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Review on allelopathic effects of agriculture land associated plants on the different developmental stages of wheat crop

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Abstract

This review paper focuses specifically allelopathic effects of agriculture land associated plants on the different developmental stages of wheat crop. As wheat is the major cereal crop of the world, its yield per acre is adversely affected owing to allelopathic interactions. Allelopathy is a biological phenomenon by which a plant produces one or morebiochemicals that influence the germination, growth, survival, and reproduction of other plants. These biochemicals are known asallelochemicals and can have beneficial (positive allelopathy) or detrimental (negative Allelopathy) effects on the target plants and the community. Allelochemicals with negative allelopathic effects are an important part of plant defense against herbivory. Allelopathic effects of weeds and agriculture land associated trees were surveyed through literature review. As weeds are part and parcel of every growing crop and these definitely influence the yield per acre of wheat crop. Similarly a large number of deciduous trees grow along the borders of wheat lands. Wheat crop is usually cultivated in winter season in which maximum leaf fall occurs and allelochemicals of leaves affect negatively wheat crop production.

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Introduction

Wheat is grown on more land area than any other commercial crop and continues to be the most important food grain source for humans. Its production leads all crops, including rice, maize and potatoes. It grows in the presence of agroforestry trees and a diversity of weeds. The harmful effects of trees such as shade and weeds like competition for nutrients and space have been recognized since the inception of agriculture. Recent advancement in agriculture also revealed allelopathic interactions between crops and other plants. The International Allelopathy Society (IAS) has defined Allelopathy as "Allelopathy refers to any process involving secondary metabolites produced by plants, microorganisms, and viruses that influence the growth and development of agricultural and biological systems" (Kruidhof, 2008). Weeds are part and parcel of wheat crop. Mostly these show negative effects especially allelopathic effects. Belz (2007) reported that Allelopathy can be an important component of crop-weed interaction. Agricultural investigations have found that weeds cause 17-25% losses of wheat annually due to their competitive and allelopathic nature (Shah, 2006; Shad, 1987).

Whereas a number of researches identified agroforestry trees that show potential negative allopathic effects on wheat crop as well Allelochemicals such as phenolic compounds and alkaloids from trees have been observed to minimize yields in a variety of food and fodder crops (Rizvi *et al.*, 1999).

Allelopathic interactions of wheat are elucidated by a number of studies. Dhanai *et al.* (2013) prepared aqueous extracts of fresh leaf, bark and pod of *Acacia nilotica* and assessed for potential allelopathic effects on Wheat (*Triticum aestivum*). This treatment showed both positive and negative effects. Seed germination and shoot-root length of wheat was found to be significant and aqueous effect increased with increasing in the concentration of aqueous fresh leaf, pod and bark extract from 5 to 20 per cent. It was also found that negative effect was much pronounced on shoot length rather than root length. The maximum inhibitory effect among the different parts of *Acacia nilotica* was observed for pod extract. Khan *et al.*, (2009) determined the allopathic influence of aqueous extracts of *Eucalyptus camaldulensis* on germination %age and seedling growth (fresh and dry weight) of wheat. It was noted that aqueous extracts at a concentration of 10, 15 and 20% had inhibitory effect on wheat seed germination. Fresh and dry weight of seedling was also reduced significantly over control. The inhibitory effects were increased as the extract concentration increased. These findings indicate that wheat sown in fields which had leaf litter of *Eucalyptus camaldulensis* L. will be adversely affected regarding germination, growth and ultimately yield of wheat.

According to Muhammad and Majeed (2014) Sunflower is a potent allelopathic plant which possesses important allelochemicals with known allelopathic activity on other plants. In this study, allelopathic effects of fresh aqueous extracts (FAE) and air dried aqueous extracts (DAE) of root, shoot and leaves of sunflower (*Halianthus annuus* L.) were investigated on germination and seedling growth of wheat (*Triticum aestivum* L.). In seed bioassay experiments carried out at Botany Department of Peshawar University during 2010. Results showed significantly inhibitory effects of aqueous extracts on seed germination, growth and dry biomass of seedlings of wheat. In wheat seedlings, significant germination inhibition (15.21%), increased mean germination time (MGT) (57.76%), reduced plumule and radical growth (21.66 and 28.44%) and lowered seedlings dry biomass (31.05%) were recorded under dry aqueous extracts of leaf when compared to control. In experiment, dry aqueous extracts (DAE) were more phytotoxic than fresh aqueous extracts (FAE). Similarly, inhibitory effects of aqueous extracts of different parts of sunflower were recorded in the order leaf > shoot > root for tested plant.

