Journal of Pharmacognosy and Phytochemistry
Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
JPP 2020; 9(1): 517-522
Received: 01-11-2019
Accepted: 03-12-2019

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Phytotoxic effect of *Emblica officinalis* on germination and growth parameters of some agricultural crops of Bundelkhand region

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Abstract
Emblica officinalis is very important MPTs and fruits species of semiarid region of the country grown by the farmers for number of uses preferable on the farm boundary and also intercropped with different crop combinations. The study was conducted to determine the effect of different plant part extracts of *Emblica officinalis* on seed germination and related parameters of 5 agricultural crops i.e. wheat, chickpea, lentil, mustard and barley. The studies showed that Mustard crop was most of affected by extract of different parts of *Emblica officinalis* having mean value 91.33% - 94.67%. The Mustard recorded least values for root length for all the plant extracts as well as concentrations. Seed germination and shoot root length of Mustard was found to be non-significant and aqueous effect increased with increasing in the concentration of aqueous fresh leaf, bark and root extract from 5 to 20%.

Keywords: *Emblica officinalis*, allelochemicals, germination, wheat, chickpea, barley and mustard

Introduction
Emblica officinalis, the Indian gooseberry is an important agroforestry tree species of arid and semiarid region of the country belongs to family Phyllanthaceae. *Emblica* is a moderate sized deciduous tree with feathery foliage and spreading crown and considered to be a fairly good fodder tree. This species is mainly important for its medicinal values and fruits are reputed to contain high amounts of vitamin C. Amla has a hallowed position in Ayurveda, an Indian indigenous system of medicine. According to belief in Indian mythology, amla is the first tree to be created in the universe, which belongs to the family of Euphorbiaceae and is also known as *Phyllanthus emblica* or Indian gooseberry.
Allelopathy plays an important role in agroforestry system leading to a wide range of influences and interactions in biotic communities. Interaction among species through the release of chemicals and these chemicals are recognized as allelochemicals. Rice (1984) [14] and Putnam (1985) [13] accounted that allelochemicals are almost found in all plant tissue, i.e. leaves, fruits, stems and roots. Under agroforestry system the species is grown along with other species and therefore interact with each other. So the purpose of the present study was to elucidate the allelopathic potential of different concentration of fresh leaf, bark and root extracts of *Emblica officinalis* on 5 agricultural crops (Wheat, Chickpea, Lentil, Mustard and Barley) of Bundelkhand region.

Material and Methods
The present study was conducted at Bundelkhand University Jhansi. Bioassay was used to test the allelopathic effects under laboratory conditions. Fresh leaves, bark and roots of 5yrs old superior tree of *Emblica officinalis* were collected sun dried and grounded in mechanical grinder and passed through a mesh sieve to remove the visible plant residues. The aqueous extract were prepared by soaking 50, 100, 150 and 20 gm of leaf in 1000ml distilled water for 24hrs at room temperature for preparation of 5, 10, 15 and 20% concentration and replicated 3 times 10 seeds of each of 5 test crops for each replication were placed uniformly on the top of double layered Whatman filter paper No.1 in petridish. The media was watered doing with the respective of leaf, bark and root extracts at the rate of 2 ml per petridish to maintain the moisture for proper germination. The following observations on growth parameters of all test crops were record. On the third day after sowing, the germination was recorded daily up to one week. After the completion of germination percent was calculated for each treatment. On the one week after sowing, five seedlings from each replication were measured with the help of measuring scale from the collar region to the shoot tip of the seedlings. Then in the same way the root length of these seedlings was taken from the collar to the tip of the longest root.

After measurement, the average shoot and root length were calculated for each treatment. The vigour index was calculated from following formula: Vigour index = Germination % x (Root length + Shoot length)

Result and Discussion

The results obtained from the present study revealed that phytotoxic effects of different plant part of *Emblica officinalis* affected seed germination and growth parameters for all the five test crops.

