

## Allelopathic effects of medicinal plant species on seed germination and seedling growth of wheat varieties

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### ABSTRACT

*Allelopathic effect of three medicinal plant species viz. Costus speciosus, Tinospora cordifolia and Coleus forskohli was examined on seed germination and seedling growth of four popular varieties (Pusa gold, HD2733, VL-914, RSP 561) of wheat (Triticum aestivum L.). The aqueous leaf extracts reduced the seed germination and seedling growth of wheat. On the basis of value of per cent reduction in seed germination and germination relative index (GRI), the inhibitory effect of different leaf extracts was maximum in susceptible varieties (VL-914 & RSP 561) followed by tolerant varieties (Pusa gold & HD2733). The root and shoot length, root and shoot dry weight declined with the increase in the concentration of the extracts of all the three medicinal species. Leaf extract of these medicinal species also showed inhibitory effect on sugar and protein levels but stimulatory effect on total amino acid contents of wheat seedlings. The results indicated that the allelopathic effect of leaf extracts of Coleus forskohlii was maximum in terms of all studied physiological and biochemical parameters.*

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### INTRODUCTION

*Costus speciosus, Tinospora cordifolia and Coleus forskohlii* are important medicinal plant species occurring naturally in almost all the places of Bihar and north eastern India. Allelopathy is regarded as a biochemical warfare. Plants inhibit the seed germination and growth of other plants by means of producing toxic chemicals i.e. Allelochemicals or allelopathins. International

Allelopathy Society in 1996 broadened its definition as "Allelopathy refers to any process involving secondary metabolites produced by plants, microorganisms, viruses and fungi that influence the growth and development of agricultural and biological systems excluding animals". Therefore the role of allelochemicals in agro – ecosystem has attracted the attention of numerous workers. Several aromatic and medicinal plants which produce and store large amounts of secondary metabolites passively have pronounced effect on the growth and distribution of flora in their vicinity but very little work has been done in these areas. Mathela (1994) reported that the secondary metabolites (flavonoids, glycosides, steroids and diterpenoids) of some medicinal and aromatic plants accounted for allelopathic activity likewise,

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Alagesaboopathi (2011) studied allelopathic effect of medicinal plants *Andrographis paniculata* which showed inhibition in germination and seedling growth of *Lens culinaris* (Chatterjee et al. 1988). Various parts of *Costus speciosus* are used in fever, dropsy, anasarca, gravel, cholera, phitis and bronchial asthma (Asolkor et al. 1992). The stem of *T. cordifolia* is one of the constituents of several ayurvedic preparations used in general debility, dyspepsia, fever and urinary diseases (Singh et al. 2003).

Hence, laboratory experiment was undertaken to study the behaviour of *Costus speciosus*, *Tinospora cordifolia* and *Coleus forskohlii* leaf extracts on germination and seedling growth of *Triticum aestivum* L.

## MATERIALS AND METHODS

The experiment was conducted during Rabi season in the Department of Botany and Plant Physiology laboratory, Faculty of Basic Sciences and Humanities, Rajendra Agricultural University, Pusa, Samastipur, Bihar. Leaves of the three test species of medicinal plants were shade dried for 10 days, then powdered in grinders and sieved. For making leaf extract, 15 g leaf powder was soaked in 100 ml distilled water for 24 hours to get 15% extract. By dilutions with distilled water 5, 10 and 15% concentrations of extracts were prepared. Seeds of *Triticum aestivum* were surface sterilized with 0.1% mercuric chloride for 2.0 minutes and repeatedly washed with sterilized distilled water. The seeds were soaked in different concentrations of extracts for 24 hours before planting on to the moist filter paper lined in petridishes and kept at  $20 \pm 2^\circ\text{C}$  in BOD incubator with three replications. The germination relative Index (GRI) was calculated according to the formula given by Srivastava and Saren [14]:  $\{ \sum x_n (h-n) \}$ , where  $X_n$  = number of seeds germinated on nth count,  $h$  = total number of counts,  $n$  = count number. Seven-day-old wheat seedlings were used for the extraction and determination of carbohydrates as reducing sugar according to the method of Miller [9], soluble protein by method of Singh [12] and for total free amino acids by the method outlined by Lee and Takahashi [6].

