Alinteri J. of Agr. Sci. (2020) 35(2): 45-50
e-ISSN: 2587-2249
info@alinteridergisi.com

http://dergipark.gov.tr/alinterizbd
http://www.alinteridergisi.com/
DOI: 10.47059/alinteri/V35I2/AJAS20074

RESEARCH ARTICLE

Assessment of Allelopathic Prospective of Agriculture Land Trees on Morphological and Yield Attributes of Wheat Varieties of Pakistan

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ARTICLE INFO

Article History:
Received: 20.04.2020
Accepted: 11.08.2020
Available Online: 05.11.2020

Keywords:
Allelopathy
Agroforestry
Wheat
Morphological attributes
Yield

ABSTRACT

The study was specifically designed to assess the allelopathic potential of some agriculture land related trees. The aqueous extracts of five different trees *Corymbia citriodora, Juglans regia, Alianthus altissima, Populus ciliata* and *Melia azadrach* were applied on two selected wheat cultivars *(Triticum aestivumL.)* CM 301 approved variety V1 and a local variety V2. Aqueous extracts of 20g/200ml ratio concentration were prepared separately. The allelopathic effects on morphological parameters of wheat as well as reduction or enhancement ratio of wheat yield were studied. Five Treatments (T0, T1, T2, T3, T4, T5) for both varieties were arranged in completely randomized design (CRD) with three replications each. The morphological parameters were measured after 40 days of sowing. Data were subjected to analysis of variance through (ANOVA) and least significant differences (LSD) were found by using software (Statistix 8.1). All treatments showed remarkable positive and negative effects on the parameters under investigation. Significant difference was observed by parameters such as number of tillers (0.0183), root length (0.018), flag leaf length (0.0191), flag leaf width (0.0153), numbers of awns (0.0164) and grains weight (0.0193). Some parameters showed non-significant difference like number of spikeslets (0.0930) and numbers of grains (0.1518). While numbers of spike (0.3754), spike length (0.6088) and plant height (0.4461) showed highly non-significant growth. The study concludes that *Juglans regia* and *Melia azedarach* showed growth enhancing effect while *Populus ciliata* and *Alianthus altissima* strongly inhibit the growth and yield of both wheat varieties.

Please cite this paper as follows:

Jalali, I., Shah, A. H., Farooq, M., Jabeen, T., Khan, K. R. and Zohra, L. (2020). Assessment of Allelopathic Prospective of Agriculture Land Trees on Morphological and Yield Attributes of Wheat Varieties of Pakistan. *Alinteri Journal of Agriculture Sciences*, *35*(2): 45-50. doi: 10.47059/alinteri/V35I2/AJAS20074

Introduction

Cultivated crops are providing nutritional requirements constantly to human beings all over the world. Wheat *(Triticum aestivum* L.*)* is the second largest cereal crop of the globe. In Pakistan, wheat crop is considered to be one of the most important cereal crops of the country (Marwat et al. 2013). According to an estimate of FAO Pakistan is the 9th largest wheat producing country, accounting for 3.04% of the world wheat production from an area of 3.57% of the world. As regard the nutritional profile of wheat is concerned it provides

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almost 55% of carbohydrates, 20% calories of the food and proteins 14.70%, fat 2.10%, minerals 2.10% and substantial number of vitamins especially thiamine and vitamin –B and minerals like zinc and iron (Shewry *et al.*, 2006).

Wheat *is a major crop in Pakistan, during financial* year 2020, 24.946 million ton of wheat was produced (Monthly Economic Update*, 2020). Average grain yield of wheat is very low i-e. 2.845 tons ha*$^{-1}$ *(ESP, 2016-17).* The crop needs special care in agronomic practices for good yield. The uses of pure seed, suitable land preparation, balanced fertilization and irrigation play important role for higher wheat yield.

Cropland based agroforestry is a major practice in Pakistan in which several trees are planted or grown naturally around crop lands. During winter, leaves from these trees fall down and after decomposition, leaf litter is formed (Hasan et al., 2019). Physical and chemical degradation of leaf biomass and the mineralization of nutrients is termed as decomposition (Boulton and Boon, 1991). Formation of leaves litter adds fertility to the soil however, some trees species leaves release such allelochemicals that affect negatively wheat crop yield (Shah et al., 2018).

