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Allelopathic Effects of Bark and Stem of Trees and Weeds Species on Morpho-agronomic Traits of Wheat

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Abstract. Potential weeds in wheat field and trees growing on borders of small land holdings are threatening to wheat growth and yield. A field experiment was conducted to evaluate the phytotoxic potentials of stem and barks of different weeds and trees that are switch sorrel (*Dodonaea viscosa* L), river red gum (*Eucalyptus camaldulensis* L.), earth smoke (*Fumaria indica* L.), walnut (*Juglans regia* L.), athel tree (*Tamarix indica* Willd.), dandelion (*Taraxacum campylodes* L.), Indian olive (*Olea ferruginea* Royle.) on morpho-agronomic traits of wheat (*Triticum aestivum*),cultivar Pirsabaq 2005. 500 g stem dry powder of each allelopathic plant was applied on wheat. The result revealed that all the treatments showed significantly inhibitory effects. Within treatments *Eucalyptus camaldulensis* has maximum allelopathic effect on plant height (61.63cm), while minimum effect was observed in *Juglans regia* treatment (69.95cm). Similarly, *Eucalyptus camaldulensis* showed maximum allelopathic effect on length of internodes (15.84cm) and length of spike (7.17cm), while *Olea ferruginea* Royle and *Taraxacum campylodes* showed minimum effect on these two parameters espectively. Maximum number of grains per spike and weight of 100 grain were observed with *Taraxacum campylodes* and *Juglan regia* treatments, while minimum number of spikelet per spike and weight of 100 grain were found in *Eucalyptus camaldulensis* and *Olea ferruginea* Royle treatments respectively. Maximum grain yield was found in *Taraxacum campylodes* treatment (21.67g).The results pointed out that bark of *Eucalyptus camaldulensis* has highest phytotoxic effect while stem of *Taraxacum campylodes* has minimum effect. *Eucalyptus camaldulensis* should not planted near agricultural field of wheat, while *Taraxacum campylodes* residues should be left in field which can none toxic for wheat.

Keywords: morpho-agronomic traits, allelopathic effects, wheat crop

Introduction

Development of Pakistan mostly depends on agriculture, which paid about 25% to the national economy, providing employment for over 50% main source of income generation in rural areas. The main crops have low production during the last four years (2012-2016). The main factors for the low yield of crops include conventional sowing methods, poor quality seed and poor weed management practices (Jabeen and Ahmed, 2009). Herbicides are generally used to weed control in agriculture crops which adversely affect the environment and human health. Allelopathic plants were used together with their residues in the soil in order to control weed growth were applies instead of chemical herbicides and chemical fertilizers (Inderjit and Keating,1999).

Allelopathy is a phenomenon in which chemicals release by plants and micro-organisms may increase or decrease the plant growth (Muhammad and Majeed, 2014). Many researchers focused on this issue by showing significant reduction in germination of wheat due to allelopathic activity of some weeds (Kiarostami, 2004). Kamal and Bano (2008) studied the allelopathic effects of sunflower (*Helianthus annuus* L.) on micro-organisms

In an experiment walnut leaves extract was applied on wheat plants and all of them reduce the germination of wheat (Roohi *et al*., 2009). Hussain and Ilahi (2009) studied the allelopathic potential of Cenchrus ciliaris Linn. and Bothriochloa pertusa (L.). Several species were characterized by phytotoxic potential when their residues were applied to soil (Elizabeth *et al*., 2008; Chon *et al*., 2005; Xuan *et al*., 2004). The allelopathy of Eucalyptus has been investigated by various researchers (Ullah *et al*., 2013; Elizabeth *et al*., 2008; Bajwa and Naz, 2005; Sasikumar *et al*., 2002; Del Moral and Muller, 1970). Eucalyptus species secrete benzoic acids and cinnamic acid which retard the growth of crops and weeds growing close to it (Sasikumar *et al*., 2002; Kohli *et al*.,1998). Volatile oils and phenolic

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acids released from the roots bark, and leaves of *Eucalyptus* have suppressive effects on other plant species (Sasikumar *et al*., 2002). Accumulation of allelochemicals in the soil is due to continuous planting of *Eucalyptus* causing degradation of soil and effect productivity (EL-Khawas and Shehata, 2005). The concentrations of (25, 50 and 75%) of *Chenopodium album* L. showed the allelopathic effect on spike length, number of tillers and plant height, which cause to lower grain yield in wheat (Majeed and Chaudhry, 2012). volatile compounds release from *Eucalyptus* species can inhibit the growth of crops and also lower grain yield (Putnam, 1984).

