ALLELOPATHIC POTENTIAL OF EUCALYPTUS *CAMALDULENSIS* L. AS AN ORGANIC HERBICIDES

Iqtidar Hussain[1] and Adnan Noor Shah[2]

ABSTRACT

The Influence of aqueous extract of Eucalyptus was examined during 2018. By applying the water extract of eucalyptus to different weed species, namely Bindweed, barley, London rocket, wild safflower, Wild oat, common lambsquaters, Bird's seed grass, Broad leaved dock and Umbrella milkweed .In addition to the control, 10 ml of dry leaf water extract was applied at intervals of 3 days for each treatment. The data obtained after 20 days showed that the fresh weight and dry weight of each tested weed were significantly reduced compared to the treatment with water (control). Germination, root length (cm), shoot length (cm) and chlorophyll content of the weeds are adversely affected by the application of the extract instead of the control. These results indicate that the water extract of eucalyptus can be used as a biological inhibitor of weed control in our planting systems.

Keywords: allelopathy, eucalyptus, herbicide

INTRODUCTION

Weed compete for sunlight, nutrients, carbon dioxide (CO_2), water and space etc. may reduce crop quality and quantity. Weeds are serious threat for both irrigated and rain fed agriculture land. Yield losses have been reported from 5-100% in different crops of Pakistan, depending upon the weed density, frequency, type and intensity of competition for growth/yield, and yield components (Ashiq and Aslam, 2014). Weed control is the cry of time. There are various kinds of practices involved in weed control. Weeds can be controlled biologically, culturally, mechanically and chemically. Chemical control is the most effective option for weed suppression and control. However, a part from raising concerns for environmental degradation, animals and human health, over use of chemical herbicides over the years has produced herbicides resistance in certain weed species (Marwat *et al*., 2011). Therefore, there is a need to reduce the excessive use of herbicides and to devise new mechanisms which could efficiently control weeds without adversely affecting the environment. One such step in this direction may be the use of allelopathic plants and their residues. In order to attain sustainable weed management, allelopathy may be a positive to chemical control alternative (Cheema *et al*., 2003. a, b and Cheema *et al*., 2004).

[1] Department of Agronomy, Faculty of Agriculture, Gomal University, Dera Ismail Khan, KP, Pakistan

[2] Assistant Professor, Department of Agronomy, Faculty of Agriculture, Gomal University, Dera Ismail Khan, KP, Pakistan

Putnam (1984) reported that eucalyptus species release volatile compounds such as benzoic acid, cinnamon and phenols to inhibit crop growth and nearby weed growth. Bisal *et al*., (1992) described eucalyptus as having an adverse effect on the germination and seedling growth of wheat, barley, lentils, chickpeas, mustard and many weeds. Schumann *et al*., (1995) reported that eucalyptus water extract significantly reduced the growth of weeds. The leaves of eucalyptus are the main source of toxic compounds released, decomposed and dropped onto land, releasing chemicals considered to be allelo-chemicals (Alam and Islam, 2002).

The same chemical substances also have adverse effects on adjacent plants in the ecosystem, resulting in reduced germination, delayed germination, seedling death and reduced growth (Ghafar *et al*., 2000; Khan *et al*., 2008). Allelo chemicals are found in all plant tissues, including leaves, roots, stems and seeds. They are often water-soluble and are released into the soil environment through foliar leaching, root exudation and decomposition or evaporation of plant residues (Dastegir and Hussain, 2015; Basharat *et al*., 2017).

Nowadays there is a need to search new methods for weed control which are eco-friendly, cheapest and use farm produced materials. So, this study was formulated to investigate the capability of water extracts of *Eucalyptus camaldulensis* for their allelopathic effects on weeds. The main objective was to evaluate the allelopathic phytotoxic effect of aqueous extract of *Eucalyptus camaldulensis* as herbicides for weed control in laboratory conditions.

MATERIALS AND METHODS

The experimental trails were undertaken at the post graduate laboratory, department of Agronomy, Faculty of Agriculture, Gomal University, Dera Ismail Khan during 2018. The weeds studied were Field bindweed (*Convolvulus arvensis* L.), Wild barley (*Hordium vulgare* L.), Wild safflower (*Carthamus oxycantha* M.B.), Wild oat (*Avena fatua* L.), Common Lambsquarter (*Chenopodium album* L.), London rocket (*Sisymbrium irrio* L.), Bird's seed grass (*Plaris minor*), Broad leaved dock (*Rumex dentatus*) and Umbrella milkweed (*Euphorbia helioscopia*).

