried at room temperature (25˚C- 30˚C), grinded into powder and placed separate in paper bags. Glass wares were carefully cleaned with tap water and sterilized at 170˚C for at least 4 hours. All the data were statistically analyzed through ANOVA.

Preparation of aqueous extracts

Five and 10 gm of root and shoot straw were soaked separately in 100 ml distilled water at 25˚C for 24 and 48 hours and filtered to get aqueous extracts. These extracts were tested against rice seedling in pots under field conditions. Pots were provided with soil of similar composition. Pots were superficially sprinkled with aqueous extract. For each treatment, five pots, each with 5 seedlings were experimentally tested. The pots were placed under room temperature in Net house in department of Botany, university of Peshawar, Peshawar. Various morphological parameters like Plant height, number of leaves, length and width of leaves, Number of spikes, length of spike, and number of seeds per spike and size of internodes were recorded after completion of growth period.

Preparation of hot water extracts

Five gm of dried straw materials of root and shoot were separately boiled in 100 ml of water for 5 minutes and filtered. The room cooled extracts were applied against the same test species under the same condition as before.

Leachates Experiments

Five gm of litter of root and shoot straw of wheat were soaked as such and then the filtered extract was thoroughly sprinkled on the pots after three days of rice seedling sowing. In control seedlings were remain as such. For each treatment, five pots, each with 5 seedlings were tested. Plant height, number of leaves, length and width of leaves, Number of spikes, length of spike, and number of seeds per spike and size of internodes were recorded after completion of growth period.

Mulching experiments

Five gm crushed root and straw were placed in pots in which rice seedlings were sown in the soil of the same composition. For each treatment five pots, each with 5 seedlings were tested experimentally. Controls were kept as such with out any treatment and the same parameters were recorded as considered before.

RESULTS AND DISCUSSIONS

Wheat (*Triticum aestivum*) is the main food crop in the world, and plays an important role in agricultural production. In order to enhance wheat yield (Zhang *et al*.2004). Wheat (*Triticum aestivum*) allelopathy has potential for the management of weeds (Wu *et al*. 2001), The present study suggested that *Triticum estivum* exhibited harmful effect against the various parameter of rice plant which is used as test species under field condition. Aqueous extracts root and shoot straw significantly reduced the plant height, length of leaf, width of leaf, number of spike per plant, length of spike, number of seeds per spike and size of internode of the rice plant (Table 1& 2). It was also observed that 10% W/V aqueous extract for 24 hour duration and 5 % W/V for 48 hour duration showed more inhibitory effect that their respective concentration and duration. These observations showed that both concentration and duration increased the effects of allelochemical present in *Triticum aestivum*. It was also observed that number of leaves under all treatments was not significantly affected, although length and width of the leaves were affected significantly. Similarly number of spike per plant and number of seeds per spike were also retatarded in this work (Table 1 & 2). Most of the work done so for was related to exploring that wheat allelopathy plays a significant role in controlling weeds. Some of the renounced worker in this category are Alsaadawi (2001), Wu *et al*. (2001), Qing (2005), Labbafy, *et al*. (2009), Zuo *et al*. (2010) and Bertholdsson (2010), who all described that wheat has strong allelopathic potential against weeds. In the present study, it was observed that an addition to weeds this plant also effect crop plants like rice as well.

The use of hot water extract is unnatural but it reduces the time period for extraction of allelochemicals (Barkatullah *et al*, 2010). Further it may be evaluated from such experiment that temprature may effect the release of toxic substances from allelopathic plant. Hot water extract of root and shoot straw of wheat extract in this study, effects all the characteristics like plant height, length of leaf, width of leaf, number of spike per plant, length of spike, number of seeds per spike and size of internodes of the rice plant in the same manner as described earlier for cold water extract, but having a little strong allelopathc potency. Hussain *et al*., (2004), Chung *et al*.,(2007), Peneva (2007), and Hussain & Ilahi (2009) and

Barkatullah *et al*, (2010) also reported similar effects, which more or less supported our study.

Remains of crop plant in field generally decomposed to release some nutrients to the soil, so as to increase soil fertility,. But it was also observed that during decomposition some of the allelochemcals also released into the soil, which reduce crop plants yield. Similar situation were also observed in the present study, where root and shoot straw, used as litter cause retardation in rice plant characteristics (Table. 4). These agree with Kaul & Bansal (2002), who reported that litter from *Ageratina adenphora* reduced growth of *Lantana camara*. Similarly, Maciel *et al*., (2003) also reached to similar results. Litter from *Cenchrus ciliaris* and *Bothriochloa pertusa* (Hussain & Ilahi, 2009) and *Dodonaea viscosa* (Barkatullah *et al*, 2010) also proved inhibitory to test species.

Some of the allelopathic substances are released from plants to the environment through leaching by fog, mist and rain, which are thus involved in allelopthic behavior of the plants(Nakano *et al*, 2003). Wheat root and shoot straw artificial leachates have the same inhibitory effect as described earlier for rice plant characteristics (Table 4). Leachates from *Broussonetia npapyrifera*(Hussain, *et al*. 2007), Stble leachates from soyabean and wheat (Yuyan *et al*. 2010) and leachates *Cenchrus ciliaris* L. and *Bothriochloa pertusa*(Hussain *et al*, 2011)also have been reported. These further strengthened our findings.

Fresh weight, dry weight and moisture contents of rice plant show variable results by the aqueous extracts, Hot water extract, litter and leachates of root and shoot straw of wheat. Fresh weight, dry weight and moisture contents were recorded to reduced by all the treatments except for 5 % W/V wheat shoot straw extract, where fresh weight was enhanced as compare to control. These findings are lined with the results of Pervez *et al* (2003) for *Tamarinds indica*, Hussain *et al*, 2004 for *Broussonetia papyrifera* and Barkatullah *et al* (2010) on various test species.

