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Phytotoxic Effect Of Cyanodon Dactylon (L.) Pers. and Cyperus Rotundus L. On Growth And Biochemical Changes of Vigna Radiata (L.)R. Wilczek

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Abstract

This study is based on the phytotoxic effect of aqueous extracts of the weed Cyanodondactylon (L.) Pers. and Cyperus rotundus L. on seed germination, early seedling performance and pigment profile of Vigna radiata (L.) R. Wilczek.. The different concentrations (5g/l, 10g/l, 20g/l, 30g/l, and 40g/l) of aqueous extracts of C.dactylon and C.rotundus were employed to investigate their influence on the seedling physiology of green gram. The aqueous whole plant extracts (from 10g/l to 40g/l concentrations) of C.dactylon and C.rotundus exhibited an inhibitory effect on germination percentage, root length, shoot length, vigour index, pigments, proteins, carbohydrates, and amino acid contents of V. radiata over control. The extracts of both weeds caused a stimulatory effect on green gram seedlings at 5g/l concentrations and the intensity of inhibition increased when the extract concentrations were increased. The photosynthetic pigments such as chl-a, chl-b and total chlorophyll exhibited significant reduction while carotenoid content was increased in all treatments compared to control. The aqueous extracts of C.rotundus showed more inhibition on green gram seedlings than C.dactylon. All treatments significantly reduced the Physiological activities of the pulse crop. All treatments significantly reduced the Physiological activities of the pulse crop, and the results suggest that the aqueous extractives from the bioparts of C.dactylon and C.rotundus were phytotoxic to the green gram seedlings.

Key words: Allelopathy, seed germination, Cyanodondactylon, Cyperus rotundus. Vigna radiata.

1. Introduction

Allelopathy is an important mechanism of plant interference mediated by the addition of plant – produced secondary products to the environment. Some interactions of plants with other organisms and environmental factors are mediated by secondary metabolites, which are plant-specific and had been evolved by the effects of natural selection during the adaptation of the plant to corresponding interactions (Shirley, 1996). Plants have developed several mechanisms to survive biotic and abiotic stress factors. One of these mechanisms is chemical defense, which is based on many secondary metabolites that plants

synthesize and accumulate in their organs. These compounds, called allelochemicals, are responsible for both harmful and beneficial biochemical interactions between plants and other organisms, including bacteria, yeasts, insects, and mammals. Weeds are undesirable plants that compete with main crops in the growth media for nutrients, moisture, space, light, and hamper the healthy growth, ultimately reducing the growth and yield both qualitatively and quantitatively. Alam et al. (1990) reported that weeds are known to exhibit allelopathy by releasing water-soluble allelochemicals from leaves, stems, roots, rhizomes, flowers, fruits, and seeds. Weeds that

compete with main crop plants for nutrients and environmental variables typically appear to be toxic to the plants' germination and seedling growth. Kato-Noguchi et al. (2002) studied various weeds allelopathic potential in the laboratory. Batishet *al.* (2007b) conducted an experiment using the residue of *Chenopodium murale* on chickpea's growth and found that their root and shoot length significantly decreased. The phytotoxic effects can be attributed either to allelochemicals present in the plant or weed residues or microbial toxins produced during decomposition (Rice, 1984). Allelopathy is an important mechanism of plant interference by the addition of plant-produced phytotoxins to the plant environment. Many of the phytotoxic substances suspected of causing germination and growth inhibition have been identified from plant tissues and soil. Plants produce a large variety of secondary metabolites like phenols, tannins, terpenoids, alkaloids, polyacetylenes, fatty acids, and steroids, which have an allelopathic effect growth and development of the same plant or neighboring plants. One of the most worked out aspects of allelopathy is manipulated in ecosystems is its role in agriculture. Some of the toxic effects of decomposition products on plants are inhibition of seed germination, stunted growth, inhibition of the primary root system and increase in secondary roots, inadequate nutrient absorption, chlorosis, slow maturation, and delay of failure or reproduction (Patrick and Koch, 1958; Patrick et al., 1964). Quayyamet *al.* (2000) reported that the *Cyperus rotundus* aqueous extracts and leachate of leaves and tubers significantly reduced rice germination and seedling growth.