Eucalyptus is mostly grown along banks of crop and roadside in Pakistan and its leaf litter may release in soil and have allelopathic impacts on growth and germination of *Acacia nilotica* also causing changes in soil environment in terms of nutrient availability (Bughio and Mangrio, 2013). Air-dried and fresh aqueous extracts of leaves, shoots, roots of sunflower (*Helianthus annuus* L.) have allelopathic effects on seedling growth of wheat (*Triticum aestivum* L.) and maize (*Zea mays* L.). Results showed significantly allelopathic effects on seed germination, growth and dry biomass of seedlings of maize and wheat (Muhammad and Majeed., 2014).

Bajalan *et al*. (2013) observed the allelopathic effect of various parts of *Juglans regia* on germination of wheat. An aqueous extract of the root, fruit's green peel and distilled water were used in experiment. The results showed the strong allopathic effect of the extract of *Juglans regia* on germination of wheat in comparison with control.

Syed *et al*. (2014) conducted an experiment to evaluate the allelopathic effect of leaf leachates and root exudates of 19 medicinal plants commonly found in Pakistan by sandwich methods and plant box. Various parts of walnut (*Juglans regia* L.) showed allelopathic effect on wheat germination. The treatments included an aqueous extract fruit's green skin, leaf and root (with of concentrations 100%, 50% and 25%) and distilled water (control). The results reveal that extract of the fruit's green skin has a stronger allelopathic effect as compared to leaf and root (Ambika, 1980). Leaves, shoot and bark of *Quercus baloot* Griff have allelopathic effects on *Lactuca sativa, Setaria italica and Pennisetum americanum*. Aqueous extract, plant parts and rain leachate obtained from Quercus baloot significantly reduced the germination, plumule and radicle growth of *Lactuca sativa*, *Setaria italica* and Pennisetumamericanum (Dastagir and Hussain, 2015).

Gurmani *et al*. (2020) studiedthe allelopathic effect of plant extracts for weed suppression and productivity in Wheat (*Triticum aestivum* L.). The result reveal that combination of leaf extractsof Moringa oleifera with *Parthenium hysterophorus* and *Cannabis sativa* (water extract at 3%) wassignificantly suppress weeds in wheat and achieve higher wheat growth. Similarly Nadeem *et al*. (2020) explored the allelopathic effects of aqueous extracts of *Carthamus tinctorius* L. on emergence and seedling growth of *Echinochloa cruss-galli* and concluded that 8% or higher concentration of *C.tinctorius* leaf aqueous extract may be exploited to biologically suppress the *E. cruss-galli* Zhang (2020) studied the physiological and biochemical mechanisms mediated by allelochemical Iso liquiritigenin on the growth of lettuce seedlings.

Lot of research work has been conducted regarding the allelopathy and crops but yet no attention was given to study the allelopathic effect of some trees like *Eucalyptus camaldulensis*, *Olea ferruginea* and *Juglans regia* growing on borders of wheat crops and weed like *Taraxacum campylodes*. Bearing these considerations in mind the main object of this study was to investigate the allelopathic effects of tree barks and stem of weeds on morpho-agronomic traits of wheat as these falls in the agricultural field during winds and storm. If allelopathic plants residues have negative effect then it can be used as organic herbicides that are non-toxic and friendly to the environment.

Materials and Methods

Plant materials. Bark of *Dodonaea viscosa* (T1), *Eucalyptus lanceolata* (T2), *Juglans regia* (T4), *Olea-ferruginea royle* (T5), *Tamarix indica* (T6), *Taraxicum campylodes* (T7) and stem of *Fumaria indica* Hussh Pugsley (T3)were collected from these plants near borders of wheat crop in Mansehra and from Botany Department, Hazara University during April 2017.Wheat (*Triticum aestivum*) variety Pirsabaq (2005) was supplied by Cereals Crops Research Institute Pirsabaq Nowshera Field preparation and application of dry stem of allelopathic plants.

Field preparation and application of dry stem of allelopathic plants. The field was designed according to randomized complete block design for cultivation. The field was divided into three plots and each plot was prepared in line method. Each plot consists of twenty-one rows and one row was kept as a control after each treatment in order to avoid mixing with each other. Seeds of wheat were sown in experimental plots and dry stem of allelopathic plants were applied separately to a single plot and control was taken. To each plot 500 g of each treatment were applied per row. After germination had completed, thinning was done.

