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Allelopathic effect of different accessions of *Jatropha curcas* on field crops in Bundelkhand Region (U.P.) India

Neel Ratan, Ghan Shyam, R.K. Gupta and *U.N. Singh

Department of Botany,
D.V. (P.G.) College,
ORAI - 285001 (U.P.) INDIA
*Corresponding Author
Email : drunsingh@rediffmail.com; drunsingh1945@gmail.com

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ABSTRACT

Allelopathic effect of three accessions of *Jatropha curcas* on four field crops viz. *Triticum aestivum, Raphanus sativus, Linum usitatissimum* and *Lens esculenta* through bioassy was studied in laboratory. The level of inhibition of aqueous leaf extract of *J. curcas* varied with its accessions and type of tested field crops. The tolerance of the crops was in order of *Lens esculenta* > *T. aestivum* > *Raphanus sativus* > *Linum usitatissimum.* Invariably, maximum inhibition was observed in the higher concentrations of aqueous extract.

Figures : 02 References : 11 Tables : 02
KEY WORDS :Allelopathy, Field crops, *Jatropha curcas*, Leaf aqueous extract.

Introduction

In agroecosystem crop inhibitions in association with trees are not uncommon. Such inhibitions are primarily caused by shade effect as well as belowground (root zone) competition for nutrients and water. In some cases inhibitory effects may also result from allelochemicals secreted by component tree species. The phytotoxic substances exuded by trees retard the germination and growth of weed and crop species[9,11]. Chemicals released by plants might be beneficial or detrimental to the growth of receptor plants[10]. Now a days *Jatropha curcas* is getting much attention due to its suitability as oil yielding crop which can serve as an alternative source of biofuel. As land is a limited resource, research is in progress to incorporate this species in agroforestry system to get the dual benefit (oil as well as crop yield*). J. curcas* has short gestation period, hardy in nature with high quality oil content. It's oil is close to cottonseed and better than rapseed, groundnut and sunflower, which gives no pollution, when burnt[4]. Of late *J. curcas* is getting a momentum as a biofuel tree species, which can be raised as block plantation or intercropped with food crops. Stem extracts of *J. curcas* contain phytochemicals like saponin, tannins, glycocide, alkaloids and flavonoids of phenolic nature[3]. The present study was carried out to find the allelopathic effect, if any from the leaf extract of *J. curcas* accessions on four field crops viz. *Triticum aestivum* (wheat), *Raphanus sativus* (Mooli), *Linum usitatissimum* (Alsi) and *Lens esculenta* (Masur).

Materials and Methods

The seeds of *Jatropha curcas* accessions namely NRCJ-2, NRCJ-12 and NRCJ-82 were obtained from National Research Centre for Agro-forestry (NRCAF) Jhansi and grown during 2011 in Bohadpur Govt. Agriculture Farm (BGAF) at Orai (U.P.) located at an elevation of 141.6 m above the mean sea level (msl) and 25^0 59' N latitude and 79^0 37' E longitude. The study consisted of three factors : (i) three accessions of *Jatropha curcas* viz. NRCJ-2, NRCJ—12 and NRCJ-82, (ii) three concentrations *viz.* 1%, 3% and 5% of leaf extracts besides control, (iii) four tested crops *viz.* wheat (*Triticum aestivum* L.) *var.* WH-147, Mooli (*Raphanus sativus*) var. Kashi sweta, Alsi (*Linum usitatissimum*) *var.* Garima and Masur (*Lens esculenta*), *var.* K-75. Fresh leaves from 3 accessions of *J. curcas* (5 years old) were collected from the experimental farm of BGAF, Orai. The materials of each category were air dried under shade for 3 days,

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TABLE- 1: Effect of leaf extracts of *Jatropha curcas* on selected field crops through bioassay

