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Research Article

ALLELOPATHY POTENTIAL OF INVASIVE ALIEN SPECIES *AGERATUM CONYZOIDES* L. ON GROWTH AND DEVELOPMENTAL RESPONSES OF GREEN GRAM (*VIGNA RADIATA* (L.) R. WILCZEK) AND BLACK GRAM (*VIGNA MUNGO* (L.) HEPPER).

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ABSTRACT

An experiment was conducted to evaluate the allelopathic potential of aqueous extracts of *Ageratum conyzoides* L. on the germination and seedling growth of green gram and black gram. It was noted that various concentrations of whole plant extracts (5, 10, 15 and 20g/L^{-1}) of *A. conyzoides* gradually reduced the germination (%), seedling length, dry weight, photosynthetic pigments, protein, amino acid contents of green gram and black gram. The inhibitory effects were concentration dependant. Further, the results revealed that the extract of *A. conyzoides* had more adverse affects on the growth of green gram than black gram.

Key words: Allelopathic potential, *Ageratum conyzoides*, black gram and green gram.

INTRODUCTION

Allelopathy is an important mechanism of plant interference by the addition of plant-produced phytotoxins to the environment. Many of the phytotoxic substance suspected of causing germination and growth inhibition have been identified from plant tissues and soil, these substance are termed allelochemics or allelochemicals[1]. Commonly plants produce a large variety of secondary metabolites like phenol, tannins, terpenoids, alkaloids, polyacetylene, fatty acids, steroids, which have an allelopathic effect on the growth and development of the same plant or neighboring plants. Considerable knowledge has been obtained concerning the chemicals involved in allelopathy[2].

Ageratum conyzoides L. is one of the well known invasive species, belonging to astraceae family, originated from Central America. *Ageratum* was derived from the Greek words 'a geras', meaning non-aging, referring to the longevity of the whole plant and *conyzoides* derived from 'konyz' the Greek name of *Inula helenium* which, the plant resembles[3]. It has a particular odor likened in that of a male goat and hence its name 'goat weed' or billy goat weed'[4]. It is usually found in waste places, rice fields, gardens, low secondary growth forests, forest-edges, roadsides, water courses etc., where there is ample exposure to sunlight[5]. *A. conyzoides* is a weed in many annual and perennial crops and has been reported as host of many crop diseases[6]. Weeds interfere with growth and production of crops and therefore exert significant ecological and economic impacts[7,8]. Rice yield in Asia has been negatively associated with *A. conyzoides* density[9]. Some studies have demonstrated allelopathy in the weed; however, shoot competition for light appears to be a major mode of interference in crops[6]. Hence, the present investigation has been aimed to evaluate the allelopathic potential of *A. con-*

yzoides on growth and development of two pulses i.e. black gram ***(****Vigna mungo* (L.) Hepper) and green gram (*Vigna radiata* (L.) R. Wilczek).

MATERIALS AND METHODS

Experiments were carried out during April to August-2013 at Department of Botany and Botany Wing-DDE, Annamalai University, Annamalai Nagar, Tamil Nadu, India. Whole plants of *A. conyzoides* were collected from post harvest paddy fields in the premises of Faculty of Agriculture, Annamalai University and the collected plant samples thoroughly rinsed under the tap water by 2 to 3 times followed by 0.1% Mercuric Chloride ($HgCl_2$) for maximum sterilization. Thereafter, plants were made into small pieces and dried under shade for 20 days then crushed with ordinary grinder until a powder form is formed. The weed powder at the quantity of 0 (T_0) 5(T_1), 10 (T_2), 15 (T_3), and 20 (T_4) g/L^{-1} with normal tap water was allowed for 48 hours in room temperature then filtered by muslin cloth and filtrate was used in the experiment.

The seeds of black gram (*Vigna mungo* (L.) Hepper) cv. ADT-3 and green gram (*Vigna radiata* (L.) R. Wilczek) cv. CO-3, were procured from Tamil Nadu Agriculture University, Coimbatore, Tamil Nadu. Seeds with uniform size, colour and weight were selected and stored in metal tins as suggested by Rao et al.,[10].Viability of seeds were analyzed by water soaking method.

The experiment was carried out using earthen pots (30cm x 18cm) filled with 6 kg of soil mixture (sand: red soil: cow dunk=2:2:1: w/w) and the seeds were sown. Each pot was irrigated uniformly with different concentrations of weed extracts and the normal tap water was used as control. The experiments were carried out with five replicates and the extracts/water was irrigated to the pots in alternative day's up to 15th day from the day of seed sown. Germination percentage was recorded up to 7th day of both the crops. The growth parameters (seedling length, fresh and dry weight) and bio chemical constituents such as chlorophyll[11], amino acids[12] and proteins[13], were analyzed on 15th DAS. Obtained data were analyzed for its significance using Analysis of Variance (ANOVA), followed by Tukey's Multiple Range Test (TMRT) at $P<0.5\%$ level.