Seed Germination

The data presented in Table No.1 exhibited the effect of different plant part extracts of *Emblica officinalis* on germination percentage of five test crops. The data showed in the table clearly that mustard crop was most affected by extract of different plant parts of *E. officinalis*, whereas, barley was the least affected test crop and recorded 100% germination tree extracts, whereas, wheat, lentil and chickpea have intermediate affect. The mustard crop was significantly affected at 20% concentration and resulted in 83.88% germination, whereas, same extracts and concentrations resulted 100% germination for wheat, chickpea, lentil and mustard and 96.67% for barley. The effect of different plant part extracts irrespective of concentration was significant for wheat and chickpea, whereas it was non-significant for barley, mustard and lentil. The interaction between plant extracts and concentrations was non-significant for all test crops. The difference between concentrations irrespective of plant parts was significant for all test crops except chickpea.

Table 1: Effect of Emblica officinalis on Germination (%) of Different Agricultural Crops

Plant/Plant Parts (P)		Concentration of Extract					Mean
		20%	15%	10%	5%	0%	
Wheat	Leaf	86.67	90.00	93.33	96.67	100.00	93.33
	Bark	90.00	93.33	96.67	96.67	100.00	95.33
	Root	96.67	96.67	100.00	100.00	100.00	98.67
	Mean	91.11	93.33	96.67	97.78	100.00	
	C.D. (0.005)	P= 2.50	C= 2.89	P*C= NS			
Chickpea	Leaf	100.00	100.00	100.00	100.00	100.00	100.00
	Bark	86.67	96.67	93.33	96.67	100.00	94.67
	Root	86.67	90.00	93.33	96.67	100.00	93.33
	Mean	100.00	100.00	95.56	97.78	100.00	
	C.D. (0.005)	P= 4.22	C= NS	P*C= NS			
Lentil	Leaf	86.67	90.00	93.33	96.67	100.00	86.67
	Bark	93.33	93.33	93.33	96.67	100.00	93.33
	Root	93.33	96.67	96.67	96.67	100.00	93.33
	Mean	91.11	93.33	94.44	96.67	100.00	
	C.D. (0.005)	P= NS	C=3.81	P*C= NS			
Mustard	Leaf	83.33	86.67	90.00	96.67	100.00	91.33
	Bark	90.00	93.33	93.33	96.67	100.00	94.67
	Root	86.67	90.00	93.33	96.67	100.00	93.33
	Mean	86.67	90.00	92.22	96.67	100.00	
	C.D. (0.005)	P= NS	C= 3.48	P*C= NS			
Barley	Leaf	100.00	100.00	100.00	100.00	96.67	99.33
	Bark	100.00	100.00	100.00	100.00	96.67	99.33
	Root	100.00	100.00	100.00	100.00	96.67	99.33
	Mean	100.00	100.00	100.00	100.00	96.67	
	C.D. (0.005)	P= NS	C= 1.63	P*C= NS			

Shoot Length: The data with respect to shoot length as affected by different plant part extracts and concentrations of *Emblica officinalis* on different test crops studied under the experiment is presented in Table No 2. showed that lentil recorded least values for shoot length for the plant extracts as well as concentrations. The maximum values for shoot length were observed for wheat. Within a particular test crop leaf extract has the most adverse effect on shoot length and root extract exhibited least effect for all the test crops. For wheat maximum shoot length 10.53cm was recorded under control and minimum 6.95 cm for 20% root extracts. The minimum shoot length of 4.65 cm was observed for 20% leaf extract for lentil. The effect of different plant part extracts irrespective of concentrations was non-significant for all test crops. The interaction between plant part extracts and concentrations was also non-significant for all the test crops. The difference between different concentrations irrespective of plant parts was significant for all the test crops.

