Allelopathic Effect of Stem Bark Extract of *Anogeissus Latifolia* L. on Seed Germination and Seedling Growth of Mung Bean and Wheat

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Abstract: ***The present study was undertaken to explore the allelopathic potential of A. latifolia L. The effect of different concentrations of stem bark extract was studied on various growth parameters of Mung bean seed and Wheat Seed. Both the plants responded to the aqueous bark extract at different rate. Bark extract at 0.25%. 0.5%, 0.75%, 1%, 2% and 5% concentration were used to study the effect on seed germination, shoot length, root length and seedling vigour. A. latifolia stem bark extract inhibited the above growth parameters in both the plants studied. In case of Wheat, bark extract at 0.5%, 0.75% and 1% stimulated the shoot length. Our findings indicate that Wheat plant is more resistant to the allelochemicals. The allelochemicals present in A. latifolia bark adversely affects the seed germination, seedling growth and seedling vigour on Mung and Wheat plant.***

Keywords: *A. latifolia*, seedling vigour, allelochemicals, and seedling growth

1. Introduction

Allelopathy is biological processes in which one or more biochemicals synthesized by an organism and when released in the surrounding environment, affects the germination, growth, development, survival, and reproduction of other organisms. Secondary metabolites from plant including phenols, terpenoids, alkaloids, fatty acids, sterols are known for their allelopathic potential which either stimulate or inhibit the growth of the plant (Inderjit, 1996). These allelochemicals are found in all plant parts and are categorized into five different categories: Phenylpropanes, acetogenins, terpenoids, steroids, and alkaloids (Rice, 1984). When allelochemicals directly inhibit the growth of the plant then it is termed as the negative allelopathy (Huxley, 1999), while in certain plants the allelopathic chemicals from one plant stimulate the growth of the other plant then it is called as positive allelopathy (Fernandez *et al.,* 2006). This allelochemical can be released in surrounding environment by many ways like volatilization, root exudation, leaching and decomposition of plant residues (Putnam and Weston, 1986). Allelopathy shows the effects like inhibition of seed germination, seedling growth and alteration in physiology of seed germination (Siddiqui et.al., 2009). Allelochemicals with their allelopathic potential play an important role in plant defense mechanism through acting against herbivory. The present study was undertaken as very little work is caried out towards the assessment of inhibitory or stimulatory potential of allelochemicals from the bark of *A. latifolia.*

2. Materials and Methods

1) Collection and processing of the plant material

Stem bark sample of *A. latifolia* was collected from the hilly regions of Kolhapur district. The bark was collected in the summer season in the Month of May. The bark sample was cut into pieces, sun-dried then oven dried at 60^0C. Dried bark sample was ground into powder and stored in an air tight plastic container.

2) Preparation of the aqueous extracts

The oven dried bark of *A. latifolia,* was ground on mechanical grinder. 0.25g, 0.5g, 0.75g, 1g, 2g and 5g of bark powder sample was added to 100mL distilled water and kept for 24 hours at room temperature (28-30^0C). The resultant extracts were filtered through Whatman No.1 filter paper and stored in conical flask.

3) Germination studies

The effect of bark extracts on seed germination was studied by placing 20 seeds of each test crop in triplicate in Petri dishes containing three layers of Whatman No. 1 filter paper. Aqueous extract (15mL) of bark sample was added in petri dishes. Control plate was prepared by using distilled water instead plant extract. The effect of bark extract on seed germination, shoot length, root length, fresh weight, vigour index was recorded after 120 hours of germination. The germination % was calculated by using following formula

$$Germination\ \% = \frac{Number\ of\ Seeds\ germinated}{Total\ Number\ of\ Seeds\ taken\ for\ germination} X\ 100$$

Vigour index was calculated by using the formula proposed by (Abdul-Baki and Andersion, 1973)

Vigour index (VI)= (Root Length+ Shoot Length) X Germination Percentage

3. Results

1) Seed Germination

Effect of aqueous bark extract of *A. latifolia*, on seed germination of the Mung bean and Wheat seeds is shown in Table No. 1, Table No. 2, Fig. 1 and Fig. 2. It is evident from the table that the seed germination was inhibited by aqueous bark extract. The bark extract concentrations above 0.75% found more inhibitory to seed germination. The highest inhibition was recorded at 5% of bark extract concentration in both the Plants than the control. The extract was found more inhibitory to Mung seeds than the Wheat seed. In both plants, dose dependent inhibition of seed gemination was observed.

