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## Allelopathic effect of *Dendrocalamus stocksii* (Munro.) on growth and yield of ground nut (*Arachis hypogaea*)

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### Abstract:

The present study was conducted to assess allelopathic effect of *Dendrocalamus stocksii* (Munro.) on the growth and yield of ground nut (*Arachis hypogaea*). Bamboo leaf leachate was prepared by soaking the dry leaves in tap water for 24 hours in a ratio of 1:10 w/v. Using prepared leachate as stock solution the leachate of various concentrations viz., control (0%), 25, 50 and 75 and 100 per cent were prepared by adding tap water accordingly. The results revealed the concentration-dependent significant ( $p=0.05$ ) inhibitory effect of bamboo leaf leachates on the germination, radicle and plumule length of groundnut in laboratory condition. The leaf leachate of 100% concentration reduced down the germination percentage (56%), radicle length (3.00 cm) and plumule length (5.36 cm) as compared to control treatment where the germination percentage (86.66%), radicle length (5.02 cm) and plumule length (12.08 cm) were maximum. Similarly, the allelopathic effect of leaf leachate on transplanted seedlings of groundnut in prepared beds inside the poly house were significantly ( $p=0.05$ ) inhibitory for the test seed weight and straw yield/ha. Minimum test seed weight (430.33 g) was recorded in the treatment of 25 % concentration as compared to control (601.33 g) and straw yield per hectare in the treatment of 100 % concentration (2421.1 kg/ha) as compared to control (4729.4 kg/ha). However, the non-significant effect of leaf leachate was observed on other yield parameters i.e., number of tillers per plant, number of pods / plant, test seed weight, seed yield per plant, number of seeds per pod and grain yield per ha. Finally, it is concluded that the harmful effect of leaf leachates of *Dendrocalamus stocksii* is more prominent in early stage of germination, emergence of radicle and plumule etc., rather than after transplanting; it is recommended to avoid the effect of these allelochemicals in early growth stage in field condition.

**Keywords:** Allelopathy, *Dendrocalamus stocksii*, Groundnut, Leaf-leachates, Yield

### INTRODUCTION

Bamboo based Agroforestry has considerable potential to provide food and nutritional security with contributing in economic development of developing countries in the tropics (Kittur et al., 2006). But due co-existence of woody perennials (trees, shrubs, palms and bamboos) with the agricultural crops, their allelopathic compatibility may be crucial to determine the success of an agroforestry system (Rizvi et al. 1999). Adopting as a component in agroforestry bamboo has various

advantages i.e., short rotation period, more CO<sub>2</sub> sequestration, profitability and can be harvested annually as compared to other tree species (Ahlawat, 2014). Bamboo is considered as an extremely versatile plant and has capability of providing ecological, economic and livelihood security to the people. It generates plenty of oxygen, low light intensity and protects against ultraviolet rays and is also considered to be an atmospheric and soil purifier, it conserves water and greatly reduces soil erosion (Amneth, 1996). Although,

having many advantages and wider adoptability of bamboos in an agroforestry system, but a little is known about the allelopathic potential of these species.

Generally, any unfavourable effect of one plant upon another plant is likely to be considered as competition unless it is distinguished from the effect of various phytotoxins released from the donor plant (Muller, 1966). These phytotoxins (allelochemicals) can be released in soil through the process of volatilization, stem flow or litter decomposition, form leaf aqueous leachate and play a major role in the basic metabolism and affect numerous physiological and biochemical processes of intercrop species (Narwal and Tauro, 1994; Rice 1984). The toxic metabolites are distributed in all other plant parts in various concentrations, but the leaves are considered as the most potent source of the allelochemicals (Kumar *et al.*, 2006). The concentration depended inhibitory effect of various concentrations of leaf aqueous extract of *Tectona grandis* on protein content of leaf, stem and root of black gram and green gram (Manimegalai, 2012) and germination and seedling growth of *Raphanus sativus* by walnut leaf extract has been already reported (Bahuguna *et al.*, 2013).

