

Allelopathic effect of *Rauwolfia tetraphylla* L. on seedling root vigour of french bean (*Phaseolus vulgaris* L.)

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Received : 12-10-2017 ; Revised : 12-11-2017 ; Accepted : 18-11-2017

ABSTRACT

The study on allelopathic action of *Rauwolfia tetraphylla* L. root extracts recorded the seedling behaviour of French bean (*Phaseolus vulgaris* L.) with special emphasis on young roots. A sequence of aqueous root extracts (200, 150, 100, 50, 25 and 12.5 mg ml⁻¹) were applied to analyse the initial effect of root growth and seedling, obligatory to establish a healthy plant. Various seedling parameters and critical analysis on deviating of root system specified the active allelopathic effect. Medium concentration (100 mg ml⁻¹) of root extracts stirred the total root length, surface area that may be supportive for supplementary absorption of mineral nutrients and water from soil to establish the healthy seedling. In present experiment, it may be authenticated by the appearance of shoot length, vigour index of the seedling. Therefore, allelopathy can be incorporated as seed treatment tool for seed invigoration under seed/crop production programme.

Keywords : Allelopathy, *Phaseolus vulgaris*, *Rauwolfia tetraphylla*, seedling root

The enrichment in productivity under crop or seed production system depends on abundant factors like genotype, cultivation progression, and environmental wavering in addition to quality seed. The exploitation of definite genotype(s) not express in apposite manner due to appearance of unhealthy, poor seedlings at preliminary stage of cultivation. Various features are related to stable growth pattern of seedling for creating the plant uniformity at field where root dynamics viz. surface area, volume, root types, rhizosphere condition etc. are crucial. Superior root can initiate better seedling helpful for establishing of good plant and economic yield in final.

It is well known that some of the best-yielding crops are competent to beat others due to their superior efficiency in securing a better and steady supply of water and nutrients. On the other, the failure of a crop to prosper in a particular soil may be due to lack of adaptation of its root system to the environment compulsory upon it. But the roots are the least known, least understood, and least acceptable part of the plant in crop study.

Root length, diameter and distribution are imperative features to be considered at describing and comparing root systems. Critical root length and variable root-diameter can be achieved through computerised analysis. Using WinRHIZO, root analysis software, we perform sensitive scanning protocols for rapid assessment of root characteristics like length and surface area, diameter and tips, root branching patterns, etc. Root length and surface area are important indicators for a potential to uptake the water and nutrients as well as most important input parameters for rhizosphere modelling. The aim of the present work is to evaluate the allelopathic effect of a phytochemicals related to rhizospheric pattern that may

reflect its ultimate effect on productivity and quality of the produce. The advantageous or destructive properties of one plant on different plant through discharge of chemicals from any constituent in the manner of leaching, root exudation, volatilization, breakdown of the remaining and other processes under both usual and agricultural system is referred as allelopathy. The allelopathic treatment may inhibit (Terzi, 2008) or promote (Kocace Aliskan and Terzi, 2001) the seedling parameters on some crops (Inderjit *et al.*, 2005a, b) in which the study on root pattern is very meager. Therefore, root extract of *Rauwolfia tetraphylla* L. is careful to know its allelopathic action on root model of French bean (*Phaseolus vulgaris* L.) seedling.

MATERIALS AND METHODS

The root extraction procedure of *Rauwolfia tetraphylla* was carried out in laboratory, Dept. of Seed Science and Technology, Bidhan Chandra Krishi Viswavidyalaya. The 5g root was dig out in distilled water to attain 10 ml in ultimate through extraction procedure (5000 rpm, 15 minutes) at cold centrifuge. Varied concentrations of aqueous root extracts viz. 12.5 mg ml⁻¹ (T₁), 25 mg ml⁻¹ (T₂), 50 mg ml⁻¹ (T₃), 100 mg ml⁻¹ (T₄), 150 mg ml⁻¹ (T₅), 200 mg ml⁻¹ (T₆) in addition to control (T₀, water) were prepared from freshly prepared extract of young roots of *Rauwolfia tetraphylla* L. These were applied on French bean seeds (cv. *Pusaparbati*) for 16 hrs. as various treatments after surface sterilization of seed. The treated seeds were air dried to sustain earlier seed moisture followed by assessing through Glass-plate Method (Chakraborti, 2010) for seedling parameters with a special emphasis on root considering selected best four treatments at the

Table 1: Influence of root extract on seedling parameters at 8th day of emergence