Vigna radiata (L.) is an annual Pulse crop in the family Leguminaceae, which is grown widely in Asia. It is a small herbaceous annual plant growing to a height of 30 to 120cm with a slight tendency to twining in the upper branches. The central stems are more or less erect with side branches that are semi-erect. The leaves are 5-10 cm long trifoliate with long petioles. Both the stems and leaves are covered with short hairs, generally shorter than those in black gram. The pods are linear, sometimes curved, round and slender with short pubescence. The seeds are small and nearly globular. The color of the seed is usually green, but yellow-brown or purple brown

seeds also occur. The color of the cotyledons is yellow. The crop is fully self-fertile and self pollinated. Green gram is a protein rich staple food. It contains about 25 % protein, which is almost three times that of cereals. It supplies the protein requirement of vegetarian population of the country. It is consumed in the form of spilt pulse and whole pulse, which is an essential supplement of cereal based crops. In addition to being an important source of human food and animal feed. Green gram also plays a vital role in sustaining soil fertility by improving soil physical properties and fixing atmospheric nitrogen. It is a drought resistant crop and suitable for dryland farming and predominantly used as an intercrop with other crops. The weeds are causing inhibition on germination and growth crops and reducing the yield of the desirable crops by releasing allelochemicals from the dead or live weeds. Hence the present investigation has been made to determine the allelopathic effect of two weed species. *C.dactylon* and *C.rotundus* in green gram. The main purpose of this study was to assess the phytotoxic activity of the two weed species of *C.dactylon* and *C.rotundus* on green gram cultivars by laboratory study.

2. Materials and Methods

The weed plants, *C.dactylon* and *C.rotundus* were collected from the crop fields freshly for the experimental study, whenever needed. The entire plants (root and shoot parts) are used for the preparation of extracts. The whole plant extracts were employed to study their effect on the germination and seedling growth of *V. radiata*. The seeds cv. were procured from Tamil Nadu Agricultural University, Coimbatore. Seeds with uniform size, colour and weight were selected and stored in metal tins. All the experiments were conducted in the Department of Botany, Rani Anna Government college for women.

2.1 Preparation of aqueous extract

Fresh plants of two weeds were washed thoroughly and cut into small pieces and were allowed to dry under shade for 20-25 days then made it to fine powder. 100g of powder was soaked in 1 litre distilled water and kept 48 hours at room temperature with occasional shaking. The infusion was decanted and filtered through three layers of Whatman No.1 filter paper. From this (100g/l), different concentrations (5, 10, 20, 30 and 40g/l)

were prepared using distilled water for further studies.

2.2 Germination study

The seeds of green grams were steeped in water to determine their viability those that floated were discarded. The viable seeds were sterilized for two minutes in 0.2% mercuric chloride (HgCl₂) solution. The seeds were then thoroughly washed with tap water. The seeds were arranged in sterilized Petri dishes of 10 cm diameter lined with filter paper. Each petri dish was moistened uniformly by different weed extracts concentrations, and the distilled water was used as control. The Petri dishes were covered and kept at room temperature (30°±2°) and were opened periodically for proper aeration. Germination percentage was recorded on 5th day while root and shoot length, Biomass, vigour index and pigment contents were recorded on 10th day after treatment. All measurements were made on samples drawn replicated five times. The obtained data were statistically (ANOVA) analysed to find out the significance (P < 0.5% level) of the treatments on crops.