Research was conducted in a Randomized Complete Block Design (RCBD) which was replicated four times. Ten seeds were sown in each cup having 100g sandy loam soil. The leaves extract was made according to the following procedure. Older matured leaves of E. *camaldulensis* were collected, washed with water and dried in the sun for three (3) days, then samples were dried in an oven at 80°C for 72 hours. After grinding of dried leaves, the leaves powder with 25% w/v was soaked in distilled water for three days at the room temperature, the extract was filtered through whatmans No. 1 filter paper. Seeds of each weed were soaked in solution for 5 hours before sowing in cups. Ten (10) ml aqueous extract of Eucalyptus leaves was applied with an interval of two days to each treatment except control, where only water was applied. The cups where only distilled water was applied treated as control. The data was taken after 20 days of sowing by using the analysis of variance technique (Steel *et al*., 1997), the obtained data were analyzed and were then subjected to comparison through LSD test with “Statistix 8.1” software.

RESULTS AND DISCUSSION

Germination percentage

Eucalyptus camaldulensis L. significantly reduced the weeds germination as compared to control (Table 1). The lowest germination (%) was recorded in wild oat and field bindweed by applying aqueous extract condition. While maximum germination was registered in London rocket. The germination (%) by applying aqueous extract ranged between 8.3% to 41% as compared 35% to 75.2% in water application. The highest inhibition in wild oat and field bindweed could be due to sensitivity of its embryo towards allele-chemicals present in *Eucalyptus camaldulensis* L. The results are similar with the findings of Khan *et al*., (2007) and Khan *et al*., (2008). Who reported that different Eucalyptus species have inhibitory effect on germination of different species of plants. The results of this study about germination clearly indicate the allelopathic potential of *Eucalyptus camaldulensis* L. and supported by Basharat *et al*., (2017).

Fresh weight (g)

Data (Table 2) showed the suppressing effect of Eucalyptus extract on fresh weight of nine weeds. All the weeds species included in the experiment have significantly recorded lower fresh weight by applying Eucalyptus extract than control. More fresh weight was registered by Jangli Palak (14.2g) followed by (13.4) in control. Less fresh weight was observed in the London rocket by applying aqueous extract of *Eucalyptus camaldulensis* L. The difference in fresh weight between Eucalyptus extract and water ranged from 3.48 to 9.97 g. The heavier fresh weight of Jangli Palak and Wild safflower due to their plant conopy, more absorption of water and photosynthates accumulated during photo-synthesis. The maximum decrease in fresh weight of Jangli Palak by Eucalyptus extract may be due to allelopathic potential of Eucalyptus. Eucalyptus showed phytotoxic effect on nine species of weeds. Similar findings were described by Khan *et al*., (1999) and Khan *et al*., (2008), who reported that Eucalyptus extract reduces the fresh weight of maize and weeds seedling respectively.

Dry weight (g)

The data on dry weight in table-3 revealed that all nine weeds have reduced dry weight as affected by Eucalyptus aqueous extract compared with control. Different weeds have differences among themselves regarding dry weight. Dry weight synthesis showed their ability to convert nutrients, carbon dioxide and water into photosynthates. However, non-significant differences were found among nine weeds but we can observed visual differences. Maximum dry weight was observed in wild safflower, Bird's seed grass and jangli palak respectively. Differences in dry weight of seedling grown in Eucalyptus extract and water applied treatment ranged from -0.45 to 0.78. These results coincide to those Khan *et al*. (1999) and Khan *et al*. (2008) who found reduction in dry weight of different plants by Eucalyptus extract application. They also reported phytotoxity of allelochemicals present in leaves of *Eucalyptus camaldulensis* L.

