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Effect of Seed Priming with Botanicals on Plant Growth and Seed Yield of Lentil (*Lens culinaris* M.)

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A B S T R A C T

A field experiment was conducted during rabi season, 2018-19 at the Research Farm, Department of Seed Science and Technology, Chauras Campus, H. N. B. Garhwal University, Srinagar (Garhwal), Uttarakhand, India to study the effect of seed priming with botanicals on plant growth and seed yield of lentil (*Lens culinaris* M.). The experiment was laid out into Randomized Block Design and replicated three times. The field experiment consisted of six treatments viz., seed priming with neem leaf extract (50%), castor oil (20%), ginger extract (50%), onion extract (50%) and garlic extract (50%) and control. The seed priming with 50% extract of garlic inhibits germination due to the presence of Allicin. The maximum germination percentage (90.80%), number of branches per plant (5.20), seeds per pod (1.87), 1000 seeds weight (20.24 g), yield per plant (3.51 g) and yield per ha (9.94 g) were observed when seeds were primed with neem leaf extracts (50%). Whereas, maximum plant height at 60 DAS (12.80 cm) and number of pods per plant (174.73) were observed when seeds were primed with onion extract (50%).

Introduction

Pulses are the edible seeds of plants in the legume family and grown in major area in India. It contributes a significant role in Indian agriculture due to their adaptability in various climatic conditions. In Indian meal, the pulses are used as a source of vegetable protein. Pulses grow in pods and come in a variety of shapes, sizes and colors. The United Nations Food and Agriculture Organization (FAO) recognizes 11 types of pulses: dry beans, dry broad beans, dry peas, Bambara beans, pigeon peas, chickpeas, cow peas, lentils, vetches, lupins and pulses nes. Pulses are healthy, nutritious and easy to cook with. Growing pulses also promotes sustainable agriculture, as pulse crops help decrease greenhouse gases, increase soil health, and use less water than other crops.

Importantly, seed priming has shown its effectiveness in improving seed germination, seedling growth and crop stand against the

negative impacts brought about by stress in the field. Seed priming is a commercially used technique for improving seed germination and vigour. It involves imbibitions of seeds in water under controlled conditions to initiate early events of germination, followed by drying the seed back to its initial moisture content (Varier *et al.,* 2010).Treatment with water, salt solution, certain hormones, organic and inorganic chemicals, and pesticides, etc. (Vasileva and Ilieva, 2007) are primarily practiced in seed priming. Also, pre-soaking, hardening, hormonal priming, hydropriming, halopriming, Osmoconditioning, and ascorbate priming are some common priming techniques to improve speed and synchrony of seed germination. Botanical priming is new endeavor and many botanical extracts have been studied for their effect on seed and seedling parameters.

In recent years, the use of local botanicals has gained much importance, mainly among researchers, because of its high benefits in plant growth, yield and seed quality attributes. The neem tree, *Azadirachtinindica*, a source of several insecticidal alkaloids is a sub-tropical tree native to the arid areas of Asia and Africa (Saha *et al.,* 2006). Azadirachtin is the main pesticidal component of neem. Neem products are naturally available materials, cheaper, and also safe for beneficial organisms. Seed treatment with neem leaf extract and their use in agriculture is increasing because of beneficial effects on plants. Some other botanicals like garlic extract, onion extracts, castor oil etc. can also be used for seed treatment and various effect of them can be seen on growth and yield of a plant. Botanical seed treatment is extracted from naturally occurring sources based on botanical ingredients. It has synergistic effect on early and uniform seed germination and enhances tolerance to pest and disease during early crop stage. Botanical extracts been reported to possess antifungal activities against seed borne fungies (Suratuzzaman *et al.,* 1994; Ashrafuzzaman and Hossain, 1992; Hossain and Schlosser 1993). Botanicals have been found to be effective for reduction of population of Fusarium associate with seed (Bowers and Locke, 2000). Available literature indicate that plant extracts and plant essential oils possess effective antimicrobial principles against food and grain storage fungi (Mishra and Dubey, 1994).

Materials and Methods

Climate

In the experimental site except during the rainy season, rests of the months are usually dry, with exception of occasional showers during winter or early spring. Srinagar Garhwal region comes under sub-tropical climate, with both extremes in the temperature *i.e.,* winter and summer. The monthly meteorological data on various weather parameters were recorded at meteorological observatory of Research Farm, Department of Seed Science and Technology, Chauras Campus, H. N. B. Garhwal University, Srinagar, Garhwal, Uttarakhand (India), during the whole experimental period in 2018-19.