According to the International Allelopathy Society, any process involving secondary metabolites produced by plants, algae, bacteria and fungi that influence the growth and development of any biological system is termed as allelopathy (Iqbal et al. 2010). In allelopathy, competitions of the plants have negative effects when two or more organisms attempt to directly use the same resources. A large number of allelochemicals, which are released by plants are stimulatory or have inhibitory effects with the interactions of weeds and crops (Burhan & Shaukat, 2000). Thus, allelopathy is *t*he interference mechanism in which living or dead plants release allelochemicals exerting an effect (mostly negative) on the associated plants and can play an important role in natural ecosystem (Fitter, 2003).

In present research project allelopathic effects of five common agriculture land associated trees (*Corymbia citriodora, Juglans regia, Alianthus altissima, Populus ciliata,* and *Melia azadrach)* were investigated on morphological and yield traits of local and approved wheat varieties. The reason of choosing these tree species lies in the fact that all of these trees are quite common in wheat growing region in Pakistan. Most of them grow faster than others and serve as source of wood for construction and fuel, therefore, farmers prefer these trees along wheat fields.

Materials and Methods

Collection of Allelopathic Leaves

During the month of October and November 2017 fresh leaves of proposed allelopathic trees (*Corymbia citriodora, Juglans regia, Alianthus altissima, Populus ciliata,* and *Melia azadrach.*) were collected from surroundings of different wheat crop fields of district Mansehra (KP) Pakistan. The town of Mansehra lies between 34°20′2 North and 73°12′5″ East. Average temperature during the experiment was maintained at 25^{o}C.

Preparation of Aqueous Extracts

The leaves were shade dried, washed and grinded. The grinded material was added separately to 250 ml of sterile distilled water in 500 ml Erlenmeyer flask, wrapped in aluminum foil and placed for 10 days in the laboratory. The extracts were filtered into separate bottles and labelled. The experimental treatments were, T_1 (*C. citriodora),* T_2 (*J. regia),* T_3 (*A. altissima),* T_4 (*M. azedarach),* T_5 (*P. ciliata)* and T_0 (distilled water). Two wheat cultivars were used in the experiment, V1 (CM301) approved variety and V2, traditional local variety.

Pot Experiment

The experiment was conducted in completely randomized design (CRD). Each pot having 200g fertile, damp soil was placed in open air where appropriate rate of sunlight was available, necessary for the growth of wheat plant. Soil was taken from an open wheat field. Plant extract solutions were applied to keep the soil moist throughout the experiment for better absorption.

Data Collection

Data was recorded for morphological and yield attributes. These parameters were plant height (cm), root length (cm), shoot length (cm), number of tillers per plant, number of spikes, number of spikelet, spike length (cm), number of grains per plant, number of awns, awns length, flag leaf length (cm) and flag leaf width (cm)Wheat grain number and weight. These parameters assessed the quantitative and qualitative characteristics of wheat plant.

Statistical Analysis

All statistical analyses were carried out using statistical program package Statistix 8.1. Analysis of variance (ANOVA) was applied to find out the significant level by statistically analyzing the recorded data (Khan *et al.*, 2016) and the difference between treatments and control mean values were tested using Dunnett's test (one-way ANOVA).

Results and Discussion

In present research work allelopathic effects of five agroforestry trees were assessed on two varieties of wheat. In association with various tree species has been reported by many workers (Gill, 1994; Khan et al. 2009: Nandal *et al.*, 1999; Singh, et al.1993). In this study, leaf extract from selected plants commonly grown around wheat fields were used to analyze their effect on germination and growth morphology and yield of local and approved varieties of wheat.

Corymbia citriodora

It was recorded that T1 (*Corymbia citriodora*) promoted root length and number of awns (Figure 1). Growth inhibiting properties of *C. citriodora* for wheat, mustard and gram has been reported by many previous studies (Singh et al. 1992; Huang et al. 1997; Khan et al. 2009). However, current study is the first ever report on positive effect of aqueous extract of this plant.