Shoot length (cm)

Results about shoot length (cm) of all species have been found significantly reduced by application of *Eucalyptus camaldulensis* L. aqueous extract when compared with control (Table-4). Maximum shoot length was observed in Jungli Palak (17.9 cm) followed by wild barley (17.3 cm) and chattri dhodak (16.3 cm) in treatment by application of water. Minimum shoot length (5.033 cm) was observed in wild safflower in Eucalyptus aqueous extract treated plants. The difference in shoot length between Eucalyptus extract application and water application ranged from 0.28 to 6.65. It is clear from data the Eucalyptus extract affected the shoot length from the plumules of embryos of nine weeds. Growth of shoot length is inhibited by Eucalyptus aqueous extract by presence of phytochemicals in it. Yamane *et al*., (2017), Khan *et al*., (2008) and Shinwari *et al*., (2017) reported that all plant physiological processes such as hormone balance, protein synthesis, respiration, photosynthesis, chlorophyll formation, permeability and plant water relationships may be distributed by allolopathy.. Similarly, Blake (1985) and Khan *et al*., (2008) reported that Eucalyptus camaldulensis L. inhibits the growth of related species by reducing its germination, photosynthesis, and ultimately economic yield.

Root length (cm)

Nine species of weeds showed significantly difference in root length by applications of Eucalyptus aqueous extract over control (Table 5). It has been pointed in the literature about Eucalyptus that higher allelopathic effect has been found on root growth rather than shoot growth by inhibition or promotion of cell division (Devi, *et al*., 1997 and Shinwari *et al*., 2017). Minimum root length was observed in field bindweed (3.1cm) in control rather than by application of aqueous extract of Eucalyptus. It was followed by chattri dhodak (3.2 cm) and jangli palak (3.5 cm) treated by aqueous extract. Each specie of weeds have different behavior in this regard- this may be due to growth of hypocotyls and radical of weeds seedling has been mentioned in the manuscript in the form of inhibition or promotion of water and nutrient uptake. Phytochemicals involved in allelopathy in some plants may increase the permeability of cell membrane which cause increase in the root length. Our results are confirmed by Devi *et al.,* (1997) and Shinwari *et al.,* (2017). Whole Yamane *et al.,* (1992) also concluded from their result that allele-chemicals disturbed the normal permeability and plant water uptake.

Chlorophyll content (µg cm^{-2})

Chlorophyll are green pigments found in all photosynthetic plants (Green plants). Chlorophyll are colored complex organic molecules in a biological system which absorb radiant energy in the visible range of electromagnetic spectrum (i.e. light) and convert it into chemical form of energy (Sinha, 2004). All nine weeds depicted its sensitivity about chlorophyll content (Table 6) with application of Eucalyptus aqueous extract. Maximum chlorophyll content production was recorded by bird's seed grass (42.3 µg cm^{-2}) followed by wild oat (40.0 µg cm^{-2}) and London rocket (36.0 µg cm^{-2}). Minimum chlorophyll content (10.00 µg cm^{-2}) was found in field bindweed. Chlorophyll content differences ranged -1.87 to 11.1 Yamane *et al.,* (1992) explained that chlorophyll formation and photosynthesis are adversely affected by phytotoxic allele-chemicals. In our study, there was strong allelopathic impact noticed regarding chlorophyll contents of nine species of weeds by application of Eucalyptus extract, this may be due to disturbance in metabolism of plant processes which involve in the formation of chlorophyll content.

Table 1. Suppressing effect of Eucalyptus aqueous extract on Germination % of nine weeds

Weeds	Control	Extract	Difference
Field bind weed	60 c	08.5 e	51.5
Wild Barlay	65 ab	16.2 de	48.8
Wild Safflower	66 ab	42 bcd	24
Wild oat	67 ab	8.3 e	58.7
Common Lambsquaters	35 cde	12.3 e	22.7
London rocket	75.2 a	14.0 e	61.2
Bird's seed grass	67 ab	25.3 d	41.7
Broad leaved dock	55 bc	41 bc	14
Umbrella Milkweed	52 bc	33 de	19

Different letters in the same column differ significantly at the $p \leq 0.05$ probability level according to the least significant difference (LSD) test

Table 2. Suppressing effect of Eucalyptus aqueous extract on Fresh wt. (g) of nine weeds

Weeds	Control	Extract	Difference
Field bind weed	11.50 b	5.04 d	6.46
Wild Barlay	12.60 ab	6.67 d	5.93
Wild Safflower	13.4 a	4.39 de	9.01
Wild oat	10.2 b	6.3 d	3.9
Common Lambsquaters	8.7 c	4.2 de	4.5
London rocket	6.9 c	3.42 e	3.48
Bird's seed grass	12.52 ab	7.52 c	5
Broad leaved dock	14.2 a	4.23 de	9.97
Umbrella Milkweed	11.2 b	3.91 e	7.29