The data for the climatic features of the experimental site have been recorded during the period of experimental trail *i.e*, November-March and is presented in the following figure.1.

Meteorological data

The Research farm falls under humid and sub-tropical climatic condition which exhibits dry summer and rigorous winter with occasional dense fog from mid-November to mid-February. In winter, there is less rainfall comparison to summer season. The

temperature reaches 45 ºC on some days from May-June and 2 ºC in December-January. The maximum temperature range between 13ºC-26ºC and minimum between 5 ºC-20 ºC. The maximum precipitation during experiment is 16.3 mm mostly received during December and minimum during November.

The data of temperature, relative humidity and rainfall during the experiment was obtained from the meteorological observatory of Horticulture Research Centre, Department of Horticulture, Chauras Campus, Srinagar Uttarakhand has been presented in appendix I and depicted in fig.1.

Soil condition

In order to find out the soil texture, response and fertility status, a composite soil sample representing the distinct areas of the experimental site was drawn from the experimental plot from 0-20 cm depth before transplanting the crop. Prepared and processed composite soil sample was analyzed at departmental laboratory and the results thus obtained have been presented in the table

Materials

During the course of experiment, Lentil Cv. PL-8was used. This variety is developed by G B Pant University of Agriculture and Technology, Pantnagar, Uttarakhand. The fruits of this variety are green and long tender. It is long duration crop. This variety is high fruit weight and good bearing.

Land preparation

Through ploughing, the ground was carried to a good tilth, and two crosses were harrowing. The beds were ready and channels for adequate irrigation were supplied.

Fertilizer application

15 t/ha FYM were applied in the field and then cross ploughing was done with the help of tractor so that FYM could be mixed thoroughly.

Preparation of botanical extracts

Preparation of stock solution

The stock solution of botanical extracts was prepared by grinding the 25 g of botanical with adding 25 ml water in it. By this, 1:1 solution of all the botanicals was prepared. In case of neem, leaves were used, while rhizomes in ginger, bulbs in onion and cloves in garlic were used to prepare stock solution.

Method of priming

The 50% solution of botanicals was prepared for priming of seeds. The 20% solution of castor oil was prepared by adding 10 ml oil into 40 ml of distilled water.

The seeds were kept overnight into solution for soaking. On the next day, the seeds were dried into shade and sown into respective plots.

Sowing

The seeds were sown done on 15 November, 2018 by manually with 2 seeds at a location, at a depth of 3-4 cm in the rows which were prepared before sowing.

Irrigation

The crop was raised in winter season, so much irrigation was not needed. The light irrigation was given after sowing followed by after ten days of interval. Thereafter, irrigations were given as per the requirement.

Thinning

The thinning was done at 35 days after sowing of seeds to obtain optimum plant population in each experimental plot.

Intercultural operations

Hoeing and weeding operations were done whenever required. Necessary plant protection measures were being taken up to protect the crop from pest and diseases.

Harvesting

Harvesting was done after the seeds attained physical maturity. The harvesting of the crops was done on 9 March, 2019.

Observations recorded

Five plants were randomly selected from each plot. The following observations were recorded on the different growth and yield parameters. The characters studied under the present experiment are listed below.

Growth parameters

Germination percentage (%)

Number of germinated seeds were recorded every 48 h after initiation of germination until 10 days. Germination percentage was calculated (Association of Official Seed Analysis 1983) as follows:

Germination percentage = (No. of seed germinated/ Total No. of seed sown) × 100

Plant height at 60 and 90 DAS

Height of the selected plants was measured from the base of the plant (soil surface) up to the growing tip of the main stem with meter scale and expressed in centimetres. It was recorded at 60 and 90 DAS and at maturity under irrigated and rainfed conditions.

Number of branches

Five plants from each replication were selected and number of branches was counted and the mean was calculated.

Plant Fresh weight

Five plants from each replication were uprooted at 60 DAS and their weight was measured with the help of balance machine and expressed in gram.

Total Dry matter

Five plants from each replication were uprooted at 60 DAS and oven dried at 65°C till constant weight was obtained. Plant dry weight was expressed as g plant^{-1}.