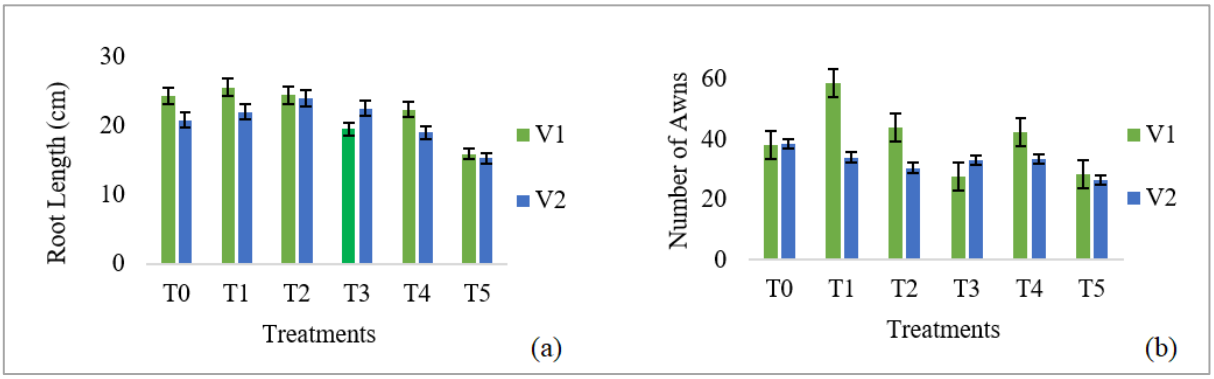

Figure 1. Graph showing (a) root length and (b) number of awns in all treatments

Juglans regia

Number of tillers, flag leaf length and flag leaf (Figure 2) width were promoted by T2 (*Juglans regia*). A phytotoxic compound 'juglone' (5-hydroxy1,4-napthoquinone) has been reported from many members of family Juglandaceae (Bajalan et al., 2013). Intense inhibitory properties of this compound has been reported for plant growth parameters (Hejl and Koster, 2004), yet, our study reveals its constructive role in yield characters.

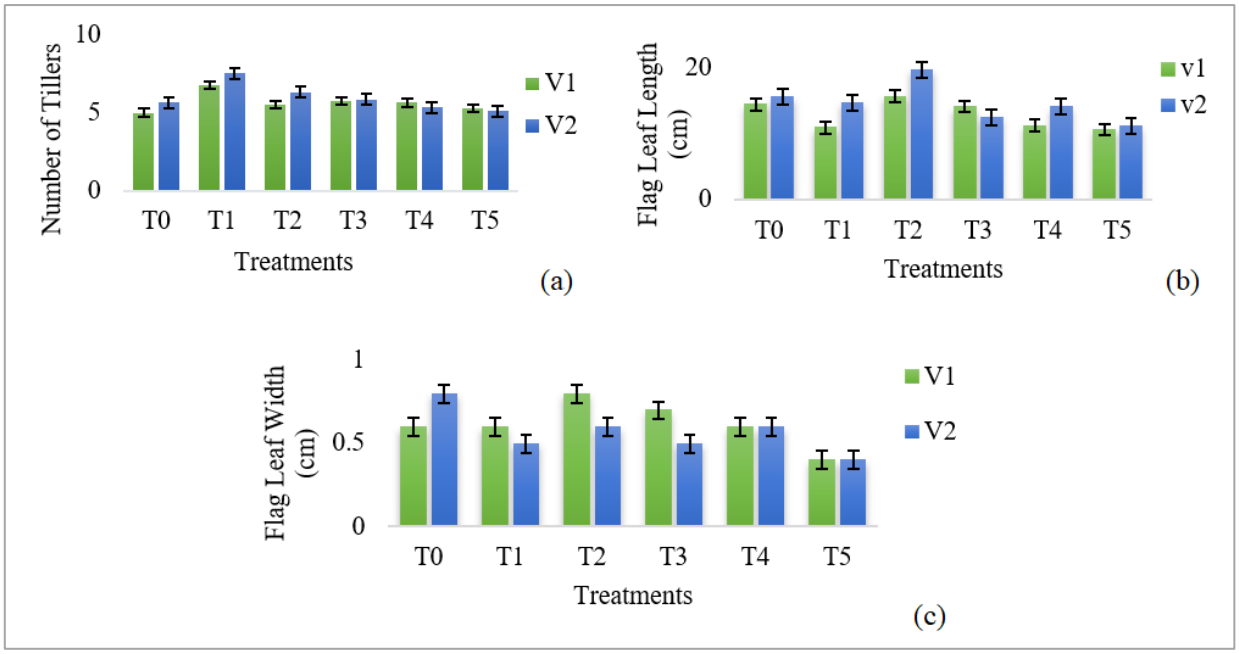

Figure 2. Graph showing (a) number of tillers, (b)flag leaf length and (c) flag leaf width in all treatments

Ailanthus altissima

Spike length was maximum in T3 (*Ailanthus altissima*), while plant height, shoot length, grain weight and number of grains were higher in T4 (*Melia azedarach*) (Figure 3). Thakur et al. (2019) isolated phenolic acids and its derivatives from leaf litter of *M. azedarach*. The study conducted by them reveals that it has inhibitory effects on seed germination, initial growth and biomass of black gram and chickpea. However, they reported less phytotoxic effects of leaf litter on later growth or near maturity. This study favors our finding in this regard.

