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Allelopathic Effect of Winter Weeds on Little Canary Grass (*Phalaris minor* Retz.) and Wheat (*Triticum aestivum* L.)

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A B S T R A C T

Aqueous extracts of *Medicago denticulata, Melilotus indica* and *Chenopodium album* at 5%, 7.5% and 10% significantly reduced plant population of *Phalaris minor* under laboratory and shade house conditions, thus, indicating the inhibitory role of allelo-chemicals from these weeds. Under laboratory conditions, seed germination and relative germination ratio of *Phalaris minor* was affected more than wheat with highest reduction in germination under aqueous extract of *Melilotus indica*, followed by *Chenopodium album*. 7.5% came to be the best concentration that significantly reduced *Phalaris minor* germination and optimally maintained wheat population. In tray experiment under shade house conditions, reduction in germination was recorded more under 10% concentration and combined application of weed aqueous extracts. Highest reduction was observed under combined application of *Medicago denticulata* (10%) + *Melilotus indica* (10%) + *Chenopodium album* (10%) that led to only 42.33% emergence in comparision to 85.68% emergence under control. Hence, these weed aqueous extracts can be used as potential herbicides for future weed management programmes as these are natural plant products, easily biodegradable and eco-friendly.

Introduction

Wheat is amongst the most extensively grown crops which triggered the green revolution in the country. Wheat crop occupying about 17% of the world's cropped land and contributing 35% of the staple food production will have a crucial bearing on food security and the global economy in the coming decades (Tesfay *et al.*, 2014) it. India will need 109 million tons of wheat during the year 2020 AD, which can be achieved by increasing its productivity 4290 kg/ha and annual growth rate of 4.1 % (Mishra, 2007). Therefore, it is necessary to increase the production and productivity of wheat to provide food to the increasing population. The predominant feature for increasing crop production is minimizing losses in yield due to biotic and abiotic factors. Weeds are the most severe biotic stress to the crop and account for about one third of total losses caused by various biotic stresses (Gopinath and Mina, 2009). Weed infestation is a major bottleneck to higher wheat productivity also. Wheat fields in Northern India are badly infested with wide range of grassy and non-grassy weeds in general and *Phalaris minor*

Retz. in particular. *Phalaris minor* is highly competitive and can cause yield reductions of up to 100% (Chhokar and Malik, 2002) and requires huge amounts of herbicides for its control (Om *et al.,* 2002). Isoproturon was recommended for the control of *Phalaris minor* in wheat. But extensive use of isoproturon over many years has led to the evolution of resistance in *Phalaris minor* in northwest India (Chhokar and Malik, 2002). This led to adoption of fenoxaprop, clodinafop, and sulfosulfuron in isoproturon resistant areas since 1997 that initially gave higher yields, but resulted in a weed flora shift and resistance problems at few places, which eventually reduced yields and increased the cost of weed management. To overcome these problems, there is a need to reduce the reliance on synthetic herbicides and shift to low-input sustainable agriculture. Therefore, it is imperative to devise non-chemical and organic ways of controlling weeds in field crops (Farooq *et al.,* 2011). In this direction, efforts to utilize allelopathy and natural plant products for effective weed management are being made (Singh *et al.,* 2003b). In accordance with this, screening of natural plant products depicting herbicidal and pesticidal potential has gained momentum since they are biodegradable (Duke *et al.,* 2002). Information is available on the allelopathic effect of weeds on crop plants, crop plants on weeds, weeds on weeds or crops on crops. Little has been done to explore phytotoxic potential of weed species on other weeds under field condition. Studies specifically exploring the management of *Phalaris minor* by using medicinal/allelopathic plants are very few (Om *et al.,* 2002). However, the three major broad leaved weeds of wheat- *Medicago denticulata*, *Melilotus indica* and *Chenopodium album* are known to release certain allelochemicals like phenolic compounds, flavonoids, terpenoids, alkaloids, steroids, carbohydrates, and amino acids etc. from their roots, stems, leaves and decomposition products that inhibit the germination and growth of number of crop plants and weed species. The above facts inspired the present study with the specific objective to assess the bioefficacy and phytotoxicity of *Medicago denticulata*, *Chenopodium album*, and *Melilotus indica* on germination of wheat and *Phalaris minor* in laboratory and shade house condition.

