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Bioefficacy of Weed Based Extracts in the Control of Rhizoctonia Root Rot Disease of Buckwheat

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ABSTRACT

Buckwheat (*Fagopyrum* sp) is a dicotyledonous crop widely cultivated in the Himalayan regions. The seeds of buckwheat are highly proteinaceous and possess high nutraceutical properties. One of the major advantages of using its flour is the absence of gluten. Therefore, it can be used in the diet of people suffering from celiac disease. However, the root rot in buckwheat caused by a fungal pathogen *Rhizoctonia solani* is a limiting factor in growing this crop. Eco-friendly and cost effective plant based extracts are replacing synthetic chemicals in pathogen control. The present study reports the use of weed based botanicals, i.e. *Ricinus communis* and *Datura metel,* in control of the pathogen and thus recovering the yield loss in buckwheat. Our preliminary *in vitro* experiment revealed better inhibition of pathogen by *Ricinus communis* ethanolic extract when compared to *Datura metel*. This work further validates the role of bioactive compounds in disease control and management.

Keywords: Alkaloids, Bioactive compounds, Buckwheat, *Datura metel, Rhizoctonia solani*, *Ricinus communis.*

INTRODUCTION

Buckwheat (*Fagopyrum esculentum* Moench, Polygonaceae) is a crop which holds tremendous agronomic and nutritional benefits. It is a short duration crop and does not require much soil management. Buckwheat is well suited to cold arid environment of Himalayas. The seeds are extremely beneficial for human health as they contain a fair amount of good quality protein with high lysine content, is an excellent source of dietary fiber, a rich source of vitamin C and nutritionally important minerals, which perform important metabolic functions in the body. Buckwheat is used in preparing pancake mixes as well as in various breads. It is often blended with wheat flour for use in bread, pasta products, and some breakfast cereals (1). Buckwheat hulls are used in aromatherapy products and as fillers in pillows and comforters (2).

Buckwheat seeds are a source of essential fatty acids (oleic, linoleic and linolenic acid) and

Even though the crop is endowed with high medicinal, nutraceutical and industrial value, it is still an underutilized crop. Various issues such as change in food habits, changing cropping patterns and improved economic conditions are further leading to a drastic decline in buckwheat cultivation in the hills (5). However, one of the major causes in the decline of crop production is the fungal disease, '*Rhizoctonia* root rot' caused by *Rhizoctonia solani*, a soil borne pathogenic fungus. The soil moisture in the hilly terrain is favourable for such fungal infection. Earlier studies have reported occurrence of *Rhizoctonia solani* AG-1C group that affected the buckwheat crop in the Nepal hills (6).

Rhizoctonia solani is a soil borne pathogen with highly competitive saprophytic activity (7). Therefore, continuous application of fungicides becomes imperative, especially in organic soil where organic matter is usually high. The disease management strategies currently adopted include use of synthetic chemicals such as Bromopal, copper oxychloride, zinc sulphate, magnesium sulphate, and Bordeaux paste with Streptocycline antibiotic (8). However, use of such chemicals poses a threat to environment which results in several environmental, ecological and human health problems. Hence, there is an urgent need to develop an alternative cost effective, environmentally safe, and eco-friendly method for management of the disease.

The use of herbal plant extracts as biocontrol agents is gradually becoming a method of choice in management of plant diseases as these are more eco-friendly and safe. Plant extracts, as potential antifungal substance, have been explored against several fungal diseases (9). Tapwal, et al (10) have reported antifungal activity of plant extracts against five phytopathogens, of which *Cannabis sativa* extract showed maximum inhibitory potential for *Curvularia lunata*. There are reports on use of bioactive plant extracts in control of *Rhizoctonia solani* (10, 11). Recently, Sadda and Verma have reported potential role of *Ricinus communis* in root rot control of Sponge Gourd (12). So, it would be worthwhile to evaluate the efficacy of certain weeds such as *Ricinus communis*, *Datura metel* etc. in control of the fungal pathogen.

METHODOLOGY

Plant Material:

Buckwheat (*Fagopyrum tataricum*) seeds were procured from the local market in Ranikhet, Uttarakhand.

Fungal Culture:

The fungal (*Rhizoctonia solani* AG-1C) culture was procured from NCIPM, National Research Centre on Plant Biotechnology, Pusa, New Delhi. The culture was further maintained in PDA petriplates and stored at low temperature for preservation.

Preparation of Weed Extract:

Leaves of the weeds (*Ricinus communis* and *Datura metel*) were collected and washed thoroughly using tap water to remove any dirt and then blotted dry (Fig I a & b). The leaves were dried at room temperature (34ºC) for a week to prepare 'dried leaf extract' in organic solvent ethanol (AR, 98% purity), The dried leaves were homogenized into a fine paste to prepare the extract (3 gm in 50 ml ethanol), which was kept on stirrer for two hours and then filtered through muslin cloth to obtain ethanolic extract (Fig Ic). The extract was further diluted to 100, 250, 500 and 1000 ppm concentrations.

a) b) c)

Figure I: Dried leaves of –
a) *Datura metel* b) *Ricinus communis* c) Ethanolic extracts prepared from the weeds

Experimental set up:

