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Phytotoxic potential of *Calotropis procera* against germination behavior and morphological growth performance of lentil (*Lens culinaris*)

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Abstract

This study was carried out to assess the allelopathic potential of *Calotropis procera* against lentil. Four different concentrations of *Calotropis procera* leaf extracts (100%/, 75%, 50% and 25% concentrated) were used to irrigate pots containing lentil seeds. Allelopathic effects of *C. procera* on lentil crop were gauged using different germination indices and physical growth parameters like root and shoot growth, number of leaves and branches and other morphological growth parameters. Results concluded that *C. procera* leaf extract has obvious suppressing effects on lentil since at higher concentration of leaf extract, lentil seeds showed significantly lower germination percentage and reduced growth in all physical growth parameters.

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Introduction

Phytotoxic nature of allelochemicals may exhibit stimulatory or inhibitory effects on the growth performance of subsequent or companion crop plants and these effects are featured as selective and concentration dependant in nature (Manzoor *et al.*, 2013; Jalili *et al.*, 2007; Cheema *et al.*, 2004; Naseem *et al.,* 2003). Within the plant under effect, these allelochemicals halt a range of physiological and metabolic activities like those of respiration, photosynthesis, water uptake and DNA synthesis (Einhelling, 2002). Investigation carried out on the allelopathic effects of different weeds against crops has revealed that these water soluble allelechemicals cause a significant inhibition of a number of growth parameters in those crops (Kadioglue *et al.*, 2005; Singh *et al.*, 2005; Batish *et al.*, 2007).

Calotropis procera, generally known as kapock tree, rubber bush, Sodom apple, calotropis or milkweek (kareem *et al.*, 2008) is locally called "*Akk*" in Pakistan (Yasin *et al.*, 2012). *C.procera* comes from Asclepiadaceae (Parihar *et al.*, 2011), a family having its members widely distributed in the world, especially in subtropical and tropical regions (Yasin *et al.*, 2012). Being abundant in warm regions, it grows on sandy, dry and alkaline soils most often along roads, fallow lands, sand dunes and in or around cropped field as a weed (Sastry and Kavathekar, 1990). *C. procera* shows perennial growth pattern with tall erected stem rich in branches which makes it assuming a shrub-like shape. Sometimes it grows up to 3 meter thus resembling the shape of a small tree (Yasin *et al.*, 2012). It propagates mainly through seeds while a localized asexual propagation occurs through root suckers. Qureshi *et al.* (2009) reported it amongst dominant plants of natural flora in Pakistan.

Lentil (*Lens culinaris*) comes from Febaceae family and is native to sub-continent. Besides its excellent growth on sandy loam soil it has been reported to grow significantly well on nutrient deficient soil. It is resistant to drought and can also be cultivated on saline and waterlogged soil (Muehlbaur *et al.,* 2001). In Pakistan, it is grown at an area of 30.4 thousand hectares with an average production of 480 Kg/hectare (Hussain *et al.,* 2007). Lentil espouses a fair concentration of vitamin B and many other vitamin groups. Minerals like calcium, sodium, phosphorus, potassium etc have also been reported in lentil. Besides, lentil seed homes about 26% of protein concentration in it (Muehlbauer *et al.,* 2001).

Calotropis procera has been investigated for its pharmacological, insecticidal and anti-phytopathogenic properties (Nenaah and Ahmed, 2011; Begum *et al.,* 2010 and Kareem *et al.,* 2008). It has been used to biological control of many plants (Ahmad and Khan, 2004). However, only handful studies have been carried out to evaluate the allelopathic effects of *C. procera* against various agricultural crops (Samreen *et al.*, 2009; Kayode, 2004). *C. procera* has been reported to have water soluble organic compounds which might suppress the growth of plants by inhibiting the production of gibberlins and indole acetic acid (*Yasin et al.2012).* Al-Zohrani and Al-Robai (2007) reported that *C. procera* has phytotoxic effects which can check the normal growth of agricultural crops. Samreen *et al.,(*2009) also confirmed presence of water soluble allelochemicals in *C. procera* leaf extracts which can significantly reduce seed germination and other growth parameters of crops.