Table 2: Effect of Emblica officinalis on Shoot Length (cm) of Different Agricultural Crops

Plant/Plant Parts (P)		Concentration of Extract					Mean
		20%	15%	10%	5%	0%	
Wheat	Leaf	7.25	7.42	8.08	8.91	10.53	8.44
	Bark	7.38	7.44	8.55	9.42	10.53	8.66
	Root	6.95	7.71	8.88	9.57	10.53	8.73
	Mean	7.19	7.52	8.50	9.30	10.53	
	C.D. (0.005)	P= NS	C= 0.74	P*C= NS			
Chickpea	Leaf	5.02	5.22	5.27	5.42	6.95	5.57
	Bark	5.17	5.25	5.38	5.48	6.95	5.65
	Root	5.22	5.40	5.47	5.69	6.95	5.75

	Mean	5.14	5.29	5.37	5.53	6.95	
	C.D. (0.005)	P= NS	C= 0.31	P*C= NS			
Lentil	Leaf	4.65	4.67	4.89	5.03	5.61	4.97
	Bark	4.93	5.02	5.12	5.16	5.61	5.17
	Root	4.99	5.07	5.32	5.41	5.61	5.28
	Mean	4.86	4.92	5.11	5.20	5.61	
	C.D. (0.005)	P= NS	C=.033	P*C= NS			
Mustard	Leaf	5.15	5.37	5.55	6.05	7.22	5.87
	Bark	5.85	5.87	6.29	6.88	7.22	6.42
	Root	5.50	5.97	6.62	6.93	7.22	6.45
	Mean	5.50	5.74	6.16	6.62	7.22	
	C.D. (0.005)	P= NS	C= 0.56	P*C= NS			
Barley	Leaf	6.24	6.30	6.44	6.71	8.07	6.75
	Bark	6.32	6.55	6.74	7.05	8.07	6.94
	Root	6.52	6.81	7.20	7.36	8.07	7.19
	Mean	6.36	6.55	6.79	7.04	8.07	
	C.D. (0.005)	P= NS	C= 0.75	P*C= NS			

Root Length: The data showed in the Table No. 3 that the mustard recorded least values for root length for all the plant extracts as well as concentrations. The maximum values for root length were observed for wheat followed by barley. Within a particular test crop leaf extract has the most adverse effect on root length and root extract exhibited least effect for all test crops. For wheat maximum root length 9.51 cm was recorded under control and minimum 5.49 cm for 20% leaf extract. The minimum root length 2.20cm was observed for 20% leaf extract for mustard and lentil. The effect of different plant part extracts irrespective of concentration was non-significant for all test crops, whereas, the interaction between plant part extracts and concentrations was also non-significant. The difference between different concentrations irrespective of plant parts was significant for all the test crops.

Table 3: Effect of Emblica officinalis on Root Length (cm) of Different Agricultural Crops

Plant/Plant Parts (P)		**Concentration of Extract**					**Mean**
		20%	**15%**	**10%**	**5%**	**0%**	
Wheat	Leaf	5.49	5.73	6.67	7.55	9.51	6.99
	Bark	5.73	6.19	6.80	7.61	9.51	7.17
	Root	5.91	6.47	7.01	7.78	9.51	7.34
	Mean	5.71	6.13	6.83	7.65	9.51	
	C.D. (0.005)	P= NS	C= 1.16	P*C= NS			
Chickpea	Leaf	4.12	4.26	4.36	4.42	5.75	4.58
	Bark	4.31	4.51	4.60	4.65	5.75	4.76
	Root	4.42	4.61	4.70	4.88	5.75	4.87
	Mean	4.28	4.46	4.55	4.65	5.75	
	C.D. (0.005)	P= NS	C= 0.23	P*C= NS			
Lentil	Leaf	2.20	2.24	2.43	2.47	4.35	2.74
	Bark	2.35	2.39	2.58	3.13	4.35	2.96
	Root	2.43	2.53	2.75	3.35	4.35	3.08
	Mean	2.33	2.39	2.59	2.98	4.35	
	C.D. (0.005)	P= NS	C= 0.39	P*C= NS			
Mustard	Leaf	2.20	2.22	2.36	2.45	3.23	2.49
	Bark	2.34	2.43	2.56	2.61	3.23	2.63
	Root	2.37	2.59	2.62	2.65	3.23	2.69
	Mean	2.30	2.41	2.51	2.57	3.23	
	C.D. (0.005)	P= NS	C= 0.19	P*C= NS			
Barley	Leaf	5.93	6.30	6.54	8.20	9.12	7.22
	Bark	6.23	6.39	6.58	8.33	9.12	7.33
	Root	6.43	6.60	6.67	8.71	9.12	7.51
	Mean	6.20	6.43	6.60	8.41	9.12	
	C.D. (0.005)	P= NS	C= 0.91	P*C= NS			

