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Full Length Research Paper

Allelopathic effect by aqueous extracts of different parts of *Croton bonplandianum* Baill. on some crop and weed plants

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The present study was conducted to investigate the allelopathic effects of *Croton bonplandianum* weed on seed germination and seedling growth of crop plants (*Triticum aestivum* L., *Brassica oleracea* var. *botrytis* L. and *Brassica rapa* L.) and weed plants (*Melilotus alba* Medik., *Vicia sativa* L. and *Medicago hispida* Gaertn). Root, stem and leaf aqueous extracts of *Croton* at 0.5, 1.0, 2.0 and 4.0% concentrations were applied to determine their effect on seed germination and seedling growth of test plants under laboratory conditions. The aqueous extracts from root, stem and leaf had no effect on seed germination of test plants. The extracts from stem had a stimulatory effect on the shoot length at all concentration levels, as against an inhibitory effect of leaf extracts. Stem extracts at low concentration generally promoted root length but aqueous extracts from leaf and root inhibited root length and dry weight. Root length, shoot length of weed species decreased progressively when plants were exposed to increasing concentration (0.5, 1, 2 and 4%). The pH, osmotic potential and total phenolic contents, the osmotic potential and phenolic content increased with increasing concentrations of aqueous extracts of different parts of *C. bonplandianum* while pH does not have any major change.

Key words: Allelopathy, aqueous leaf extract, aqueous stem extract, aqueous root extract, *Melilotus alba, Medicago hispida, Vicia sativa, Croton bonplandianum.*

INTRODUCTION

The *Croton bonplandianum* is an obnoxious weed of Euphorbiaceae family. It is a native of South America and was reported from India during late 1890 (Kaul, 1967). It now occurs widely along roadsides, railways abandoned fields in wide open ravines and paddy or sugarcane fields and on sandy or sandy clay soils. This species is seldom found in areas enclosed by shrubs and trees where free movement of air sets hindered. For obvious reasons, *C. bonplandianum* is a problematic weed for farmers, ecologists/biologists, horticulturists, environmentalists and common man especially in North India. It competes with other plant species upon invasion resulting in adverse effects on the natural vegetation and standing crops. Its invasion in crop fields hinders the preparation of fields while ploughing. Due to its competitive nature, it reduces the availability of nutrients to crops thereby reducing productivity. DeCandolle (1832) was probably the first person to suggest the possibility that many plants may excrete something from their roots which may be injurious to other plants. Molisch (1937) proposed the term ‘allelopathy’ for expressing the harmful effects that one plant species may have on another through the mechanism of chemical retardants escaping into the environment. The concept of allelopathy was further supported and further developed by Bonner (1950), Grummer and Beyer (1960), Evenari (1961), Whittaker (1970), Pitman and Duke (1978) and Fischer et al. (1978). According to Lavabre (1991), allelopathic effects are controversial and still poorly understood. Allelochemicals (inhibitors) are produced by plants as end products, by-products and metabolites and are contained in the stem, leaves, roots, flowers, inflorescence, fruits and seeds of the plants. Of these plant parts, leaves

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seem to be the most consistent producers of these allelochemicals.

The four ways in which allelochemicals escape from a plant are: (i) volatilization, during which the terpenes are released from the leaves of some plant species; (ii) leaching (which has shown that living or dead leaves of many plants contain growth inhibitors); (iii) exudation in which case roots of several crop and non-crop species release large quantities of organic compounds that inhibit the growth of other plants; and (iv)decomposition, through which allelochemicals are released from the plant residue.

MATERIALS AND METHODS

Preparation of aqueous extract

The *Croton bonplandianus* plants which grew naturally in Aligarh Muslim University campus were uprooted and collected at their mature stage on August 4 and 20, 2007, for the experiment. The plants were brought into the laboratory and were immediately separated into leaf, stem and root parts. Each part of the fresh plant was cut into small pieces, shade dried and then ground separately with help of grinder and made fine powder. 4 g powder of root; stem and leaves of *C. bonplandianum* were steeped in 100 ml of distilled water and filtrate through a muslin cloth followed by filter paper (No. 1. Whatman International, Maidstone, UK). After 24 h of soaking at room temperature 921 - 22°C) and then further diluted so as to get 0.5 to 4% aqueous extract, respectively, as adopted from Singh et al. (1989).

