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Early growth of Cotton is affected by increasing concentration of fresh leaves extract of *Calotropis procera*

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Abstract

An experiment was conducted to explore the effects of *C. procera* fresh leaves extract on cotton growth and vigor during seedling and early establishment stage. The trial was carried out in randomized complete block designed (RCBD) with 3 replications and 4 treatments viz., distilled water, 15%, 30% and 45% solution of *Calotropis procera* fresh leaves extracts. Data regarding the cotton seedling vigor and growth was collected and mean value of each trait were statistically compared through HSD Tukey's test ($P \leq 0.05$). The highest shoot length seedling^{-1} (252.25 mm), root length seedling^{-1} (98.33 mm), stem diameter seedling^{-1} (0.35 mm) and dry weight of the shoot seedling^{-1} (0.85 g) was noticed in distilled water treatment. Leaf extract treatments caused significant reduction in seedling vigor and growth. The highest reduction was noticed when treated with 45% aqueous extract of *C. procera*. The above-mentioned treatment caused significant reduction in various seedling traits, which may hinder early establishment of cotton crop. Therefore, the farmers should remove the dense population of *C. procera* around cotton fields to avoid allelopathic effects of weed and to reduce damaging effects on early growing cotton plants.

Keywords: Allelopathy, Growth inhibition, Seedling growth, Sustainable yield

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Introduction

In agricultural crops, weeds are known to cause significant yield losses and may challenge the sustainability of any agriculture system. Weeds may compete with crop species and may take significant proportion of space and exhaust important soil nutrient. Moreover, weeds also release chemical substances called "allelochemicals" which may have inhibitory effects on crops. The threat of the weeds had forced farmers to use pesticides as a possible control measure for weeds. Allelochemicals affects the growth of the neighboring crop plants by releasing the chemicals into the environment by root exudation, foliar application, leaching, volatile emission and decomposition of plant residues (Weir et al., 2004; Field et al., 2006). Phenomenon of such interference is referred as "allelopathy".

Calotropis procera is highly poisonous shrub and a member of the family Asclepidiaceae. This shrub release allelochemicals into the environment as exudates from the roots, stems, leaves or decomposition of plant material in soil (Callaway & Vivanco, 2006). Released allelochemicals are known to affect various growth stages and plant processes such as pigment synthesis, germination of pollen grains, mineral uptake, cell division, production of plant hormones, photosynthesis, respiration, protein synthesis, movement of stomata, nitrogen fixation, membrane permeability and specific enzyme activities (El-Khatib et al., 2004; Villar et al., 2005). Allelopathic potential of weeds and crops have been investigated against different crops (Kato-Noguchi & Tanaka, 2006). *Calotropis procera* milky sap contains toxic calotropin, uscharin, aglycones and calotoxin (Zeng et al., 2008). It also contained secondary metabolites, which were isolated from this plant, including many flavonoids, cardiac glycosides, tri-terpenes and sterols that may help its allelopathic potential of this plant (Hanna et al., 2002).

Allelopathic weeds had higher resistance to biotic stress than crop species and thus may accumulate higher biomass and outgrow the host crop species. Moreover, allelochemicals may induce antixenosis type of insect resistance, which significantly decrease insect infestation, diseases and improves the yield of the crop (Farooq et al., 2013). In the rhizosphere, growth of the roots was extremely subjected to the allelochemicals (Baziramakenga et al., 1995) and root tissues are highly permeable than the shoot tissues. It also damaged the root metabolic activities and division of cells in the tips of roots (Nishida et al., 2005). In different crops, allelopathic potential of many crop plants and weeds have been investigated (Kato-Noguchi & Tanaka, 2006). Reduction in dry weight of cotton has been observed due to the phyto-toxic effect of protease present in *C. procera* extract (Singh et al., 2010). Shoot dry biomass of *Zea mays* may also be reduced due to eucalyptus extracts (Singh et al., 2010). In brassica crop, all parts of the *C. procera* extract have significant effect on root length, shoot length, shoot dry weight, chlorophyll content and relative water content of the crop (Gulzar and Siddiqui, 2017).