RESULTS AND DISCUSSION

Aqueous extracts of *A. conyzoides* showed inhibitory effects on seed germination percentage, root and shoot length, fresh and dry weight of both the test crops compared with their respective control set (table-1 and fig.1). The degree of inhibition was increased with increasing the extract concentrations. The higher concentration (T_4) showed significant inhibitory effects on all growth parameters of both the crops. The maximum reduction on germination percentage, seedling length and biomass production was noticed in green gram than black gram. The study of Regila and Vijayakumar,[14] supports the present findings that aqueous leaf extract of *Jatropha curcas* inhibit the growth of *Capsicum annum*. Duhan and Lakshminarayanan[15] noticed that allelopathic activity depended on the concentration of the extracts, target species and the plant tissues from which the chemicals were extracted. Increasing inhibitory rates with increasing concentration was in accordance with previous reports.[16,17] There is much evidence that *A. conyzoides* inhibits germination and growth of other plants through chemicals produced by its root and shoot systems. Fresh leaves and volatile oils of *A. conyzoides* inhibited the seedling growth of various crops[18] including peanut, redroot amaranth, cucumber and ryegrass. Kong *et al*.,[19] reported that the shoot extracts of *A. conyzoides* inhibited germination of *Amaranthus caudatus*, *Digitaria sanguinalis* and *Lactuca sativa*. Extracts of *A. conyzoides* reduced the germination of wheat and rice seeds [20, 21]. The phenolics present in leaf extracts and residues of *A. conyzoides* negatively interfere with the growth and development of wheat [22]. Root and shoot length and biomass accumulation of rice are significantly reduced by 18 to 30% when grown in the rhizosphere soil of *A. conyzoides*[23]. *A. conyzoides* causes reduction in growth and nodulation of chickpea (*Cicer arietinum*) [24].

The results showed that the percentage of inhibition on the total chlorophyll, proteins and amino acid contents of both test crops increased with increasing the extract concentrations of *A. conyzoides* (tables, 2&3). Similar findings were made by Padhy *et al.,* [25] in which, the reduction of chlorophyll pigments in rice seedlings was caused by leachates of *Ageratina adenophora*.

Phytotoxic effects may be caused by more than one chemical component present in the organ and the crop species react differently to these compounds and the inhibition might have been presence of allelochemicals in the plant extracts. Allelopathic agents may act in many ways directly and indirectly to modify plant growth. They may inhibit cell division, cell elongation, inhibit hormonal relations, modify mineral uptake, retard photosynthesis, inhibit protein synthesis, change permeability of membranes, inhibit specific enzymes, affect respiration and stomatal opening [26,27]. Membrane plays as key role in the ability of a plant cell to withstand stress of plants. Allelochemicals can damage cell membrane through direct interact with its constituent or an impairment of some

metabolic function necessary to the maintenance of membrane function[28].

Allelopathic inhibition is complex and can involve the interaction of different classes of chemicals like flavonoids, chromenes, benzofurans and terpenoids, carbohydrates, and amino acids, with mixtures of different compounds sometimes having a greater allelopathic effect than individual compounds alone[26]. *A.conyzoides* possessing the wide range of secondary metabolites including flavonoids, chromenes, benzofurans, terpenoids, Ageratochromene-dimer, B-caryophyllene and caffeic acid. Among these secondary metabolites, some are allelochemicals inhibiting the growth of other organisms[4,29]. The weed *A. conyzoides* may release these allelochemicals into the soil, which chemically arrest the primary bio chemical process of during seed germination and create an environmental stress on growth of pulse crop seedlings.

CONCLUSION

A.conyzoides exhibited strong growth suppressing allelopathic effect on germination and growth of black gram and green gram. Further the experimental data revealed that the higher degree of growth suppression caused by *A. conyzoides* on green gram rather than black gram. However, phytochemical profiles of *A. conyzoides* and their specific role on crop growth and soil health under field conditions are to be studied for understanding the mechanisms of their allelopathic potential in detail.

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Table-1
Allelopathic potential of *A. conyzoides L.* on germination percentage, shoot length, root length (cm/plant) and total fresh and dry weight (g/plant) of *V. mungo* and *V. radiata.*

Extract Concentrations	*V.mungo*					*V. radiate*				
	Germination %	Shoot length	Root length	Total fr.wt.	Total dry wt.	Germination %	Shoot length	Root length	Total fr.wt.	Total dry wt.
T0	91[a]	9.23[a]	6.67[a]	0.172[a]	0.094[a]	96[a]	11.52[a]	7.74[a]	0.216[a]	0.121[a]
T1	82[b] (-9.89)	7.83[b] (-15.16)	5.27[b] (-20.98)	0.147[b] (-14.53)	0.073[b] (-22.34)	86[b] (-10.41)	10.12[b] (-12.15)	6.31[b] (-18.47)	0.204[a] (-5.55)	0.103[b] (-14.87)
T2	76[c] (-16.48)	6.49[c] (-29.68)	4.85[c] (-27.28)	0.132[b] (-23.25)	0.057[c] (-39.36)	71[c] (-26.04)	8.75[c] (-24.04)	4.92[c] (-36.43)	0.185[b] (-14.35)	0.082[c] (-32.23)
T3	62[d] (-31.86)	5.01[d] (-45.72)	3.46[d] (-48.12)	0.112[c] (-34.88)	0.042[d] (-55.31)	58[d] (-39.58)	7.31[d] (-36.54)	3.50[d] (-54.78)	0.166[c] (-23.14)	0.063[d] (-47.93)
T4	44[e] (-51.64)	4.61[e] (-50.05)	2.03[e] (-69.56)	0.086[d] (-50.00)	0.036[e] (-61.70)	36[e] (-62.05)	5.91[e] (-48.69)	2.12[e] (-72.60)	0.139[d] (-35.64)	0.045[e] (-62.80)

