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Allelopathic effects of *Boerhavia difussa* L. aqueous extracts on Soybean (*Glycine max* L.) Seed Germination, Shoot and Root Growth and Dry Matter Production

Nikam S.R.[1*], Namdas D.D.[2] and Padale T.R.[3]

[1]Ph.D. Scholar, Department of Botany,
Sadguru Gadage Maharaj College, Karad Shivaji University, Kolhapur (Maharashtra), India.
[2]Research Guide, Department of Botany,
Yashwantrao Chavan Institute of Science, Satara (Maharashtra), India.
[3]Pharmacy Student, Department of Pharmacology,
Dr. Shivajirao Kadam College of Pharmacy, Sangli (Maharashtra), India.

(Corresponding author: Nikam S.R[*])
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ABSTRACT: Allelopathy is the production of chemical compounds by one plant to interfere with the growth and development of another plant. Allelochemicals often stimulate or restrict plant growth and have been proposed as a viable medication development technique for ecologically friendly biological weedicides. The discovery of plant materials with plentiful sources, affordable prices, and pronounced allelopathic effects will undoubtedly have significant ecological effects as the biological weedicide. Under laboratory conditions, soybean (*Glycine max* L.) seeds were treated with aqueous extracts of *Boerhavia* L. at concentrations of 5, 10, and 15% (w/v) to determine their effects on germination rate, percentage of germination, seedling growth (shoot and root length), and dry matter production. The treatments were setup in a three-replication factorial arrangement with a completely randomized design. The test was carried out on January 25, 2023. Results showed a difference betweenplant parts, concentration levels, and their interaction for the aforementioned parameters that was significantly different (P<0.05). At doses of 5,10, and 15%, aqueous extracts of all parts completely prevented plant germination. Aqueous extracts from weed plant, in contrast, had a smaller impact at 5% concentrations while having a muchgreater impact at higher concentrations on crop germination and growth. Crop roots were more susceptible to the effects of allelopathy than crop shoots. It is advised that an integrated weed management strategy be created and used to remove weeds from soybean fields in order to prevent poor seed germination and seedling growth and guarantee the crops long-term viability. *B. difussa* was found to be an allelopathic weed with water soluble allelochemicals in its plant parts and had such phytotoxic potency that could suppress the growth and nutrient accumulation of associated crop plants.

Keywords: Aqueous extract, weed, allelopathy, germination, Sangli district.

INTRODUCTION

Weeds produce a lot of seed. Weeds are capable of producing enormous numbers of seeds, multiplying swiftly, establishing quickly, storing dormant seeds for a long time, adapting vegetative reproductive systems, and settling in disturbed environments. Weeds are referred to as invasive plants (Rao *et al*., 2011). When agriculture first began, the idea that weeds were undesirable was born (Jabeen *et al.*, 2013). The genus name *Boerhavia* (also written *Boerhaavia*) honors Hermann Boerhaave (1668-1738), a Dutch botanist, scholar, and physician at the University of Leiden in the eighteenth century. All elochemicals can affect the target plants in either a positive or negative way. Allelochemicals are substances that come from the stem, leaves, roots, flowers, inflorescence, fruits, and seeds of plants and are created by them as final products, byproducts, or metabolites. According to Sisodia *et al.* (2010). The greatest constant production of allelochemicals was seen in the leaves. According to Nandan *et al.* (1994), weeds are a rich source of allelochemicals that alter the environment of nearby plants. The species was given its name for its typical dispersed branching claim that the plant's botanical name is usually spelled as *B. difusa* Despite Latinizing Boerhaave's name to Boerhavius and adopting the spelling B, Linnaeus named *Boerhavia diffusa.* The appropriate one to employ is *diffusa* (Apu *et al.*, 2012). Some of the common names for *B. difussa* include Gondhapurna, Punernava (Bengali, Sanskrit), Pigweed, Spreading hogweed (English), etc. dispersed. The common names for *B. difussa* in India. Include

Shilatika, Punernava, Raktapushpa, Shothaghni, Kathillaka, Varshabhu, and Raktapushpa etc. One seed is present in each of the tiny, short-stalked, pale rose blooms. *B.diffusa* is a perennial herb with a strong root system and numerous procumbent branches that produces light rose colored bloom stiny, short -stalked, very viscid fruits with one seed. The plants also included a series of Pharmacological Potential of *Boerhaavia diffusa* boeravinones *viz*., boeravinone A, boeravinone B, boeravinone C, boeravinone D, boeravinone E, boeravinone F. Punarnavoside, a phenolic glycoside, is reportedly present in roots (Jain and Khanna 1989; (Seth *et al*., 1986).