Treatments and experimental design

There were 15 treatments including four concentration levels (0, 0.5, 1, 2 and 4%) of each leaf stem and root extracts. Seeds and filter papers were moistened with 10 ml each of 0.5, 1, 2 and 4% aqueous extracts. 10 ml of distilled water was added to the untreated control (0%). The treatments were arranged in completely randomized design (CRD) with five replicates kept at room temperature on a laboratory bench with 12 h supply of fluorescent light during the night The whole experiment was repeated once.

Determination of pH

The pH of each extract prepared from different parts of *C. bonplandianum* was determined by immersing the electrode of a digital ph meter (EcoScan). The mean of five replicates were taken and presented.

Determination of osmotic potential

The osmotic potential of extracts of different parts of *C. bonplandianum* was determined using the following formula:

Osmotic Potential = 0.36 x Conductivity (in mS)

Determination of total phenolic content

Total water-soluble phenolics in the aqueous residue extracts and residue-amended soils were estimated as per the method of Swain and Hills (1959) using Folin-Ciocalteu reagent. Their amounts were determined spectrophotometrically at 700 nm against the standard of ferulic acid.

Physical parameters

After seven days, the seedling root length (cm), shoot length (cm) and dry weight were determined (mg). The root and shoot length were determined manually while the dry weight with the help of 4 digit digital balance of Scientech, Model ZSA 120, Colorado (USA)

Statistical analysis

After seven days, the seedling root length, shoot length and dry weight were determined. The data were subjected to one way analysis of variance and the mean values were separated at $P < 0.05$ applying 2-sample t-test. The statistical analysis was done using SPSS/PC version 10 software.

RESULTS AND DISCUSSION

As compared to the control (0%), the aqueous extracts of *Croton* from root, stem and leaf parts at 2 and 4% concentration levels exhibited significant ($P < 0.05$) inhibition on seedling growth. The effect was in general, more severe on *Melilotus alba* compared to other weed plants. Among the different parts, leaves were the most allelopathic and stems were least allelopathic. The inhibitory effect was concentration dependent (Figures 1, 2 and 3). The inhibition effect was found to increase with increasing concentrations of different aqueous extracts (Sisodia and Siddiqui, 2008, 2009). The radicle length, plumule length and dry weight of seedlings were reduced significantly in response to all the *C. bonplandianum* extracts. At 4% concentration of the leaves extract, in *Vicia sativa* the radicle length and plumule length were reduced by nearly (41%) and (26%) respectively (Figure 3).

Generally, in studies with aqueous extracts, the observed inhibitory effect are attributed to change in pH and osmotic potential thereby raising concern about allelopathy and its ecological existence and relevance (Harper, 1977; Conway et al., 2002; Sisodia, 2008). In the present study, pH of extracts (that is, root, stem and leaves) ranged from 6.13 to 6.68 (Table 1). Likewise, the osmotic potential range -0.43 bars to -0.96 bars is again unlikely to cause any inhibitory effect on the plant growth (Mersie and Singh, 1987). After making these observations, it could be concluded that extracts might possess growth inhibitors. The amount of phenolics was also determined in extracts from different parts at mature stage. In leaves extract, amount of phenolic was about 828 µg/ml in 4% extract. Among different parts, the content of phenolics was the maximum in leaves and less in stem (Table 1).

The observed different phytotoxicity of *C. bonplandianum* may be attributed to the presence of variable amount of phototoxic substances in different