Sharmin N.S (2014) carried out study which was undertaken to find out the interaction among *Moringa oleifera*, a perennial medicinal tree and Wheat (*Triticum aestivum*).

To know about the allelopathic effect an experiment was conducted with five different concentrations (0% i.e. fresh water, 25%, 50%, 75% and 100%) for each of Moringa leaf, bark and root extracts which were used to examine the effects on germination and growth of *Triticum*, Germination percent and plumule length was reduced compared to control. Bark extract concentration of 25% produced longest hypocotyls (58mm) and flag leaf (17.28cm); and 50% produced longest (60.75cm) plant. Highest soil plant analytical development (SPAD) value (60) was recorded in 50% concentration of leaf extract applied plant. *Triticum* tiller number was positively affected by 50%, 100% leaf and 50% bark extracts. Soil moisture percent was increased with extract application. Longest (11.08cm) and shortest (9.5 cm) spike was recorded on 75% bark and 25% root extract application. All concentrations of leaf and root extract shown negative result for root and shoot weight. Maximum and minimum *Triticum* grain weight was recorded at 50% *Moringa* bark and 50% *Moringa* leaf extract, respectively.

Kamel M and Hammad SA (2015) carried out study to investigate the allelopathic effect of aqueous extracts of leaves and stem of *Acacia saligna* on wheat. Data of the test specie reveals significant degrees of suppression and a negative response to the increasing concentration of different extracts. Germination percentage also decreases with the different concentrations of extracts of *Acacia saligna*. Seed inhibition was found to be 23% in wheat when treated with leaf extract. Stem extract showed lower effect on germination rate. The extracts also produces significant decrease in shoot and root length.

Hozayn M. *et al.* (2015) conducted pot and field experiments to conclude the allelopathic effects of *Casuarina equisetifolia* leaf litter on wheat. The result showed an appreciable effect of *Casuarina equisetifolia* leaf litter in improving growth of wheat. The effect on wheat decreased in general with higher doses of incorporated leaf litter. Best response was studied in case of shoot and root lengths. Wheat yield and other parameters which include spike attributes, plant height, straw yield and biological yield were also significantly affected by *Casuarina* leaf litter.

S.H. Mousavi *et al, (*2013) in their study investigate the effect of leaf, stem and root water extract of Alfalfa (*Melilotus indicus*) plant on seed germination and seedling growth of bread wheat. Results of experiment showed that allopathic effect of different concentration was highly significant for germination percentage but germination rate and mean germination time decreased significantly by increasing in concentration of allopathic extracts; also there was clear allopathic effect of alfalfa extract on seedling growth of wheat. Results of experiment showed that leaf extract exhibited the highest inhibitory effect while root extract exhibited the lowest inhibitory effect on seed germination and seedling growth of wheat.

Jabeen *et al.,* (2013) uses three weed species viz., *Asphodelus tenuifolius* Cav., *Euphorbia hirta* L., and *Fumaria indica* (Haussk.) Pugsley in the form of powder and mixed with uniform amount of soil. Wheat seeds were grown and it was observed that soil of *Asphodelus tenuifolius* considerably increased the germination and rate of germination of wheat, while the powder of other two species reduced this phenomenon. The powder of *Fumaria indica* and *Asphodelus tenuifolius* significantly reduced the plant height, while the *Euphorbia hirta*s howed non-significant effects on the wheat plant height. Soil containing *Euphorbia hirta* powder showed the significant reduction in the fresh and dry shoot weight of wheat plant.

Nitesh Joshi, Ambika Joshi (2016) studied the effect of various aqueous extracts of weed plants, *Hyptis sauveolens* (L.), *Ricinus communis* (L.), *Alternanthera sessilis* (L.), *Ipomoea carnea* (Jacq), *Malachra capitata* (L.) and *Cymbopogon citrutus* (Stapf), on seed germination, of *Triticum aestivum* L. var k9. There was a significant reduction in all the parameters at high concentrations of the weed extracts in all the plant species under the study.

Table 1. Comparison of different studies on allelopathic effect of agriculture land associated plants.