Vigour Index: The data showed that the maximum values for vigour index were observed for wheat crop followed by barley in the Table No. 4. The least values were recorded for lentil for all the plant extracts as well as concentrations. Within a particular test crops leaf extract has the most adverse effect on vigour index and root extract has least effect for all the test crops. For wheat the maximum vigour index 2004.000 was recorded under control and minimum 1103.767 for 20% leaf extract. The minimum vigour index of 593.167 was observed for 20% leaf extract for lentil. The effect of different plant part extracts irrespective of concentration was significant for mustard and lentil crops, whereas, it was non-significant for other 3 test crops. The difference between different concentrations irrespective of plant parts was significant for all test crops.

Table 4: Effect of Emblica officinalis on Vigour Index of Different Agricultural Crops

Plant Parts (P)		Concentration of Extract					Mean
		20%	15%	10%	5%	0%	
Wheat	Leaf	1103.767	1183.500	1380.133	1590.000	2004.000	1452.280
	Bark	1179.600	1275.233	1480.667	1641.667	2004.000	1516.233
	Root	1244.333	1366.267	1589.000	1734.667	2004.000	1587.653
	Mean	1175.900	1275.000	1483.267	1655.444	2004.000	
	C.D. (0.005)	P= NS	C= 175.95	P*C= NS			
Chickpea	Leaf	914.000	948.333	962.333	983.333	1270.000	1015.600
	Bark	820.400	942.367	934.133	977.167	1270.000	988.813
	Root	831.133	900.900	950.667	1021.667	1270.000	994.873
	Mean	855.178	930.533	949.044	994.056	1270.000	
	C.D. (0.005)	P= NS	C= 57.17	P*C= NS			
Lentil	Leaf	593.167	619.467	680.667	728.200	996.333	723.567
	Bark	679.633	690.500	725.167	799.467	996.333	778.220
	Root	694.500	734.867	781.800	844.267	996.333	810.353
	Mean	655.767	681.611	729.211	790.644	996.333	
	C.D. (0.005)	P= 49.10	C= 56.70	P*C= NS			
Mustard	Leaf	607.700	656.233	712.500	823.067	1044.667	768.833
	Bark	736.500	770.900	829.067	919.233	1044.667	860.073
	Root	682.133	771.700	862.700	926.667	1044.667	857.573
	Mean	675.444	732.944	801.422	889.656	1044.667	
	C.D. (0.005)	P= 60.33	C= 69.67	P*C= NS			
Barley	Leaf	1216.667	1259.667	1298.000	1491.000	1670.000	1387.067
	Bark	1254.667	1294.000	1331.333	1538.000	1670.000	1417.600
	Root	1295.333	1340.667	1387.333	1606.867	1670.000	1460.040
	Mean	1255.556	1298.111	1338.889	1545.289	1670.000	
	C.D. (0.005)	P= NS	C= 167.94	P*C= NS			

Shoot Root Ratio: The experiment is presented in Table No. 5. The data showed that the barley recorded least values for shoot root ratio for all the plant part extracts as well as concentration. The maximum value for shoot root ratio was observed for mustard. Within a particular test crops root extract has most adverse effect on vigour index and leaf extract has least adverse effect for all test crops. For mustard maximum shoot root ratio 2.54 was recorded for 20% bark extract and minimum value for shoot root ratio 2.24 recorded under control. The minimum shoot root ratio 0.82 was observed for 5% leaf extract for barley. The effect of different plant part extracts irrespective of concentration was non-significant. The difference between different concentrations irrespective of plant parts was significant for wheat and lentil and non-significant for chickpea, mustard and barley.