3. Results and Discussions

Weed species, *C.dactylon* and *C.rotundus* tested for their allelopathic potential on germination and seedling green gram growth by applying weed extracts. Aqueous extracts of *C.dactylon* and *C.rotundus* caused a significant inhibition of the germination of the green gram over control (Table-1). The intensity of inhibition differed depending upon the type of extracts. *C.dactylon* extracts stimulated the seed germination only at 5 g/l concentrations but in their higher concentrations (10, 20, 30 and 40g/l) there was an inhibitory effect over control. All the concentrations of *C.rotundus* extracts showed retarding effects on germination percentage of green gram seeds. More inhibition was observed in green gram crops when treated with *C.rotundus* extract treatments. Different workers observed similar inhibition of seed germination by weed extract. The inhibitory effects of *Ipomeacarne* spp. *Fistulosa*, *Cyperus rotundus*, *Cynodondactylon*, *Echinochloacolonum*, *Portulaca oleracea* and *Lagascamollis*. on sorghum, wheat, kidney bean, rice, onion and radish (Jadhav et al., 1997; Challa and Ravindra, 1998).

The study of Bendall (1975) showed that the root

extract of Canada thistle inhibited *Trifolium subterraneum* seed germination by 87%. These studies support the present findings. The *C. rotundus* weed extract treatment showed greater inhibition on seed germination of green gram. Number of workers has reported similar inhibition on seed germination by weed extract treatment. The inhibitory effect of stem extract of *Polygonum orientale* on the germination of mustard, lettuce, rice and pea was reported by Datta and Chatterjee (1978,1980). Qasem . (1995) found that the inhibitory effect *Amaranthus retroflesus*, *Asclepiassyriaea*, *Chrysanthemum vulgare* and *Datura stramonium* exhibited on cabbage, carrot, eggplant, pepper, sunflower and soyabean (Beres and Kazincz., 2000). Saxena and Varshney .(1995) also reported that the shoot extract of *Cyperus rotundus* stimulated seed germination in pea and chickpea. These results favour the present findings. The reason for the inhibitory effects of weed on green gram may be due to higher amounts of growth inhibitory substances in the extracts. The study of Tripathi et al. (1998) revealed that the leaf extracts of *Tectona grandis*, *Albizia procera* and *Acacia nilotica* stimulated germination in soya bean.

Table -1. Allelopathic influence of *Cyanodondactylon* and *Cyperusrotundus* extracts on germination (%) of *Vignaradiata*

	<i>Cyanodondactylon</i>	<i>Cyperus rotundus</i>
control	98	96
5	100 (2.0)	98 (2.0)
10	89 (-9.1)	84 (-12.5)
20	74 (-24.4)	65 (-32.3)
30	58 (-40.8)	39 (-59.3)
40	33 (-66.3)	17 (-82.3)

Data in parentheses indicate % increase/decrease over control.

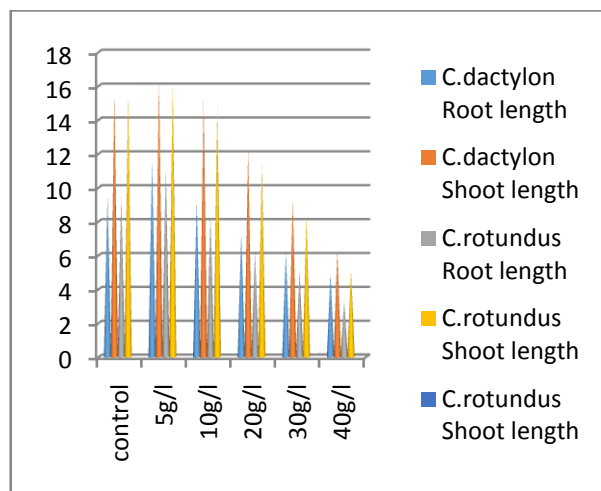


Fig-1 Allelopathic Influence of *C. dactylon* and *C. rotundus* extracts on root length(cm/seedling), shoot length(cm/seedling) and dry weight (mg/seedling) of *Vigna radiate*.