In the traditional agroforestry system several tree species are growing in or around the agricultural field, *Dendrocalamus stocksii* (Munro.) solid bamboo is one of the commonly used species in traditional agroforestry system of Western Ghats (Rane *et al.*, 2013) due to its multiple uses and solid thorn less nature of culms it is also maintained in field bunds/farm boundaries and in homesteads (Viswanath *et al.*, 2012). The farmers are using this species as a cash crop in combination with various agricultural crops. But it might have allelopathic effect on the agricultural crops. Hence, our study is an attempt to find out the allelopathic effect of *D. stocksii* leaf leachates on ground nut in laboratory condition and poly house.

## MATERIALS AND METHODS

The research was carried out at College of Forestry, Dr. B.S.K.K.V., Dapoli, Ratnagiri district of Maharashtra having Geo-coordinates of 17°45' N latitude and 73°12' E longitude with an elevation of 250 m MSL, during the year 2014-15. The climate of the study area was warm and humid with an average annual rainfall ranging from 3000 to 3500 mm, temperature 17.81°C to 31.29°C and relative humidity (RH) was 74.21 per cent during the study period. Dry leaves of *D. stocksii* were collected from the bamboo plantation (spacing 10 × 10 and 12×10) at the Forestry Research farm of College of Forestry, Wakavali. The leaf leachates were prepared by soaking dry leaves in tap water (pH 6.4 and electric conductivity 0.09) for 24 hours in a ratio of 1:10 weight by volume and fil-

tered with the help of cheese cloth. Using this as stock solution, various concentrations of leachates (25, 50, 75 and 100%) were prepared by adding tap water accordingly (Bahuguna *et al.*, 2013). Freshly prepared leachate was used to irrigate the seeds of groundnut in laboratory and prepared bed inside the poly house. The seeds were surface sterilize with (0.1 % mercuric chloride) for one minute to and followed by washing of seeds several times to remove the mercuric chloride. Germination trial was conducted on sterilize plastic trays in laboratory condition wherein hundred seeds of groundnut were placed in each tray containing single blotting paper. The required leachates were uniformly added to the respective trays to irrigate the seeds. To observe the effect of leaf leachates on yield of groundnut the seedlings were transplanted in prepared beds inside the poly house and treated with various leaf leachates accordingly. The germination and yield trials were laid out in Complete Randomized Design with five treatments *viz.*, T<sub>1</sub>= Control treatment (0% leaf leachate), T<sub>2</sub>= 25% leaf leachate, T<sub>3</sub>= 50 % leaf leachate, T<sub>4</sub> = 75 % leaf leachate, and T<sub>5</sub> =100% leaf leachate and replicated three times. The data pertaining to growth and yield were analyzed subjected to CRD and t- test, statistically using the Microsoft excel and SAS 9.3 (TS1MO) software.

## RESULTS AND DISCUSSION

**Laboratory condition:** The data given in Table 1 showed that all the treatments of bamboo leaf leachates significantly ( $p=0.05$ ) reduced down the germination percentage of groundnut in a proportionate manner with increasing concentration. Maximum germination percentage at final day (15 DAS) was recorded in control treatment T<sub>1</sub> (86.66%) while minimum in the treatment of 100 per cent concentration *i.e.*, treatment T<sub>5</sub> (56 %). Reduction in germination observed is attributed to the allelochemicals present in leaf leachate of *D. stocksii*. The allelopathic compounds present in various plant parts are expected to inhibit seed germination by inhibiting the hydrolization of reserve food material, cell division and several other reactions which are important for seed germination (Rice, 1974). The presence of various phenolic acids in fallen leaf extract of *Bambusa arundinacea* has been confirmed by (Eyini *et al.*, 1989) and found them responsible to pose allelopathic effect on seedlings of *Arachis hypogaea*. Similarly, Bahuguna *et al.*, (2013) also found the significant decrease in the germination percentage of redish (63.80%) at final count when treated with walnut leaf extract of 100 percent concentration as compared to control (73%). Rawat *et al.*, (2018) also reported that the germination percentage of cowpea was maximum in control treatment (88.66%) and reduced down to (73.33%) when treated with the leaf leachate of 100% concentration.