While, T1, T2 and T3 (*C. citriodora, J. regia*and *A. alitissima*) promoted number of spikes. Awn length was maximum in control treatment.

Melia azadrach

It was observed that *Melia azadrach* promoted number of grains. Kumar et al., (2017) reported that leaf litter of *M. azedarach* contain phenolic acids and their derivatives which have inhibitory effect on germination and growth of black chickpea and green gram crops. However, they also found that leaves litter of *M. azedarach* has short-lived inhibitory effect and get alleviated over of the time. This might be the reason that *M. azedarach* showed negative effect on earl growth and germination yet improved the number of grain at lateral stages.

Populus ciliata

While *Poplus ciliata* showed total inhibitory effect and did not promote a single growth parameter in any variety.

Inhibitory effect of *P. ciliata* has been reported by various previous studies (Sharma et. al., 2000). According to Singh et., al. (2001), reduced crop growth and production might be due to phytotoxins produced by leaves of poplus species and they concluded that the likelihood of allelopathic effect of the poplus trees with crops could be the reason for the observed poor crop performance.

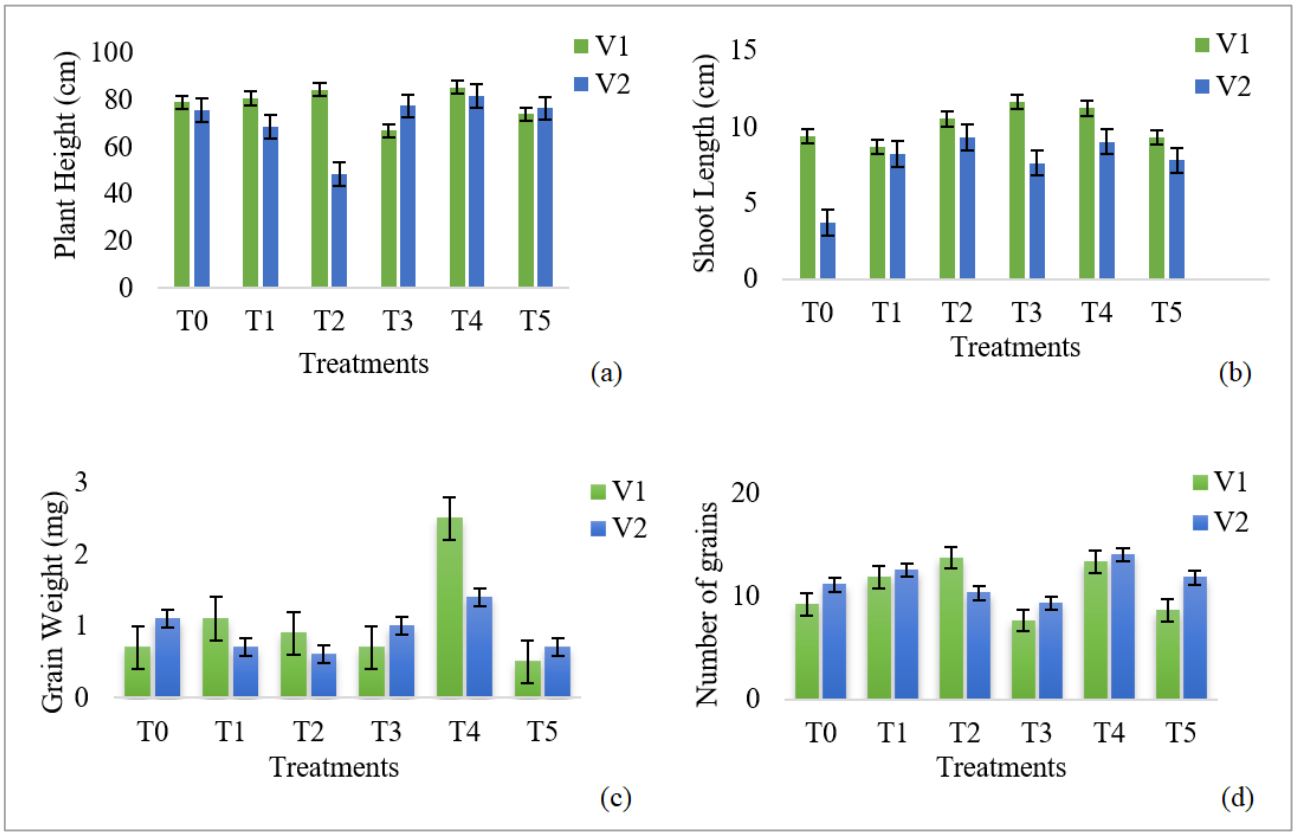

Figure 3. Graph showing (a) plant height (b)shoot length (c) grain weight and (d) number of grains in all treatments