	Control	T ₁	T ₂	T ₃	T ₄	T ₅	T ₆	SEm (±)	SD (0.01)
Gr % (TRvalue)	89.18 (71.28)	91.7 (73.81)	93.69 (76.12)	93.73 (76.12)	93.77 (76.25)	89.1 (71.19)	89.1 (71.19)	0.561	2.36
RL	4.55	4.60	5.10	5.32	5.80	5.82	5.69	0.029	0.12
SL	4.14	4.19	4.5	5.0	5.2	5.12	5.14	0.019	0.081
VI	774.97	806.04	899.74	967.61	1031.78	974.16	965.25	5.76	24.25
FW	0.490	0.501	0.520	0.550	0.591	0.620	0.640	0.005	0.019
DW	0.029	0.030	0.033	0.036	0.039	0.040	0.041	0.001	0.002

Gr % - Germination percentage, RL – Root length, SL – Shoot length, VI – Vigour index,
FW – Fresh weight, DW – Dry Weight.

Table 2: Influence of root extract on seedling root parameters at 8th day of emergence.

Characters	Control	T ₃	T ₄	T ₅	T ₆	SEm (±)	LSD (0.01)
TRL (cm)	47.068	56.683	61.783	52.907	47.285	0.211	0.674
SAR (cm ²)	35.197	45.757	47.567	36.413	35.920	0.186	0.594
VR (cm ³)	2.633	2.183	1.717	2.747	2.717	0.025	0.079
ADR (mm)	1.600	1.197	1.113	1.303	1.477	0.013	0.041
RL (0-0.5 mm dia.)	17.218	27.478	32.747	24.997	17.110	0.091	0.290
RL (0.5-1 mm dia.)	11.707	11.773	11.900	10.693	11.173	0.095	0.304
RL (1-1.5 mm dia.)	5.703	4.620	4.800	5.057	4.857	0.083	0.266
RL (1.5-4.5 mm dia.)	9.507	7.353	6.630	8.313	9.680	0.084	0.269
RL (above 4.5 mm dia.)	4.637	3.857	3.590	3.733	4.643	0.055	0.176

TRL - Total root length, SAR - Surface area of root, VR - Volume of rhizosphere,
ADR - Average diameter of root, RL - Root length

Table 3: Correlation study on different seedling characters

Characters	Gr % (TR value)	SL	RL	FW	DW
SL	-0.054*				
RL	-0.086*	0.918			
FW	0.020*	0.923	0.974		
DW	-0.066*	0.957	0.955	0.950	
VI	0.179*	0.953	0.942	0.957	0.945

* Non-significant, Gr % - Germination percentage, RL – Root length, SL – Shoot length, VI – Vigour index,
FW – Fresh weight, DW – Dry Weight.

Table 4: Correlation study on root parameters

Characters	SAR	VR	ADR	RL of 0-0.5 mm dia.	RL of 0.5-1 mm dia.	RL of 1-1.5 mm dia.	RL of 1.5-4.5 mm dia.	RL of >4.5 mm dia.
VR	-0.944							
ADR	-0.878	0.773						
RL of 0-0.5 mm diameter	0.886	-0.840	-0.962					
RL of 0.5-1 mm diameter	0.629	-0.707	-0.215*	0.317*				
RL of 1-1.5 mm diameter	-0.639	0.461*	0.731	-0.570*	0.024*			
RL of 1.5-4.5 mm diameter	-0.926	0.873	0.954	-0.984	-0.405*	0.564*		
RL of >4.5 mm diameter	-0.703	0.621	0.896	-0.934	-0.039*	0.530*	0.887	
TRL	0.925	-0.891	-0.953	0.993	0.406*	-0.581*	-0.985	-0.899

* Non-significant, TRL - Total root length, SAR - Surface area of root, VR - Volume of rhizosphere,
ADR - Average diameter of Root, RL - Root length.

day of final count (8th day) by Root Image Analyzer, WIN RHIZO (PRO-BASIC STD 4800). The experiment was conducted in 2016.

Measurements involved total root length, average root diameter, surface area, as well as root length measurements as a function of different root diameter classes. The scanning was done by using one light source below at the flat-bed scanners. The output as greyscale images were analyzed with WinRHIZO using a method of automatic global thresholding (Anon. 2000). One way analysis of variance was undertaken for analysis at 1 per cent level of significance using SPSS (version 10.0, 1990) and correlation matrix was analysed using OP stat software.