Table 1: Effect of aqueous bark extract of stem bark of *A. lalifolia* on the germination of the Mung and Wheat seed

Extract Concentration (%)	Germination %			
	Mung		Wheat	
	24hr	48hr	24hr	48hr
Control	67	90	65	100
0.25%	62	85	55	93
0.50%	57	80	52	88
0.75%	55	75	50	78
1%	52	70	48	73
2%	50	60	43	65
5%	40	58	38	60

2) Seedling Fresh Weight

Effect of aqueous bark extract of *A. latifolia* on the fresh weight of mung and wheat seedlings is shown in the Table No. **2**, Table No. **3, Fig. 1 and Fig. 2.** From the table it clear that the fresh weight of mung seedling is decreased at all studied concentrations of bark extract. The bark extract at 0.5% 0.75%, 1%, 2% and 5% decreased the fresh weight of Mung seedling by 28.27%, 33.49%, 40.62%, 42.52% and 62.47% respectively than the control. In case of wheat seedling, the fresh weight is reduced from lower to higher concentration. The bark extract at 0.5%, 0.75%, 1%, 2% and 5% decreased the fresh weight of wheat seedling by 15.34%, 23.3%, 31.82%, 36.93% and 44.32% respectively than the control. Lower concentration of 0.25%, less affected the fresh weight in both the plants.

3) Seedling Growth

Effect of aqueous bark extract of *A. latifolia* on shoot length and root length is shown in Table No.2, Table No. 3, Fig. 1 and Fig. 2. It is evident from the Table No.2 that shoot length of mung seedling is reduced at all studied concentration. Maximum reduction by 57.72% recorded at 5% bark extract concentration and less reduction in shoot length by 21.77% is recorded at 0.25% extract concentration. A. *latifolia* show continuous decrease in the shoot length with increasing concentrations of the bark extract when compared with control. In Case of wheat, shoot length is marginally reduced by 0.22% at 0.25% extract concentration. Bark extract concentration at 0.50% 0.75% and 1% caused noticeable rise in shoot length by 22.77%, 10.45% and 8.36% respectively. But bark extract at 2% concentration reduced the shoot length by 18.7% and at 5% extract concentration maximum reduction observed by 59.52% when compared with the control.

Effect of aqueous bark extract of *A. latifolia*, on the root length of Mung and Wheat seedlings is shown in the Table No.2, Table 3, Fig. 1 and Fig. 2. It is observed that root length of mung seedling is significantly affected in response to various concentrations of aqueous bark extracts. The root length of Mung seedlings was reduced with increase in concentration of bark extract. Bark extract concentration at 2% and 5% more adversely affected the root elongation by 48.04% and 89.13% respectively when compared with control.

4) Seedling Vigour

Effect of aqueous bark extract of *A. latifolia* on the vigour index of the Mung and Wheat seedlings is shown in the Table No. 2, Table No. 3, Fig. 1, and Fig.2 respectively. It is noticed that the vigour index of mung seedling is more sensitive to the bark extracts. *A. latifolia* showed dose dependent reduction in vigour index. Recordable reduction was observed at all studied concentrations, but concentrations at 2% and 5% showed maximum reduction in the vigour index by 43.04% and 68.3% respectively than the control. From the Table No. 3, it is observed that the vigour index of wheat seedling is less sensitive to bark extract of *A. latifolia.* Vigour index of wheat seedling also affected negatively from lower to higher concentration. Maximum reduction in vigour index was observed at 2% and 5% bark extract concentration by 53.31% and 79.32% respectively, when compared with control.

Table 2: Effect of aqueous extract of bark of A. latifolia on the fresh weight, shoot length, root length, and Vigour index of mung seedling var. Gold-9.