C. procera plants are abundantly present among roads, water channels, bodies of fields and grounds. This plant is also quite abundant in cotton fields. During the rainy season, its growth increases significantly which may result in leaves leachates which enters in soil near cotton plants. The literature on the effect of *C. procera* leaves extract on cotton early growth has been limited. Hence, the present study was aimed at evaluating the allelopathic effects of *C. procera* leaves extracts and growth of cotton.

Materials and methods

C. procera insect and disease-free plants were collected from the site of MNS-University of Agriculture, Multan. The collected plant material of *C. procera* were washed thoroughly by distilled water. Samples were crushed in liquid nitrogen with a mortar to grind into fine powder. Powdered material was added into 100 ml distilled water according to the treatments. Muslin cloth were used to filter the extract. Concentrations of 15%, 30%, and 45% *C. procera* fresh leaves were prepared from the powder as per treatment including control having only distilled water.

Cotton seed of variety FH-142 was sown in glass jars having 5 cm × 12.5 cm (D × H). Each jar was filled with field soil containing 30% sand and 10% farm yard manure. Three seeds were sown in each jar which were thinned to single seedling upon germination and subsequent emergence. There were 3 replications for each treatment. Experiment was conducted at 27 ± 2 °C under 16 hours photoperiod and humidity was maintained at 60%. 2 ml of each concentration was sprayed over each seedling after every 72 hours till experiment was terminated after 15 days.

Soil mass was removed from jars and roots were carefully washed with distill water to remove the soil and dirt. Roots and seedlings were cleaned with paper towels and mass was determined over analytical balance and values were determined in milligrams while root and shoot length (mm) of cotton seedlings was measured with the help of scale. Shoot and root biomass was placed in an oven for 48 hours at 60ºC to get constant dry weight seedling^{-1}.

Results and Discussions

The highest root length seedling^{-1} was observed in distilled water treated Jars (98.33 mm) followed by Jars where 15% fresh leaf extract of *C. procera* was applied (93.59 mm). Whereas, the lowest in 45% fresh leaf extract (76.66 mm). Results indicated that root grew normally under control treatment (Fig 1).

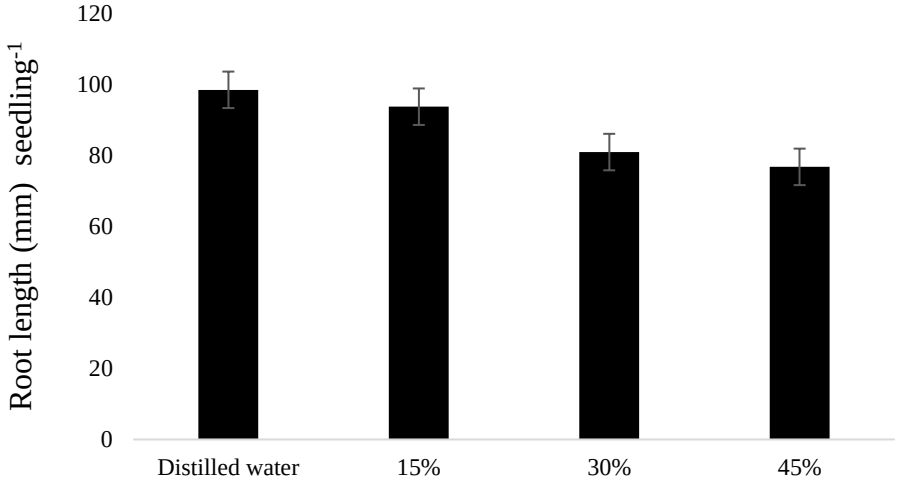

Fig. 1. Root length per seedling of cotton (mm) as affected by *C. procera* fresh leaves extract concentration of 0%, 15%, 30% and 45%

Low root length of the cotton seedlings showed the inhibition of root growth due to allelopathic effect of the *C. procera* leaves extract. Increased concentration of *C. procera* leaves extract considerably reduced the root length of cotton seedlings when compared with control plants. Earlier findings also showed that all parts of the *C. procera* extract had significant effect on root length (Gulzar and Siddiqui (2017). Allelopathic effects of *C. procera* extracts was not species species and were observed in diverse genera such as grasses, where roots were among the major target of allelochemicals released by this noxious weed (Al-Zahrani & Al-Robai, 2007).