Crops/Trees	***Triticum aestivum***					***Raphanus sativus***				
					Germination (%)					
Conc. of extracts	0%	1%	3%	5%	Mean	0%	1%	3%	5%	Mean
NRCJ-2	46	39	39	42	42	60	45	47	46	49
NRCJ-12	46	39	39	45	42	60	46	56	57	55
NRCJ-82	46	37	37	43	41	60	48	41	37	46
Mean	46	38	38	43		60	46	48	46	
CD	NS[1]	NS[2]	NS[3]			4	5	NS		
					Root length (cm)					
NRCJ-2	8.74	8.17	6.51	3.07	6.62	5.30	4.08	0.49	0.34	2.56
NRCJ-12	8.74	8.11	5.87	3.24	6.50	5.30	4.33	0.51	0.41	2.64
NRCJ-82 8.74	8.74 8.73	10.04 4.86	2.21 2.78	1.97	5.74 5.30	5.30 4.72	5.75 0.47	0.42 0.48	0.65	3.03 Mean
CD	NS	1.51	NS			NS	0.74	NS		

Shoot length (cm)										
NRCJ-2	3.74	4.10	4.20	4.04	4.02	5.91	3.70	2.63	1.29	3.38
NRCJ-12	3.74	4.25	4.60	4.06	4.16	5.91	3.26	2.07	3.07	3.58
NRCJ-82	3.74	3.39	2.95	4.08	3.54	5.91	3.89	4.15	3.60	4.39
Mean	3.74	3.91	3.92	4.06		5.91	3.62	2.95	2.65	
CD	NS	NS	NS			0.60	0.70	NS		
Total dry weight (mg/5 seedlings)										
NRCJ-2	0.0591	0.0746	0.0629	0.0469	0.0609	0.025	0.027	0.21	0.019	0.023
NRCJ-12	0.0446	0.1044	0.0852	0.0599	0.0735	0.025	0.020	0.029	0.020	0.023
NRCJ-82 0.0494	0.494 0.0865	0.0806 0.0961	0.1402 0.0569	0.0641	0.0836 0.025	0.025 0.021	0.017 0.027	0.031 0.021	0.024	0.024 Mean
CD	NS	NS	NS			0.001	0.001	0.002		
Vigour index										
NRCJ-2	574	478	418	299	442	673	350	147	77	312
NRCJ-12	574	482	408	331	449	673	349	144	198	341
NRCJ-82	574	497	191	260	380	673	463	187	157	370
Mean	574	485	339	296		673	387	159	144	
CD	NS	103	NS			NS	64	NS		

Crops/Trees	***Linum usitatissimum***					***Lens esculenta***				
Germination (%)										
Conc. of extracts	0%	1%	3%	5%	Mean	0%	1%	3%	5%	Mean
NRCJ-2	52	45	43	46	46	85	73	70	71	75
NRCJ-12	52	31	24	24	33	85	76	75	70	76
NRCJ-82	52	30	31	25	34	85	73	73	71	75
Mean	52	35	33	32		85	74	73	73	
CD	5	6	NS			NS	NS	NS		
Root length (cm)										
NRCJ-2	3.59	1.31	0.44	0.36	1.42	5.64	5.31	1.99	1.41	3.59
NRCJ-12	3.59	1.48	0.74	1.08	1.72	5.64	3.63	3.78	1.35	3.60
NRCJ-82	3.59	1.32	0.41	0.44	1.44	5.64	0.49	0.53	0.77	1.86
Mean	3.59	1.37	0.53	0.63		5.64	3.14	2.10	1.18	
CD	NS	0.41	NS			0.56	0.65	1.14		