**Table 1.** Effect of *Dendrocalamus stocksii* leaf leachates on germination radicle and plumule length of groundnut.

DAS	Germination %					Radicle length (cm)					Plumule length (cm)				
	T <sub>1</sub>	T <sub>2</sub>	T <sub>3</sub>	T <sub>4</sub>	T <sub>5</sub>	T <sub>1</sub>	T <sub>2</sub>	T <sub>3</sub>	T <sub>4</sub>	T <sub>5</sub>	T <sub>1</sub>	T <sub>2</sub>	T <sub>3</sub>	T <sub>4</sub>	T <sub>5</sub>
3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	78.33	70.33	56.66	54.33	49.33	2.94	2.65	2.3	2.18	1.91	0.96	0.88	0.98	0.96	0.91
7	82.00	72.50	64.75	56.00	52.33	3.24	3.25	3.02	2.78	2.69	2.4	1.96	1.91	1.53	1.98
9	75.75	74.66	65.00	61.00	53.00	3.3	3.33	3.41	2.82	2.81	4.74	4.29	2.96	2.53	2.12
11	84.66	75.00	67.00	59.66	54.66	4.22	3.32	3.59	2.95	2.92	8.88	6.42	5.99	4.94	4.79
13	85.00	75.33	69.00	60.33	55.00	4.34	4.20	3.59	2.97	2.95	10.1	7.11	6.69	5.26	4.98
15	86.66	75.33	69.33	61.66	56.00	5.02	4.45	3.59	3.31	3.00	12.08	9.56	7.31	6.43	5.36
Mean	70.34	63.31	55.96	50.43	45.76	3.29	3.03	2.79	2.43	2.33	5.56	4.44	3.61	3.12	2.88
SE m ±	23.21					2.97					0.28				
CD@5%	2.97					0.14					0.33				

(DAS= Days after sowing; T<sub>1</sub>=Control, T<sub>2</sub>= 25 %, T<sub>3</sub>= 50%, T<sub>4</sub>= 75%, T<sub>5</sub>= 100% concentration of leaf leachate)

Maximum radicle (5.02 cm) and plumule length (12.08 cm) were recorded in control treatment while minimum radicle (3.00 cm) and plumule length (5.36 cm) in the treatment of 100 per cent concentration. The concentration dependent inhibitory effect of bamboo leaves leachate was observed on radicle and plumule length might be due the presence of various allelochemicals in bamboo leaves. These allelochemicals affect normal growth of receptor plant by affecting cell division, cell elongation, metabolic processes (Moreled and Novitsy 1987), leaf area, plant height, total chlorophyll and protein content etc., (Eyini et al., 1989). Bhat et al., (2011) also found that the reduction in plumule length of *V. unguiculata* when treated with 3% (7.77 ± 3.67 cm) and 5% (7.16 ± 0.73) leaf extract of *Anogeissus latifolia*. Rawat et al., 2017 also reported that the maximum reduction in radicle length (1.71 cm) and plumule length (2.04 cm) of finger millet when treated with leaf leachate of 100 per cent concentration as compared to untreated seeds (control) radicle length (5.49 cm) and plumule length (3.59). Similarly, the concentration dependent inhibitory effect of fallen leaf aqueous extract was observed previously i.e., *Bambusa arundinacea* on growth of *Arachis hypogaea* (Eyini et al., 1989), shoot length of brinjal, chilli and tomato (Krishna et al., 2003).

**Prepared beds in Poly-house:** In general stimulatory effect of all the treatments of leaf leachates was observed on number of tillers per plant (Table 2) however, the result was non-significant. Maximum number of tillers per plant was recorded in the treatment of 50 percent concentration (3.46) as compared control treatment T<sub>1</sub> (3.22). Similarly the effect of leaf leachate was non-significant on number of pods per plant, Maximum number of pods was recorded in the treatment of 25 per cent concentration (3.36) while minimum in treatment T<sub>5</sub> (2.31) (Table 2). The effect of leaf leachate on number of seeds per pod was non-significant but inhibitory with increasing concentration, maximum number of seeds per pod were recorded in control treatment T<sub>1</sub> (2.07), while minimum the treatment of 100 per cent concentration T<sub>5</sub> (1.60).

All the concentrations of leaf leachates significantly reduced down the test seed weight of ground nut as compared to control treatment (601.33 g) with minimum in the seeds treated with leachate of 25 per cent concentration (430.33 g). The reduction in test seed weight of groundnut might be due to the presence of various allelopathic compounds in the leaf leachate of *Dendrocalamus stocksii*. Similarly, Dongre et al. (2010) had also found concentration dependent inhibitory effect of leaf extracts of various test weeds viz., *Ageratum conyzoides* L., *Anagallis arvensis* L., *Chenopodium album* L., *Parthenium hysterophorus* L. and *Rumex dentatus* L. on seed weight of green gram.