Table 5: Effect of Emblica officinalis on Shoot-Root Ratio of Different Agricultural Crops

Plant/Plant Parts (P)		Concentration of Extract					Mean
		20%	15%	10%	5%	0%	
Wheat	*Leaf*	1.32	1.38	1.21	1.18	1.17	1.25
	Bark	1.29	1.22	1.26	1.24	1.17	1.23
	Root	1.19	1.21	1.27	1.24	1.17	1.22
	Mean	1.27	1.27	1.25	1.22	1.17	
	C.D. (0.005)	P= NS	C= 0.08	P*C= NS			
Chickpea	Leaf	1.23	1.23	1.21	1.23	1.21	1.22
	Bark	1.21	1.17	1.18	1.18	1.21	1.19
	Root	1.20	1.17	1.17	1.18	1.21	1.19
	Mean	1.21	1.19	1.18	1.20	1.21	
	C.D. (0.005)	P= NS	C= NS	P*C= NS			
Lentil	Leaf	2.11	2.10	2.09	2.22	1.30	1.96
	Bark	2.10	2.10	1.98	1.71	1.30	1.84
	Root	2.41	2.00	2.20	1.62	1.30	1.91
	Mean	2.21	2.07	2.09	1.85	1.30	
	C.D. (0.005)	P= NS	C= 0.34	P*C= NS			
Mustard	Leaf	2.34	2.44	2.35	2.47	2.24	2.37
	Bark	2.54	2.52	2.50	2.66	2.24	2.49
	Root	2.36	2.33	2.52	2.62	2.24	2.41
	Mean	2.41	2.43	2.45	2.59	2.24	
	C.D. (0.005)	P= NS	C= NS	P*C= NS			
Barley	Leaf	1.06	1.00	0.99	0.82	0.89	0.95
	Bark	1.02	1.03	1.04	0.85	0.89	0.97
	Root	1.01	1.05	1.08	0.85	0.89	0.98
	Mean	1.03	1.03	1.04	0.84	0.89	
	C.D. (0.005)	P= NS	C= NS	P*C= NS			

Germination Index: The experimental data presented in Table No. 6 and the data showed that the mustard recorded least values for germination index for the plant part extracts as well as concentrations. The maximum values for germination index were observed for barley. Within particular test crops leaf extract has the most adverse effect on germination index and root extract exhibited least effect for all the test crops. For barley maximum germination index 1.429 was recorded for all plant part extracts except control and minimum value for germination index 1.381 recorded under control. The minimum germination index 1.190 was observed for 20% leaf extract for mustard. The effect of different plant parts extracts irrespective of concentration was non-significant for all test crops except wheat. The interaction between plant part extracts and concentrations was non-significant for all test crops. The difference between different concentrations irrespective of plant parts was significant for all the test crops.

Table 6: Effect of Emblica officinalis on Germination Index of Different Agricultural Crops