## RESULTS AND DISCUSSION

The values of germination and GRI of seeds after 7 days are presented in Table 1. On increasing the concentration of aqueous leaf extracts of all the three species the seed germination percentage of Pusa Gold, HD2733, VL-914 and RSP561 varieties of wheat were significantly declined. However, lower concentration (5%) of leaf extracts of *Costus speciosus* did not show a significant adverse effect on germination when compared to control. Higher and significant decline in germination in VL-914 and RSP561 was noted in comparison to Pusa Gold and HD2733. Minimum germination was found in VL-914 and RSP561 in comparison to Pusa Gold and HD2733. The GRI values were maximum in control for seeds of all the four wheat varieties and decreased with increase in the concentration of leaf extracts of all the three medicinal plant species. The interaction between treatments and varieties was found significant ( $p < 0.05$ ). Rietveld [12] has also observed that allelopathic effect of juglone on germination and growth of several herbaceous and woody species. Kaur and Rao [15] found similar results on germination of various crops with increase in leaf leachate concentration.

Root length and shoot length invariably decreased as the level of leaf extract increased (Table 2). Maximum value of root and shoot length was recorded in distilled water treatment (control). The maximum inhibition in root length and shoot length occurred when seeds were treated with *Coleus forskohlii* leaf extract followed by *Tinospora cordifolia* and *Costus speciosus* extracts. The suppression followed the order: *Coleus forskohlii* > *Tinospora Cordifolia* > *Costus speciosus*. As compared to germination and shoot growth, the inhibition was more pronounced in root growth. Leaf extracts of all the medicinal species except *Costus speciosus* significantly inhibited root and shoot length. The greater inhibition in root and shoot growth as compared to germination of seeds, observed in this study was in accordance with earlier findings [4]. Such an effect of leaf extracts was also reported by Prasad et al. [11] and Alagesaboopathi [1]. The effects on different growth parameters of wheat seedlings were concentration dependent and statistically significant ( $P < 0.5$ ).

**Table 1. Effects of aqueous leaf extracts of *Costus speciosus* (S1), *Tinospora Cordifolia* (S2) and *Coleus forskohlii* (S3) on germinations and germination relative index (GRI) in wheat seed**

Treatment	Wheat Genotypes	Germination (%)			GRI		
		S <sub>1</sub>	S <sub>2</sub>	S <sub>3</sub>	S <sub>1</sub>	S <sub>2</sub>	S <sub>3</sub>
0 %	Pusa Gold	100.00	100.00	100.00	402.00	402.00	402.00
	HD- 2733	99.00	99.00	99.00	389.00	389.00	389.00
	VL – 914	100.00	99.00	100.00	402.00	389.00	400.00
	RSP 561	99.00	100.00	99.00	389.00	385.00	383.00
	Mean	99.5	99.5	99.5	339.5	391.2	393.5
5%	Pusa Gold	98.0	98.0	97.0	385.0	383.0	380.0
	HD- 2733	96.0	95.0	95.0	370.0	366.0	362.0
	VL – 914	95.0	94.0	94.0	368.0	360.0	364.0
	RSP 561	94.0	93.0	93.0	352.0	345.0	338.0
	Mean	95.7	95.0	94.7	368.7	363.5	361.0
10%	Pusa Gold	93.0	94.0	93.0	364.0	364.0	360.0
	HD- 2733	92.0	92.0	91.0	348.0	344.0	340.0
	VL – 914	91.0	90.0	90.0	355.0	346.0	346.0
	RSP 561	89.0	88.0	88.0	342.0	338.0	336.0
	Mean	91.2	91.0	90.5	352.2	348.0	345.5
15%	Pusa Gold	88.0	87.0	87.0	348.0	346.0	340.0
	HD- 2733	86.0	85.0	85.0	335.0	332.0	320.0
	VL – 914	84.0	83.0	83.0	336.0	329.0	324.0
	RSP 561	82.0	81.0	80.0	324.0	315.0	307.0
	Mean	85.0	84.0	83.7	335.7	330.5	322.7
LSD (0.5)							
Treatment (T)		1.5	1.0	2.0	6.2	5.4	5.3
Variety (V)		1.3	1.8	1.8	5.3	4.7	4.5
Interaction (TXV)		0.8	1.5	1.2	3.6	3.2	3.1

**Table 2. Allelopathic effect of aquesus leaf extract of *Costus speciosus* (S1), *Tinospora Cordifolia* (S2) and *Coleus Forskhlii* (S3) on growth parameters of wheat seedlings**