The highest shoot length seedling^{-1} of cotton was recorded in distilled water treated jars (252.32 mm), whereas the lowest (203.17 mm) was recorded when 45% aqueous solution of fresh leaf extract of *C. procera* was applied on cotton seedling (Fig 2). Increasing the concentration of *C. procrea* becomes highly toxic to the shoot length of cotton seedling. Reduction in shoot length of cotton seedlings could be owed to allelochemicals present in *C. procera* fresh leaf extract. (Gulzar and Siddiqui, 2017. The reduction in shoot length of wheat crop was noticed due to the effect of different concentrations of *C. procera* extracts (Al-Zahrani & Al-Robai, 2007).

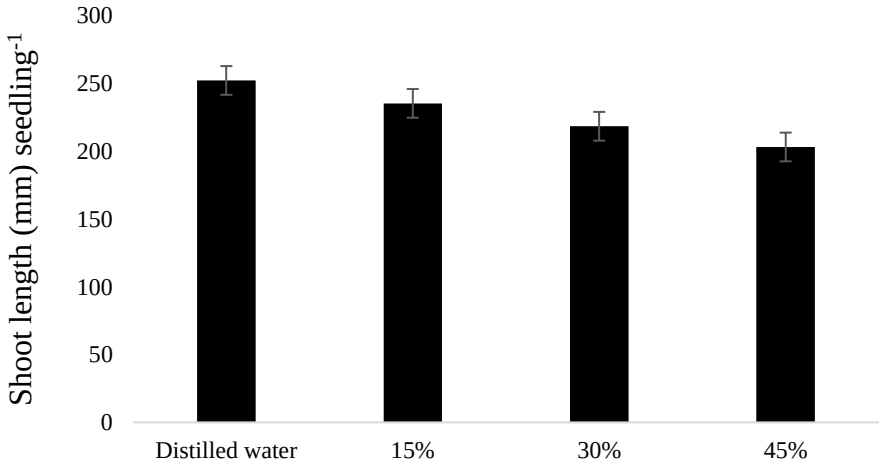

Fig. 2. Shoot length seedling^{-1} of cotton (mm) as affected by aqueous *C. procera* fresh leaves extract concentration of 0%, 15%, 30% and 45%

The highest shoot diameter was noticed in distill water treated jars (0.35 mm) and the lowest was observed when 45% fresh leaf extract applied jars (0.27 mm). Differences in shoot diameter of cotton seedlings was found with increasing concentration of *C. procera* fresh leaf extract (Fig. 3). At early stage, cotton seedlings were highly susceptible to the allelochemicals. Increased concentrations of *C. procera* are highly toxic in reducing the shoot diameter over the distilled water treatment (Al-Rowaily et al., 2020). Essential of oil from leaves of *C. procera* were extracted through hydro distillation from eotypes in Saudi arabia and Egypt which caused significant antimicrobial and allelopthic effects against two weeds (Al-Rowaily et al., 2020). GC-MS analyses showed that essential oil

obtained from the *C. procera* contained high concentration of sesquiterpenes and diterpenes (Al-Rowaily et al., 2020).