Plant Parts (P)		Concentration of Extract					Mean
		20%	15%	10%	5%	0%	
Wheat	Leaf	1.238	1.286	1.333	1.381	1.429	1.333
	Bark	1.286	1.333	1.381	1.381	1.429	1.362
	Root	1.381	1.381	1.429	1.429	1.429	1.410
	Mean	1.302	1.333	1.381	1.397	1.429	
	C.D. (0.005)	P= 0.03	C= 0.04	P*C= NS			
Chickpea	Leaf	1.429	1.429	1.429	1.429	1.429	1.429
	Bark	1.238	1.381	1.333	1.381	1.429	1.352
	Root	1.238	1.286	1.333	1.381	1.429	1.333
	Mean	1.302	1.365	1.365	1.397	1.429	
	C.D. (0.005)	P= NS	P= 0.60	P*C= NS			
Lentil	Leaf	1.238	1.286	1.333	1.381	1.429	1.333
	Bark	1.333	1.333	1.333	1.381	1.429	1.362
	Root	1.333	1.381	1.381	1.381	1.429	1.381
	Mean	1.302	1.333	1.349	1.381	1.429	
	C.D. (0.005)	P= NS	C= 0.05	P*C= NS			
Mustard	Leaf	1.190	1.238	1.286	1.381	1.429	1.305
	Bark	1.286	1.333	1.333	1.381	1.429	1.352
	Root	1.238	1.286	1.333	1.381	1.429	1.333
	Mean	1.238	1.286	1.317	1.381	1.429	
	C.D. (0.005)	P= NS	C=0.05	P*C= NS			
Barley	Leaf	1.429	1.429	1.429	1.429	1.381	1.419
	Bark	1.429	1.429	1.429	1.429	1.381	1.419
	Root	1.429	1.429	1.429	1.429	1.381	1.419
	Mean	1.429	1.429	1.429	1.429	1.381	
	C.D. (0.005)	P= NS	C= 0.02	P*C= NS			

The present study's findings are discussed in the highlights of the observation keeping in the view of the allelopathic effects of agroforestry tree like *Emblica officinalis* or other tree species on field crops like Wheat, Chickpea, Lentil, Mustard and Barley or other crops of other researchers.

The present findings corroborate the earlier report by Noor *et al*., (1995) [12] studied allelopathic effects of aqueous extracts from under canopy soil and from different parts of *Prosopis juliflora* on germination and early seedling growth of various cultivars of *Zea mays*, *Triticum aestivum* and *Albizia lebbeck* were studied. Fruit and seed extracts considerably delayed and reduced germination of root, shoot and seedling growth compared with root, leaf and flower extract. Soil extract showed an inhibitory effect on germination but seedling growth remained unaffected in most of cultivars.

The inhibitory effect was also observed on seed germination at higher concentration is in accordance with similar effect of agroforestry tree *Acacia nilotica* on different species *viz*. *G. hirsutum*, *C. annum*, *L. esculantum* (Saxena and Sharma, 1996) [15].

Allelopathic metabolites leached out from woody plants often suppressed the growth of undergrowth species sharing the same habitat (Chou, 1989) [2]. Many woody species are reported to have phytotoxins (Akram *et al*., 1990; May & Ash, 1990; Chou & Lee, 1991; Ferguson, 1991; Kil & Yun, 1992) [1, 10, 3, 8, 9]. Chou & Yang (1982) [4] showed that leachates of the bamboo, *Phyllostachys edulis* (Carr.) H. de Lehaie contains significant amounts of allelopathic compounds that can suppressed the growth of undergrowth weeds.

Considerable research work on allelopathy has been done in developed countries and has been implicated in major problems related to crop production, agriculture, horticulture and forestry. Allelopathic studies has also been initiated in India and some significant information has been generated (Narwal,1994) [11]. Numerous allelochemicals are released from plant primarily through leaching from above ground parts and affects the chemical properties of soil. It has been ascertained that dominant plant species exert influence on the floor conditions and nutrient availability.

However, there is very scanty work is available on allelopathic effect of *Emblica officinalis* on test crop except for Siddiqui *et al*. (2009) [16]. The result revealed that different concentrations of *Emblica officinalis* and *Acacia leucophloea* extracts caused highly significant and significant inhibitory effect on germination and root elongation. The Bioassays indicated that the inhibitory effect was proportional to the concentrations of the extracts and higher concentration has the stronger inhibitory effect. The study also revealed that inhibitory effect was much pronounced in root development rather than seed germination. The results of present study agree with findings of Siddiqui *et al*. (2009) [16].