Allelopathia related by the plants accumulate in the soil to physiological activity level (Hussain *et al*, 2004). Indejit and Duke (2003) highlighted the advantage of the plants to release phytochemicals from dead tissues, and their incorporation to the soil could be accelerated by leaching, thus facilitating their effects in the field. This phenomenon was tested on various assayed Part of *Dodonaea viscosa*, which were used as mulch. It was observed that the germination, radical growth and plumule growth of all the test species were significantly retarded (Table 3). Hussain *et al* (2004) and Eppard *et al* (2005) also showed similar phytotoxicity by other plants.

The mechanism and action of allelochemicals have wide range, effecting cell lysis, blistering, or growth inhibition and chlorophyll contents of susceptible plants that also lead to reduction of growth (Mulderij *et al*. 2003; Wu *et al*., 2003). Some of the reported allelochemicals from wheat include various phenolic acids like p-hydroxybenzoic, vanillic, cis-p-coumaric, syringic, cis-ferulic, trans-p-coumaric, and trans-ferulic acids. These allelochemicals vary in different parts of wheat plant and responsible for allelopathic potential (Wu *et al*. 2000). According to Zhang *et al*., (2004), Hydroxamic acids and phenolic acids are the predominant allelochemicals frequently reported which could produce plant natural defense against weed.

Both wheat residue allelopathy and wheat seedling allelopathy can be exploited for managing weeds. But in the present study allelopathy of wheat has been conducted against rice to show

its behavior against crop plants which showed that wheat straw equally effects crop plant following them in the next growing period. Wheat allelopathy requires further study in order to maximize its allelopathic potential for weeds, pests and diseases managment, and to minimize its hazardous effects on the growth of wheat itself and other crops.

Table 1. Effect of aqueous extract of Wheat root straw on rice seedlings characteristics.

Each value is mean of 5 replicates each with 5 seedlings. Fresh weight, dry weight and moisture contents are mean of 10 seedlings. All values are given as percent of control.

S. No	Soaking duration	24 hours		48 hours	
	Treatments	5% W/V	10% W/V	5% W/V	10% W/V
1	Plant height(cm)	79.69	70.90	72.01	67.59
2	No. leaves	89.47	84.21	84.21	78.95
3	Length of leaves(cm)	96.96	76.33	93.30	90.01
4	Width. Leaves (cm)	56.82	62.88	75.76	70.45
5	No. of spike	47.83	34.78	39.13	36.70
6	Length of spike(cm)	84.70	82.70	85.91	82.21
7	No. of seeds/spike	81.55	77.99	66.99	74.11
8	Size of internodes(cm)	58.47	46.54	68.02	61.65
9	Fresh weight (g)	75.00	67.31	73.21	73.16
10	Dry weight (g)	75.99	83.43	99.04	90.87
11	% Moisture contents	97.74	69.03	58.08	68.79

Table 2. Effect of aqueous extract of Wheat Shoot straw on rice seedlings characteristics.

Each value is a mean of 5 replicates each with 5 seedlings. Fresh weight, dry weight and moisture contents are mean of 10 seedlings. All values are given as percent of control.

S. No	Soaking duration	24 hours		48 hours	
	Treatments	5% W/V	10% W/V	5% W/V	10% W/V
1	Plant height(cm)	75.24	68.32	67.12	64.74
2	No. leaves	85.26	86.32	86.74	83.16
3	Length of leaves(cm)	101.59	85.45	90.61	90.61
4	Width. Leaves (cm)	68.97	60.69	68.97	68.97
5	No. of spike	46.09	62.61	78.26	59.83
6	Length of spike(cm)	91.81	72.60	83.63	90.75
7	No. of seeds/spike	78.96	77.02	68.61	72.82
8	Size of internodes(cm)	76.37	35.80	51.71	63.64
9	Fresh weight (g)	77.75	72.94	67.31	70.74
10	Dry weight (g)	70.18	85.42	106.77	83.95
11	% Moisture contents	117.00	76.56	40.97	74.78

Table 3. Effect of Hot water extract of Wheat root and shoot straw on rice seedlings characteristics

Each value is a mean of 5 replicates each with 5 seedlings. Fresh weight, dry weight and moisture contents are mean of 10 seedlings. All values are given as percent of control.

S. No	Treatments	Shoot Straw	Root straw
1	Plant height(cm)	73.08	72.86
2	No. leaves	105.26	94.74
3	Length of leaves(cm)	86.21	69.79
4	Width. Leaves (cm)	64.39	71.97
5	No. of spike	65.22	69.57
6	Length of spike(cm)	74.38	83.63
7	No. of seeds/spike	69.26	71.84
8	Size of internodes(cm)	62.05	70.41
9	Fresh weight (g)	72.56	69.98
10	Dry weight (g)	84.68	98.16
11	% Moisture contents	77.18	54.23

Table 4. Effect of leachates of Root and shoot straw of wheat on rice seedlings characteristics.

Each value is a mean of 5 replicates each with 5 seedlings. Fresh weight, dry weight and moisture contents are mean of 10 seedlings. All values are given as percent of control.

S. No	Treatments	Leachates	Mulching
1	Plant height(cm)	79.53	77.31
2	No. leaves	105.26	105.26
3	Length of leaves(cm)	90.31	75.26
4	Width. Leaves (cm)	113.64	83.33
5	No. of spike	82.61	86.96
6	Length of spike(cm)	88.61	97.86
7	No. of seeds/spike	75.73	78.32
8	Size of internodes(cm)	75.58	75.58
9	Fresh weight (g)	80.95	79.58
10	Dry weight (g)	12.00	12.50
11	% Moisture contents	145.83	132

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