Lentil is one such crop which shows considerably weak performance when it comes in competition with weeds, owing to its slow initial growth and low height (Erman *et al.,* 2004). A decrease as much as 84% in the yield of lentil crop has been reported on account of competition with weeds. Widespread occurrence of *C.procera* near lentil fields raises a question over its possible adverse impacts on this crop. Besides, there is every possibility that it may invade field crops in near future as did many other weeds in the past (Yasin *et al.*, 2012). Thus considering the susceptibility of lentil to the phytotoxic effects of weeds, it becomes important to investigate how *C.*

procera, being one of the dominant weeds in and around lentil fields, interacts with the germination and growth performance of lentil. The current study was therefore carried out to assess the allelopathic effects of *C.procera* on germination and other growth parameters of lentil (*Lens culinaris*).

Materials and methods

The experiment was conducted in completely randomized design (CRD) with five replications during December 2012 at room temperature (25 C^{o}) in the laboratory of Department of Forestry Bahaudddin Zakariya University Multan.

Plant Material And Treatments

Fresh leaves of *Calotropis procera* were collected from *C. procera* plants growing in the cropped area of Agriculture Research Farm of Bahauddin Zakariya University Multan. There were three soil + sand + clay (1:1:1) filled pots in each replication.

C. procera leaves (50, 100 150 and 200 g) were chopped down and boiled in 1 L tap water for 60 minutes and applied to respective pots in comparison with control (no *C. procera* leaves). The solutions were filtered through muslin cloth and the extracts were collected in tagged bottles.

The experiment was carried out in Completely Randomized Design with five replications. Ten seed of lentil were sown in each pot. The extracts were applied to respective pots to keep the soil moistened throughout the duration of the study. The study was carried out for a period of three weeks.

Germination Parameters

Following the standard procedure (AOSA, 1990), germinated seeds were counted and recorded after every 24 hours interval. A seed was considered as germinated when its radical become at least 2 mm in size. Ten days after sowing, the final germination percentage was calculated. Germination Energy (GE), Mean Germination Time (MGT), Final Germination Percentage (FGP), Relative Germination Rate (RGR) and Germination Index (GI) were determined using the formula as mentioned by Li (2008). Besides, Days Required For 50% Germination of Total Seeds (T_{50}'), Days Required For 50% of Total Germinated Seeds (T_{50}), Speed of Germination (S), Speed of Accumulated Germination (AS), Coefficient of The Rate of Germination (CRG) were calculated using formulas as mentioned by Anjum and Rukhsana (2005). Germination Value (GV), Peak Value (PV), Percent Inhibition (PI) and Delay Index (DI) were determined using formulas as used by Malaviya and Anuradha (2011). Corrected Germination Rate Index was calculated using formula as used by Dewir *et al.,* (2011) and Germination Distribution (GD) was determined following the mentioned by Schrader and Williams (2000).

Growth Parameters

Data were recorded on root fresh weight, shoot fresh weight, root dry weight, shoot dry weight, root length, shoot length, number of leaves, number of branches and seedling vigor index Root/Shoot ratio, percent radical inhibition according to the standard techniques.

Statistical Analysis

The data were pooled and analyzed using MSTAT-C Program. LSD test at 5% level of probability was used to test the differences among mean values (Steel *et al.,* 1997).

Results

The study showed that the different concentrations of *C. procera* aqueous leaf extracts had significant effects on the all parameters of germination behavior (as shown in table 1) in lentil. Seed germination behavior seemed to be normal (positive germination) in the control whereas the minimum value of seed germination percentage and all other parameters was obtained in the T_5 treatment.

Results showed a significant decrease in the number of branches due to application of treatments. Minimum number of branches was recorded in T_5 which were significantly different from all other treatments. Highest number of branches was recorded in Control and it was statistically insignificant from the following three treatments.

Highest number of leaves was recorded in control which was statistically insignificant from the following treatment. Minimum number of leaves was recorded in T_5. The T_5 treatment was followed by T_4 and T_3 which were statistically insignificant from each other.

Table 1. Allelopathic effect of *C. procera* leaf extract on germination behavior of *L. culinaris*.