Days to 50% flowering

The time taken to produce flower by 50% of plants in each treatment of each replication was recorded and days counted by date of sowing.

Stem dry weight

Five plants from each plot were uprooted at the time of 50% flowering and their main stem was separated. The stem than oven dried at 65 ^{o}C for 24 h and their weight was measured at balance machine and expressed in gram.

Leaf dry weight

Five plants from each plot were uprooted at the time of 50% flowering and their leaves were separated. The leaves than oven dried at 65 ^{o}C for 24 h and their weight was measured at balance machine and expressed in gram.

Yield Parameters

Number of pods per plant

Pods of 5 plants were selected randomly at maturity from each treatment and counted and average number of pods plant^{-1}was calculated.

Number of seeds per pod

After threshing the bunch of five plants, number of seeds were counted and divided with total number of pods recorded from these five plants.

Yield per plant (g)

After threshing, the total yield of five tagged plants per plot was weighed and the resultant was divided by the total tagged plants and the seed yield per plant was obtained.

Yield per plot (g)

Seed yield of each net plot was weighed and recorded after threshing and winnowing.

Yield per hactere (kg)

Straw yield was calculated in kg by subtracting the grains yield from the biological yield.

Test weight (100) seeds (g)

One hundred seeds were randomly taken from the harvest (8% seed moisture) and weighed on a precision balance to record their mass.

Statistical analysis

The statistical analysis for all the characters studied was done by method recommended by Panse and Sukhatme, (1961) for Randomized Block Design and for the statistical analysis of data. The CD (Critical Difference) at 5% level of significance for each character was worked out.

Results and Discussion

In further studies garlic was not use after germination because 50 Percent of garlic reduces germination to 0%.

In this study results of the experiment entitled Effect of Seed Priming with Botanical Extracts on Plant Growth and Yield of Lentil (*Lens culinaris* M.) obtained during the course of investigation are summarized with the help of suitable table and graphs. The botanical seed treatments were found significant for different morphological fetures of lentil.

Growth parameters

Germination percentage

It is evident from Table 4.1 that the seed priming with neem leaf extracts resulted as maximum germination percentage (90.80 %) followed by T_5 (89.23 %) and T_4 (88.44 %) when compared to control (86.01%). No seeds were germinated when the seeds were primed with 50% garlic extracts (Fig.2).

Plant height

The data pertaining to the plant height given in the Table 4.2indicated thatthere was significant difference in plant height at90 DAS (Fig.3). Maximum plant height (34.27 cm) was observed in treatment T_4, followed by T_5 (33.80 cm) and T_3 (31.93 cm). Whereas, least plant height (28.80) was observed in control. There was no significant difference in plant height at 60 days after sowing.

Number of branches per plant

It is revealed from observed data presented in Table 4.2 that there was significant difference

between treatments in relation to number of branches per plant (Fig.4). Higher number of branches (5.20) were recorded in T_2 followed by T_4 (4.53) and T_3 (4.33). While the lowest number of branches (3.60) were observed in which was at par with T_5 (4.40).

Plant freshweight(g)

Various seed priming treatments shown significant difference in fresh weight of plant at 60 DAS (Fig.5). Higher plant weight was observed in T_3 (25.77 g) when compared to control (19.12 g). Treatments T_5, T_2 and T_4 were recorded plant fresh weight 24.13 g, 20.45 g and 20.20 g, respectively (Table 4.3).

Total dry matter (g)

Seed priming with various botanical extracts revealed significant difference in total dry matter of plant at 60 DAS (Fig. 4.5). Maximum total dry matter (6.50 g) was observed in T_3, while the least total dry matter (4.75 g) was recorded in control which was at par with T_5, T_2 and T_4, respectively in ascending order (Table 4.3).

Days to 50% flowering

It is evident from the Table 4.4 that there was significant difference between the treatments in relation to days to 50% flowering (Fig. 5). Maximum days to produce 50% of flowers (63.67 days) were taken by control. Seed priming with onion extracts was resulted as minimum days (56.33 days) for producing 50% of flowers.

Stem dry weight at 50% flowering

The data in Table 4.4 indicating that maximum stem dry weight (641.67 mg) at the time of 50 % flowering was observed in T_4 followed by T_5 (511 mg), T_2 (500.33 mg) and T_3 (492.67 mg). Minimum dry weight (438.67 mg) was observed in control.