S.No	Citation	Plant name	Part used	Effect
1.	Dhanai *et al.*(2013)	*Acacia nilotica*	Leaf, bark and pod	Inhibitory effect more on shoot growth than root growth
2.	Khan *et al.*(2009)	*Eucalyptus camaldulensis*	_____	Inhibitory effect on seed germination, growth and yield.
3.	Muhammad and Majeed (2014)	*Helianthus annuus*	_____	I. Inhibit significant germination ii. Increased mean germination time iii. Reduced plumule & radical growth.
4.	Sharmin (2014)	*Moringa oliefera*	*M. oleifera* bark extract	i. Produced longest hypocotyls and flag leaves. ii. Increased spike length iii. Produced lower shoot weight
			M. oleifera root extract	i. Rate of seed germination decreased ii. Show negative effect in case of shoot weight
			M. oleifera leaf extract	i. Inhibit germination percent of wheat ii. Reduced spike length
5.	Kameland Hammad (2015)	*Acacia saligna*	Leave & stem extracts	i. Seed inhibition ii. Decreased shoot and root length
6.	Hozayn *et al.*(2015)	*Casuarina equisetifolia*	Leaf litter	i. Improves growth of wheat ii. Significantly affect wheat yield and others parameters.
7.	Mousavi *et al.*(2013)	*Melilotus indicus*	leaf, stem and root water extract	i. Leaf extract exhibited the highest Inhibitory effect on seed growth and germination. ii. Root extract exhibited the lowest inhibitory effect on seed germination and seedling growth of wheat. iii. germination rate and mean germination time decreased significantly by increasing in concentration of allopathic extracts
8.	Jabeen *et al.* (2013)	i. *Asphodelus tenuifolius*	----------	i. Increased germination rate ii. Reduced plant height
		ii. *Euphorbia hirta*	----------	i. Reduced fresh and dry weight of shoot ii. Non-significant effect on plant height iii. Reduces germination
		iii. *Fumaria indica*	----------	i. Reduced plant height ii. Reduces rate of germination
9.	Nitesh and Ambika (2016)	i. *Ipomea carneai*. ii. *Alternantheria sessilisi*. iii. *Malachra capitata*	Leaf extract	Reduction in length of radical
		Alternanthera sessilis	Leaf extract	Reduces plumule growth
		i. *Ipomea carnea* ii. *Alternantheriasessilis*	leaf extract	Reduces fresh weight of seedlings.
		Ipomea carnea	Leaf extract	Reduces seed index vigor the most.
10.	Siddique *et al.*(2009)	*Prosopsis juliflora*	Leaf extract	i. Inhibit seed germination ii. Decreased root length
11	Alrababah *et al.* (2009)	*Pinus halepensis*	Leaf extract	Reduces seed germination
		Quercus coccifera	Leaf extract	Reduces seed germination
12	Jabeen *et al.*(2013)	*Euphorbia hirta*	Leaf extract	Reduction in the fresh and dry shoot weight

The tolerance level of allelopathic activities of various weed extracts in terms of seed vigor index represented as *Cymbopogon strictus>Ipomoea carnea>Hyptis saveolens>Malachra capitata>Ricinus communis>Alternanthera sessilis*. All the weed extracts studied had a marked effect on all the parameters studied, suggesting sever allelopathic effects on seed germination of Wheat.

Siddique *et al.* (2009) tested the allelopathic effect of different concentrations of water extracts of *Prosopsis Juliflora* leaves on different growth parameters of wheat.

The effects of different concentrations of aqueous extract were compared to distilled water (Control Co.). Aqueous effect caused pronounced inhibitory effect on seed germination and root length of receptor plant. Seed germination and root length results indicated that the inhibitory effect was proportion to the concentration of the extract. Inhibitory effect was much pronounced radicle length rather than germination. Hence, it could be concluded that the mesquite leaf aqueous extract contain water-soluble allelochemicals. Which could inhibit the seed germination and reduce radicle length of wheat

Alrababah, (2009) explored the allelopathic effects of green and senescent leaf and soil extracts of two agroforestry trees- *Pinus halepensis* and *Quercus cocciferaon* the germination of wheat, barley, lentil, chickpea, and fababean as the major grain crops of Jordan. Results revealed that allelopathic effects reduced seed germination of these crops. Soil containing *Euphorbia hirta* powder showed the significant reduction in the fresh and dry shoot weight of wheat plant (Jabeen *et al.*, 2013).

Conclusion

Wheat is grown on more land area than any other commercial crop and continues to be the most important food grain source for humans. A number of trees are grown in the boundaries of Wheat land. In leaf fall season a huge volume of leaves is shed litter of which provides considerable amount of humus and enhances fertility of the soil.

But leaves also released allelopathic chemicals that distorted wheat crop enormously. The findings of this review article depicts that wheat is the major cereal crop of the world, its yield per acre is adversely affected owing to allelopathic interactions. So, it is recommended that wheat should not be planted close to *Prosopis sjuliflora, Quercus coccifera, Acacia saligna, Moringa oliefera, Eucalyptus camaldulensis and Acacia nilotica* due in order to avoid their adverse effects on various developmental stages of the crop.

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