Shoot length (cm)										
NRCJ-2	4.31	2.75	0.79	0.50	2.09	9.15	9.91	7.88	6.58	8.38
NRCJ-12	4.31	1.98	1.55	1.80	2.41	9.15	6.61	6.92	6.68	7.34
NRCJ-82	4.31	2.75	2.21	2.10	2.82	9.15	6.22	6.55	6.87	7.20
Mean	4.31	2.49	1.52	1.47		9.15	7.58	7.12	6.71	
CD	NS	0.56	NS			0.85	0.98	1.71		
Total dry weight (mg/5 seedlings)										
NRCJ-2	0.014	0.013	0.015	0.013	0.014	0.058	0.065	0.054	0.039	0.054
NRCJ-12	0.014	0.015	0.016	0.017	0.015	0.058	0.065	0.053	0.054	0.057
NRCJ-82	0.014	0.014	0.013	0.015	0.014	0.058	0.064	0.053	0.055	0.057
Mean	0.014	0.014	0.015	0.015		0.058	0.064	0.053	0.049	
CD	NS	NS	NS			NS	0.003	NS		
Vigour index										
NRCJ-2	411	183	53	40	172	1257	1111	691	567	906
NRCJ-12	411	107	55	69	160	1257	778	802	562	850
NRCJ-82	411	122	81	63	169	1257	490	517	542	701
Mean	411	137	63	57		1257	793	670	557	
CD	NS	44	NS			105	122	211		

Note : [1]- CD for concentrations (C); [2]- CD for *Jatropha* accessions (A); [3]- CD for C x A

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ground and passed through a mesh sieve (0.2 mm) to remove the visible plant residues. The aqueous extracts of each category were prepared by soaking 10, 30, 50 g of leaf powder in 100 ml distilled water for 24 hr, at room temperature (25±2^{0}C) for the preparation of 1, 3 and 5% concentrations, respectively. The solution was first passed through the cotton cloth and then filtered through Whatman No. 1 filter paper. The distilled water served as control (0%). Healthy seeds were surface sterilized with 0.2% (w/v) mercuric chloride and twenty seeds (replicated 5 times, that is CRD design) placed uniformly on the top of double layered Whatman No. 1 filter paper (petriplates- 9 cm diameter). The media was watered daily with the respective leaf extracts at the rate of 2 ml per petriplate to maintain the moisture for proper germination. The number of germinated seeds was counted daily upto 15 days. To assess the root and shoot length and total dry weight of 5 seedlings from each replication were randomly selected. The vigour index was calculated by using the formula[1].

Vigour index = Germination (%) x (Root length + shoot length)

The phenols present in the leaves of *J. curcas* were analyzed by following the procedure which is based on the principle that phenols react with phosphomolybdic acid in Folin Ciocalteau reagent in alkaline medium and produce blue coloured complex[6]. The data were subjected to statistical analysis[8].

Results and Discussion

The results showed the inhibitory effect of leaf extracts of different accessions of *Jatropha curcas* on the entire test crops *viz., T. aestivum, R. sativus*, *L. usitatissimum* and *L. esculenta*. However, the level of inhibition varied with *Jatropha* accessions, type of test crops and concentration of extracts. In general, increase in the level of concentration of the leaf extract showed decreasing trend for many parameters of the test crops. The seed germination of *T. aestivum* and *L. esculenta* were found non significant while, significant reduction was observed in *R. sativus* and *L. usitatissimum*. Among the *Jatropha* accessions NRCJ-82 in *T. aestivum* (41%) and NRCJ-12 in *L. usitatissimum* (33%) lead to lowest germination. When comparing the percent reduction of germination over the control (irrespective of concentration) all the three *Jatropha* accessions has less detrimental effect on *L. esculenta* and *T. aestivum* than on *R. sativus* and *L. usitatissimum*. The reduction in germination by *Jatropha* accessions (irrespective of concentrations) was in the order NRCJ-12 < NRCJ-2 < NRCJ-82 in *T. aestivum* and *R. sativus* while, NRCJ-2 < NRCJ-82 < NRCJ-12 in *L. usitatissimum* and NRCJ-12 < NRCJ—82 < NRCJ-2 in *L. esculenta* (Table 1, Fig. 1).

