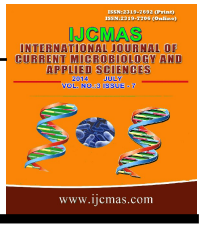
International Journal of Current Microbiology and Applied Sciences
ISSN: 2319-7706 **Volume 3 Number 7 (2014) pp. 327-335**
http://www.ijcmas.com



Original Research Article

Allelopathic Impact of Lantana Camara on Vegetative Growth and Yield Components of Green Gram (*Phaseolus radiatus*)

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A B S T R A C T

Keywords

Lantana camara, Allelopathy, agricultural crop, P haseolus radiatus,

An experiment was conducted to understand the allelopathic effects of different concentrations derived from leaf-litter dust of *Lantana camara* on the vegetative growth parameters such as - development of total number of leaves per plant, height of the plant, total leaf area, leaf area index and components of yield such as - production of number of heads per plant, production of seeds per head, weight of seeds, seed yield per plant of green gram (*Phaseolus radiatus*).Results showed different concentrations of leaf-litter dust caused significant inhibitory effect on vegetative growth and yield of the test crop. The study indicates that the allelochemicals released from the leaf-litter dust into the soil suppressed the above parameters of the of the green gram plant.

Introduction

The term “allelopathy” is used to refer to the impact of secondary metabolites produced by plants including micro-organisms that influences the growth and development of agricultural and biological systems. To describe this phenomenon, Molish, (1937) coined the word allelopathy as “encompassing the chemical interaction among all plants and microbes involving stimulatory as well as inhibitory effect”.

Under field conditions weed infestation is one of the major factors responsible for yield reductions in crops. With the help of allelopathy, weed-crop interactions can easily be explained. In most of the scientific research, allelopathic interactions between them were not considered. Hence, the present investigation is aimed at to find out the allelopathic impact of *Lantana camara on* vegetative growth parameters, yield and components of yield of green gram crops.

The replacement of one species by another is by biochemical inhibition of germination and growth of existing species by the intruder species. The major requisite of allelopathy are organic substances,

allelochemicals, allelochemics or phytochemicals, that are produced by plants as secondary metabolites such as alkaloids, phenoics, flavonoids, terpenoids and glucosinolates. Substances passing out from the leaves and other plant parts after they have been shed are known to inhibit the seed germination ,growth and development of other species Rice,(1974). Day et al.,(2003) reported that allelochemicals as non-nutritional chemicals produced by one organism which affect germination growth, health and behavior/population biology of other crops. It is believed that adverse effects of plant residues on crop yields are usually due to phytotoxic compounds leached from them due to decomposition, volatilization, leaf leachates and root exudates.

Occupying a total area of 7,073 sq.km, Rayagada district of Odisha has a rich floristic heritage. The district generates income mainly through agriculture based activities. Paddy, wheat, ragi, green gram, black gram, Green gram, ground nut, potato, maize are the major crops grown in the area.

In some agricultural fields of Rayagada district, plants like *Lantana camara* being grown for fencing. It invades forests, riverbanks, roadsides, pastures and agricultural lands. Even, it was observed by the cultivators that the density of the crop plants decreases near the boundaries of the Lantana fencing. Its leaves, roots and fruits contain allelochemicals mainly aromatic alkaloids and phenolics.

As allelopathic effects between the crops and weeds are partly responsible for the yield reduction of crops, hence the present study was conducted to determine the influence of leaf litter-dust of *Lantana camara* on vegetative growth parameters, yield and components of yield of green gram (*Phaseolus radiatus).*

Materials and Methods

For the present piece of investigation, green gram (*Phaseolus radiatus* L.) cv TARM-1 have been selected as the test cultivar, to study the effect of leaf- litter dust of *Lantana camara* plant on vegetative growth parameters, yield and components of yield per plant of green gram.

Green gram (Phaseolus radiates L.) cv TARM- 1, also known as Mung, golden gram and is native to India. The split bean is known as moong dal. The beans are small, ovoid in shape and green with the hush and yellow when dehusked. The plants are annual, small and slightly hairy with yellow flowers and lengthy pods.

Lantana camara L, is a profusely branching, aromatic, vigorous shrub in Verbenaceae family, with square sectioned stems, often hooked prickles over the stems. The leaves are opposite, ovate, often toothed and flowers small form in clusters compact heads with variable colours, that are flat-topped. Flowering occurs through most month of the year especially from September to April. The fruit is a single-seeded 'berry' (drupe) 4-8 mm diameter, fleshy and purplish-black when ripe, containing 1-2 seeds (1.5 mm long).

Lantana camara is a declared noxious weed Day et al.,(2003).But however; its allelopathic effects on crops have been studied least Narwal,(1994).