Leaf dry weight at 50% flowering

The data in relation to leaf dry weight at the time 50% flowering was revealed significant difference between treatments (Fig.7). The maximum leaf dry weight was observed in T_5 (3.57 g) followed by T_4 (3.54 g), T_2(3.32 g) and T_3(2.50 g). Whereas, the minimum leaf dry weight (2.46 g) was observed in control (Table 4.4).

Yield parameters

Pods per plants

The data on number of pods per plant, presented in Table 4.5 indicated significant differences between various treatments (Fig. 8).Among the treatments, T_5 recorded significantly higher number of pods per plant (174.73), followed by T_2 (157.47), T_4(149.40) and T_3 (135.80). Whereas, minimum number of pods per plants was found in T_1 (118.40).

Seeds per pods

It is evident from Table 4.5 that result indicated significant differences between various treatments (Fig.9). Among the treatments, T_2 and T_4 recorded similar and higher number of seeds per pods (1.87), which were followed by T_5 (1.86), T_3 (1.81). Whereas, minimum number of seeds per pods (1.76) was found in T_1.

Yield per plant (g)

Plant (g)

The data on yield per plant, presented in Table 4.6 indicated significant differences between various treatments (Fig.10).Among the treatments, T_5 recorded significantly higher yield per plant (3.90 g), followed by T_2 (3.51 g), T_3 (3.46 g) and T_4 (135.80 g). Whereas, minimum yields per plant (3.27 g) was found in T_1.

Yield per plot (g)

The data with respect to yield per plot, given in Table 4.6has shown significant differences between various treatments (Fig.11). Among the treatments, T_2 recorded significantly higher yield per plot (167 g), followed by T_5 (160 g), T_3 (148 g) and T_4(144 g). Whereas, minimum yield per plot (139 g) was found in T_1.

Yield per hectare (q)

In relation to yield per hectare, T_2 recorded significantly higher yield per hectare (9.94 q), followed by T_5 (9.56 q), T_3 (8.83 q) and T_2 (8.57 q). Whereas, minimum yield per hectarewas found in T_1(8.29 q).

Table.1 Soil analysis of experimental plot

S.No.	Properties	Value
1	Texture	Sandy clay
2	Soil Ph	6.3
3	Organic carbon (%)	0.85
4	Available nitrogen (kg/ha)	94.3
5	Available phosphorus (kg/ha)	3.55
6	Available potassium (kg/ha)	131

Experimental details

1	**Experimental design**	**Randomized Block Design**
2	Number of replications	3
3	Number of treatments	6
4	Total number of plots	18
5	Spacing	30 × 10 cm
6	Plot size	1.2 × 1.4 metres
7	Variety used	PL-8
8	Date of sowing	15-November-2018
9	Date of Harvesting	9 March, 2019

Details of treatments

Sr. No.	Treatment No.	Treatments
1.	T1	Control
2.	T2	Neem leaf extract
3.	T3	Castor oil
4.	T4	Ginger extract
5.	T5	Onion extract
6.	T6	Garlic extract

Table.4.1 Effect of seed priming with botanicals on germination percentage of lentil

Treatments		Germination percentage (%)
T_1	Control	86.01
T_2	Neem leaf extract	90.80
T_3	Castor oil	81.25
T_4	Ginger extract	88.44
T_5	Onion extract	89.23
T_6	Garlic extract	0.00
S.EM.		**1.04**
CD at 5%		**3.28**

Table.4.2 Effect of seed priming with botanical extracts on Plant Height at 60 DAS and 90 DAS and number of branches

Treatments		Plant height at 60 DAS	Plant height at 90 DAS	Number of branches per plant
T_1	Control	12.67	28.80	3.60
T_2	Neem leaf extract	13.00	30.07	5.20
T_3	Castor oil	13.20	31.93	4.33
T_4	Ginger	14.73	34.27	4.53
T_5	Onion	12.80	33.80	4.40
S.EM.		**0.90**	**0.71**	**0.13**
CD at 5%		**NS**	**2.33**	**0.44**

Table.4.3 Effect of seed priming with botanicals on Plant fresh weight and dry weight at 60 DAS

Treatments	Plant fresh weight at 60 DAS	Total dry matter at 60 DAS
Control	**19.12**	**4.75**
Neem leaf extract	**20.45**	**5.40**
Castor oil	**25.77**	**6.50**
Ginger	**20.20**	**4.90**
Onion	**24.13**	**5.87**
S.EM.	**0.49**	**0.35**
CD at 5%	**1.60**	**1.16**