Minimum root length was exhibited by application of NRCJ-82 in *T. aestivum* (5.74 cm) and *L. esculenta* (1.86 cm) and NRCJ-2 in *R. sativus* (2.56 cm) and *L. usitatissimum* (1.42 cm). Shortest shoot length was recorded by application of NRCJ-2 in *T. aestivum* (4.02 cm), *R. sativus* (3.38 cm) and *L. usitatissimum* (2.09 cm) and NRCJ-82 in *L. esculenta* (7.20 cm). Minimum total dry weight was observed under NRCJ-2 in *T. aestivum* (0.0609 mg/5 seedlings) *R. sativus* (0.023 mg/5 seedlings), *L. usitatissimum* (0.014 mg/5 seedlings) and *L. esculenta* (0.054 mg/5 seedlings) (Table-1). Toxicity of *Jatropha* accessions for vigour index was in order of NRCJ-12 < NRCJ-2 < NRCJ-82 in *T. aestivum*, NRCJ-82 < NRCJ-12 < NRCJ-2 in *R. sativus,* NRCJ-2 < NRCJ-82, NRCJ-12 in *L. usitatissimum* and NRCJ-2 < NRCJ-12 < NRCJ-82 in *L. esculenta*. It is evident that NRCJ-12 has minimum detrimental effect on *T. aestivum*; NRCJ-82 for *R. sativus* and NRCJ-2 for *L. usitatissimum* and *L. esculenta*. Among the four tested crops, the tolerance of the crops (irrespective of *Jatropha* accessions and concentrations) was in order of *T. aestivum* > *L. esculenta* > *R. sativus* > *L. usitatissimum* considering the per cent decrease order control (Fig. 2). The biochemical analysis of leaves of *J. curcas* revealed that the catechol eq./g of sample ranges from 0.3312 mg (NRCJ-82) to 0.7315 mg (NRCJ-12) (Table-2). Someone also reported the inhibitory effect of *J. curcas* aqueous extracts on germination, radicle and pumule length of all the tested crops and the inhibition was more at higher concentrations[2]. Investigation on the phytochemical screening of *J. curcas* stem bark extract revealed the presence of saponine, steroids, tannins, glycosides, alkaloids and flavonoids in the extract[5]. The inhibition in treated seeds might be due to the excessive presence of inhibiting allelochemical in extracts[7]. These allelochemicals might inhibit the synthesis of gibberellins and indol acetic acid (IAA). The retarded growth of radicle and pumule in treated seedlings might be due to the inhibition of cell division and elongation by allelochemicals[7].

TABLE-2 : Quantity of phenol present in the different accessions of *Jatropha curcas*

Clones	Phenol (mg catechol eq./g of sample)
NRCJ-2	0.4914
NRCJ-12	0.7315
NRCJ-82	0.3312