Dhanai *et al*. (2013) [5] also studies on allelopathic effect of different aqueous extracts of *Acacia nilotica* on seed

germination and growth of wheat and provides the evidence of *A. nilotica* has allelopathic potential and suitable tree species for agrisilviculture systems. The findings of present study agree with results of above study.

Reference

1. Akram M, Ahmed N, Hussain F, Aslam KM. Allelopathic potential of four species of Ficus. Pakistan Journal of Scientific and Industrial Research. 1990; 33:52-54.
2. Chou CH. The role of allelopathy in phytochemical ecology. In: Chou, C. H. & Waller, G. R. (Eds), Phytochemical Ecology: *Allelochemicals, mycotoxins* and insect pheromonesand allomones, pp. 81–99. Institute of Botany: Academia Sinica Monograph Series Taipei, ROC. 1989; 9:535.
3. Chou CH, Lee YF. Allelopathic dominance of *Miscanthus transmorri* sinensis in an alpine grassland community in Taiwan. Journal of Chemical Ecology. 1991; 17:2267-2281.
4. Chou CH, Yang CM. Allelopathic research of subtropical vegetation in Taiwan. II. Comparative exclusion of under story by Phyllostachys edulis and Cryptomeria japonica, Journal of Chemical Ecology. 1982; 8:1489-1508.
5. Dhanai CS, Lokesh Bharsakle, Charan Singh. Allelopathic effect of different aqueous extracts of *Acacia nilotica* on seed germination and growth of wheat. Indian Forester. 2013; 139(11):999-1002.
6. Dhanai CS, Todaria NP, Singh B. Effect of multipurpose tree extracts on summer crops. Allelopathy Journal. 2010; 26:2.
7. Dhanai CS, Todaria NP, Singh B. Allelopathic effects of trees extracts on germination and seedling growth of field crops. Allelopathy Journal. 2005; 15(2):285-293.
8. Ferguson DE. Allelopathic potential of western cone flower (*Rudbeckia occidentalis*). Canadian Journal of Botany. 1991; 69:2806-2808.
9. Kil BS, Yun KW. Allelopathic effects of water extracts of *Artemisia princeps* var. *orientalis* on selected plant species. Journal of Chemical Ecology. 1992; 18:39-51.
10. May FE, Ash JE. An assessment of the allelopathic potential of eucalyptus. Aust. J Bot. 1990; 38:245-254.
11. Narwal SS. Allelopathy in agroforestry. In: Agroforestry - tradition & innovations. Eds. Pratap Narain, K.S. Dadhwal and R.K. Singh. ICAR- UNDP Advance centre on Agroforestry Central Soil & Water Conservation Research & Training Institute Dehradun. 1994, 159-169.
12. Noor Mehar, Uzma Salam, Ajmal Khan M. Allelopathic effects of *Prosopis juliflora* Swartz. Journal of Arid Environments. 1995; 31:83-90.
13. Putnam AR. Weed Allelopathy. In Duke, S.O. (Ed.), Weed Physiology. Reproduction and Ecophysiology. 1985; 1:131-155.
14. Rice EL. Allelopathy, 2nd ed. New york Academic Press. 1984, 283.
15. Saxena A, Sharma AK. Allelopathic potential of *Acacia tortilis* in agroforestry systems of arid regions. Journal of Allelopathy. 1996; 3:81-84.
16. Siddiqui S, Yadav R, Yadav K, Wani FA, Meghvansi MK, Sharma S *et al*. Allelopathic Potentialities of Different Concentration of Aqueous Leaf Extracts of Some Arable Trees on Germination and Radicle Growth of *Cicer arietinum* Var.–C-235. Global Journal of Molecular Sciences. 2009; 4(2):91-95.