Mean with different alphabets in a column differed significantly as per Tukey's Multiple Range Test (TNRT) (P<0.05).Data in parenthesis indicates % increase (+), decrease (-) over control

Table-2
Allelopathic potential of *A. conyzoides* L. on chlorophyll content (mg/g.fr.wt) of *V. mungo and V. radiata*

Extract Conc.	*V.mungo*			*V.radiata*		
	Chl.a	Chl.b	Total chl.	Chl.a	Chl.b	Total chl.
T0	0.382 [a]	0.319 [a]	0.701 [a]	0.285 [a]	0.264 [a]	0.549 [a]
T1	0.364 [b] (-4.71)	0.315 [a] (-1.25)	0.685 [a] (-2.28)	0.251 [b] (-11.92)	0.217 [b] (-17.80)	0.468 [b] (-14.75)
T2	0.331 [c] (-13.35)	0.278 [b] (-12.85)	0.609 [b] (-13.12)	0.224 [c] (-21.40)	0.196 [c] (-25.75)	0.421 [c] (-23.31)
T3	0.302 [d] (-20.94)	0.242 [c] (-24.13)	0.544 [c] (-22.39)	0.188 [d] (-34.03)	0.176 [d] (-33.33)	0.364 [d] (-33.69)
T4	0.279 [e] (-26.96)	0.197 [d] (-38.24)	0.502 [d] (-28.38)	0.143 [e] (-49.82)	0.159 [e] (-39.77)	0.328 [e] (-40.25)

Mean with different alphabets in a column differed significantly as per Tukey's Multiple Range Test (TNRT) (P<0.05).Data in parenthesis indicates % increase (+), decrease (-) over control.

Table-3
Allelopathic potential of *A.conyzoides L.* on Amino acid, protein, Total Sugar and Starch contents (mg/g.fr.wt) of *V.mungo and V.radiata* (15thday old seedlings)

Extract Conc.	*V.mungo*				*V.radiata*			
	Amino acid	Protein	Total sugar	Starch	Amino acid	Protein	Total sugar	Starch
T0	0.560 [a]	0.285 [a]	0.583 [a]	0.584 [a]	0.621 [a]	0.291 [a]	0.661 [a]	0.670 [a]
T1	0.540 [a] (-3.57)	0.265 [a] (-7.01)	0.551 [b] (-5.48)	0.559 [b] (-4.28)	0.609 [a] (-1.93)	0.271 [a] (-6.87)	0.640 [a] (-3.17)	0.651 [a b] (-2.83)
T2	0.523 [b] (-6.60)	0.241 [b] (-15.43)	0.518 [c] (-11.14)	0.538 [c] (-7.87)	0.585 [b] (-5.79)	0.258 [b] (-11.34)	0.626 [a b] (-5.29)	0.630 [c] (-5.97)
T3	0.484 [c] (-13.57)	0.217 [c] (-23.85)	0.449 [d] (-22.95)	0.485 [d] (-16.95)	0.513 [c] (-17.39)	0.231 [c] (-20.61)	0.512 [c] (-22.54)	0.532 [d] (-20.59)
T4	0.426 [d] (-23.92)	0.192 [d] (-32.63)	0.403 [e] (-30.87)	0.386 [e] (-33.90)	0.446 [d] (-28.18)	0.185 [d] (-36.42)	0.406 [d] (-38.57)	0.469 [e] (-30.00)

Mean with different alphabets in a column differed significantly as per Tukey's Multiple Range Test (TNRT) (P<0.05).Data in parenthesis indicates % increase (+), decrease (-) over control.

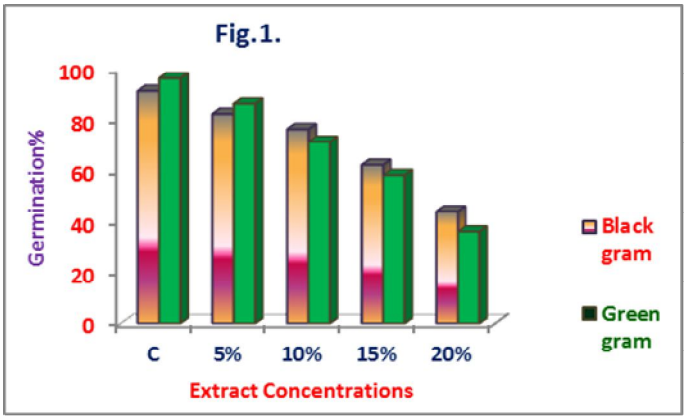

Fig.1.
Germination % of Black gram and Green gram seeds Exposed to various concentrations of *A.conyzoides* extract

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