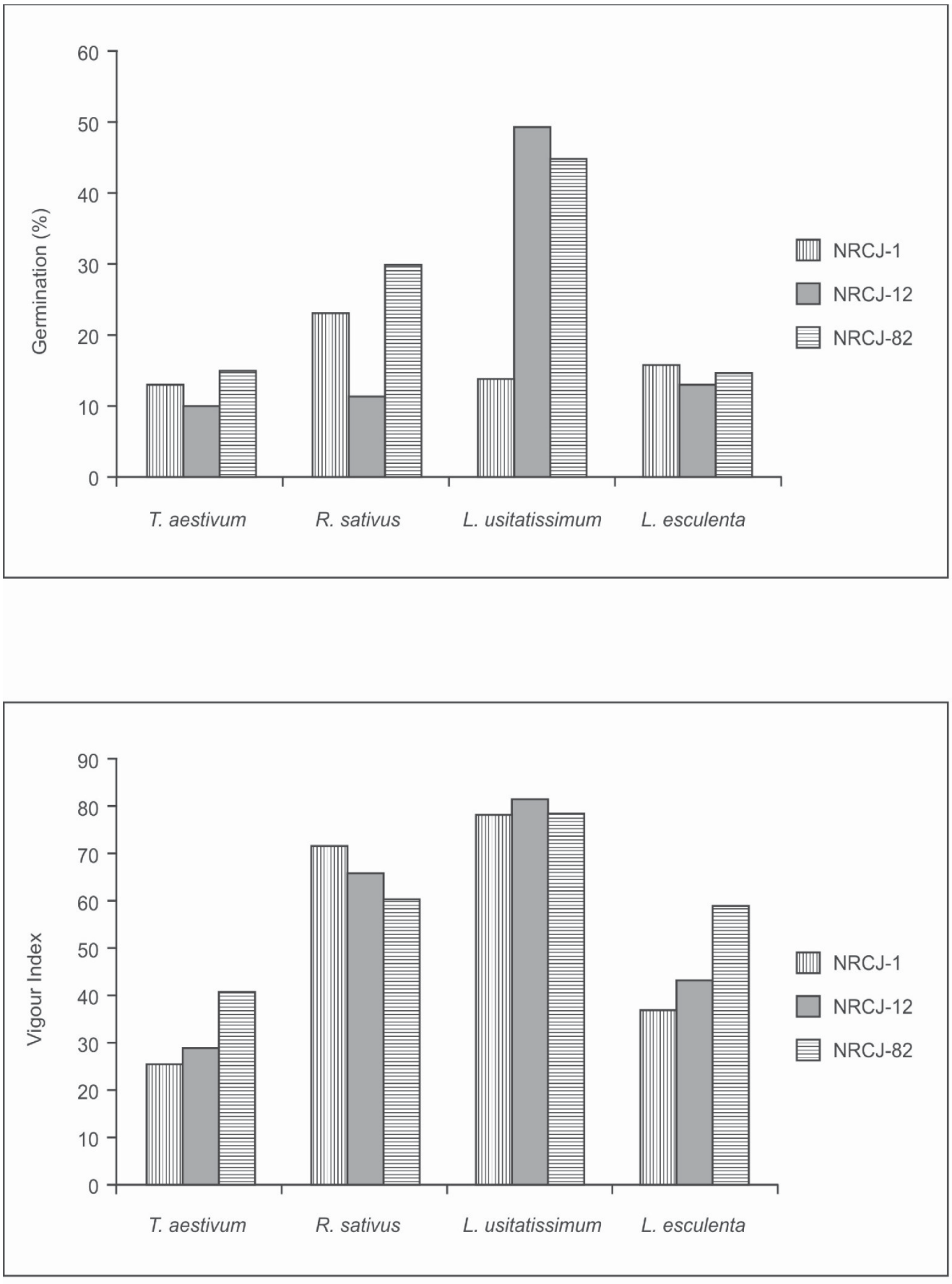

Fig. 1 : Percent reduction over control by leaf extracts of different *Jatropha* accessions on germination and vigour index (irrespective of conentrations) on different crops