RESULTS AND DISCUSSION

The values in table 1 specified the higher concentrations of aqueous root extract of *Rauwolfia tetraphylla* that amplified the germination percentage though after T₄ it was abruptly reduced. The length of primary root and shoot was enlarged in higher concentration (root extract) in 8th day; that was non-significant after T₄. Enlarged length of seedling noticeably signified the superior vigour index where peak effect came from last three concentrations, keeping a non-significant deviation among them. Considering the fresh and dry weight of the seedlings (Table 1), the superior concentrations of root extracts enhanced the seedling growth due to greater addition of dry matter in healthy seedlings. The accumulation of dry matter was significantly elevated up to T₄ similar to other parameters (Table 1) though an exception was found in fresh wt. representing a significant rising up to T₆.

The results of table 2 specified the rhizosphere pattern of seedling allowing for best 4 concentrations of root extract where superior performance of whole root length (primary-secondary roots and others) was maintained in medium concentration level (100 mg ml⁻¹) *i.e.* T₄ and it was steadily declined in rising of concentration. The entire surface area of the root was also high in T₄ (Table 2) alike to the whole root length though it was non-significant to T₃.

In table 2, the root diameter pointed out the treatments effect in a contrasting manner. Control (T₀) showed the uppermost with a diminishing style up to T₄ but rose again with rising the concentration (T₅ and T₆). Correspondingly, the volume of rhizosphere was not dependable on the establishment of new root initials. The volume was decreased gradually though it increased at later stages. In categorization of root system, the variable roots on the basis of thickness were critically observed (Table 3) in assessment of overall elongation in an exact duration (8 days). The minimum diameter (0-0.5mm) containing roots showed extreme elongation

in T₄ though later (0.5-1mm) all concentrations showed a non-significant mode including control. But the root length intensification was interrelated to upper most concentration and control with amplification of root diameter *i.e.* larger than 1.5 mm.

The specific new root initials at early seedling establishment may influence the formation of quality shoot for better seedlings where the maximum length of shoot was observed in T₄ (Table 1).

In table 3, different traits indicated a strong positive correlation though non-significant relation was observed in case of germination (%) with other seedling parameters irrespective of negative and positive direction. Table 4 indicated the correlation matrix of distinctive root characteristics of seedling. The total root length indicated a positive correlation with root surface area and new root initials (0-0.5mm) and strong negative relation with superior diameter containing roots. The reverse indication of correlation was also noted in volume of the rhizosphere and average diameter with the above seedling characters. The variable root thickness (diameter) showed positive correlation with volume though negative indication was noted in root length and surface area. The physiological role of allelochemicals may be beneficial or deleterious correlated to concentrations, duration, plant specificity *etc.* (Rizvi and Rizvi, 1992). The enrichment of total root length signified the additional progress of fresh surface root initials *i.e.* lateral roots that can fully exploited the rhizosphere in specified soil. Consequently, the plant consumed adequate quantity of nutrients and moisture from that soil. Surface area of total root was also larger due to creation of more new roots. The progression in root surface area was constructive for exploitation of soil nutrients related to seedling establishment and build up a healthy plant for better yield.

Considering diverse root types, presence of new root initials may be the cause of healthier seedling formation. The greater diameter of primary roots in addition to secondary type may enhance the average of root diameter where number of new root initials (lateral roots) may not be the leading in reflection of root diameter. The prime seedling quality indicator, vigour index should be dependent on selection pressure of other seedling parameters. The precise root parameters may have an influential role in advancement of quality seedling due to effective utilisation of soil nutrients (Frageria and Stone, 2006). The variable concentrations of root extract motivate the allelopathic action on germinating seeds through modification of physiological or specific seedling parameters that may favour the seedling vigour. Categorisation of root system was effective to reproduce high vigour seedling linked to uniformity and early

seedling establishment, particularly in short duration crop.

The young root initials were competent to reach and exploit local patches of nutrients in the soil (Lynch, 1995) in contrast to older ones through their delicate epidermal layers. Greater addition of nutrient may enhanced the rate of dry matter accumulation supportive for early establishment of vigorous seedlings. The rapid sequence of cell division in advancement of morphological characters, particularly root was very much linked to diverse biochemical markers (Tinus *et al.*, 2000) like DNA, RNA and protein synthesis etc. (Mandal *et al.*, 2013) that may be influenced in existence of appropriate allelochemicals.

A critical study on root system indicated the seedling efficacy in application of seed treatment. The allelopathic action of precise root extracts (T_4) on French bean seed enhanced the establishment seedling through adaptation of ideal root system. Hence, allelopathy can be operated as invigoration treatment considering its specific concentration (100 mg ml^{-1}) for French bean.

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