The Native One of the most significant traditional pulse crops in the upper areas of Maharashtra is soybean (*Glycine max* L.) (India). For subsistence farmers, its grain provides food and a source of income, and its by products, like as the stalk and leaves, are used as feed and firewood. It gives the diet a crucial supply of protein and minerals, particularly Fe and Zn. Leguminous crops likes soybean are crucial because they help with crop rotation in areas where Maharashtra (India)is known for just cultivating cereals. Despite the crop's value, weed invasion poses a severe danger to its productivity. *B. diffusa* is a perennial herb with a strong root system and numerous procumbent branches, and its flowers are small pale rose blossoms. The allelopathic potential of this plant on the germination and seedling development of the crops warrants additional scientific research. Therefore, the goal of this study was to ascertain whether the aqueous extracts of *Boerhavia' s* shoot, leave, flower, and root had any allelopathic effects on the germination, seedling growth, and dry matter production of soybean under laboratory conditions (Netsere and Mendesil 2011**).** Since seed germination is the biological process that is most responsive to bioactive chemicals, seed emergence has been favoured in allelopathic studies (Aliotta *et al*., 2006). One of the most significant traditional pulse crops in the upper areas of Maharashtra is soybean (*Glycine max* (L.)). Its grain serves as both a food supply and a source of revenue for subsistence farmers, while its byproducts, like as the stalk and leaves, are used as both feed and fire wood The impacts of different portions of the same weed's allelopathic effects on plant germination and early growth vary as well (Veenapani, 2004; Aziz *et al.*, 2008). The concentration and types of secondary metabolites produced determine the overall allelopathic action, which may be stimulatory or inhibitory (Bhowmik, 2003).

MATERIAL AND METHODS

Preparation of aqueous extract of *B.diffusa.* Preparation of an aqueous extract from a naturally occurring *B. diffussa* plant found on the side of the road on April 1, 2022, Karad plants were randomly uprooted and gathered when they were in the blossoming stage. The plants were collected and taken to the Sadguru Gadage Maharaj college Research Laboratory Department of Botany, Karad. The fresh plant's were divided into 1-2 cm sections. Each plant portion was then placed in paper bags, dried for 24 hours at 70°C in the oven, and then pounded using an electric stainless steel Wiley mill. Using a electronic balance, five, ten, and fifteen grams of a plant part's powder were measured, and 300 microliters of distilled water were added. The mixture comprising 5g, 10g, and 15g of *Boerhavia* extracts was recovered by filtering through muslin cloth and labeled as 5, 10, and15%aqueous extracts, respectively, after 24 hours of soaking at room temperature (21–22°C).

Bioassays and experimental design. For the study, one kilogram of Mahabeej JS-335 variety soybean seeds was received from Sheti Vibhag Pramukh, Karad Taluka Sahakari Khat Vikri Sangh Limited. After being treated with sodium hypochlorite in a 500 ml flask for three minutes, the seeds of the variety were thoroughly rinsed with distilled water. Bioassay was carried out in accordance with the methods described by (Wakjira *et al*., 2005; Tefera, 2002). One hundred seeds of soybean crop were separately placed in a petri-dish (9cm diameter) lined with 9 cm blue colored blotting paper. There after the seeds were treated with 10 ml of the 5,10 and 15% of aqueous extracts of weed and with 10 ml. of distilled water as a control. The treatments were laid out in a completely randomized design with factorial arrangement in three replications and kept at room temperature (21-22°C) on a laboratory bench. The mixture comprising 5g, 10g, and 15g of weed extracts was recovered by filtering through muslin cloth and labeled as 5, 10, and 15%aqueous extracts, respectively.