Table 4.4 Effect of seed priming with botanicals on Days to 50% flowering, Stem dry weight at 50% flowering and Leaf dry weight at 50% flowering

Treatments		Days to 50% flowering	Stem dry weight at 50% flowering (mg)	Leaf dry weight at 50% flowering (g)
T_1	Control	63.67	438.67	2.46
T_2	Neem leaf extract	60.67	500.33	3.32
T_3	Castor oil	58.33	492.67	2.50
T_4	Ginger	59.67	641.67	3.54
T_5	Onion	56.33	511.00	3.57
S.EM.		**0.94**	**6.88**	**0.10**
CD at 5%		**3.07**	**22.43**	**0.32**

Table.4.5 Effect of seed priming with botanicals on Pods per plant and Seeds per pod

Treatments		Pods per plant	Seeds per pod
T_1	Control	118.40	1.76
T_2	Neem leaf extract	157.47	1.87
T_3	Castor oil	135.80	1.81
T_4	Ginger	149.40	1.87
T_5	Onion	174.73	1.86
S.EM.		**4.33**	**0.02**
CD at 5%		**3.84**	**0.08**

Table.4.6 Effect of seed priming with botanicals on yield per plant,yield per plot and yield per hector

Treatments		yield per plant (g)	Y yield per plot(g)	yield per hector(qt)
T_1	Control	3.27	139.33	8.29
T_2	Neem leaf extract	3.51	167.00	9.94
T_3	Castor oil	3.46	148.33	8.83
T_4	Ginger	3.42	144.00	8.57
T_5	Onion	3.90	160.67	9.56
S.EM.		**0.12**	**5.81**	**0.35**
CD at 5%		**0.38**	**18.95**	**1.13**

Table.4.7 Effect of seed priming with botanicals on 1000 seeds weight(g)

Treatments		1000 seeds weight(g)
T_1	Control	17.83
T_2	Neem leaf extract	20.24
T_3	Castor oil	19.07
T_4	Ginger	18.59
T_5	Onion	18.73
S.EM.		**0.45**
CD at 5%		**1.46**

Fig.1

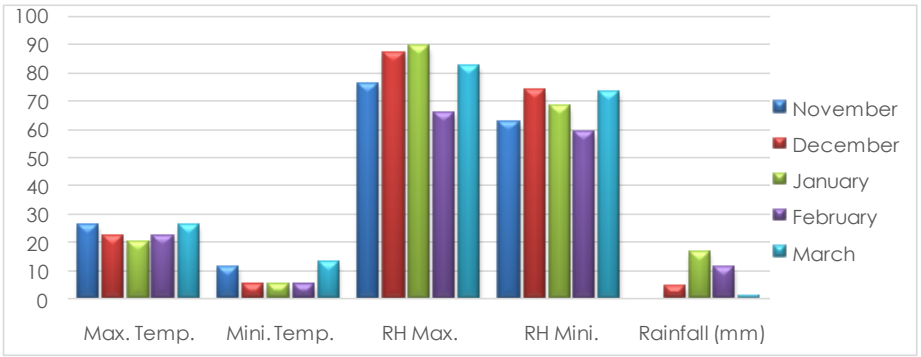


Fig.2 Effect of seed priming with botanical extracts on Plant Height at 60 DAS and 90 DAS