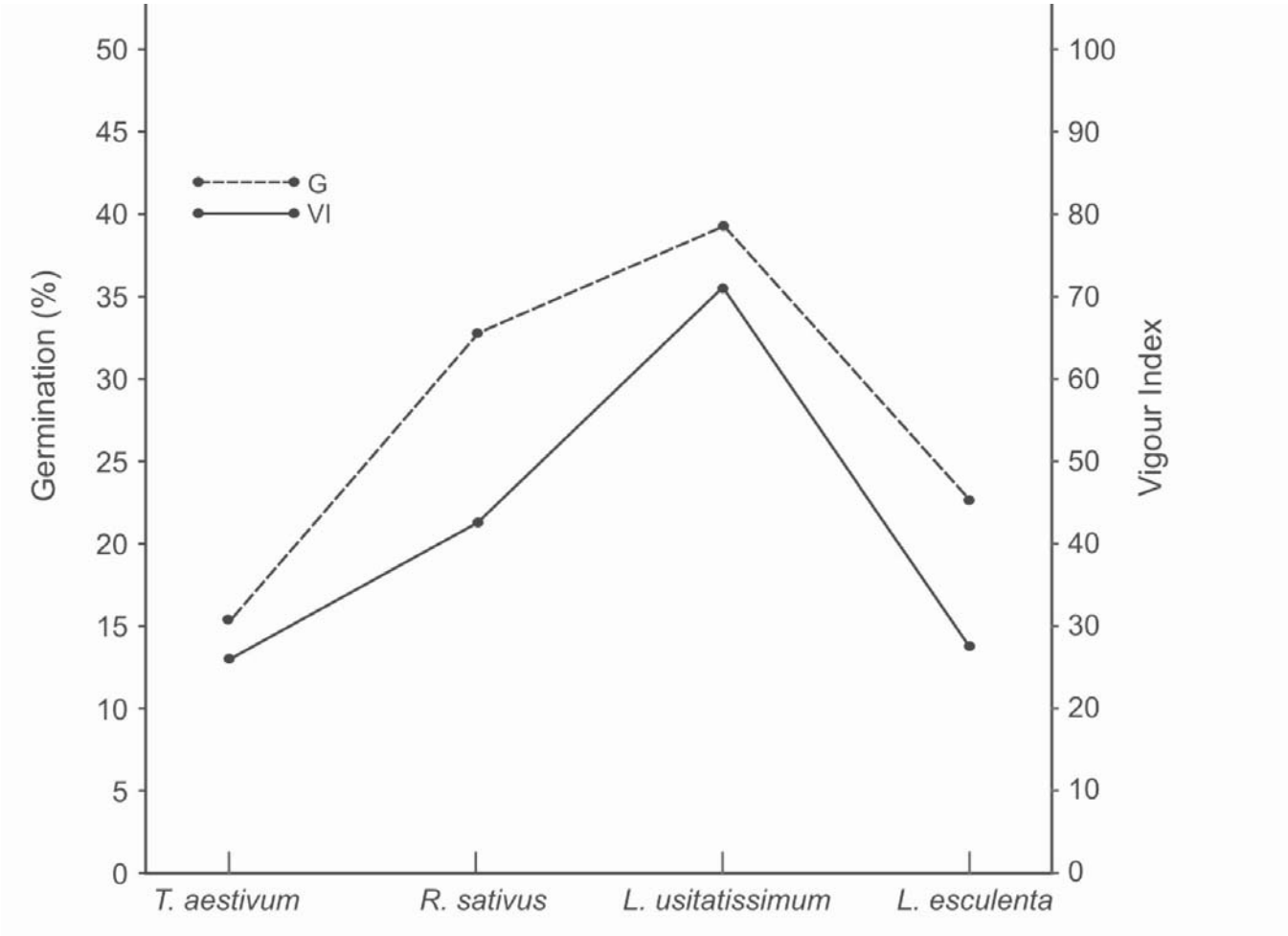

Fig. 2 : Percent reduction over control in germination and vigour index by leaf extracts (irrespective of *Jatropha* accessions and conentrations) on different crops

The results of this study revealed that allelopathic influences are (i) accession specific within the species (donor), (ii) level of inhibition varies with field crops (receiver), and (iii) the toxicity also depends on the concentration of allelochemicals in the medium. Suitability of crops for intercropping with *J. curcas* (irrespective of *Jatropha* accessions and concentrations) was in the order of *T. aestivum* > *L. esculenta* > *R. sativus* > *L. usitatissimum*. Higher concentration of leaf extracts exhibits more toxicity on all the tested crops. The result obtained in the study would serve as a basis for further investigation under field conditions to confirm the allelopathic potential of *J. curcas*. This study can be very much helpful in biofuel programme through agroforestry research and development of India.

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