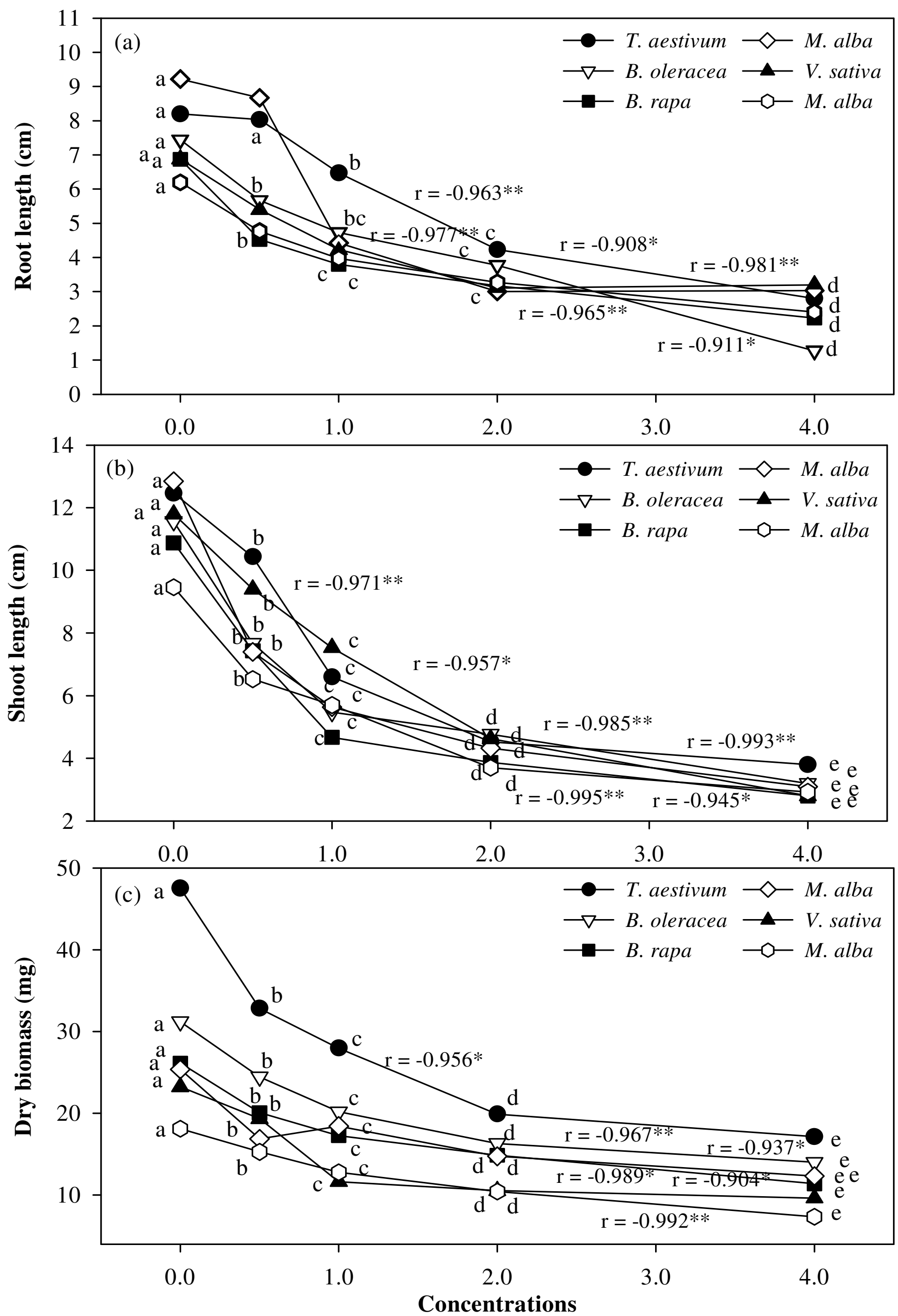

Figure 1. Effect of different concentration of aqueous extracts of root at flowering stage on (a) root length and (b) shoot length and (c) dry biomass of test plants (crops as well as weeds).
Different superscript symbols along a curve respresent signinficant difference among themselves at $P < 0.05$
applying DMRT.
r represent correlation coefficient
* and ** represent significance of correlation at $P < 0.05$ and $P < 0.01$ respectively

parts that leach out under natural conditions. Foliar leachates have been regarded to be most phytotoxic in nature (Xuan et al., 2004) probably owing to their proportionately greater biomass and with greater metabolic activity or production of more metabolites (Xuan et al., 2004).

Some recent studies indicating the phytotoxic/allelopathic effect of aqueous extracts of weeds include *Mikania micrantha* (Ismail and Kumar, 1996), *Vulpia sp.* (An et al., 1999), *Cyperus rotundus* (Quayyaum et al.,