In order to study the vegetative growth, yield and components of yield of the test crop influenced by leaf-litter dust of *Lantana camara*, pot culture method, as described below, was adopted. Freshly fallen senescent leaves of Lantana *camara* were collected from old plants in the morning hours in field fencing places adjacent to College campus randomly. The

leaves collected were washed thoroughly with water, sun dried, mechanically powered in willey mill and kept in polythene bags for further use.

The surface sterilized seeds of green gram of uniform size, shape, colour were allowed to grow in the 13 cm clay pots, filled with equal quantity of well powered sandy soil and cow dung manure in a ratio of 8:1 parts (w / w).The experiments were conducted in the open field (19° 10` N $83^0$ 25` E) in the departmental garden and were allowed to grow till harvest. To get 4, 8, 12, 16 and 20% concentrations of leaf-litter dust in the soil of the pot, 4,8,12 and 20g of dust were added per 100 g of soil manure mixture in pots separately prior to the sowing of seeds. The visually selected and surface-sterilized seeds of the test cultivar were directly sown @ 10 seeds per pot. The pots were divided into 6 sets with 5 pots each. Out of 6 sets, the set which was not provided with dust served as control. Care was taken to add equal volume of water in each pot periodically during the growth period of crops. After 10 days of germination, the seedlings were thinned to stand 1 healthy seedling per plant. The plants were allowed to grow in pots till harvest. The vegetative growth parameters such as (a) development of total number of green leaves per plant, (b) height of the plant, (c)total leaf area and (d)leaf area index (LAI)were recorded at interval of one week after 20 days of germination till flowering in both control and treated sets, following the methods adopted by Patnaik,(1998).

The yield and parameters of yield such as (a) number of heads per plant (b) number of seeds per head, (c) weight of 1000 seeds and (d) seed yield per plant at the time of harvest in both control and treated sets, as per the methods adopted by Patnaik,(1998). The data so obtained were subjected to statistical analysis for calculation of standard error (S.E).

Results and Discussion

Production of number of green leaf-lets per plant

From the table-1 it is clearly marked that green gram plants grown in pots provided with 4,8,12 and 16 % of leaf-litter dust of *Lantana camara* showed positive correlations between production of green leaf-lets and advancement of plant age and negative correlations between development of leaf-lets/plant and increase in concentrations.

Height of the plant

At the time of flowering stage, the mean maximum height recorded in plants raised in control set was 30.4 ± 0.23, whereas at the same age, mean minimum height was recorded in plants treated with 16 % concentration of leaf-litter dust of *Lantana camara* was 18.3 ± 0.27 Other concentrations showed intermediate values (Table -1).

Total leaf area (TLA)

The development of total leaf area in the test cultivar influenced by different concentrations of leaf-litter dust of *Lantana camara* supplied in the soil was drastically altered. The TLA exhibited positive correlations in plants of both control and treated sets with advancement of plant age till flowering and negative correlations with increase of dust concentrations applied into the soils (Table-1).

Leaf area index (LAI)

The LAI also considerably lowered down by

the influence of different concentrations of litter-dust of *Lantana camara.* The LAI of green gram plants grown in control and 16% leaf litter-dust at the time of flowering exhibited intermediate values between95.47 to 172.3 (Table-1).

Development of number of pods / plant

All the concentrations of leaf-litter dust of *Lantana camara* considerably reduced the number of pods per plant. The mean maximum and minimum number of pods recorded in plants grown in control and pots provided with 16 % concentration of leaf-litter dust were 22.3 ± 0.19 and 12.3 ± 0.19 respectively. Plants grown with 4,8 and 12% leaf-litter dust concentration produced intermediate values (Table-2).

Development of number of seeds per pod

Table-2 indicates that development of number of seed setting per pod in treated plants was considerably reduced by the influence of different concentration of dust applied into the soil. Plants of control set exhibited 18.5 ± 0.16 seed setting per pod, where as the value was reduced by the influence of 16% concentration of dust in the soil. Other concentration of the dust exhibited intermediate values.

Weight of 1000 seeds

All the concentrations of leaf-litter dust of *Lantana camara* significantly caused reduction in seed development as a result of which weight of 1000 seeds was decreased. Better and healthier seeds were produced in control plants showing maximum(69.6± 0.24) whereas the weight of 1000 seeds collected from plants grown in 16% leaf-litter dust concentration was reduced to minimum(20.3 ± 0.13). Intermediate values were recorded in Plants grown in soils provided with other concentrations of dust (Table-2).

Seed yield / plant

Plants of control set yielded the maximum quantity of seeds (28.71 ± 0.06) and minimum (2.64 ± 0.05)seed yield per plant grown in 16% concentration of leaf-litter dust of *Lantana camara*. Intermediate values were recorded in plants grown in other concentrations (Table-2).