Data gathering and statistical evaluation. 15 days following, the start of the treatment, the number of seeds that germinated (i.e., the number of seedlings with visible shoot and root growth) was counted. Following technique, the germination rate (GR) was estimated as follows:

R is defined as $(N1*1) + ½(N2– N1)+1/3(N3–N2)+ 1/n(Nn–Nn^{-1})$**,** where N1, N2,

N3 ....Nn-1, N n is the percentage of germinated seeds acquired in the first (1), second (2), third (3), (n–1),and (n) days, respectively (Wardle *et al.,* 1991) ruler was used to measure the shoot and root length (cm) of the respective crop on the same day by randomly selecting ten seedlings for each treatment. All of the seedlings were used as the sample, though, if the germination percentage was less than 10.A sample of seedlings from a treatment for Finally, means separation was performed using Duncan' s method on the average data from the two studies using SAS software (Almodovar *et al*., 1988). A ruler was used to measure the shoot and root length (cm)of the respective crop on the same day by randomly selecting ten seedlings for each treatment. All of the seed ling s were used as the sample, nevertheless, if the germination percentage was less than 10. To measure the lengths of the shoots and roots, seedlings from a treatment were divided into the corresponding plant parts, oven dried for 24 hours at 70°C to a constant weight, and the dry matter of each part was weighed separately using a sensitive electronics balance.

Number of seeds that germinated (number) Finally, means separation was performed using Duncan's Multiple Range Test at 0.05 probability level and analysis of variance was performed using SPSS software on the average data acquired from the two studies.

The average data from the two experiments was then subjected to an analysis of variance using SPSS software, and the means were separated using Duncan's method. The shoot and root lengths (cm) of the respective crop were measured with a ruler on the same day using ten seedlings from each treatment at random. All of the seedlings were used as the sample, nevertheless, if the germination percentage was less than 10. Seedlings were divided into the appropriate plant after samples from a treatment were taken to measure the length soft he shoots and roots.

RESULT AND DISCUSSION

Results showed a difference between weed plant sections, concentration levels, and their interactions for all parameters investigated that was statistically significant (P<0.05) (Table 1). Aqueous extract at 5% and 15% concentration reduced soybean seed germination while in 10% it occurs maximum germination percentage (Fig.1). The seedlings' dry matter, shoot and root growth, and germination rates were all quite low (5% extract) as well. Contrarily, the 5% shoot and root aqueous extract had less of an impact on the germination and growth of the crops, whereas the effects were significantly diminished at high concentrations. Additionally, the results showed at soybean was more susceptible on the allelopathic effect (Table 1).

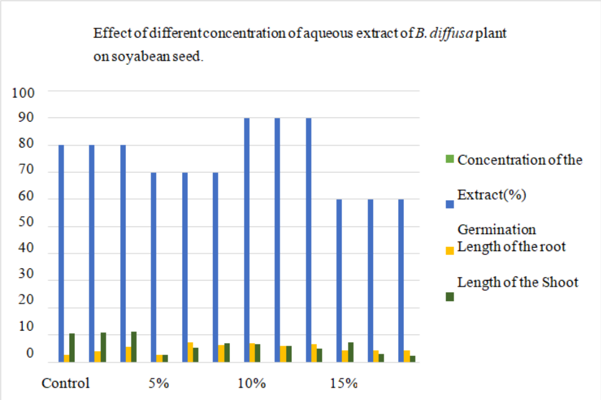

Fig. 1. Variation in the yield of soybean, after weed treatment.

Table 1: Effect of different concentration of aqueous extract of *B. diffusa* plant on soybean seed germination, Shootand Root growth and dry matter production.