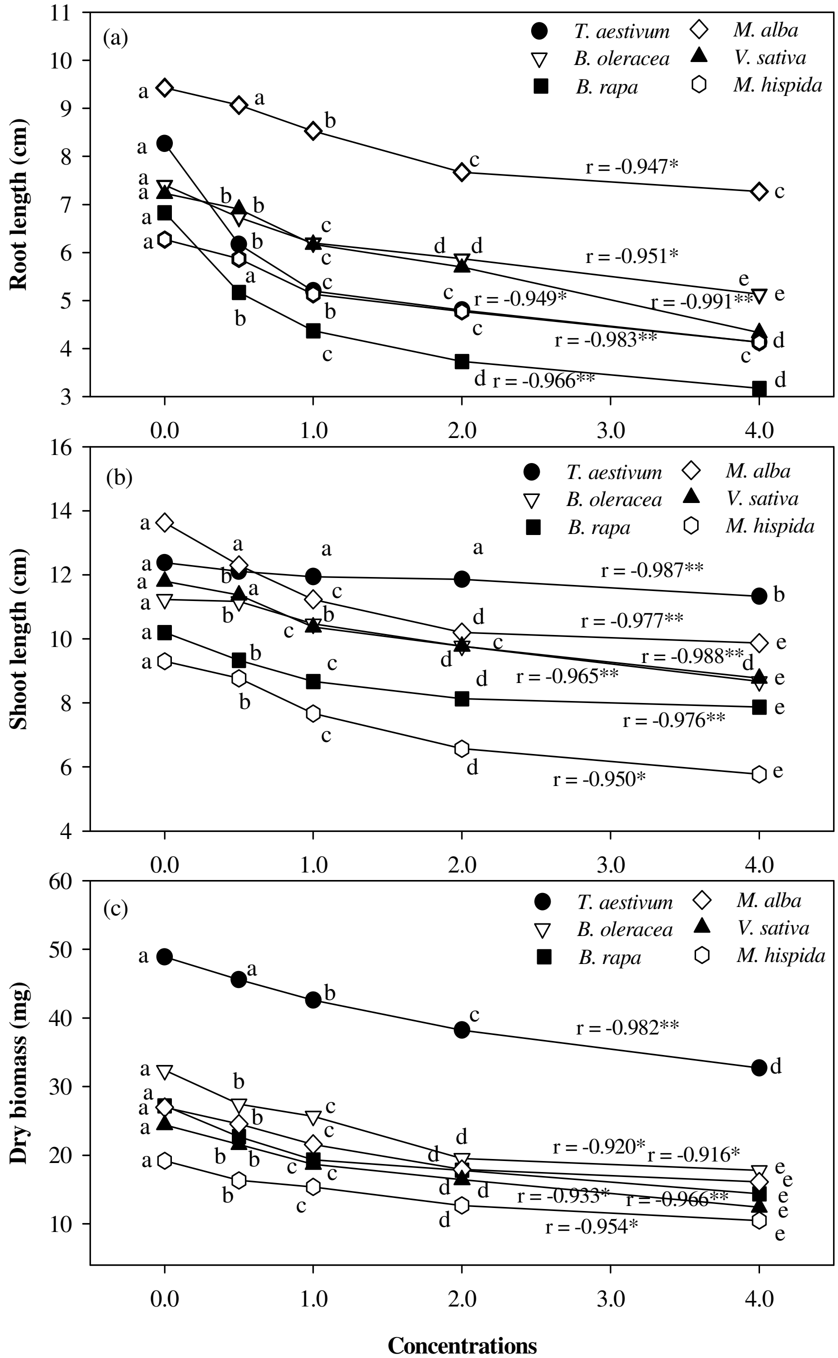

Figure 2. Effect of aqueous extracts of shoot at flowering stage on (a) root length (b) shoot length and (c) dry biomass of test plants (crops as well as weeds).
Different superscript symbols along a curve respresent signinficant difference among themselves at $P < 0.05$ applying DMRT.
r represent correlation coefficient
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a2000), *Cardaria draba* (Kiemnec and McInnis, 2002), *Parthenium hysterophorus* (Batish et al., 2002a; Singh et al., 2003a), *Brassica nigra* (Tawaha and Turk, 2003), *Raphanus raphanistrum* (Norsworthy, 2003) and *Ageratum conyzoides* (Batish et al., 2002b; Singh et al., 2003b,c). All these studies indicate the release of phototoxic chemicals during the preparation of aqueous extracts. Based on this, studies were further extended to explore the impact of *C. bonplandianum* (especially) leaves, as they possessed greater phytotoxicity on the