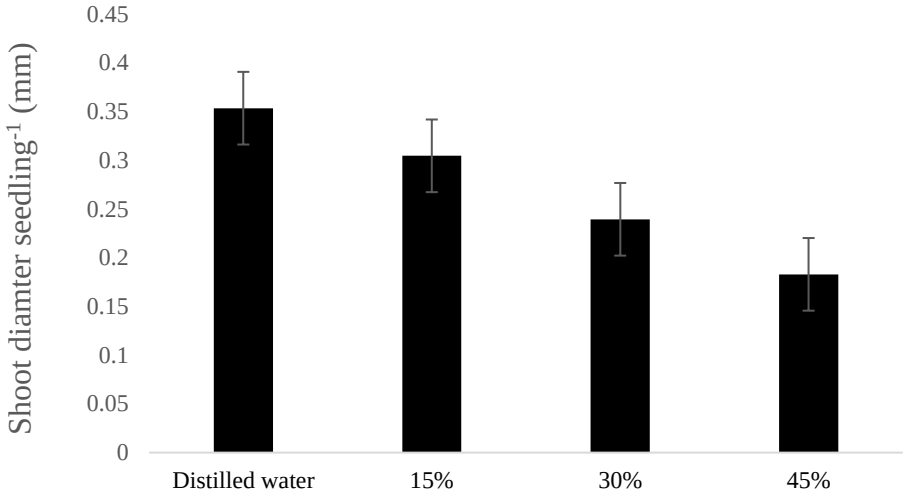

Fig. 3. Shoot diameter per seedling of cotton (mm) as affected by *C. procera* fresh leaves extract concentration of 0%, 15%, 30% and 45%

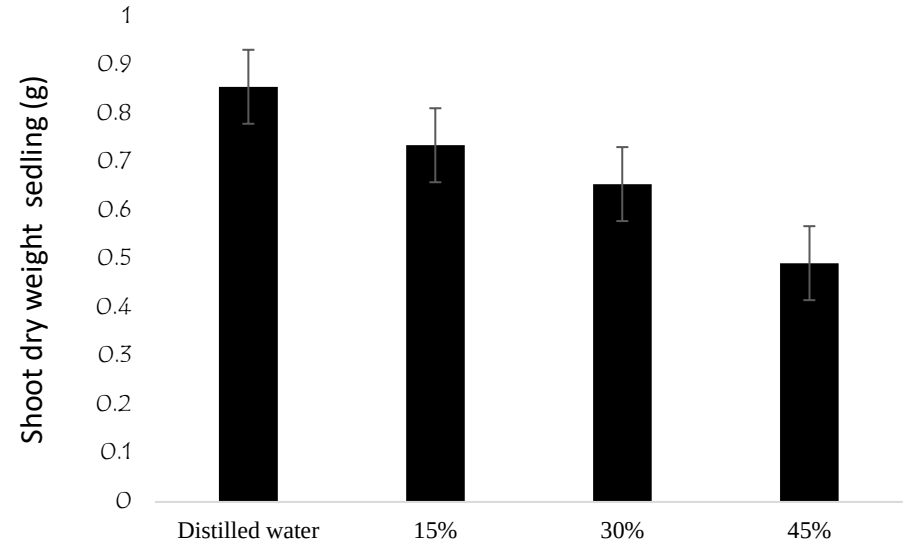

Fig. 4. Shoot dry weight seedling^{-1} of cotton (g) as affected by *C. procera* aqueous fresh leaves extract concentration of 0%, 15%, 30% and 45%

The highest shoot dry mass seedling^{-1} of cotton was noticed in the jars where distilled water was given throughout the experiment period (0.85 g) and the lowest in 45 % fresh leaf extract applied in the jars (0.49 g) (Fig. 4). *C. procera* leaves extract likely contains several alkaloids which might be responsible to restrain the growth of cotton (Khan & Baloch, 1999; Hanna et al., 2002; Yarnia et al., 2009; Singh et al., 2010).

Conclusion

Calotropis procera fresh leaves likely possess allelopathic compounds which inhibit the seedling growth of cotton. Furthermore, it was observed that with increased concentration of fresh leaves aqueous extracts; the cotton seedling growth was gradually decreased. In arid and semi-arid areas, during summer monsoon rains there are likely chances of leaching of allelochemicals from *C. procera* affecting the early growth of nearby cotton seedlings. Hence farmers should be vigilant and remove *C. procera* plants from and around vicinity of cotton fields. However further research on reduced concentration of fresh leaves extracts of *C. procera* and quantification of its allelochemicals is needed.

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