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Allelopathc Effects of Medicinal Plant Species on Seed Germination and Seedling Growth of Wheat Varieties

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Authors' contributions

This work was carried out in collaboration between all authors. All authors read and approved the final manuscript.

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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 (Pusa gold, HD2733, VL-914, RSP 561) popular wheat (*Triticum aestivum L.*) Varieties. The aqueous leaf extracts reduced the seed germination and seedling growth of wheat. The value of percent reduction in seed germination and relative germination index (GRI), 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 leaf extracts of all the three medicinal species. Leaf extract of all three species showed inhibitory effect on sugar and protein and a stimulatory effect on total amino acid contents of the wheat seedling. The results indicated that the allelopathic effect of leaf extracts of *Coleus forskohlii* was maximum in terms of all physiological and biochemical parameters.

Keywords: Allelopathic effect; medicinal leaf extracts; wheat; germination and seedling growth.

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HIGHLIGHTS

- *Two tolerant varieties e.g. Pusa Gold & HD2733 and two susceptible varieties e.g. VL-914 & RSP561 are selected in high aqueous concentration of allelopathic effects of three medicinal plant species.*
- *Among 12, 4 varieties of wheat are obtained for a relevant result.*

1. 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 also regarded as a biochemical warefare [1]. Plants inhibit the seed germination and growth of other plants by means of producing toxic chemicals i,e. Allelochemicals or allelopathy. International Allelopathy Society in 1996 broadened its definition "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". Chemicals from the growth of adjacent plants, therefore the role of allelochemicals in agro – ecosystem has attracted the attention of numerous Scientists. 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 [2] reported that the secondary metabolites (flavonoids, glycosides, steroids and diterpenoids) of some medicinal and aromatic plants accounted for allelopathic activity likewise, Alagesaboopathi [3] studied allelopathic effect of medicinal plants *Withania sominifera* which showed inhibition in germination and seedling growth of Wheat [4]. Various parts of keokand plant are used in fever, dropsy, anasarca, gravel, chotera, phitis and bronchial asthma [5]. The stem of *T. cordifolia is* one of the Constituents of several Ayurvedic preparations used in general debility, dyspepsia, fever and urinary diseases [6].

Hence, laboratory experiment was undertaken to study the behaviour of phytochemicals present in *Costus speciosus, Tinospora cordifolia* and *coleus forskohlii* extracts in germination and seedling growth of *Triticum aestivum L.* Hence, the present study was carried out to determine the allelopathic effects of medicinal plants species on *Triticum aestivum L.* This study was conducted under laboratory conditions.

2. MATERIALS AND METHODS

The experiment was conducted during Rabi season of 2012 in the Department of Botany and plant physiology laboratory, Faculty of Basic Sciences and Humanities, Rajendra Agricultural University, Pusa, Samastipur, Bihar. There was shade dried for 10 days, then powdered in grinders and sieved. For 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 sterilised with 0.1% mercuric chloride for 2.0 minutes and repeatedly washed with sterilised distilled water. The seeds were soaked in different concentrations of extracts for 24 hours. The experiment was done in 11 cm dia petri dishes with blotting paper and kept 20 ± 2ºC in BOD incubator under controlled conditions with three replications. The germination relative Indix (GRI) was calculated according to the formula given by Srivastava and Saren [7]: {xn (h-n), where Xn = 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 [8], Singh [9] for soluble protein and lee and Takahashi [10] for total free amino acids.

3. 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 germination percentage of Pusagold, HD2733, VL-914 and RSP561 varieties of wheat seeds significantly declined. However, lower concentration (5%) of leaf extracts of *Costus speciosus* did not show significant adverse effect on germination when compared to control. Higher and significant decline in germination from control in VL-914 and RSP651 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

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

Treatment		Germination (%)			GRI		
	Wheat genotypes	S_1	S_2	S_3	S_1	S_2	S_3
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 group parameters of wheat

Treatment	Wheat genotypes	Root length (cm)			Shoot length (cm)			Root dry with (mg)			Shoot dry wlight (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	11.42	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 ad protein metabolism of wheat

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

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 [11] observed that allelopathic effect of juglone on germination and growth of several herbaceous and woody species. Kaur and Rao [12] 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). The maximum value of root and shoot length was recorded in distilled water (control). The maximum inhibition in root length and shoot length occured when treated with C*oleus forskohlii* leaf extract followed by *Tinospora cordifolia* and minimum was in *Costus speciosus.* The suppression followed the order: C*oleus 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 length 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 [13]. Such an effect of leaf extracts was also reported by Prasad et al. [14] and Alagesaboopathi [3]. The effects on different growth parameters of wheat seedlings were concentration dependent and statistically significant ($P<0.5$).

Dry weight of root and shoot of different varieties of wheat significantly decreased as the concentrations of leaf extracts of all the test medicinal plant species increased. In each leaf extract concentration segment maximum values of root and shoot dry weight were recorded 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 by the order *Coleus forskohlii* > *Tinospora cordifolia*> *Costus speciosus*. This reducation may be due to the phytotoxic activity of phytochemicals present in aqueous extracts of all medicinal plant species [15]. Further, the phenolic compounds were also inhibitory on seed germination of different crops [16].

The level of reducing and non–reducing sugar in wheat seedlings was more in control than aqueous leaf extracts. The level was higher in Pusa Gold and HD 2733 as compared to VL – 914 and RS P561 varieties (Table 3). On increasing, aqueous 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* in comparison to *Tinospora cordifolia* and *costus speciosus* leaf extracts. Less sugars were produced due to reduced starch hydrolysis with increase in leaf extract concentrations. Mandal et al. [17] also observed that sugar contents of seedlings decreased with increase in leachate concentration. The leaves of *Costus speciosus contained* maximum quanitity of protein followed by *Tinospora cordifolia* in minimum in *Coleus forskohlii* (Table 3). The Protein content decreased linearly with an increase in leaf extract concentration in the same way as reported by Prasad et al. (2013). The concentration of total amino acids present in 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 an increase in the 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. All leaf extracts promoted amino acid when protein was included the effect decreased. A similar effect was observed by Mandal el al. [17] and Prasad et al (2013). The interaction between treatments and varieties for protein and total amino acids were highly significant ($P<0.05$).

4. CONCLUSION

The in-vitro results in the present study indicated the allelopthic effect of these 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 the allelopathic effect of these medicinal plants species.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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