	T50'	T50	PI	DI	GI	FGP
T1	4.99±0.17	4.81±.24			12.51±.34	95±1.58
T2	6.48±.27	5.75±.29	12.58±.35	0.36±.07	8.82±.34	83±1.22
T3	6.1±.40	4.92±.43	17.88±1.29	0.314±.086	9.75±.59	78±1.22
T4	7.40±.57	4.99±.22	25.25±1.05	0.49±.09	7.94±.93	71±1
T5	8.33±.27	5.79±.31	37.87±2.5	0.81±.12	5.43±.49	59±2.4

	MGT	PV	S	AS	GE (%)	GV
T1	7.42±.08	2.1	9.48±.32	14.54+.72	70	4.284
T2	7.81±.04	1.73	7.42±.24	10.32±.35	50	2.8718
T3	7.61±.07	1.71	7.76±.32	11.16±.58	65	2.6676
T4	7.65±.06	1.46	6.52±.56	9.18±.91	50	1.9564
T5	8.1±.11	1.2	4.86±.31	6.49±.52	45	1.44

	CGRI	RGR	GD	CRGI
T1	13.4±.39		3.2±.2	13.48±.13
T2	10.63±.35	0.87±.02	4±0	12.78±.07
T3	12.54±.85	0.816±.01	4±0	13.13±.13
T4	11.13±1.11	0.74±.01	4±0	13.04±.10
T5	9.21±.69	0.61±.02	4.6±.24	12.48±.18

*T_1 = Treatment 1, *T_2= Treatment 2, *T_3=Treatment 3, *T_4=Treatment 4, *T_5= Treatment 5

*T50'= Days Required for 50% Germination of total germinated seeds ,*T50= Days Required for 50% Germination of total seeds ,*PI=Percentage Inhibition ,*DI= Delay Index ,*GI= Germination Index,*FGP= Final Germination Percentage ,*MGT= Mean Germination Percentage,*PV=Peak Value ,*S= Speed of Germination,*AS= Accumulated Speed of Germination ,*GE= Germination Energy ,*GV= Germination Value ,*CGRI= Corrected Germination Rate Index ,*RGR= Relative Germination Rate ,*GD=Germination Distribution ,CRG=Coefficient of Rate of Germination

Study showed that an increase in treatment concentration reduced the root fresh and dry weight. At T_5, minimum fresh and dry weight was obtained. In both parameters, T_5 was statistically insignificant from T_4 and the highest reading was obtained in control.

In case of fresh and dry weight of the shoot, the phytotoxicity of aqueous extract inhibited the mean value. Maximum value for both the parameters was obtained in Control while minimum value was recorded in the treatment having the highest concentration of the lead extracts (T_5).

Shoot and Root length both seemed to have been affected by the treatments. Minimum means value of shoot length was recorded in treatment T_5 and it was statistically significant from the rest of the treatments. Similarly, highest mean values for root length was recorded in the control treatment while the minimum value was seen when the treatment concentration was the highest. Percent radical inhibition was seen maximum in T_5 which was significantly lower than all other treatments.

Seedling vigor showed a gradual decrease in value with an increase in the concentration of the treatments. Here, all the treatments were statistically significant from each other with the minimum mean values obtained in the T_5 treatment.

Discussion

This study demonstrates the phytotoxic effects of *C. procera* on the seed germination behavior and growth performance of lentil. The allelopathic effects of *C. procera* leaf extract were found to be dependent on the concentration of the extract. The results indicated that the leaf extract of *Calotropis procera* imposed allelopathic effects on germination of lentil seeds and this inhibition of germination increased with an increase in the concentration of the leaf extract. Hussain & Ilahi (2009) reported that *C. procera* leaf extracts can suppress germination and growth of seeds. A few researchers reported that the inhibition in germination of seeds by *C. procera* leaf extracts might be attributed to water-soluble organic acids (Samreen *et al.,* 2009). Moradshahi *et al.* (2003) reported that higher concentration of *C. procera* leaf extract might suppress seed germination by suppressing the synthesis of such chemical compounds like gibberellins and indole acetic acid.

