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Effect of aqueous extract of Jatropha leaf on germination and seedling growth of French bean and brinjal

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Abstract
A experiment was conducted under laboratory condition to ascertain to find the effect of aqueous extract of jatropha leaf on germination and seedling growth of French bean and Brinjal. The experiment was laid out in completely randomized design having four treatments with three replications at Assam Agricultural University, Jorhat, Assam. Jatropha leaf extract at 5%, 10%, 15% and 20% (W/V) concentrations were bio-assayed against germination and seedling growth of french bean and brinjal. In both the crops, germination percentage, germination index, shoot and root length, fresh and dry weights of shoot and root were appreciably reduced by aqueous extract of jatropha leaf in a concentration dependent manner. However, germination of french bean seed was found to be more sensitive to jatropha leaf extract. From the recorded data of the present investigation, it was observed that reduction in germination percentage in french bean with 20% concentration of aqueous extract was 34.48% over control, whereas in brinjal, it was only 24.00%.

Keywords: Jatropha leaf extract, germination, french bean, brinjal

Introduction
Increasing population density and rapid economic development, particularly in developing countries like India, has led to huge increase in energy demand (Mahajan *et al*., 2011) [9]. Due to this severe energy crisis and escalation of petroleum prices, alternate energy sources are gaining considerable importance (Sahoo *et al.*, 2009) [15]. Bio-diesel derived from plant species has been identified as a major renewable source of energy. Among various plants, jatropha (*Jatropha curcas*) has been demonstrated as the most potential biofuel containing plant species which can be grown in diverse climatic conditions. Jatropha oil is close to cottonseed oil, and better than oil extracted from rapeseed, groundnut and sunflower (Gubitz *et al*., 1997), which gives no pollution, when burnt (Abugre and Sam 2010) [1]. Therefore, cultivation of jatropha for its oil is promoted by many researchers, NGOs, private entrepreneurs and governments as a possible solution to combat environmental degradation and worldwide shortage in energy supply. French bean and brinjal are the two important vegetable crops with shorter crop duration may pose some advantages to be grown as an intercropping system for food within the biofuel crop jatropha. Brinjal fruits are low in calories and having a mineral composition beneficial for human health. They are also a rich source of potassium, magnesium, calcium and iron (Zenia and Halina, 2008) [19]. The failure of most crops in an intercropping system has primarily been attributed to allelopathic interaction. Allelopathy is defined as any direct or indirect, harmful or beneficial effects by one plant (including micro-organisms) upon another through production of chemical compounds that escape into the environment (Rice, 1984; Azania *et al.*, 2003) [14, 3]. Jatropha extracts contain allelochemicals like tannins, glycosides, alkaloids and flavonoids (Igbinosa *et al.*, 2009) and such phytotoxic substances are reported to cause growth inhibition in various receiver plants (Javaid and Anjum, 2006). However, information on allelopathic effects of jatropha on french bean and brinjal is scanty.

Materials and Methods
Fresh jatropha leaves weighing 200 gm were ground homogeneously in a mortar and mixed with 1000 ml of distilled water and kept for 24 hours. Then the slurries were strained through two layers muslin cloth and were centrifuged at 4500 rpm for 10 minutes. The supernatant was considered as 20% aqueous extract. By subsequent dilution with distilled water, aqueous extracts of 15%, 10% and 5% were prepared and kept at 4 °C till further use.

Surface of the french bean and brinjal seeds were sterilized by dipping in 0.10 percent (W/V) $HgCl_2$ for one minute and rinsed several times with distilled water. Ten seeds of french bean and brinjal were placed in separate glass Petri dishes (15 cm diameter) with 3 replications fitted with single layer of filter paper. The filter papers of different Petri dishes were moistened sufficiently by adding equal volume (15 ml) of aqueous extract of different concentrations. A control was set with distilled water. The Petri dishes were covered and kept in room temperature. The covered Petri dishes were opened periodically for aeration and to add stock solutions to keep the filter paper moistened.

Results and Discussion

Allelopathy, the production and release of toxic chemicals produced by one species that affect a receiving susceptible species, has been the subject of diverse degrees of scientific enquiry. Recent progress has been made in understanding the biochemical and molecular changes that are induced by allelochemicals in susceptible plant species, and the complex mechanisms that are used by allelochemical-resistant plants to defend against allelochemical-induced toxicity. It was observed that germination percentage of both french bean and brinjal were reduced by jatropha leaf extract. In both the crops, minimum and maximum reduction in germination percentage were observed with 5% and 20% concentrations of aqueous extract respectively, which revealed that inhibition of germination of french bean and brinjal by jatropha leaf extract was concentration dependent (Table 1 and 2). This finding of the present investigation is in line with the results of other studies reported by several workers. For example, Abugre and Sam (2010) [1] recorded similar reduction in seed germination of several crops by aqueous extract of jatropha leaf. Germination index of french bean and brinjal, a criteria to evaluate the effect on rate of germination, was recorded in different concentrations of jatropha leaf aqueous extract. The speed of germination was retarded by aqueous extract of jatropha leaf as indicated by low germination index values. It is noteworthy to mention that decline in germination rate was more with higher concentrations. This result of the present study is in line with the findings of other investigations reported by several workers. For example, Shafer and Garrison (1986) [16] reported significant delay in germination of tomato by other allelopathic donor plants. Germination index of tomato was also reduced by root extracts of squash (Omar *et al.*, 1989a) [12] and radish (Omar *et al.*, 1989b) [11].