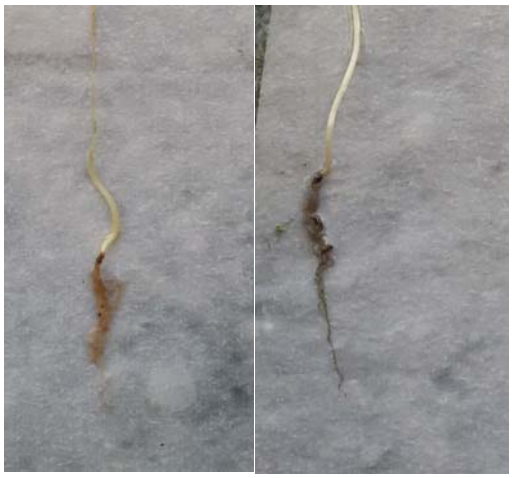
The Buckwheat seeds were surface sterilized with 0.1% $HgCl_2$ solution and thoroughly washed thrice with distilled water. Then the seeds were sown in a sterilized plastic tray containing autoclaved cocopeat and were allowed to germinate for seven days. The buckwheat seedlings were rinsed off the cocopeat and each seedling was added to three test tubes labelled as Control [C, only distilled water], Suspension 1 [S1, 1 mm fungal mat mixed in 100 ml water] and Suspension 2 [S2, tube with Suspension1 and weed extract]. Four replicates were performed in each experimental set up of C, S1 and S2. After three more days the shoot length, root length and colour of the root were recorded. Then the botanical extracts (*Datura metel* and *Ricinus communis*) were added to the tubes containing fungal suspension [S2]. Further, all the test tubes containing Suspension 2 [S2] were treated with weed extract at different concentrations of 100, 250, 500, 1000 ppm (in triplicates for each concentration). The readings were taken after three, five and seven days consecutively. The colour of the root, shoot length and root length were recorded in both control and treated [S1 and S2] seedlings. The setup was made in replicates.

RESULTS AND DISCUSSION

Plant extracts known as botanicals have been reported to contain bioactive components. In our study, the results showed that the plant extracts are effective in significantly reducing the

fungal infection in buckwheat (Table 1). Of the two extracts used, *Ricinus communis* extract was found to be the better bioactive extract in control of the *Rhizoctonia* fungal pathogen.

Earlier studies have reported role of flavonoids and tannins in *Ricinus communis* as antibacterial agents (13). Recent study by Onaran (14) studied effect of plant extracts with antifungal activities against *Rhizoctonia solani* and found *Ricinus communis* to be a potential plant. It was clearly observed after three days of addition of suspension [S1] to the buckwheat seedlings, the root rot symptoms started to appear on roots (Figure II). The colour of root changed to dark brown and some brown lesions were observed on the root. Further, the addition of weed extract in different concentrations led to decrease in severity of symptoms on the root surface. The bioactive extract prepared from *Ricinus communis* was found to be better when compared to *Datura metel* (Table I).



(a) (b)

Figure II: Roots of buckwheat seedlings
a) Control root
b) *Rhizoctonia solani* infected root

Table I: Variation in shoot length, root length and colour of the root in response to treatment with fungal culture and fungal culture + weed extract (*Ricinus communis*).

0 day			
	Root colour	**Shoot length (in cm)**	**Root length (in cm)**
Control	Light Brown	14.1±0.12	4.3±0.12
Suspension	Light Brown	13.8±0.20	4.2 ±0.15
3 days			
	Root colour	**Shoot length (in cm)**	**Root length (in cm)**
Control	Light Brown	14.3±0.10	4.4±0.12
Suspension	Dark Brown	13.5±0.12	3.8±0.12
(*Ricinus communis* extract) [S2]			
3 days			
100 ppm	Dark Brown	13.5±0.15	3.8±0.23
250 ppm	Dark Brown	12.1±0.12	3.8±0.15

500 ppm	Dark Brown	10.7±0.12	3.7±0.06
1000 ppm	Dark Brown	11.8±0.15	3.9±0.06
5 days			
100 ppm	Dark Brown	13.8±0.12	3.8±0.15
250 ppm	Dark Brown	12.5±0.06	4.0±0.10
500 ppm	Light Brown	11.0±0.12	4.0±0.12
1000 ppm	Light Brown	11.5±0.15	4.4±0.12
7 days			
100 ppm	Dark Brown	14.0±0.12	4.0±0.12
250 ppm	Dark Brown	13.0±0.12	4.2±0.12
500 ppm	Light Brown	11.0±0.15	4.2±0.12
1000 ppm	Light Brown	12.0±0.12	4.7±0.15

The highest concentration i.e. 1000 ppm showed best results in control of fungal pathogen. The results showed increase in root length after treatment with weed extract (4.7 cm) when compared to length in suspension S1(3.9 cm). The shoot length did not show consistent length variation. At this stage it is not clear whether the fungal infection has any effect on shoot length as *R. solani* infects the root mainly. However, the root length increase is in sync with the proposed weed extract effect. Additionally, the colour of the root recovered from dark brown to light brown due to decrease in severity of infection.

CONCLUSIONS

The buckwheat plant is prone to root rot disease caused by the fungal growth of *Rhizoctonia solani*. This affects the crop yield and thereby results in poor economic returns to the farmer. It is suggested that instead of using chemical based pesticides to suppress the fungal growth, environmental friendly alternatives should be explored. The use of weed based botanicals proposes to be a promising initiative to suppress the fungal growth and enhance crop yield. Ethanol weed extract of *Ricinus communis* was found to be an efficient botanical to inhibit *Rhizoctonia solani* growth under *in vitro* conditions.

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