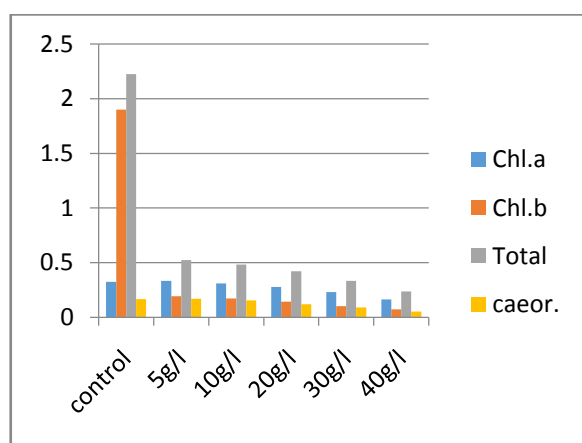


Fig: 2 Allelopathic Influence of *C. dactylon* extracts on Chl.a (mg/g fr.wt.), Chl.b (mg/g fr.wt.), Total chlorophyll (mg/g fr.wt.) and Carotenoid (mg/g fr.wt.) contents of green gram

The aqueous extracts of *C. dactylon* and *C. rotundus* stimulated the seedlings length in their lower concentrations, but increasing the concentration the shoot and root length was reduced. All the concentrations of *C. rotundus* showed adverse effects on the growth of green gram seedlings (Fig-2). *C. rotundus* caused more retardation on root growth than shoot growth. Pandeet *al.* (1998) reported that the aqueous extract of aerial parts of *Prunus amygdalus* inhibited the root and shoot length of wheat and finger millet. Patil (1994) reported that the leaf

extracts of *Glyricidia maculate* inhibited the seedling growth of rice, sorghum, green gram. Joshi *et al.* (1996) found that the leaf extract of *Faxinusmicranta* inhibited root and shoot length of *Raphanus sativa*, *Eleusine corcana*, *Trictumaestivum* and *Brassica campestris*. Afzal *et al.* (2000) reported that the seedling growth and biomass production of *Vigna radiata* and *Phaseolus vulgaris* were significantly reduced by aqueous shoot extract of *Imperata cylindrical*. The study of Lovett and Sagar (1978) noticed that the aqueous leaf extracts of *Camellina sativa* stimulated the growth of radicals of flax seedlings. Similarly the study of Tripathi *et al.* (1998) showed that the leaf extracts of *Albizia procera*, *Tectona grandis* and *Acacia nilotica* stimulated root and shoot length in soybean. Maqbool *et al.* (2012), reported that low concentrations of allelopathic water extracts as seed treatment before sowing or planting can improve germination percentage, germination power, germination index, radical length, plumule length, fresh weight and dry weight of plants. These studies conform to the present findings.

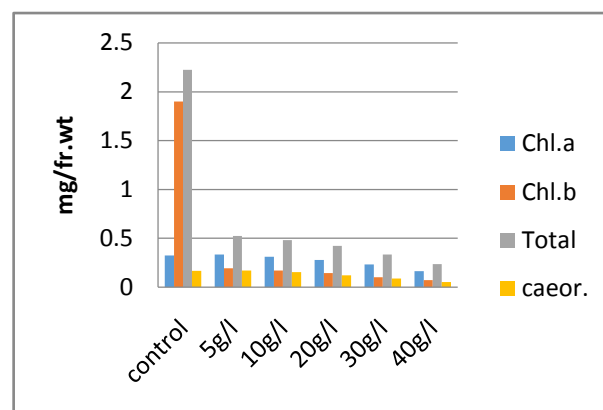


Fig: 3 Allelopathic Influence of *C. rotundus* extracts on Chl.a (mg/g fr.wt.), Chl.b (mg/g fr.wt.), Total chlorophyll (mg/g fr.wt.) and Carotenoid (mg/g fr.wt.) contents of green gram