Figure 4. A. Sowing and application of extracts, B. Wheat plant seedlings subjected to different treatments

Results revealed significant difference among all treatments regarding root length (cm), number of tillers per plant, grains weight (mg), flag leaf length and width (cm), while non-significant difference was observed in plant height (cm), number of spikes, number of spikelet and number of grains per plant (Table 1).

Table 1. Least significant difference (LSD) All-Pairwise Comparisons test of all growth parameters

Plant height						
Treatment	0	1	2	3	4	5
Mean	77.233	74.550	78.450	72.183	83.367	75.117
Homogeneous Group	A	A	A	A	A	A
Root length						
Treatment	0	1	2	3	4	5
Mean	22.600	20.782	24.183	23.955	20.683	15.900
Homogeneous Group	A	A	A	A	A	B
Shoot length						
Treatment	0	1	2	3	4	5
Mean	54.610	56.722	57.950	56.500	62.533	50.050
Homogeneous Group	AB	AB	AB	AB	A	B
Number of tillers per plant						
Treatment	0	1	2	3	4	5
Mean	5.8333	7.1333	6.4167	5.8000	6.0167	5.2000
Homogeneous Group	C	A	AB	BC	BC	BC
Number of spikes						
Treatment	0	1	2	3	4	5
Mean	1.0000	1.0500	1.1000	1.0500	1.0000	1.0000
Homogeneous Group	A	A	A	A	A	A
Number of spikelets						
Treatment	0	1	2	3	4	5
Mean	38.450	46.417	37.283	30.467	37.750	27.600
Homogeneous Group	AB	A	AB	B	AB	B
Spike length (cm)						
Treatment	0	1	2	3	4	5
Mean	25.183	23.550	25.533	24.667	24.433	21.650
Homogeneous Group	A	AB	A	A	A	B
Grains weight (mg)						
Treatment	0	1	2	3	4	5
Mean	0.7750	0.9450	0.7533	0.8617	2.0067	0.6400
Homogeneous Group	B	B	B	B	A	B
Number of grains						
Treatment	0	1	2	3	4	5
Mean	10.217	12.200	12.033	8.4667	13.650	10.250
Homogeneous Group	AB	AB	AB	B	A	AB
Number of awns						
Treatment	0	1	2	3	4	5
Mean	38.450	40.333	35.183	34.800	38.300	27.933
Homogeneous Group	A	A	A	AB	A	B
Awn length (cm)						
Treatment	0	1	2	3	4	5
Mean	40.333	38.300	38.450	34.800	35.183	27.933
Homogeneous Group	A	A	A	AB	AB	B
Flag leaf length (cm)						
Treatment	0	1	2	3	4	5
Mean	AB	BC	A	BC	BC	C
Homogeneous Group	14.983	12.817	17.633	13.317	12.650	10.833
Flag leaf width (cm)						
Treatment	0	1	2	3	4	5
Mean	0.7500	0.6000	0.7333	0.6333	0.6000	0.4000
Homogeneous Group	A	A	A	A	A	B

Conclusion

Our study concluded that local and approved variety of wheat behaved differently for different allelopathic effects of agroforestry trees. Aqueous extract of *M. azedarach* showed minimum phytotoxic effect followed by *J. regia*, while *P. ciliata,* and *A. altissima* showed maximum phytotoxic properties for local and approved wheat varieties.

Agriculture land owners and farmers should avoid to grow *P. ciliata* and *P. altissima* in or near agriculture lands. On the other hand, it is recommended to grow *M. azedarach* and *J. regia* inside or near wheat fields as their leaf humus proved as

a good growth promoter rather inhibitor. Qiao et al., (2019) found that tree shade intensity is generally the major limiting factor for crop productivity in agroforestry systems. However, as our study focus was to analyze the allelopathic effect of selected trees and not their shade intensity impact, therefore it is recommended for future studies to evaluate shade effect of selected trees on growth and yield of wheat.

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