Materials and Methods

Laboratory experiment

For the laboratory experiment the fresh biomass of *Medicago denticulata*, *Chenopodium album* and *Melilotus indica* was collected and was finely grinded after complete drying. Grinded biomass of weed plants was weighed, then was well mixed in distilled water and soaked for 48 hours at room temperature, further filtered using muslin cloth to get aqueous extract of weeds. Using this method weed aqueous extracts of 5%, 7.5% and 10% concentration (w/v, dry weight basis) were prepared as follows:

5% - 25g grinded sample added to distilled water making final volume of solution to 500 ml.

7.5% - 37.5g grinded sample added to distilled water making final volume of solution to 500 ml.

10% - 50g grinded sample added to distilled water making final volume of solution to 500 ml.

5 ml of weed aqueous extracts (5%, 7.5% and 10%) and tap water in control were loaded on the inner side of petri dish lined with double layer of germination sheets. Fifty seeds were placed in petri dish at equal distance and was covered with its lid. All the petri dishes were

then kept in an incubator at 24-25ºC temperature. The study on germination of wheat (UP 2565) and *Phalaris minor* was conducted for one week after incubation.

Shade house/ tray experiment

For the tray experiment, using the procedure similar as lab experiment, weed aqueous extracts of 7.5% and 10% concentration (w/v, dry weight basis) were prepared by adding 45 g and 60 g grinded sample to distilled water making final volume of solution to 600 ml as following, respectively. The tray with dimensions: 27cm × 22cm × 7cm (length×width×height), was filled with well grinded and sieved soil upto 5cm height. The selected seeds of wheat and *Phalaris minor* were soaked in weed aqueous extracts and tap water for 24 hours. In each tray, fifteen seeds, each of wheat and *Phalaris minor*, were placed at 2cm depth in three alternate rows with five seeds placed in one line. After spacing the seeds equally on the trays, the trays were safely kept in shade area. Trays were kept well watered at the time of planting of seeds as well as during the entire period of study. The study on germination of wheat and *Phalaris minor* was conducted for one month. Combination treatments were prepared by mixing the sole extracts in equal amount.

Results and Discussion

Laboratory experiment

Laboratory studies indicated that weed species taken for study, i.e., *Medicago denticulata, Melilotus indica* and *Chenopodium album* showed allelopathic potential by inhibition of germination of wheat and *Phalaris minor*. This confirms the results of Koloren (2007), Majeed *et al.*, (2012) and Esposito *et al., (*2008) who reported *Medicago denticulata, Melilotus indica* and *Chenopodium album* to have allelopathic potential. Germination of wheat and *Phalaris minor* was affected at every concentration of weed aqueous extract but with increase in concentration of weed aqueous extracts from 5% to 7.5% to 10%, inhibition of germination of *Phalaris minor* and wheat also increased subsequently. Similarly, Pathak and Sharma (2008) observed a decrease in the percentage of seed germination with the increasing concentration of aqueous extracts. The reduction was more pronounced in case of *Phalaris minor* than wheat. The inhibition of germination of wheat under aqueous extract of *Melilotus indica* was 76.69%, 79.23% and 34.91% less than the inhibition of germination of *Phalaris minor* under 5%, 7.5% and 10% concentration of weed aqueous extracts, respectively. This data reveals that 7.5% is the concentration of weed water extracts that showed higher inhibition of *Phalaris minor* seed germination and comparatively lower inhibition of wheat seed germination. Germination of wheat and *Phalaris minor* at 5%, 7.5% and 10% concentration of weed aqueous extracts is presented in Table 1 and 2, respectively.

Shade house/ tray experiment

In shade house experiment, in case of wheat, statistically highest emergence of seedlings after control was observed under *Chenopodium album* (7.5%) (81.00) while significantly lowest emergence per cent was found under *Medicago denticulata* (10%) + *Chenopodium album* (10%) + *Melilotus indica* (10%) (42.33%). *Phalaris minor* seedling emergence after control was significantly highest under *Chenopodium album* (7.5%) (61.00%) over rest of the treatments, significantly lowest emergence being under *Chenopodium album* (10%) + *Melilotus indica* (10%) (13.67%) which was at par with *Medicago denticulata* (10%) + *Chenopodium album* (10%) + *Melilotus indica* (10%) (15.33%).