Experimental design and statistical analysis. A Randomized complete block design with 4 replication was used to determine the effect of dry stem of allelopathic plants on morpho-agronomic wheat parameters. At maturity, plant height (cm), grain yield per plant, number of grains per spike, spike length (cm), internode length (cm) and 100-grain weight were recorded then data was statistically analyzed by using Statix 8 for analysis of variance (ANOVA) and Least significant differences (LSD) test at 5% probability (Steel and Torrie, 1980).

Results and Discussion

Plant height. Plant height of wheat showed non-significant (P>0.05) variations due to allelopathic effect of stem of selected plants (Table 1). The mean values revealed that control has maximum plant height (77.17cm), followed by *Juglans regia*, *Tamarix indica*, *Taraxacum campylodes*, *Olea ferruginea*, *Fumaria indica*, *Dodonaea viscosa* treatments, while *Eucalyptus camaldulensis* caused the minimum plant height. Least significant data showed that there was a significant effect of stem of allelopathic plants on plant height. Highest plant height was found in control (77cm), while the smallest height was seen in *Eucalyptus camaldulensis* treatment (61.63cm) (Table). Similar results were observed by Jabeen *et al*. (2013) who explained that *Fumaria indica* effect the germination, plant height, dry weight andfresh weight of shoot and root. Our results are also supported by Ambika (1980), who observed that leaf leachates of *Eupatorium odoratumas* inhibit the growth of wheat. In recent studies similar results were indicated with *Fumaria indica* in wheat (Ullah *et al*., 2013). Majeed and Chaudhry (2012) showed that concentrated extracts of *Chenopodium album* L. had allelopathic effects on plant height, number of tillers and spike length which finally lower grain yield in wheat. In recent studies similar results were reported by Gurmani *et al*. (2020) and Nadeem *et al*. (2020).

Length of internodes. Significant variation was observed in internodes length (Table 1). The mean values for internode length showed that control has maximum length of internodes (20.53cm) which was followed by *Juglans regia*, *Tamarix indica*, *Olea ferruginea*, *Taraxacum campylodes*, *Fumaria indica*, *Dodonaea viscosa* treatments, while *Eucalyptus camaldulensis* (15.84 cm) showed minimum allelopathic effect on length of internodes.

Least significant data revealed that there was significant effect of stem on lenth of internode of wheat. The highest internode length was found in control (20.53 cm), while smallest one was observed with *Eucalyptu camaldulensis.*Significant differences were also observed within *Dodonaea viscosa*, *Eucalyptu camaldulensis*, *Fumaria indica*, *Olea ferruginea* and *Taraxacum campylodes*. The non-significant difference was among *Tamarix indica and Juglan regia* (Table 2). Majeed and Chaudhry (2012) showed similar results by studying the effect of concentrated extracts of Chenopodium album on wheat. Similar results were reported by other authors (Sasikumar *et al*., 2002; Kohli *et al*., 1998).

Length of spike. Length of spike has significant (P<0.05) variation among the all treatments (Table 1). The result revealed that there was significant effect on length of spike. *Eucalyptus camaldulensis* (7.17cm)

Table 1. Analysis of variance for allelopathic effect of bark and stem on morpho-agronomic traits of wheat.

Source of variation	DF	Plant height cm		Length of internode cm		Spike length cm		Number of grains per spike		Grain yield (g)		100Grain weight (g)	
		MS	P	MS	P	MS	P	MS	P	MS	MS	P	
Treatments	7	60.2	0.059	5.38	0.01	2	0.037	321	0.058	83.11	0.028	0.857	0.17
Replications	2	23.79		1.44		0.69		126		.26.91		0.5	
Error	9												

Highly significant at P ≥ 0.01, significant at P ≥ 0.05 and non- significant at P≥0.05
DF= Degree of freedom; MS= Mean square; P= Probability; cm= Centimeter; g= gram

Table 2. Least significant data for allelopathic effect of bark and stem on morphological features of wheat.