Treatment	Wheat Genotypes	Root length (cm)			Shoot length (cm)			Root dry weight (mg)			Shoot dry weight (mg)		
		(S1)	(S2)	(S3)	(S1)	(S2)	(S3)	(S1)	(S2)	(S3)	(S1)	(S2)	(S3)
0%	Pusa Gold	8.4	8.4	8.4	12.6	12.5	12.5	15.7	15.7	15.7	52.1	52.1	52.1
	HD2733	8.3	8.2	8.2	12.0	12.3	12.2	15.6	15.6	15.5	52.0	52.0	52.0
	VL 914	8.2	8.0	8.0	11.9	12.0	12.1	15.4	15.4	15.4	51.8	51.8	51.8
	RSP561	8.2	7.9	7.9	11.9	11.9	11.8	15.3	15.3	15.2	51.6	51.5	51.4
	Mean	8.3	8.1	8.1	12.1	12.2	12.0	15.5	15.5	15.4	51.9	51.8	51.8
5%	Pusa Gold	8.0	7.9	7.9	12.1	11.8	11.7	15.0	14.8	14.8	50.5	50.4	50.3
	HD2733	7.8	7.7	7.6	11.5	11.7	11.4	14.9	14.7	14.4	50.1	49.9	49.8
	VL 914	7.6	7.3	7.2	11.1	11.2	11.2	14.4	14.3	14.3	49.2	49.1	48.9
	RSP561	7.5	7.1	7.0	11.0	11.0	11.2	14.2	14.0	13.8	48.7	48.5	48.1
	Mean	7.7	7.5	7.4	11.4	11.4	11.4	14.6	14.4	14.3	49.6	49.5	49.3
10%	Pusa Gold	7.7	7.7	7.6	11.9	11.8	10.9	14.1	14.0	13.9	48.9	48.7	48.6
	HD2733	7.6	7.4	7.3	10.7	11.4	11.2	13.9	13.7	13.5	47.7	47.4	47.2
	VL 914	7.4	7.2	7.1	10.8	10.8	10.8	13.6	13.3	13.2	47.0	46.3	46.0
	RSP561	7.3	7.0	6.9	10.6	10.6	10.4	13.3	13.0	12.8	46.8	46.1	45.7
	Mean	7.5	7.3	7.2	11.0	11.1	10.8	13.7	13.5	13.3	47.6	47.1	46.9
15%	Pusa Gold	7.6	7.5	7.5	11.3	11.2	11.1	13.6	13.3	13.1	48.1	47.0	47.9
	HD2733	7.4	7.3	7.2	10.7	10.7	10.5	13.2	12.9	12.6	47.6	47.4	47.0
	VL 914	7.2	6.9	6.9	10.4	10.2	10.1	12.6	12.4	12.1	46.9	46.6	46.2
	RSP561	6.9	6.5	6.4	10.2	9.9	9.8	12.0	11.8	11.4	46.0	45.7	45.0
	Mean	7.3	7.0	7.0	10.6	10.5	10.4	12.8	12.6	12.3	47.1	46.7	46.5
LSD (0.5)													
Treatment (T) :		0.8	0.9	0.8	0.8	0.8	0.8	0.8	0.8	0.7	1.8	1.8	1.8
Variety (V):		0.7	0.8	0.7	0.8	0.7	0.7	0.7	0.7	0.7	1.6	1.5	1.6
Interaction (TXV):		0.5	0.6	0.6	0.6	0.5	0.6	0.3	0.5	0.5	1.1	1.1	1.1

**Table :- 3 Allelopathic effect of aqueous leaf extracts of *Costus speciosus* (S1) *Tinospora Cordifolia* (S2) and *Coleus forskohlii* (S3) on carbohydrate and protein metabolism of wheat seedlings.**