Different letters in the same column differ significantly at the p≤0.05 probability level according to the least significant difference (LSD) test

Table 3. Suppressing effect of Eucalyptus aqueous extract on Dry wt. (g) of nine weeds

Weeds	Control	Extract	Difference
Field bind weed	1.1NS	0.32	0.78
Wild Barlay	0.83	0.42	0.41
Wild Safflower	1.2	0.56	0.64
Wild oat	0.65	0.32	0.33
Common Lambsquaters	0.9	0.43	0.47
London rocket	0.52	0.31	0.21
Bird's seed grass	1.1	0.43	0.67
Broad leaved dock	0.96	0.33	0.63
Umbrella Milkweed	0.87	1.32	-0.45

Different letters in the same column differ significantly at the p≤0.05 probability level according to the least significant difference (LSD) test. Whereas “NS” shows non-significant differences.

Table 4. Suppressing effect of Eucalyptus aqueous extract on Shoot length (cm) of nine weeds

Weeds	Control	Extract	Difference
Field bind weed	16.1 a	9.19 c	6.91
Wild Barlay	17.3 a	13.23 b	4.07
Wild Safflower	8 c	5.033 d	2.967
Wild oat	6.1 c	5.822 d	0.278
Common Lambsquaters	14.2 ab	12.472 b	1.728
London rocket	7.3 bc	5.63 d	1.67
Bird's seed grass	15.6 ab	9.35 c	6.25
Broad leaved dock	17.9 a	11.25 b	6.65
Umbrella Milkweed	16.3 a	11.75 b	4.55

Different letters in the same column differ significantly at the $p \leq 0.05$ probability level according to the least significant difference (LSD) test

Table 5. Suppressing effect of Eucalyptus aqueous extract on Root length (cm) of nine weeds

Weeds	Control	Extract	Difference
Field bind weed	3.1 c	4.97 b	-1.87
Wild Barlay	6.7 b	6.7 b	0
Wild Safflower	8 b	7 b	1
Wild oat	4.1 c	2.02 d	2.08
Common Lambsquaters	6.01 b	5.8 b	0.21
London rocket	12.48 a	5.3 b	7.18
Bird's seed grass	6.2 b	5.0 b	1.2
Broad leaved dock	7.4 b	3.5 c	3.9
Umbrella Milkweed	14.3 a	3.2 c	11.1

Different letters in the same column differ significantly at the $p \leq 0.05$ probability level according to the least significant difference (LSD) test

Table 6. Suppressing effect of Eucalyptus aqueous extract on chlorophyll content (µg cm^{-2}) on nine weeds

Weeds	Control	Extract	Difference
Field bind weed	15.00 de	10.00 f	5
Wild Barlay	32.5 b	25.00 c	7.5
Wild Safflower	18.00 d	13.00 e	5
Wild oat	40.00 a	22.00 c	18
Common Lambsquaters	16.00 e	12.00 e	4
London rocket	36.00 ab	14.00 e	22
Bird's seed grass	42.3 a	20.9 d	21.4
Broad leaved dock	39.4 ab	23.5 c	15.9
Umbrella Milkweed	31.6 b	24.3 c	7.3

Different letters in the same column differ significantly at the $p \leq 0.05$ probability level according to the least significant difference (LSD) test

CONCLUSION

The results showed that the allelopathy in Eucalyptus water extract inhibited all the parameters in the species studied. Use eucalyptus as a source of weed control in different agriculture crops.

However, on Barron and marginal land, these plants are encouraged to grow them because of their ability to alter the microclimate of the area.

It is recommended to further study the active ingredients of eucalyptus in order to understand the different behaviors and reactions of plants to their applications. The results of our study can be used as baseline data for future studies of organic herbicides.

This may help to develop the use of effective and novel bioactive chemicals as herbicides.

REFERENCES

Ashiq, M. and Z. Aslam, 2014. Losses Due to Weeds in Weeds and Weedicides. Department of Agronomy, U.A.F and Ayub Agricultural Research Institute, Faisalabad, Pakistan. 15.