A significant decrease in the shoot and root length of lentil was observed with an increasing concentration of the *C. procera* leaf extracts. Radicle growth proved more prone to allelopathic effects as compared to the plumule growth. This is possibly due to the fact that radicle comes in direct contact with allelochemicals prior to plumule (Yasin *et al.,* 2012). Seedling vigor also showed a consistent decrease with increasing concentration of the extracts. Oudihia and Tripathi (1999) reported that *C. procera* leaf extracts inhibited the growth and vigor of many crop species. This significant reduction in the seedling length and vigor may be attributed to such chemical compounds present in *C. procera* leaf extracts like those of p-Menthane-3 and 8-trans-diol which readily check cell division and inhibit elongation in shoot and root apex (Moradshahi *et al.*, 2003). These results are quite in line with those reported by Samreen *et al., (*2009) and Hussain & Ilahi, (2009) for phytotoxic effects of different plant species.

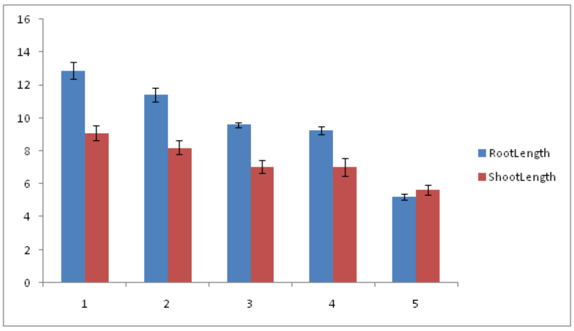

Fig. 1. Effect of *C. procera* leaf extract concentrations on Shoot and Root length.

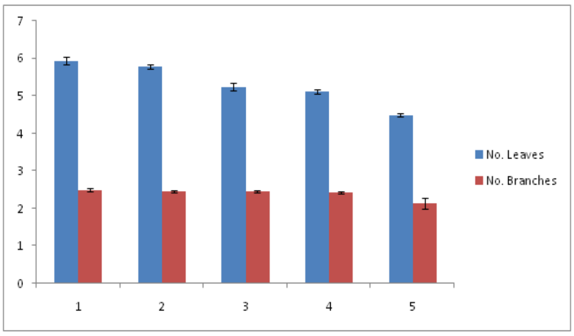

Fig. 2. Effect of *C. procera* leaf extract concentrations on Number of leaves and branches.

At higher concentrations of leaf extracts, a significant reduction in the dry weight of seedlings was observed in this study. The decrease in the moisture content reflects the failure of seedlings to absorb adequate amount of moisture from the soil. Resultantly, a drought like condition prevail which leads to poor growth of seedlings as was shown in this study. Researchers like Yasin *et al* (2012) and Hussain & Ilahi (2009) reported a similar reduction in the moisture content of the seedlings due to phytotoxic effects.

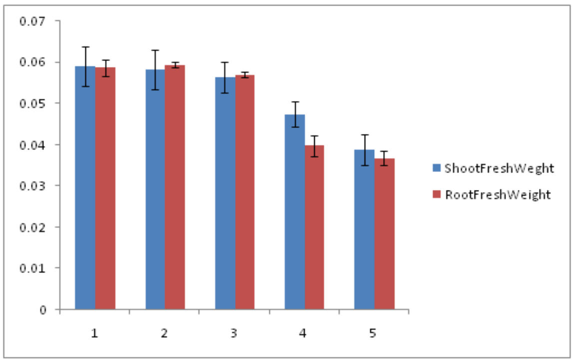

Fig. 3. Effect of *C. procera* leaf extract concentrations on Shoot and Root Fresh Weight.

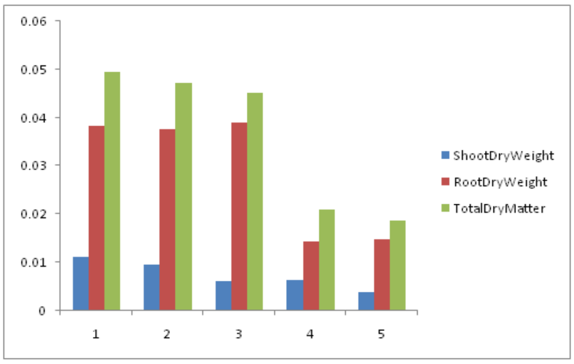

Fig. 4. Effect of *C. procera* leaf extract concentrations on seedling's Dry Matter.