Name of the plant	Treatments/Shoot length in 'cm'						
	Control (D.W)	0.25%	0.5%	0.75%	1%	2%	5%
Shoot length	9.65±0.76	7.55±1.29	7.69±0.99	6.77±1.80	5.98±1.13	5.84±1.61	4.08±0.77
Root length	4.6±1.10	3.74±1.02	3.49±1.24	3.06±0.94	3.01±0.81	2.39±0.86	0.5±0.10
Fresh Weight	4.21±0.30	3.55±0.21	3.02±0.54	2.80±0.31	2.50±0.67	2.42±0.43	1.58±0.17
Vigor Index	1445	1104	1070	1051	940	823	458

Readings are mean of three replicates ± SD

Table 3: Effect of aqueous extract of bark of *A. latifolia* on the fresh weight, shoot length, root length, and Vigour index of the wheat seedling

Name of the plant	Treatments/Shoot length (cm)						
	Control (D.W)	0.25%	0.5%	0.75%	1%	2%	5%
Shoot length	9.09±0.87	9.07±0.61	10.04±0.49	11.16±1.35	9.85±1.02	7.39±1.41	3.68±0.52
Root length	16.25±1.23	15.09±1.55	13.69±0.85	12.73±1.85	9.6±1.40	4.44±1.11	1.56±0.79
Fresh weight	1.76±0.56	1.68±0.43	1.49±0.20	1.35±0.67	1.20±0.19	1.11±0.36	0.98±0.31
Vigor Index	2534	2416	2373	2258	2076	1183	524

Readings are mean of three replicates ± SD

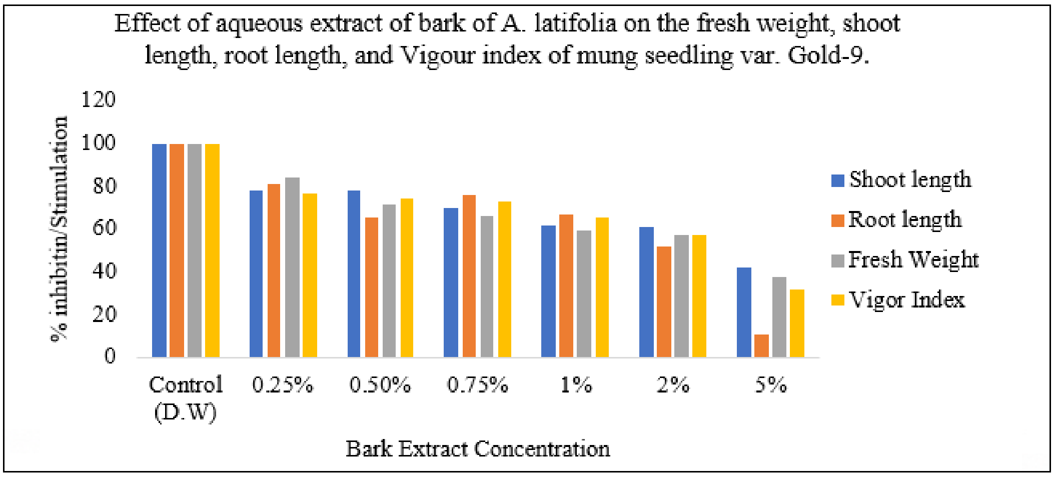

Figure 1: Effect of aqueous extract of bark of *A. latifolia* on the fresh weight, shoot length, root length, and Vigour index of mung seedling var. Gold-9.

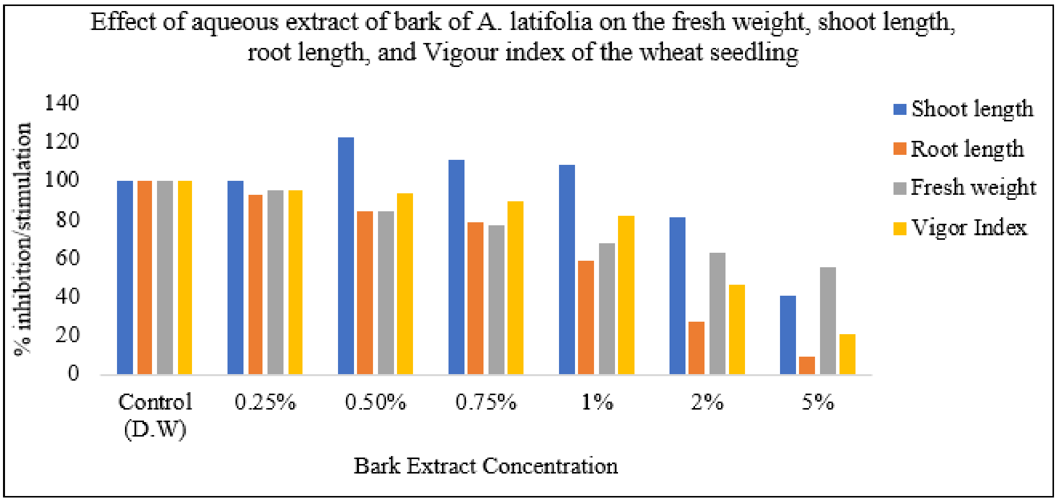

Figure 2: Effect of aqueous extract of bark of A. latifolia on the fresh weight, shoot length, root length, and Vigour index of the wheat seedling