Concentrationn of The Extract (%)	Germination				Length of the Root(cm)				Length of the Shoot(cm)				Shoot Weight(g)		Root Weight(g)	
	1	2	3	Average	1	2	3	Average	1	2	3	Average	Dry	Wet	Dry	Wet
Control																
After 3 DAYS	80	80	80	80	3.2	2.1	3.3	2.86	6.6	12.8	12.5	10.6333				
After 6 DAYS	80	80	80	80	4.5	3.5	4.3	4.1	7.4	11.3	14.3	11	0.09	2.22	0.07	0.71
After 9 DAYS	80	80	80	80	6.5	4.4	6.5	5.8	7	13.3	13.3	11.2				
5%																
After 3 DAYS	70	70	70	70	3.1	2.6	2.5	2.73	2	2.4	3.6	2.66667				
After 6 DAYS	70	70	70	70	6.5	7.8	7.6	7.3	4	7.5	4.4	5.3	0.11	1.66	0.04	0.61
After 9 DAYS	70	70	70	70	6.4	7.6	5.5	6.5	8.5	6.5	6.5	7.16667				
10%																
After 3 DAYS	90	90	90	90	6.5	7	7.3	6.93333	7.7	7.8	4.9	6.8				
After 6 DAYS	90	90	90	90	5.5	6.5	6.5	6.16667	7.7	5.3	4.9	5.96667	0.11	1.5	0.5	0.31
After 9 DAYS	90	90	90	90	7.4	5.6	7.4	6.8	7.7	4.1	3.3	5.03333				
15%																
After 3 DAYS	60	60	60	60	6.5	3.1	3	4.2	6.5	7.4	7.8	7.23333				
After 6DAYS	60	60	60	60	6.5	3.2	3.2	4.3	3.1	3	3.4	3.16667	0.13	1.55	0.02	0.21
After 9 DAYS	60	60	60	60	6.4	.	3.5	4.3	3.1	2.1	2	2.4				
F Test				**				**				**	**	**	**	**
SE(+)				3.402				1.2963				0.8495	0.046	0.84	0.007	0.10
CV(%)				17.35				49.98				27.7	28.1	90	11.78	32.6

** = Significant at 0.05 probability level. Means within a column followed by same superscript letter (S) are not significantly differentiate 0.05 probability level. §N GSPD=Number of germinated seeds after 30, 60 and 90 days.

Boerhavia weed aqueous extracts had an allelopathic effect on soybean seed germination, germination rate, shoot and root growth, and the formation of dry matter in seedlings. The portion of the plant from which the extracts were taken and their concentration levels both had an impact on the allelopathic effect. *Boerhavia* aqueous extracts at concentrations of 5, 10, and 15% totally prevented crop shoot and root growth after the seeds were sown. Results showed a *B. difussa* L. plant, concentration levels, and their interactions for all parameters investigated that was statistically significant (P < 0.05). Aqueous extract decreased seed germination and subsequent growth at all concentration levels, including 5 at 10%, 15%.

All plant components displayed allelopathic effects, however the effects differed between the different plant parts. This is attributed to the exudation (Mersie and Singh 1987) and leaching (Adkins and Sowerby 1996; Evans, 1997; Belz *et al*., 2007; Kanchan, 1980) of various types of phytotoxic compounds, including phenolics, sesquiterpenes, and lactones, from the root and vegetative part of living plants as well as from the achene, respectively. In terms of soybean seed germination, germination rate, shoot and root growth, and dry matter production of seedlings, aqueous extracts of the *Boerhavia* weed showed allelopathic effects. The portion of the plant from which the extracts were taken and their concentration levels both had an impact on the allelopathic effect. *Boerhavia* aqueous extracts at 5, 10 and 15% Aqueous extracts of all concentration levels and intermediate and higher concentration levels generated the most allelopathic effects, as determined by complete failure of germination and seedling growth, the current investigation also demonstrated. This might be because these plant components have higher concentrations of inhibitory chemicals than shoots and roots (Qasem, 1995). All plant components displayed allelopathic effects, however the effects differed between the different plant parts (Table 1). This is ascribed to the production of many types of phytotoxic chemicals, including sesquiterpenes, lactones, and phenolics, from living things' roots and vegetative parts. According to the findings of and soybeans appeared to be more susceptible to the allelopathic effect than shoots. This might be as a result of the root coming into direct touch with the extracts and then with inhibitory chemicals (Tamado *et al*., 2002). Allelochemicals may be responsible for the shorter seedling roots because they slow down cell division, which could interfere with gibberellins and indoleacetic acid activity (Tomaszewski and Thimann 1966). Aqueous extracts of all concentration levels and intermediate and higher concentration levels generated the most allelopathic effects, as determined by complete failure of germination and seedling growth, the current results of this study showed that weed has an allelopathic effect on soybeans, as shown by its inhibitory effect on seedling growth and dry matter production as well as its inhibitory effect on germination and germination rate. Similar findings have been found for several crops including *Eragrostis tef* (Zuccagni) Trotter., *maize, sorghum*, pumpkin (*Cucurbita moschata*), tomato multipurpose trees, and arable crops (Tomaszewski and Thimann 1966). Weed has the ability to limit seed germination and seedling growth, according to the results of the current preliminary laboratory experiment. Allelopathy Allelochemicals are secondary plant metabolites that are phytotoxic and they have been identified from different plants. The exudates or leachates of many weedy plants are toxic to the growth of crop plants. The phytotoxins or allelochemicals of many plants added to the soils through root exudates or leaf leachates reduce the yield of crop plants. Most investigators have shown that the allelopathic interactions between the crop and weeds were responsible for loss in crop yield. Research on allelopathy has focused on the interactions' among weeds and crops (Kalita and Dey 1998; Khalaf *et al.*, 1998; Prasad *et al.*, 1999) among weeds (Hwang *et al.*, 1997; Tiwari *et al.*, 1998) between crop species (Kleing and Milller 1980; Almezori *et al.*, 1999) and interactions among trees and crops/weeds (Eyani *et al.*, 1996; Kaur and Rao 2000; Reigosa *et al.*, 1999).