Thus, it may be concluded that *Calotropis procera* can significantly reduce the germination percentage and root/shoot growth commercial crops like lentil. Isolation and subsequent identification of its effects on lentil and on soil properties is needed to strengthen this hypothesis and will be useful for managing lentil crop.

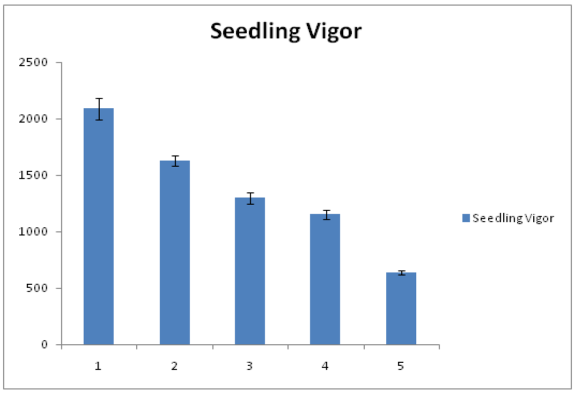

Fig. 5. Effect of *C. procera* leaf extract concentrations on Seedling Vigor.

References

Ahmad SF, Khan TA. 2004. Management of Root-Knot Nematode, Meloidogyne incognita, by integration of Paecilomyces Lilacinus with organic materials in Chilli. Archives of Phytopathology and Plant Protection **37,** 35–40.

Al-Zahrani HS, Al-Robai SA. 2007. Allelopathic effect of Calotropis procera leaves extract on seed germination of some plants. Journal of King Abdulaziz University **19,** 115-126. http://dx.doi.org/10.4197/Sci.19-1.9

Anjum T, Rukhsana B. 2005. Importance of germination indices in interpretation of allelochemical effect on seed germination. International Journal of Agriculture & Biology **7,** 417-419.

Association of Official Seed Analysts. 1990. Rules for testing seeds. Journal of Seed Technology **12,** 1-112.

Batish DR, Lavanya K, Singh HP, Kohli RK. 2007. Raloot mediated allelopathic interference of Nettle-leaved Goosefoot (Chenopodium murale) on wheat (Triticum aestivum). Journal of Agronomy and Crop Science **193,** 37-44. http://dx.doi.org/10.1111/j.1439-037X.2006.00243.x

Begum N, Sharma B, Pandey RV. 2010. Evaluation of insecticidal efficacy of Calotropis procera and Annona squamosa ethanol extracts against Musca domestica. Journal of Biofertilizera and Biopesticidea **1,** 1-6. http://dx.doi.org/10.4172/2155-6202.1000101.

Cheema ZA, Khaliq A, Saeed S. 2004. Weed control in maize (Zea mays L.) through sorghum allelopathy. Journal of Sustainable Agriculture **23,** 73-86.

Dewir YH, El-Mahrouk ME, Naido Y. 2011 Effect of some mechanical and chemical treatments on seed germination of Sabal palmetto and Thrinax morrisii palms. Australian Journal of Crop Science **5,** 248-253.

Einhelling FA. 2002. The physiology of allelochemical action: clues and views. In Reigosa MJ & Pedrol N (eds.) Allelopathy from Molecules to Ecosystem. Science Publishers, Enfield, New Hampshire, USA.

Erman M, Tepe I, Yazlik A, Levent R, Ipek K. 2004. Effect of weed control treatments on weeds, seed yield yield components and nodulation in winter lentil. Weed Research **44,** 305-312.

Hussain F, Ilahi I. 2009. Allelopathic potential of Cenchrus ciliaris L., and Bothriochloa pertusa (L.) A. Journal of Science and Technology **33,** 47-55.

Hussain MA, Mukhtar T, Haque MI, Kiani MZ. 2007. Mycoflora associated with lentil (Lense esculanta Moench) seed from 5 localities of Punjab. Pakistan Journal of Botany **39,** 903-906.

Jalili A, Abbassi F, Bazoobandi M. 2007. Allelopathic influence of canola on germination of five weeds of canola fields. Absts. International Workshop on Allelopathy- current trends and future applications, University of Agriculture, Faisalabad, Pakistan.