Treatment	Wheat Genotypes	Reducing sugar (mg/ gd. W)			Non reducing sugar (mg/gd.w)			Protein (mg/gd.w)			Total gmino acid (mg/gd.w)		
		(S1)	(S2)	(S3)	(S1)	S2)	S3)	(S1)	(S2)	S3)	(S1)	(S2)	(S3)
0%	Pusa Gold	27.0	27.0	26.9	30.2	30.2	30.1	43.4	43.4	43.4	22.0	22.0	22.0
	HD2733	26.9	26.9	26.8	30.1	30.1	30.0	43.3	43.2	43.2	21.8	21.7	21.7
	VL 914	26.7	26.7	26.6	29.8	29.8	29.8	42.9	42.9	42.8	21.6	21.6	21.5
	RSP561	26.5	26.4	26.3	29.6	29.6	29.6	42.9	42.8	42.7	21.5	21.4	21.4
	Mean	26.8	26.7	26.6	29.9	29.9	29.9	43.1	43.0	43.0	21.7	21.6	21.6
5%	Pusa Gold	25.8	25.6	25.5	28.7	28.6	28.4	41.4	41.2	41.0	31.9	31.8	31.9
	HD2733	25.6	25.3	25.1	28.5	28.5	28.2	41.2	40.8	40.7	32.2	32.3	32.2
	VL 914	25.1	24.9	24.6	27.5	27.4	27.3	40.5	40.2	39.9	33.4	33.6	33.7
	RSP561	24.8	24.6	24.2	27.1	27.0	26.9	40.3	39.9	39.5	33.5	33.6	34.4
	Mean	25.3	25.1	24.8	28.0	27.9	27.7	40.8	40.5	40.3	32.7	32.8	33.0
10%	Pusa Gold	24.9	24.6	24.4	27.2	27.1	26.9	39.1	39.0	38.8	35.2	35.3	35.3
	HD2733	24.7	24.5	24.2	27.0	26.9	26.7	38.9	38.7	38.4	35.7	35.8	35.9
	VL 914	24.2	23.8	23.9	26.4	26.3	26.2	37.8	37.6	37.3	36.9	36.8	37.0
	RSP561	24.1	23.4	23.0	26.0	25.9	25.7	37.5	37.4	37.0	36.8	36.9	37.0
	Mean	24.5	24.1	23.9	26.6	26.5	26.4	38.3	38.2	37.9	36.1	36.2	36.3
15%	Pusa Gold	24.4	24.2	24.0	26.0	25.9	25.7	37.9	37.1	36.8	37.8	37.9	38.0
	HD2733	24.1	23.9	23.8	25.9	25.8	25.4	37.0	36.8	36.4	38.3	38.0	38.4
	VL 914	23.2	23.0	22.8	25.5	25.4	25.1	36.4	36.3	35.8	38.9	40.1	40.2
	RSP561	22.7	22.4	22.1	25.1	25.0	24.7	36.2	35.7	35.2	39.2	40.3	40.5
	Mean	23.5	23.4	22.7	25.6	25.5	25.2	36.9	36.5	36.0	38.5	39.1	39.3
LSD (0.5)													
Treatment (T)		1.6	1.5	1.4	1.5	1.5	1.5	1.3	1.4	1.2	1.2	1.4	1.2
Variety (V)		1.4	1.3	1.2	1.3	1.3	1.3	1.2	1.2	1.1	1.0	1.3	1.1
Interaction (TXV)		1.0	0.9	0.9	0.9	0.9	0.9	0.8	0.9	0.8	0.7	0.9	0.8

Dry weight of root and shoot of the seedling of different varieties of wheat were also significantly decreased as the concentrations of leaf extracts of the test species was increased. Maximum values of root and shoot dry weight were recorded in Pusa Gold and HD2733 seedlings followed by VL-914 and RSP561 (Table 2). The percent in reduction in biomass was maximum in VL-914 and RSP561 variety seedlings treated with *Coleus forskohlii* leaf extracts followed by *Tinospora cordifolia* and *Costus speciosus* leaf extracts. The inhibitory effect of different leaf extracts on root and shoot dry weight of different varieties of wheat followed the order *Coleus forskohlii* > *Tinospora cordifolia* > *Costus speciosus*. This reduction may be caused due to phytotoxic activity of phenolics present in the leaf extracts as reported in many previous studies [10, 15].

The level of reducing and non-reducing sugar was more in control than in the treated seedlings. The level was higher in Pusa Gold and HD 2733 as compared to VL – 914 and RS P561 varieties (Table 3). On increasing the concentration of the leaf extracts of *Costus speciosus*, *Tinospora cordifolia* and *Coleus forskohlii*, the sugar contents of different varieties of wheat declined. Minimum sugar content was found in *Coleus forskohlii* treated seeds in comparison to seeds exposed to *Tinospora cordifolia* and *costus speciosus* leaf extracts. Less sugars might be a consequence of reduced starch hydrolysis with increase in leaf extract concentrations. Mandal, et al. [7] also observed that sugar contents of rice seedlings decreased with increase in leachate concentration. The leaves of *Costus speciosus* contained maximum quantity of protein followed by *Tinospora cordifolia* in minimum

in *Coleus forskohlii* (Table 3). The Protein content decreased linearly with increase in leaf extract concentration in the same way as reported by Prasad et. al. [11] when wheat seedlings were treated with walnut leaf extract. The concentration of total amino acids present in the wheat seedlings raised from seeds treated with leaf extracts of *Costus speciosus*, *Tinospora cordifolia* and *Coleus forskohlii* were higher than the concentration in seedlings grown in control condition and increase further with increase in concentration of leaf extracts of medicinal plants. Species irrespective of wheat varieties. However, the increase was significantly higher in VL- 914 and RSP 561 in comparison to Pusa Gold and HD- 2733. Similar effect was observed by Mandal et al. [7] and Prasad et al [11]. The interaction between treatments and varieties for protein and total amino acids were highly significant ( $P < 0.05$ ).

The results of the present study indicated the allelopathic effect of three medicinal plant species in the order: *Coleus forskohlii* > *Tinospora cordifolia* > *Costus speciosus* on seed germination and seedling growth of different varieties of wheat. Analyses of toxic chemical present in the leaf leachates and field experiments are, however, necessary before any final conclusions are drawn on allelopathic effect of these medicinal plants species.

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