4. Discussion

Seed germination is considered as most important phase in the life cycle of the plant. It is usually controlled by factors temperature, light, soil composition and various chemicals, salinity, secondary metabolites etc. In addition, many times, aqueous extracts of plant parts also inhibit or promotes the seed gemination. The inhibitory effect observed in present work indicates presence of allelochemicals in the aqueous bark extract, which bears Phyto-inhibitory potential. Aqueous extract of different plant parts of *Prosposis juliflora, Sunflower, Euphorbia helioscopia and A. fatua* inhibited seed germination of wheat, lentil and chickpea (Siddiqui et.al., 2009; Naseem et.al., 2009; Tanveer et.al., 2012 and Ahmad et.al., 2014). Similar observation made by Abu-Romman et.al., (2010) also supports result of our present study, where aqueous leaf extract of *Euphorbia hierosolymitana* inhibited the wheat seed germination. Quasam *et al.* (1993) reported that three *Amaranthus* specie *A. etroflexus*, *A. bilitiods* and *A. gacilis* reduced the germination in Wheat at higher concentration.

Khan et.al., (2012) also reported seed germination inhibition in four wheat cultivars when treated with aqueous extract of different plant parts *Parthenium hysterophorus*. Aqueous bark extract of *Ficus subincisa, Bahunia purpurea* and *Toona hexandra* reduced the seed germination in wheat, *Brassica* and *Sorghum* (Singh *et al.,* 2009). Aqueous extract of different parts of sunflower also reduced the germination in two wheat varieties Margalla 99 and Chakwall 97 (Kamal and Bano, 2008). Many agronomic crops treated with aqueous bark extract of *Tamarindus indica* showed reduction in seed germination (Parvez *et al.,*2004). In the present investigation, bark extract at lower concentration showed less reduction in seed germination of mung and wheat while, higher concentrations found more inhibitory to seed germination. Thus, the inhibition of seed germination in response to bark extract might be due to presence of most deleterious secondary metabolites. Further, isolation and purification of bioactive compounds will throw more light on its inhibitory effects.

Siyar et.al., (2019) reported decrease in fresh and dry weight of wheat seedling by treatment of aqueous extract of *M. officinalis, A. fatua* and *P. hissaricus*. Khan *et.al.* (2008) reported that aqueous leaf extract of *Eucalyptus camaldulensis* reduced the fresh weight and dry weight of wheat seedling at 10, 15 and 20% concentration. According to Baličević et.al., (2014), higher extract concentration of aqueous leaf and stem extract of *Convolvulus arvensis* (bindweed) decreased the fresh weight of maize. Kasarkar and Barge (2016) also reported reduction in fresh weight of Mung bean and Cow pea when treated with leaf extract of Neem. This decline in the fresh weight of mung and wheat seedling might be due to lowered photosynthetic rate in seedling.

For well establishment of the crop plant vigour index is important, which is determined by well root growth. The rapid root growth of young seedling is essential for good establishment of seedling and higher yield (Kent and Lauchi, 1985). According to Thapaliyal *et al.* (2008), aqueous bark extract of *Aegle marmelos, Terminalia bellirica, Terminalia chebula* and *Sapindus mukorossi* stimulated the radical and plumule growth of *Triticum aestivum*, *Lens culinaris* and *Echinochloa. frumentaceae* at lower concentration i.e. at 2%. Mutlu and Atici (2009) observed that leaf leachate of *Nepeta meyeri* increased root length and total seedling length of wheat, Canola and safflower at lower concentrations (0.125%, 0.25%, and 0.5%), but higher concentrations were found lethal. Aqueous bark extract of *Aporosa octandra*, *Anthocephallus chiensis* and *Albizia procera* decreased the seed germination and radical length of *Glycine max, Oryza sativa, Bassica campestris.* bark extract of *Anthocephallus* chiensis stimulated the radical length of *Glycine max* (Kumar and Siangshai, 2009). Singh *et al.* (2009) reported that 2% bark extract of *Ficus subincia* reduced the root and plumule length in *Triticum aestivum* and *Brassica campestries* where as 5% stimulated the growth of radical and plumule length. Quasam *et al.* (1993) reported that three *Amaranthus* specie *A. etroflexus*, *A. bilitiods* and *A. gacilis* reduced the germination, shoot length, root length and dry production in *Tricum aestivum* at higher concentrations but *A. gracilis* stimulated the total plant height and dry weight at lower concentration.