Table.1 Germination of wheat under 5%, 7.5% and 10% concentration of weed aqueous extracts

Treatments	Germination %		
	5%	7.5%	10%
Control	99.33	99.33	99.33
Aqueous extract of *Medicago denticulata* (10%)	94.67	90.67	78.00
Aqueous extract of *Chenopodium album* (10%)	94.67	92.00	51.33
Aqueous extract of *Melilotus indica* (10%)	89.67	80.67	36.00
SEm±	1.11	1.32	1.68
CD (5%)	3.90	4.65	5.92

Table.2 Germination of *Phalaris minor* under 5%, 7.5% and 10% concentration of weed aqueous extracts

Treatments	Germination %		
	5%	7.5%	10%
Control	82.67	90.67	76.67
Aqueous extract of *Medicago denticulata* (10%)	66.00	36.00	5.33
Aqueous extract of *Chenopodium album* (10%)	63.33	10.67	6.00
Aqueous extract of *Melilotus indica* (10%)	48.00	8.67	1.33
SEm±	0.86	1.11	0.43
CD (5%)	3.04	3.90	1.51

Table.3 Emergence per cent of wheat and *Phalaris minor* in tray experiment under sole and combined application of weed aqueous extracts

Treatments	Emergence %	
	Wheat	*Phalaris minor*
Control	85.68	85.68
Aqueous extract of *Medicago denticulata* (7.5%)	68.67	54.33
Aqueous extract of *Chenopodium album* (7.5%)	81.00	61.00
Aqueous extract of *Melilotus indica* (7.5%)	56.68	40.68
Aqueous extract of *Medicago denticulata* (10%)	63.33	32.00
Aqueous extract of *Chenopodium album* (10%)	70.67	38.00
Aqueous extract of *Melilotus indica* (10%)	49.00	18.33
Aqueous extract of (*Medicago denticulata* 7.5% + *Chenopodium album* 7.5%)	66.00	32.33
Aqueous extract of (*Medicago denticulata* 7.5% + *Melilotus indica* 7.5%)	60.67	23.33
Aqueous extract of (*Chenopodium album* 7.5% + *Melilotus indica* 7.5%)	48.00	30.00
Aqueous extract of (*Medicago denticulata* 7.5% + *Chenopodium album* 7.5% + *Melilotus indica* 7.5%)	46.00	20.67
Aqueous extract of (*Medicago denticulata* 10% + *Chenopodium album* 10%)	54.00	23.67
Aqueous extract of (*Medicago denticulata* 10% + *Melilotus indica* 10%)	55.67	19.00
Aqueous extract of (*Chenopodium album* 10% + *Melilotus indica* 10%)	46.33	13.67
Aqueous extract of (*Medicago denticulata* 10% + *Chenopodium album* 10% + *Melilotus indica* 10%)	42.33	15.33
SEm±	1.45	0.98
CD (5%)	4.20	2.85

This experiment clearly revealed that emergence of *Phalaris minor* was more severely affected by weed aqueous extracts than wheat. Higher concentration of aqueous extracts, i.e., 10%, showed higher allelopathic potential. Combined application of extracts led to comparatively better inhibition of emergence than sole application. Combined application of *Medicago denticulata* (10%) + *Chenopodium album* (10%) + *Melilotus indica* (10%) showed highest inhibition of emergence of wheat and *Phalaris minor* seedlings. (10%) showed highest inhibition of emergence of wheat and *Phalaris minor* seedlings. This result is in accordance with the result of Jamil *et al.,* (2009) who reported that allelochemicals are usually more effective in mixtures than singly to influence targets. Comparative emergence of wheat and *Phalaris minor* at 7.5% and 10% concentration of weed aqueous extracts and their combinations are presented in Table 3.

Present study concluded the allelopathic potential of aqueous extracts of *Medicago denticulata*, *Melilotus indica* and *Chenopodium album* on *Phalaris minor*, highest potential being in sole application of *Melilotus indica* 7.5% (by laboratory study) and combined application of *Medicago denticulata* 10% + *Melilotus indica* 10% + *Chenopodium album* 10% *Medicago indica* (by shade house study) than other treatments. Thus, aqueous extract of these weeds could be a useful plant product for the possible utilization as a bioherbicide under Integrated Weed Management Programmes (IWMPs) in future. Moreover, there is a need to explore the chemical nature of the proposed allelochemicals along with conformity of results obtained under field conditions.

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