The *Lantana camara* plant produce volatile allelochemicals from its leaves.The allelochemicals have been identified as phenolics, with umbelliferone, methylcoumarin, and salicylic acid being the most phytotoxic. In addition to phenolics, a recent report indicates lantadene A and B as more potent allelochemicals Sharma et al.,(2007).

Besides the known glycosides, verbascoside and a flavone glycoside, a novel flanonol glycoside named camaraside and a new phenylpropanoid glycoside, lantanaside have been isolated from the leaves of *Lantana camara* and defined as 3,5-dihydroxy-4′,6-dimethoxyflavonol-7-*O*-glucopyranoside and 3,4-dihydroxy-,β-phenylethyl-*O*-α-L-rhamnopyranosyl (1→3)-4-*O*- *cis*- caffeoyl-β -D-glucopyranoside respectively by spectroscopic methods and chemical transformations Mahato et al.,(2001).

Thus, the release of these phenolic compounds might have adversely affected the growth and yield of test cultivars through their interference in energy metabolism, cell division, biosynthetic processes etc.

During life time of any crop, vegetative growth is considered as one of the important stage after seedling growth.

Production of number of green leaflets was considerably reduced when treated with different concentrations of leaf-litter dust which might be due to translocation of active ingredients of allelochemics present in the dust from the soil to the leaves. Further, the higher concentrations of dust might have controlled or arrested the various metabolic processes in leaves causing lesser photosynthates and thus decreased rate in assimilation of growth regulators, which might have checked the formation of green leaves.

This inhibitory effect on plant height might be due to checking or inhibition of biosynthesis of gibberellins, which are responsible for cell-elongation and plant height. The present observations corroborate with the findings of many author in other plant by allelochemical of different pants viz. Jayakumar et al.,(1990) in groundnut and corn, Igboanugo,(1988 b.) in *Capsicum annum*, Basu et al.,(1987) in crop plants, Mishra,(2014) in *P. hysterophorous* and Kumbhar and Patel,(2013) in Patan. The development of leaf area is very much checked in plants of treated sets compared to the control plants; It is expected that the phenolics might have checked the increase of leaf area by preventing the synthesis of protein, nucleic acid and other metabolites responsible for the synthesis of growth regulators. The present findings agree with the report of Jayakumar et al.,(1990),Gentle and Duggin,(1997 b.),Sahu,(2000).

The decrease in LAI might be due to development of lesser number of leaves / unit area of land where it grows. As the development of green leaves per plant was reduced the LAI also proportionately reduced. This findings consonance with Mishra,(2013) in *P.hysterophorus.*

Yield potential of any crop is related to its photosynthetic activity during grain filling Evans and Rawson,(1970). The allelopathic influence of *Lantana camara* leaf-litter dust on yield and components of yield of all the test cultivar is discussed below.

The allelochemicals released from the dust into the soil might have checked the synthesis and translocation and/or accumulation of flowering hormones responsible for production of number of flowers per inflorescence of the plant. The present findings corroborate with the findings of Sahu,(2000). Seed setting inside the plant is another important factor of yield per plant. The development of seeds in pods depends on the photosynthates available in leaves and their translocation to seeds. The allelochemicals might have lowered seed setting per pod.

In the present investigation it is marked that all concentrations of leaf-litter dust considerably reduced the seed weight compared with respective control plants. This suggests that the allelochemicals present in the dust might have released into the soil and checked the source and sink relationship. The phenolic compounds leached from the dusts might have interfered in oxidoreduction reactions, nucleotide biosynthesis and other vital functions, controlling and/or preventing gibberellin's biosynthesis, and accumulation of growth regulators in the cells causing inhibitory effect and vegetative growth and grain development during reproductive phase, which ultimately might have reflected on seed weight. Miller and Chou,(1971) reported similar findings influenced by decaying of *Eucalyptus* litter.

In the present investigation, it was noticed that all the concentrations of dust considerably reduced the yield efficiency of the test crops compared with their respective

control plants. This decrease in the yield/plant might be due to reduction in production of number of heads per plant, low rate of seed settings which were controlled by reduction in vegetative growth parameters.

The present findings agree with reports of Acharya,(1994), Narwal,(1994), Patnaik, (1998),Padhy et al.,(2000) and Gantayet,(2007) in various crops under the influence of different allelochemicals of other plants**.**

Table – 1

Effect of different concentrations of leaf - litter dust of *Lantana camara* on vegetative growth parameters of green gram (*Phaseolus radiatus* L.cv TARM-1).