Aqueous bark extract of *Eucalyptus at* 20% concentration caused reduction in dry weight, Vigour index of wheat, rice and sorghum (Djanaguiraman *et al.,* 2005). Sasikumar *et al.,* (2001) also found that aqueous extract of bark of four *Eucalyptus* species *Eucalyptus tereticornis, E. camaldulensis, E. polycarpa* and *E. microtheca* reduced vigour index and total dry matter of red gram. In the present study, the vigour index of Mung and wheat seedling was decreased due *A. latifolia* extracts.

Phenolic compounds adversely affect the growth of the plant by inhibiting the seed germination, interfering the energy metabolism, cell division, mineral uptake and biosynthetic processes (Rice, 1984). The multiple effects resulting from the allelopathic phenolics includes decrease in plant growth, absorption of water, mineral nutrients, ion uptake, leaf water potential, dry matter production, leaf area expansion and reduced photosynthesis (Chou and Lin, 1996). Baker (1966) reported that Volatile material from the *Eucalyptus globulus* inhibit the root and hypocotyl growth of cucumber seedlings. Sasikumar *et al.* (2001) reported that caumaric acid, catechol, ferrulic acid, gallic acid, gentisic acid, hydroxylbenzoic acid, syringic acid vannilic acid showed pronounced inhibition on germination and reduced vigour in red gram. Caffic acid, hydroxybenzoic acid, vannilic acid and syringic acid inhibited the root elongation in wheat, rye and mung-bean (Vaugha and Ord, 1990). *Terminalia chebula* contains palmistic, stearic, oleic, inoleic, arachidic and behenic acids (Rastogi and Mehrotra, 1993a) whereas oleanolic acids, maslinic and arjunolic acids reported from *Terminalia tomentosa* found to inhibit growth of plants (Rastogi and Mehrotra, 1993b). Scopoletin a caumarin derivative produced by *Avena spp*. significantly inhibits the growth of *Brassica kaber* (Fay and Duke, 1977). The Benzoic acid, cinnamic acid and phenolic acids from *Eucalyptus* species, inhibit the growth of crop and weeds (Putnam,1984). Bisal *et al.* (1992) also reported that *Eucalyptus* also inhibits the growth of wheat, barly, lentil, chickpea, mustard and some weeds.

Volatile isoprenoids and benzoid from *Brassica* also suppress the growth of weeds (Tollsten and Bergstrm, 1998). Allelochemicals that inhibit the growth of some species at certain concentration might stimulate the growth of same or different species at different concentrations (Narwal, 1994 and Azania *et al.,* 2003). Thus, it is essential to identify concentration at which specific response occurs.

5. Summary

In the present study, it is observed that the aqueous bark extract of A. latifolia affects the physiology of the Mung and Wheat seedling. In both plants Root length, shoot length, Fresh weight and vigour index are reduced from low to high concentration. Maximum reduction is observed at higher concentration of 2% and 5%. IN case of wheat, bark extract concentrations at 0.50%, 0.75% and 1% stimulated the shoot length. From the study it is clear that, wheat plant is found more resistant to allelopathic stress than the Mung.

6. Conclusion

Our results reveal that aqueous bark extract of *A. latifolia* inhibited shoot length, root length, total length, reduced fresh weight, vigour index of mung seedling than the wheat seedling. Similar observations have been made in case of wheat seedlings but positively influences the shoot length than mung bean. *A. latifolia* contains high amount of phenolic content as compared. The inhibitory effects by *A. latifolia* might be attributed to their high phenolic content and might contains one or more above mentioned growth inhibiting allelochemicals indicating negative allelopathy. Stimulatory effects observed in case of wheat seedling might be due to the fact that the one or more endogenous phenolic compounds acting as hormone analogues and affecting the plant physiology positively. Thus, by defining a proper concentration of bark extract or by isolating growth stimulatory compound and intensifying its growth promoting concentration, the bark extract can be used for healthy plant growth as biotonic The, higher concentration of secondary metabolite might have inhibited the uptake of vital nutrients, which might have lowered the metabolism of seedlings reducing the fresh weight. Thus, our findings indicate that extracts of *A. latifolia* bark are rich in bioactive compounds with inhibitory potential, will be useful to formulate natural weedicide during practices of organic farming. To promote sustainable agriculture, the secondary metabolites present in the bark of *A. latifolia* can be used in the form of allelochemicals as growth regulators and natural herbicides.