The photosynthetic pigments (Fig -2 & 3) exhibited significant reduction compared to control in green gram crops due to the allelopathic influence of *C. dactylon* and *C. rotundus* weeds. Chlorophyll estimation is an indicator of biomass and the reduction in the pigment level in the test crops indirectly indicate retardation in

photosynthetic activity. In the present investigation Chl.a, chl.a, and total chlorophyll contents were highly affected by the *C. rotundus* in green gram seedlings while carotenoids content were found to be increased from lower to higher concentration in all treatments. Between Chl.a and Chl.b, the inhibition was more in Chl.b than Chl.a in the test crops which indicates its susceptibility to stress (Djanaguiraman *et al.*, 2003). Singh *et al.* (2009) reported that the allelochemicals have an immense role in reducing photosynthetic pigments. Yang *et al.* (2004) found that the chlorophyll degradation may be due to the lowering of biosynthesis of chlorophyll molecules. Carotenoids serve as antioxidants against free radicals and photochemical damage (Mishra *et al.*, 2006). The allelopathic treatments can be attributed to its antioxidant property and protective role for photosynthetic membrane under the stress conditions (Omidpanah *et al.*, 2011). These studies strongly support the present findings.

Aqueous extracts of *C.dactylon* and *C.rotundus* decreased in the biochemical contents of rice over control (Fig -4 & 5). *C.rotundus* weed extract showed more inhibitory effect than *C.dactylon* weed extract. Only at 2% extract concentration treatment of test crop showed the stimulatory effect on the starch, protein, Amino acid and catalase contents of the test crop over control. *C.rotundus* weed extracts showed less inhibitory effect in catalase and Amino acid contents in green gram than *C.dactylon* weed extract treatment on crops. Prasad *et al.* (1999) reported that extracts of *Rhamnus virgatus* significantly decreased the sugar and starch content in *Triticum aestivum*, *Eleusine coracana*, *Lens culinaris* and *Phaseolus mungo*. Bansal, (1997) noticed that the aqueous extracts of *Ranunculus arvensis* linearly decreased the protein content. The rhizome and soil extract of *Dendroclamus strictus* increased the groundnut seedlings' protein content in the lower concentrations (Tripathi *et al.*, 1998).

The decreasing of biochemical contents may be due to the action of allelochemicals which is present in the weeds. The allelochemicals are 1,8-cineole, 4 α -5 β -oxidocoumarins, alkaloids, α -cyperone, β -selinene, Calcium, Camphene, Copaene, Cyperol, Cyperolone, D-fructose, D-glucose, Limonene, Linoleic acid, Magnesium, Pectin, Sugeonol, Rotundone, Selinatriene,

Sitosterol, Stearic acid etc. A wide variety of phytoprinciples have been isolated from *C. viscos* (Mali, 2010). All basic plant processes such as hormonal balance, protein synthesis, respiration, photosynthesis, chlorophyll formation, permeability and plant water relations may be disturbed by allelopathy (Yamana *et al.*, 1992). The statistical analysis of all the parameters tested in the present investigation showed the significance of these two weed species on germination, growth and biochemical constituents of green gram seedlings.

Blum and Gerig. (2006) reported that the adsorption processes and polymerization of allelochemical compounds can change their phytotoxic effect, generally reducing their activity. Fageria *et al.* (2006) found that the Phytotoxic effects depend not only on the production and release of different metabolites by the plants, but also on the activity of the soil microbes on these compounds, which can inhibit or stimulate some plants, microorganisms and also small animals, but can also regulate the function of these compounds or change their concentrations.

Conclusion

The differential degree of an inhibitory effect of two weed extracts on germination and seedling growth of green gram may be due to various inhibitory allelochemicals at different concentrations in weed organs *C.dactylon* and *C. rotundus* in the present study. The phytotoxicity of allelochemicals present in the weed extracts might be caused synergistic activity on the growth and biochemical changes of green gram seedlings. The phytotoxic compounds interfere with the metabolic process that can trigger oxidative damage in leaves and caused phytotoxic effect on green gram seedlings. The two weed species were potentially harmful to crop species by releasing toxic chemicals from their aqueous extracts. Allelopathy has a crucial role in future weed and pest management strategies. The stimulatory activity of the weed extract in most of the parameters at lower concentrations warrants. Future studies are required to determine the nature of compounds released during the various phases of weeds decomposition with major bioactivity on seeds, weeds and crops.

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