Inhibition in the growth of shoot and root of french bean and brinjal were recorded to be concentration dependent. Shoot and root length of both the test crops were reduced to a highest extent by 20% aqueous extract of jatropha leaf. Similar trend was recorded in case of fresh and dry weights of seedlings. It was observed that both shoot and root fresh and dry weights of french bean and brinjal were reduced by aqueous extract of jatropha leaf. In both the crops, minimum and maximum reduction in fresh and dry weights were observed with 5% and 20% concentrations of aqueous extracts respectively, which revealed that reduction in fresh and dry weights by jatropha leaf extract was concentration dependent. This finding is in line with the results reported by Abugre and Sam (2010) [1]. From the aqueous extract bioassay, it can be suggested that jatropha leaf contains water soluble phytotoxic substances which inhibit germination and early seedling growth under laboratory condition in a concentration dependent manner. Swaminathan *et al.* (1989) [17] reported that the potential compounds released from donor plants, which could induce inhibitory effect on germination of receiver plants, were primarily phenolic acids. The release of phenolic compounds adversely affects the germination and growth of receiver plants through their interference in energy metabolism, cell division, mineral uptake and biosynthetic processes (Rice, 1984) [14]. Several researchers reported similar allelopathic effects of jatropha on other crops also. For example, Rejila and Vijayakumar (2011) [13] reported that aqueous leaf extract of jatropha could strongly inhibit seed germination, shoot and root growth in *Capsicum annum* L. Abugre and Sam (2010) [1] reported negative allelopathic effects of jatropha leaf extract on several receiver plants. They showed that aqueous extract of jatropha leaf had a strong inhibitory effect on germination and length of radicle and plumule of various test crops. They suggested that the inhibitory effect was due to the presence of allelochemicals in jatropha leaf that could reduce the growth of the crops. It is well documented that jatropha leaf extracts contain allelochemicals like saponins, tannins, glycosides, alkaloids and flavonoids (Akinpelu, 2009; Igbinosa *et al.*, 2009) [2], which are phenolic in nature. These phenolic compounds could be the cause for the reduction in germination and seedling growth as recorded in the present investigation. In the light of previous reports, it can be suggested that one of the reasons of reduced germination percentage, as observed in the present study, may be due to inhibition of oxygen uptake by seeds, which is essential for oxidative breakdown of reserve-food materials during the process of seed germination. Murphy and Noland (1982) [10] reported that allelochemicals could interfere with the oxygen supply to embryo and thus, reduce the cellular oxidation. Moreover, many allelochemicals were reported to inhibit IAA and GA induced seedling growth in various plant species (Tomaszewski and Thimann, 1966) [18]. Similar mechanism might have operated in the present study, which resulted in reduction in germination and subsequent seedling growth in french bean and brinjal by jatropha leaf extract.

From the recorded data of the present investigation, it was observed that reduction in germination percentage in french bean with 20% concentration of aqueous extract was 34.48% over control, whereas in brinjal, it was only 24.00%. All the applied concentrations of aqueous extract of jatropha leaf exhibited pronounced effects on germination percentage, shoot and root length, fresh and dry weights of shoot and root of french bean compared to brinjal (Fig. 1). Therefore, it is noteworthy to mention that germination and seedling growth in french bean, compared to that of brinjal, appeared to be more sensitive to aqueous extract of jatropha leaf. Such type of variation in performance and sensitivity among different plant species to allelochemicals, as observed in our study, has also been documented by other researchers (Callaway *et al.*, 2005, Jensen and Ehlers, 2010) [4, 8].