CONCLUSIONS

A liquid extract reduced soybean seed germination occurs at 5% and 15% concentrations, while maximum germination occurs at 10%. The results of the current investigation demonstrate that *Boerhavia difussa* L. has the ability to be allelopathic to *Glycine max* L. The different phyto-toxic chemicals found in plant extracts are primarily responsible for the allelopathic action of the extracts, which may alone or collectively contribute to the plant growth regulating impact. Additional research is essentially necessary to a pinpoint the extracts' active ingredients that are in charge of this activity (Bhardwaj *et al*., 2014).

Boerhavia difussa prevented soybean from sprouting and growing. These results are important since preventing germination and growth results in lower productivity. Therefore, it is important to take into account interactions between weeds and crops. *Boerhavia difusa* experimentation with petridish and marijuana yielded a range of results. Therefore, it is crucial to confirm any in vitro results with further greenhouse and field studies that account for the various natural conditions that plants encounter while developing without human intervention. Additionally, additional research must be done on the allelopathic stress of these species under various climatic and soil conditions, as well as how to quantify the molecules that cause this stress (Sidhu *et al*., 2023).

FUTURE SCOPE

The agricultural sector will be significantly impacted by the allelopathic effects of *Boerhavia diffusa* L. aqueous extracts on soybean (*Glycine max* L.) seed germination, shoot and root growth, and dry matter output. There are a number of scientific future prospects that can be recognised when more research on this subject is undertaken.

The precise chemicals responsible for the allelopathic effects of *Boerhavia diffusa* L. aqueous extracts on soybean development could, however, be the subject of in-depth research. Researchers can learn more about these compounds' mechanisms of action and potential as organic herbicides or plant growth promoters by isolating and characterizing them. To ascertain the ideal dosage and application techniques for *Boerhavia diffusa* L. aqueous extracts in soybean growing, more scientific investigation may be carried out. For farmerswishing to include this natural extract in their crop management techniques, this knowledge might be used to create useful recommendations.

Studies on the potential impacts of *Boerhavia diffusa* L. aqueous extracts on other plants and crops could be conducted. Researchers can apply novel applications and possibly beneficial consequences for agricultural systems by deepening our understanding of the broad-spectrum effects of this extract. Future research should focus on the possible commercialization of *Boerhavia diffusa* L. aqueous extractsas a natural herbicide or plant growth promoter. There may be a developing market for natural substitutes for synthetic herbicides and fertilizers as consumers show more interest in ecologically friendly and sustainable goods. Therefore, it is crucial for science to comprehend the extract's commercial feasibility in the future.

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