Kadioglue I, Yanar Y, Asav U. 2005. Allelopathic effects of weed leachates against seed germination of some plants. Journal of Environmental Biology **26,** 169-173.

Kareem SO, Akpan I, Ojo OP. 2008. Antimicrobial activities of Calotropis procera on selected pathogenic microorganisms. African Journal of Biomediccal sciences **11,** 105-110. http://dx.doi.org/10.4314/ajbr.v11i1.50674

Kayode J. 2004. Allelopathic effect of aqueous extracts of Calotropis procera on germination and seedling growth of maize. Pakistan Journal of Science **47**, 69-72.

Li Y. 2008. Effect of salt stress on seed germination and seedling growth of three salinity plants. Pakistan Journal of Biological Sciences **11,** 1268-1272.

Malaviya P, Sharma A. 2011. Impact of distillery effluent on germination behaviour of Brassica napus L. Journal of Environmental Biology **32,** 91-94.

Manzoor SA, Zubair M, Hussain SB, Mirza SN, Akhtar A, Nouman W. 2013. Evaluation of Allelopathic Effects of Calotropis procera against Triticum aestivum (Wheat) Using Seedling Vigor and Germination Indices. Journal of Biodiversity and Environmental Sciences **3,** 25-30.

Moradshahi A, Ghadiri H, Ebrahimikia F. 2003. Allelopathic effects of crude volatile oil and aqueous extracts of Eucalyptus camaldulensis Dehnh. Leaves on crops and weeds. Allelopathy Journal **12,** 189-195.

Muehlbauer FJ. 2001. Characterization of core collection of lentil germplasm for phenology, morphology, seed and straw yields. Genetic Resources and Crop Evolution **48,** 143-152.

Naseem M, Cheema ZA, Bazmi SA. 2003. Allelopathic effects of sunflower aqueous extracts on germination of wheat and some important wheat weeds. Pakistan Journal of Science and Industrial Research **5,** 71-75.

Nenaah EG, Ahmed ME. 2011. Antimicrobial activity of extracts of Calotropis procera (Ait.) and synergistic effect with reference antimicrobials. Journal of Medicinal Plants **5,** 706-716.

Oudhia P, Tripathi RS. 1999, Allelopathic research on rice seeds in chhattisgarh (India) region:An overview. In: Abstract. National Seminar on Institute Industry Co-operation Programme for Developing Skills in Students of Seed Technology, Govt. Motilal Vigyan Mahavidyalaya, Bhopal (India) 88-89.

Parihar G, Sharma A, Ghule S, Sharma P, Deshmukh P, Srivastava DN. 2011. Anti-inflammatory effect of Calotropis procera root bark extract. Asian Journal of Pharmaceutical Life Science **1,** 29-44.

Qureshi R, Khan WA, Khan B. 2009. Study of vegetation and smooth coated otter in chotiari wetlands complex, sanghar, sindh, pakistan. Pakistan Journal of Botany **41,** 2507-2516.

Samreen U, Hussain F, Sher Z. 2009. Allelopathic potential of Calotropis procera (AIT.) AIT. Pakistan Journal of Plant Sciences **15,** 7-14.

Sastry CST, Kavathekar KY. 1990. Plants for reclamation of wasteland. Publication and Information Directorate, CSIR, New Delhi, 175-179 p.

Schrader JA, Willian RG. 2000. Seed germination and seedling growth of Alnus maritima from its three disjunct populations. Journal of the American Society For Horticultural Science **125,** 128–134.

Singh HP, Batish DR, Shalinder K, Kohli RK, Dogra KS. 2005. Allelopathic interference of Ageratum conyzoides L. against some crop plants. Weed management: balancing people, planet, profit 14th Australian Weeds Conference, Wagga Wagga, New South Wales, Australia, 6-9 September-2004. Papers and proceedings 558-561.

Steel RGD, Torrie JH, Dicky D. 1997. Principles and Procedures of Statistics. Multiple comparison. 3rd Ed. McGraw Hill Book Co., New York, USA, 178-198 p.

Yasin M, Safdar ME, Iqbal Z, Ali A, Jabran K, Tanveer A. 2012. Pakistan Journal of Weed Science **18,** 379-392.