(Each value is mean of 10 replicates ± SE)

Date of sowing-1st Dec. 2012

Dust Conc. (%)	Age of the plant at the time of recording (days)	Number of green leaflets/plant	Height of the plant (cm)	Total leaf area/plant (cm^2)	Leaf area Index per plant
C	21	8.2 ± 0.17	18.3 ± 0.27	87.2± 0.9	65.7
	28	10.6 ± 0.13	19.2 ± 0.21	121.8 ± 2.3	91.18
	35	12.4 ± 0.15	25.9 ± 0.15	176.8 ±1.8	133.2
	F	15.5 ± 0.20	30.4 ± 0.23	228.7±1.4	172.3
4	21	6.9 ± 0.16	16.7± 0.11	80 .76± 2.3	60.85
	28	9.8 ± 0.13	18.6 ± 0.15	110.25± 1.9	83
	35	12.6± 0.17	23.6 ± 0.13	149.46± 1.4	112.6
	F	14.3± 0.15	27.5 ± 0.12	193.59± 2.7	145.8
8	21	5.8 ± 0.15	14.6 ± 0.21	78.68 ± 0.9	59.29
	28	8.8 ± 0.16	17.2 ± 0.12	97.45 ± 0.7	73.43
	35	11.4± 0.13	21.5 ± 0.21	141.5 ± 1.8	106.6
	F	13.4± 0.11	24.8 ± 0.25	182.4 ± 1.1	137.45
12	21	5.3 ± 0.14	13.5 ± 0.13	68.4 ± 1.3	51.54
	28	8.2 ± 0.17	15.9 ± 0.11	89.23 ± 0.9	67.24
	35	10.8± 0.21	20.2 ± 0.18	124.4 ± 1.7	93.74
	F	12.6± 0.15	21.6 ± 0.26	148.3 ± 1.6	112.13
16	21	4.7 ± 0.11	12.4 ± 0.18	58.11 ± 0.8	43.79
	28	6.2 ± 0.14	14.2 ± 0.21	76.52 ± 1.2	57.66
	35	8.4 ± 0.13	18.9 ± 0.13	98.42 ± 2.2	74.16
	F	9.8 ± 0.09	19.6 ± 0.11	126.7 ± 1.7	95.47
20	21	*	*	*	*
	28	*	*	*	*
	35	*	*	*	*
	F	*	*	*	*

* No seedlings established. F = First flowering stage.

TABLE - 2

Effect of different concentrations of leaf - litter dust of *Lantana camara* on
yield and components of yield of green gram (*Phaseolus radiatus* L.cv TARM-1).

(Each value is mean of 10 replicates ± SE)

Date of sowing-1st Dec. 2012

Dust Conc.(%)	Number of pods/plant	Number of seeds/pod	Weight of 1000 seeds (g)	Yield/plant (g)
C	22.3 ± 0.19	18.5 ± 0.16	69.6 ± 0.24	28.71± 0.06
4	20.8 ± 0.17	16.3 ± 0.14	63.2 ± 0.16	21.4± 0.08
8	18.1 ± 0.16	14.2 ± 0.13	58.1 ± 0.18	14.9 ± 0.04
12	15.4 ± 0.12	12.5 ± 0.14	24.5 ± 0.16	4.65 ± 0.06
16	12.3 ± 0.19	10.6 ± 0.12	20.3 ± 0.13	2.64 ± 0.05
20	*	*	*	*

* No seedlings established.

Lantana is now a major weed in many regions of Rayagada District of Odisha,thus directly or indirectly invades natural and agricultural ecosystems in various ways. Thus, it is a matter of utter concern that proper caution should be exercised before using the plants for fencing purposes, as *Lantana camara* plants has become the dominant under storey species, encroaching agricultural land, reducing the carrying capacity of the pastures, disrupting succession and decreasing biodiversity. Not only in natural forests but also in protected areas, *Lantana* invasion is considered a major threat to native plants. It seems mechanical control is only effective, such as clearing of lands with continual follow-up treatment to remove roots and seedlings.

Thus, experimental studies on allelopathic interaction in natural field plots and the structural attributes of vegetation affected by *Lantana* invasion are warranted. So, in a nutshell, it be concluded that as the leaf-litter leachate and dust of *Lantana camara* were found to be responsible for the poor establishment of seedlings, vegetative growth and yield of the test cultivar. Hence, *Lantana* plants should not be planted in and around the crop fields. Further there is a need of scientific data and in-detailed works at molecular and sub-molecular levels to draw any definite conclusions. Awareness should be created among the cultivators regarding the harmful effects of *Lantana camara* on agriculture in general and on this cultivar in particular.

Acknowledgement

The Author Dr. Gantayet wish to thank to the Joint Secretary, UGC, Eastern Regional Office, Kolkata for providing financial assistance to his minor research project, which enable him to carry out this work . He also thank to the Principal and Head, Department of Botany, Rayagada (Auto.) College, Rayagada, Odisha for providing necessary laboratory facility.

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