Treatments	Plant height (cm)	Length of internode (cm)	Spike length (cm)	Number of grains per spike	100grain weight (g)	Grain yield (g)
Control T0	77.18 A	20.53 A	9.88 A	60.45 A	5.33 A	29.5 A
Dodonaea viscosa T1	65.63 G	16.78F	8.42 E	35.08 F	4.33 C	16.10 F
E. camaldulensis T2	61.33 H	15.84 G	7.17 G	26.68 H	4.00 D	13.67 G
Fumaria indica T3	67.10 F	17.59 E	9.13 B	44.63 C	4.33 C	20.67 D
Juglan regia T4	69.95 B	18.11 B	8.8 D	44.27 D	5.00 B	21.33 C
Olea ferruginea T5	67.32 E	17.96 C	9.08 B	31.77 G	3.67 DE	13.33 H
Tamarix indica T6	69.27 C	18.09 B	7.96 F	40.33 E	4.67 E	18.00 E
Taraxacum campylodes T7	68.72 D	17.84 D	8.80 C	45.63 B	4.67 E	21.67 B
LSD	0.06	0.02	0.09	0.01	0.23	0.08

Means followed by similar letters in each column do not differ significantly at P<0.05.

showed maximum allelopathic effect while the minimum was observed in the control. Least significant difference indicated that control (9.88cm) has significant variation to treatments. Among *Dodonaea viscosa*, *Eucalyptus camaldulensis*, *Tamarix indica* and *Taraxacum campylodes* significant variation were also observed. Non-significant variation was reported among *Fumaria indica* and *Olea ferruginea* (Table 2.). These results confirmed the allelopathic effect of *Eucalyptus* specie as previously reported (Bughio and Mangrio, 2013). Majeed and Chaudhry (2012) showed similar reports by studying the allelopathic effect of *Chenopodium album* on wheat. Similar results were indicated by Gurmani *et al*. (2020) by studying the allelopathic effect of plant extracts for weed suppression and productivity in Wheat (*Triticum aestivum* L.).

Number of grains per spike. Number of grains per spike showed significant (P>0.05) variation among the treatments (Table 1). *Eucalyptus camaldulensis* (26.67) has maximum allelopathic effect, while control (60.45) showed minimum effect on number of grains per spike. Least significant difference showed the control to all treatments. Significant variation recorded among *Dodonaea viscosa*, T*amarix indica*, *Olea ferruginea* and *Taraxacum campylodes* (Table 2). Majeed and Chaudhry (2012) confirmed the results by studying the effect of concentrated extracts of *Chenopodium album* on wheat.

Weight of 100 grains. The analysis of variance revealed that non-significant (P>0.05) variation among the applied treatments. Majeed and Chaudhry (2012) showed similar finding by studying theeffect of *Chenopodium album* on wheat.

Grain yield. The analysis of variance showed that grain yield of wheat has significant (P<0.05) variations among the treatments (Table 1). maximum grain yield was found in *Taraxacum campylodes* among alleopathic plants (21.67g) after control, while *Olea ferruginea* (13.33 g) attained minimum grain yield. The least significant difference showed that control had significant variation to all treatments as shown in Table 2. Our results are in lined with Putnam (1984) who explained that *Eucalyptus* excreted volatile oil which retard the crops growth and also reduce grain yield. Majeed and Chaudhry (2012) showed similar results by studying the effect of concentrated extracts of *Chenopodium* album on wheat.

Conclusions

Among all the seven allelopathic plants *Eucalyptus camaldulensis*, *Dodonaea viscosa*, *Eucalyptus camaldulensis*, *Olea ferruginea*, *Fumaria indica*, *Juglans regia*, *Taraxacum campylodes* and *Tamarix indica*, stem and bark were highly allelopathic for wheat growth and yield. It affects plant wheat growth decreasing some important morpho-agronomic parameters *i.e* internode length, spike length, grain yield per plant. These results indicated that *Eucalyptus camaldulensis* is highly allelopathic plant, while *Olea ferruginea* and *Dodonaea viscosa* are the less toxic compared to the other plants. So, *Eucalyptus camaldulensis* should not be planted near to agricultural field because it leaches out different allelochemicals from their fallen litter in soil, which affect wheat growth. This research is also beneficial for agroforestry which explain what types of trees and crops are cultivated together. Further, *Juglans regia* and *Tamarix indica* should not be planted near to agricultural field of wheat because these trees species releases allelochemicals like Juglone and other terpenoids that directly affect the yield. In future study allelochemicals should be isolated from these tree species with help of High-Performance Liquid Chromatography techniques and check their allelopathic activity to make organic fertilizer and organic herbicides that are friendly to environment and human being.

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Conflict of Interest. The authors declare they have no conflict of interest.

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