**Table 2.** Effect of *Dendrocalamus stocksii* leaf leachates on germination radicle and plumule length of groundnut.

Treat-ments	No. of till-ers/ plant	No. pods/ plant	No. of seeds/ pod.	Test seed weight (g)	Seed yield /plant (g)	Grain yield (Kg/ha)	Straw yield (Kg/ha)
T1 Control	3.22	2.67	2.07	601.33	2.00	332.78	4729.4
T2 ( 25%)	3.36	3.36	2.07	430.33	1.75	292.22	3473.9
T3 (50%)	3.46	2.57	1.97	436.33	1.31	218.33	3698.9
T4 (75%)	3.27	2.87	1.87	526.00	1.66	276.67	4096.7
T5 (100)	3.33	2.31	1.60	451.67	1.51	252.22	2421.1
Mean	3.33	2.76	1.92	489.13	1.65	274.44	3684.00
SE m ±	0.11	0.21	0.11	20.08	0.13	21.55	276.44
CD @ 5%	NS	NS	NS	86.16	NS	NS	1185.8
	0.49	0.91	0.49	86.16	0.55	92.35	

(T<sub>1</sub>=Control, T<sub>2</sub>= 25 %, T<sub>3</sub>= 50%, T<sub>4</sub>= 75%, T<sub>5</sub>= 100% concentration of leaf leachate)

Gantayet *et al.* (2011) also found significant reduction in test seed weight of Niger (*Guizotia abyssinica*) as compared to control treatment when treated with leaf-litter dust of *Lantana camara*. The data presented in (Table 2) revealed that different treatments of leaf leachates had no significant effect on seed yield per plant; maximum seed yield per plant was recorded in control treatment (2.00 g), while minimum in the treatment of 50 percent concentration (1.31 g). The leaf leachate of various concentrations had no significant effect on the grain yield per hectare. In general the effect was inhibitory of all the concentrations of leachate, maximum grain yield per hectare was recorded in control treatment (332.78 kg/ha), while minimum in the treatment of 50 percent concentration (278.33 kg/ha). The straw yield per hectare, was significantly reduced by all the concentrations of leaf leachate; maximum straw yield per hectare was recorded in control treatment (4729.4 kg/ha) while minimum in treatment of 100 per cent concentration (2421.1 kg/h). The reduction in straw yield per hectare might be due to presence of various allelopathic compounds present in dry leaf leachate of *Dendrocalamus stocksii* which had comparatively less effect on other studied growth parameters after transplanting the seedlings in prepared beds. Similarly, Jayakumar and Manikandan (2005) also reported that the aqueous leaf extracts of *Acacia leucopholea* showed proportionate inhibitory effects on dry matter production per plant of groundnut and sorghum with increasing concentration. Bhatt and Todaria (1990) had also noticed reduction in dry matter production of *Hordeum vulgare*, and *Eleusine coracana* when garden soil, mulched with dry leaves of trees or treated with leaf extracts of various agroforestry tree species. The most allelopathic tree species was *Adina cordifolia* followed by *Alnus nepalensis* and *Celtis australis* was the least.

### Conclusion

Finally, it is concluded that the harmful effect of leaf leachates of *Dendrocalamus stocksii* on groundnut is most prominent in early stage of germination, emergence of radicle and plumule *etc.* The concentration depended significant ( $p=0.5$ ) inhibitory effect of all the concentrations of leaf

leachates was observed on germination percentage, radicle and plumule length. Maximum reduction in germination percentage (56%), radicle length (3.00 cm) and plumule length (5.36 cm) in as compared to control treatment where the germination percentage (86.66%), radicle length (5.02 cm) and plumule length (12.08 cm) were recorded. After transplanting the seedlings of groundnut in prepared beds inside poly house the significant ( $p=0.05$ ) inhibitory effect was observed for test seed weight and straw yield/ha. Minimum test seed weight (430.33 g) was recorded in the treatment of 25 % concentration as compared to control (601.33 g) and straw yield per hectare (2421.1 kg/ha) as compared to control (4729.4 kg/ha). It is recommended to avoid the effect of these allelochemicals in early growth stage in field condition.

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