Basharat, A.D., Saad, L., Al-Rowaily., Abdulaziz, M., Saeed, A., Bana, E.A., Ahmed-Hegazy, K and J. A. Malik, 2017. *Pakistan Journal of Botany*, 49(5), 1841-1848.

Bisal, S.S., Nandal, D.P.S.S and S.S. Narwal, 1992. Influence of Aqueous Leaves Extracts of Eucalyptus and Popular on the Germination and Seedling Growth of Winter Crops. *Proc. Ind. Soc, Allelopathy*, 95-97.

Blake, N. E. 1985. Effects of Allelochemicals on Mineral Uptake and Associated Physiological Processes. In The Chemistry of Allelopathy. Biochemical Interaction among Plants. *America Chemical Society, Washington D.C*, 161.

Cheema, Z.A., Sajid, M., Farid and A. Khaliq, 2003a. Efficacy of Concentrated Sorgaab in Combination with Low Atrazine for Weed Control in Maize. *Journal of Animal and Plant Science*, 13(4), 61-65.

Cheema, Z.A., Hussain, S and A. Khaliq, 2003b. Efficacy of Sorghum in Combination with Allelopathic Water Extracts and Reduced Rates of Pendimethalin for Weed Control in Mung bean. *Indus Journal of Plant Science*, 2, 21-26.

Cheema, Z.A., Khaliq, A and S. Saeed, 2004. Weed Control in Maize (*Zea mays* L.) throught Sorghum Allelopathy. *Journal of Sustainable Agriculture*, 23(4), 73-81.

Dastagir, G. and F. Hussain, 2015. Allelopathic Potential of Quercus baloot Griff. *Pakistan Journal of Botany*, 4716, 2409-2414.

Devi, S.R., Pellissier, F and M. N. V. Prasad, 1997. Allelochemicals. In: Plant Ecophysiology. (Ed.) M.N.V. Prasad, John Wiley & Sons, Inc., New York.

Ghafar, A., Saleem, B and M. J. Qureshi, 2000. Allelopathic Effects of Sunflower on Germination and Seedling Growth of Wheat. *Pakistan Journal of Biological Science*, 3(8), 1301-1302.

Khan, M.A., Mamoon-ur-Rashid and M. S. Baloch, 1999. Allelopathic Effect of Eucalyptus on Maize Crop. *Sarhad Journal of Agriculture*, 15, 393-397.

Khan, M.A., Hussain, I and E. A. Khan, 2007. Allelopathy in Agroforestry Systems. The Effects of Leaf Extracts of Eucalyptus Species on Three Crops. *Agroforestry systems*, 21(1), 63-73.

Khan, M.A., Hussain, I and Khan, E.A. (2008). Suppressing Effects of *Eucalyptus camaldulensis* L. on Germination and Seedling Growth of Six Weeds. *Pakistan Journal of Weed Science Research*, 14(3-4), 201-207.

Marwat, K. B., Khan, M. A., Hashim, S., Nawab, K and A. M. Khattak, 2011. Integrated Weed Management in Wheat. *Pakistan Journal of Botany*, 43, 625-633.

Putnam, A. R. 1984. Allelopathic Chemicals. Can Natural Plant Herbicides Help Control Weeds. *Weeds Today*, 15, 6-8.

Schumann, A.W., Little, K.M and N. S. Eccles, 1995. Suppression of Seed Germination and early Seedling Growth by Plantation Harvest Residues, *South African Journal of Plant and Soil*, 12, 170-172.

Sinha, R. K. 2014. Photosynthesis in Modern Plant Physiology. Narosa Publishing House, India. 178.

Shinwari, M. I., Osama, I., Shinwari, M. I. and Y. Fujii, 2017. Evaluation of Phytodiversity for Allelopathic Activity and Application to Minimize Climate Change Impact. Japanese Medicinal Plants. *Pakistan Journal of Botany*, 49(51), 139-144.

Steel, R.G.D., Torrie, J. H. and D. A. Dicky, 1997. Principles and procedures of statistics. A biometric approach. 3rd edition. *McGraw Hill Book International Corporation*, New York, 400–428.

Yamane, A., NIshimusa, H and J. Mizutani, 1992. Allelopathy of Yellow Field Cress. (Rorippa sylvestris). Identification and Characterization of Phytotoxic Constituents. *Journal of Chemical Ecology*, 18, 683-691.