References

[1] Inderjit, R. and Keating K. I. (1999). Alleloapathy: principles, Procedures, Processes and Promises for Biological Control. *Advances in Agronomy*, 67: 141-231.

[2] Rice, E. L. (1984). Allelopathy 2nd Ed. Academic Press, Orlando, Flerida, USA.

[3] Fernandez, C. B., Lelong, B., Vilsa, J. P., Mevy, C., Robles, S. Greff, S., Dupouyet and Bousquet-Melou, A. (2006). Potential allelopathic effect of Pinus halepensis in the secondary sucession: an experimental approach. Chemoecol., 16: 97-105.

[4] Huxley, P. (1999). Tropical Agroforestry. Blackwell Science, Oxford.

[5] Putnam A, Weston R. (1986). Inhibition of legume seedling growth by residues and extracts of quackgrass (*Agropyron repens*). *Weed Science*., 34 (3): 366-372.

[6] Siddiqui, S., Bhardwaj, S., Khan, S.S. and Meghvanshi. M.K. (2009). Allelopathic effect of different concentration of water extract of Prosopsisjuliflora leaf on seed germination and radicle length of wheat (*Triticum aestivumVar*-Lok-1), *Am.-Eurasian J. Sci. Res.*, 4: 81–84.

[7] Naseem, M., Aslam, M., Ansar, M. and Azhar, M. (2009). Allelopathic effects of sunflower water extract on weed control and wheat productivity, *Pak. J. Weed Sci. Res.*, 15:107–116.

[8] Tanveer, A., Jabbar, M.K., Kahliq, A., Matloob, A., Abbas, R.N. and Javaid, M.M. (2012). Allelopathic effects of aqueous and organic fractions of *Euphorbia dracunculoides* Lam. on germination and seedling growth of chickpea and wheat. *Chilean J. Agric. Res.* 72:495.

[9] Ahmad, W., Akbar, M., Farooq, U., Alia, A. and Khan, F. (2014). Allelopathic effects of aqueous extracts of Avena fatua on seed germination and seedling growth of Triticum aestivum (variety GW-273), *Environ. Sci. Toxic. Food Technol.*, 8: 38–42.

[10] Abdul-Baki, A. A. and Andersion, J. D. (1973). Vigor determination of soybean by multiple criteria. *Crop Sci*., 13:630-633.

[11] Shrivastava, A. K. and Sareen, K. (1974). Physiology and biochemistry of deterioration of Soybean seeds during storage.I-mobilization and nitrogen metabolism. Seed Research, 2:26-32.

[12] Abu-Romman, S., Shatnawi, M. and Shibli, R. (2010). Allelopathic effects of spurge (Euphorbia hierosolymitana) on wheat (Triticum durum), *Am.-Eurasian J. Agric. Environ. Sci.*, 7:298–302.

[13] Khan, N., Naveed, K., Hussain, Z. and Khan, S. (2012). Assessment of allelopathic effects of parthenium (Parthenium hysterophorus L.) plant parts on seed germination and seedling growth of wheat (Triticum aestivum L.) cultivars. *Pak. J. Weed Sci. Res*., 18(1): 39-50.

[14] Singh, B., Jhaldiyal, V. and Kumar, M. (2009). Effect of aqueous leachates of multipurpose trees on test crops. Estorian J of Ecol., 58(1): 38-46

[15] Parvez, S. S., Parvez, M. M., Fujii, Y. and Gemma, H. (2004). Differential allelopathic expression of bark seed of Tamarandus indica L. *Plant Growth Regulation.,* 42: 245-252.

[16] Kamal, J. and Bano, A. (2008). Allelopathic potential of sunflower (Helianthus annus L.) on soil metals and its leaves extracts on physiology of wheat 313 (Triticum aestivum L.) seedlings. African J of Biotech., 7(18): 3261 3265.