Table 1: Effect of different doses of aqueous extract of jatropha leaf on germination percentage (%), germination index, shoot and root length (cm), shoot and root fresh weights (g seedling^{-1}) and shoot and root dry weights (g seedling^{-1}) of french bean

Concentration (W/V)	Germination * (%)	Germination Index	Shoot length (cm)	Root length (cm)	Shoot fresh weight (g seedling^{-1})	Root fresh weight (g seedling^{-1})	Shoot dry weight (g seedling^{-1})	Root dry weight (g seedling^{-1})
5%	86.66 (68.85)	91.33	7.99	5.13	0.69	0.08	0.07	0.013
10%	76.66 (61.21)	80.00	5.11	3.58	0.45	0.06	0.05	0.010
15%	73.33 (59.21)	72.66	3.80	2.53	0.37	0.04	0.04	0.008
20%	63.33 (52.77)	71.33	2.33	2.05	0.27	0.03	0.03	0.007
Control	96.66 (83.85)	106.70	9.20	6.91	0.88	0.11	0.09	0.015
SEd ±	5.36	8.14	0.92	0.72	0.12	0.01	0.008	0.0009
CD (5%)	11.94	18.14	2.06	1.60	0.27	0.03	0.019	0.0020

***** Transformed values are in parentheses.

Table 2: Effect of different doses of aqueous extract of jatropha leaf on germination percentage (%), germination index, shoot and root length (cm), shoot and root fresh weights (mg seedling^{-1}) and shoot and root dry weights (mg seedling^{-1}) of brinjal

Concentration (W/V)	Germination * (%)	Germination Index	Shoot length (cm)	Root length (cm)	Shoot fresh weight (mg seedling^{-1})	Root fresh weight (mg seedling^{-1})	Shoot dry weight (mg seedling^{-1})	Root dry weight (mg seedling^{-1})
5%	80.00 (63.43)	59.33	3.89	3.21	9.30	0.31	0.90	0.033
10%	76.66 (61.21)	55.33	3.56	2.86	8.60	0.29	0.81	0.031
15%	73.33 (59.00)	41.33	2.65	1.96	6.20	0.25	0.67	0.023
20%	63.33 (52.78)	32.67	1.28	1.25	4.70	0.18	0.58	0.017
Control	83.33 (66.14)	62.00	3.92	3.28	9.60	0.33	0.95	0.036
SEd ±	2.91	3.04	0.19	0.31	0.50	0.03	0.05	0.004
CD (5%)	6.48	6.77	0.44	0.69	1.00	0.08	0.11	0.008

***** Transformed values are in parentheses.

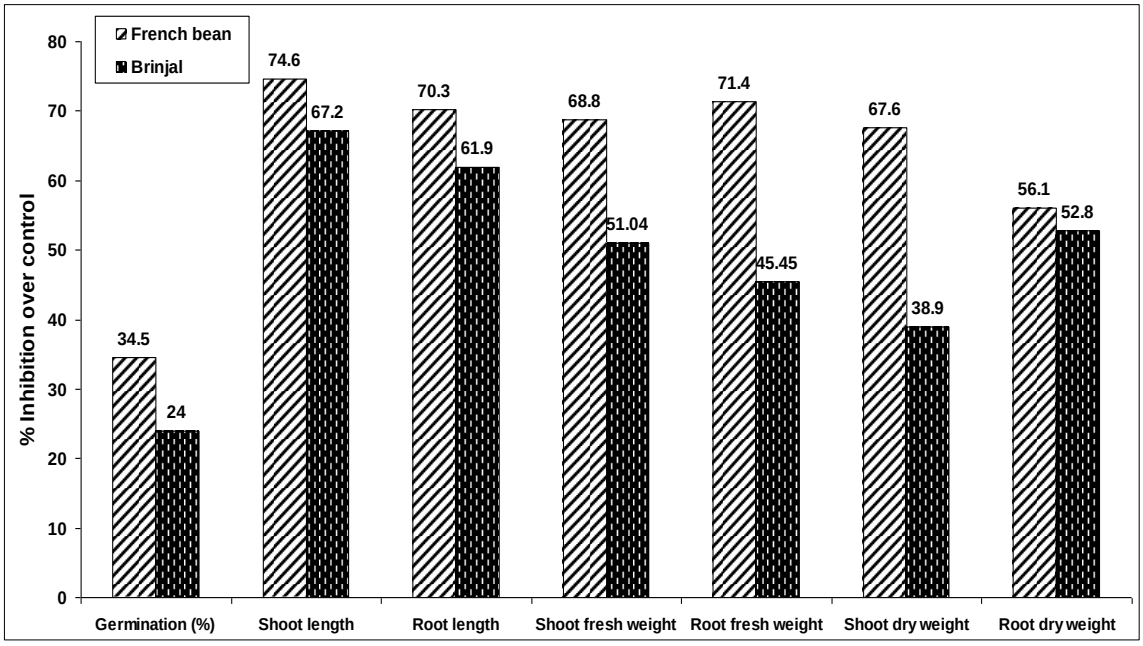

Fig 1: Effect of 20% doses of aqueous extract of jatropha leaf on percent inhibition / reduction of germination (%), shoot and root length and fresh and dry weights of shoot and root of french bean and brinjal.

Conclusion

Results of aqueous extract bioassay experiment clearly indicate that brinjal was less sensitive to allelopathic effects of jatropha compared to french bean. Therefore, it can be suggested that brinjal may be grown with jatropha plantation. However, further research in field condition will be required to confirm the results obtained from our laboratory experiment.

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