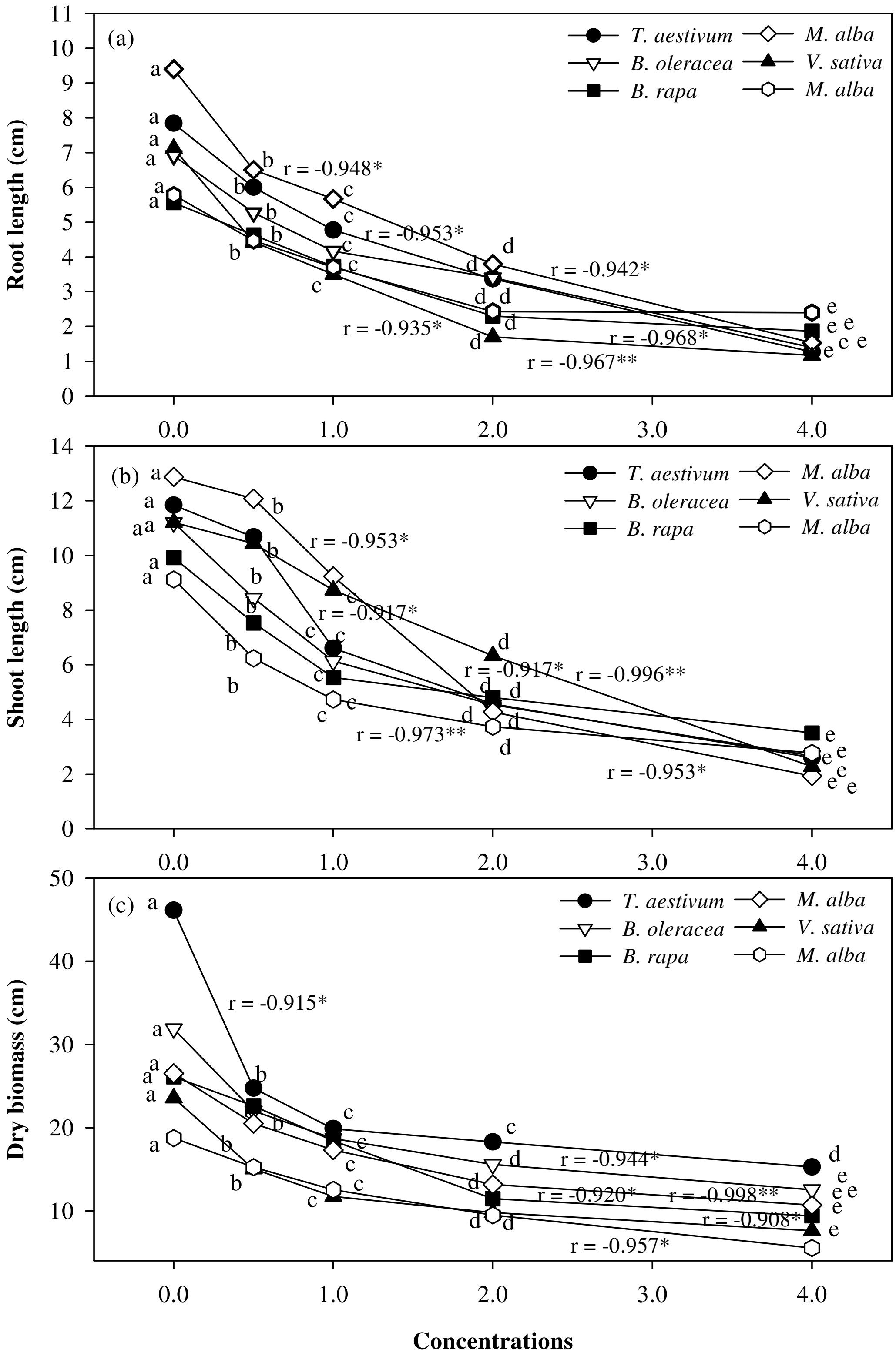

Figure 3. Effect of different concentration of aqueous extracts of leaves at flowering stage on (a) root length (b) shoot length and (c) dry biomass of test plants (crops as well as weeds).
Different superscript symbols along a curve respresent signinficant difference among themselves at $P < 0.05$ applying DMRT.
r represent correlation coefficient
* and ** represent significance of correlation at $P < 0.05$ and $P < 0.01$ respectively

Table 1. Effect on pH, osmotic potential and phenolic content by aqueous extracts root, stem and leaves of *Croton bonplandianum* Baill.

Extracts	pH	Osmotic potential (-bars) mS	Phenolic content (µg/ml)
Root			
0.5	6.59	0.43	113.32
1	6.52	0.59	224.06
2	6.31	0.68	333.03
4	6.12	0.77	543.09
LSD at 5%	0.019	0.036	0.661
Stem			
0.5	6.68	0.59	44.13
1	6.58	0.72	49.73
2	6.41	0.92	58.2
4	6.26	0.99	73.8
LSD at 5%	0.007	0.009	0.318
Leaves			
0.5	6.66	0.46	532.46
1	6.52	0.79	426.13
2	6.41	0.88	512.30
4	6.35	0.96	828.06
LSD at 5%	0.014	0.015	0.445

emergence and growth of weed plants.

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