[17] Baličević, R., Ravlić, M., Knežević, M. and Serezlija, I. (2014). Allelopathic effect of field bindweed (Convolvulus arvensis L.) water extracts on germination and initial growth of maize. *J. Anim. Plant Sci.*, 24 (2014) 1844–1848.

[18] Kasarkar, A. R. and Barge, A. N. (2016) Effect of aqueous extract of neem (*Azadirachta* indica A. Juss) leaves on germination and growth of some agricultural crops. *Journal of Medicinal Plants Studies* 2016; 4(5): 11-13

[19] Siyar, S., Majeed, A., Muhammadc, Z., Alic, H. and Inayatc, N. (2019). Allelopathic effect of aqueous extracts of three weed species on the growth and leaf chlorophyll content of bread wheat. *Acta Ecologica Sinica.,* 39:63–68

[20] Thapaliyal, S., Bali, S. R., Singh, B., Tidaria, N. P. (2008). Allelopathic effect of tree on economic importance on germination and growth of food crops. *J. Herbs, Spices and Medicinal Plants,* 13(4):11-23.

[21] Mutlu, S., and Atici, O. (2009). Allelopathic effect of *Nepeta meyeri* Benth. extracts on seed germination and seedling growth of some crop plants. *Acta Physiol Planta.*, 31:89-93.

[22] Kumar, M. and Siangshai, S. (2009). Effect of leaf and bark aqueous extracts on germination and radicle length of crops in mizoram. *Pak. J. Weed Sci. Res*., 15(4):275-281

[23] Singh, B., Jhaldiyal, V. and Kumar, M. (2009). Effect of aqueous leachates of multipurpose trees on test crops. *Estorian J of Ecol*., 58(1): 38-46.

[24] Quasam, J. R. (1993). The allelopathic effect of three *Amaranthus* sp. (pigweeds) on wheat (*Triticum durum*). *Weed Research*., 35:41-49.

[25] Djanaguiraman, M., Vaidyanathan, R., Sheeba, A. J., Durga, D. and Bangarusamy, U. (2005). Physiological responses of *Eucalypatus* globules leaf leachate on seedling physiology of rice, sorghum and blackgram. *International J of Agri and Biol.*, 1: 35-38

[26] Sasikumar, K. Vijayalakshmi, C and Parthiban, K. T. (2001). Allelopathic effects of *Eucalyptus* on redgram. *J of Tropical Agriculture*., 72: 277-281. (Rice, 1984).

[27] Chou, C. H. and Lin, H. J. (1996). Autointoxication mechanism of Oryza sativa. Phytotoxic effects of decomposing rice residues in soil. *J. Chem. Ecol.,* 2:352-367

[28] Baker, H.G. (1966). Volatile growth inhibitors produced by *Ecalyptus globulus. Plant products*, 18: 207-210.

[29] Vaughan, D. and Ord, B. G. (1990). Effects of allelochemicals in roots. Plant Root Growth- An Ecological perspective. Blackwell Scientific Publications, Landon, Pp. 399-421.

[30] Rastogi, R. P. and Mehrotra, B. N. (1993a). Compadium of Indian Medicinal plants. 2: 859. Published by Central Drug Research Indtitute, Lucknow and Publications and Information Directorate, New Delhi, India.

[31] Putnam, A. R. (1984). Allelopathic chemicals. Can natural plant herbicides help control weeds. *Weeds Today*., 15:6-8.

[32] Bisal, S. S. Nansal, D. P. S. S. and Narwal, S. S. (1992). Influence of aqueous leaves leaves extracts of eucalyptus and poplar on the germination and seedling growth of winter crops. *Proc. Ind. Soc. Allelop*., pp. 95-97.

[33] Tollsten, L. and Bergstrom, G. (1988). Headscape volatile of whole plant and macerated plant parts of Brassica and Sinapsis. *Phytochemistry*. 27: 4013-4028.

[34] Narwal, S. S. (1994). Allelopathy in crop production. Jodhpur, India: Scientific publishers.

[35] Azania, A. A. P. M., Azania, C.A. M., Alives, P. L. C. A., Palaniraj, R., Kadian, H. S., Sati, S. C., Rawat, L. S., Dahiya, D.S. and Narwal, S. S. (2003). Alleloparhic plants. Barley (Hordeum vulgare L.) *Allelopathy Journal*, 11: 1-20.

[36] Kent, H. and Laulchli, V. (1985). Germination and seedling growth of cotton:saliniy calcium interaction. *plant cell invironment*., 8:155-159.