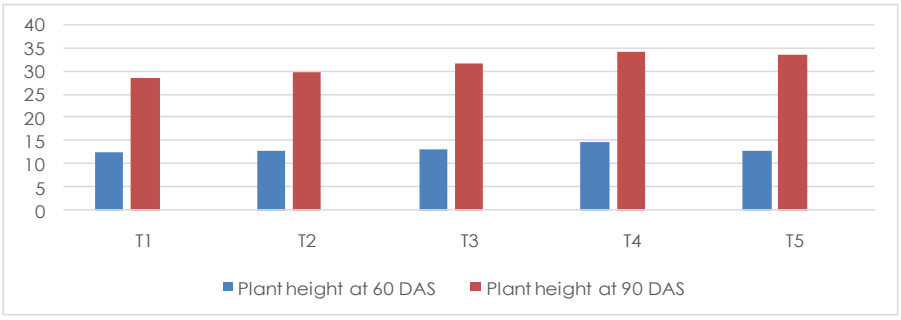


Fig.3 Effect of seed priming with botanicals on fresh weight of plant at 60 DAS

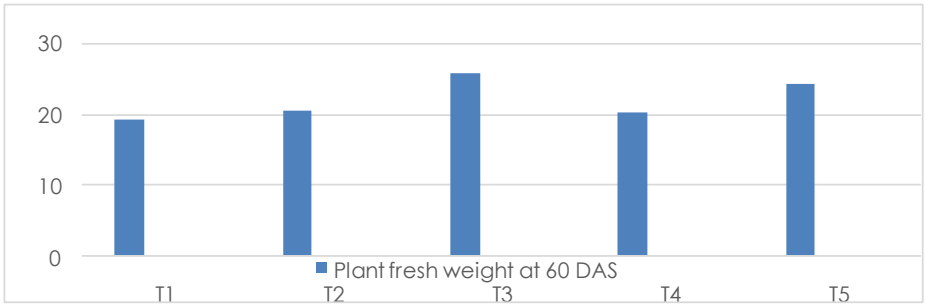


Fig.4 Effect of seed priming with botanicals on total dry matter of plant at 60 DAS

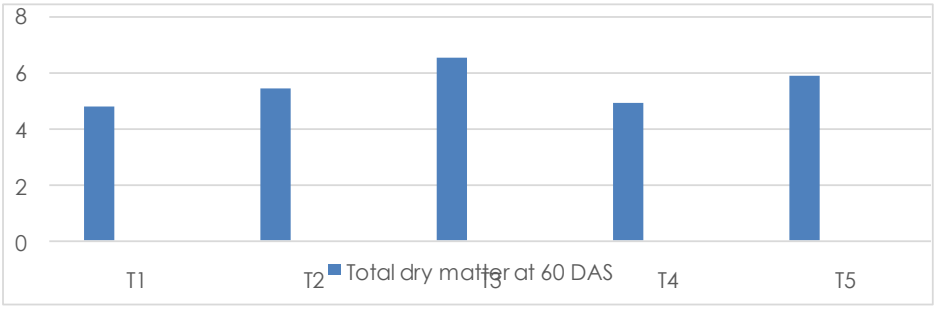


Fig.5 Effect of seed priming with botanicals on Days to 50% flowering

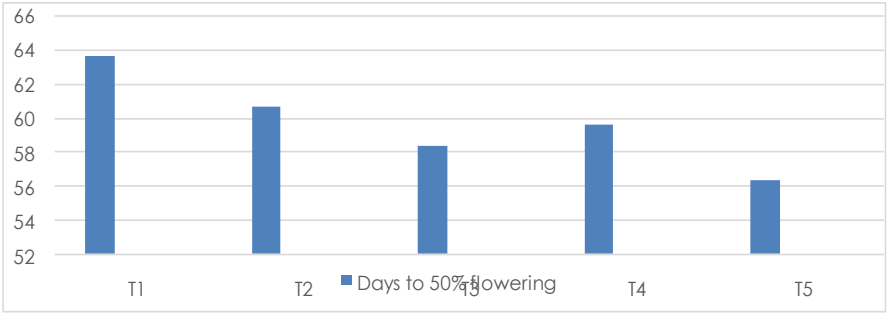


Fig.6 Effect of seed priming with botanicals on Stem dry weight at 50% flowering

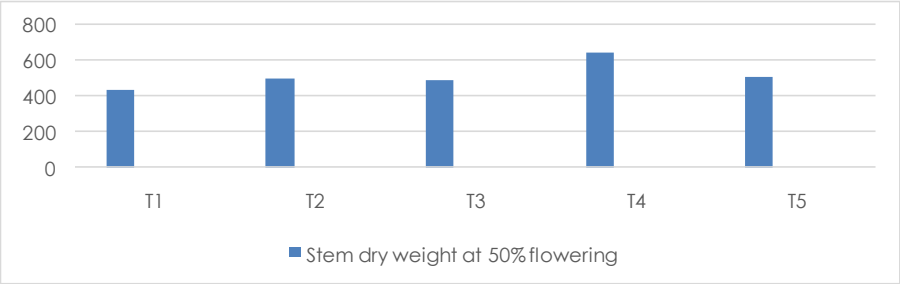


Fig.7 Effect of seed priming with botanicals on Leaf dry weight at 50% flowering

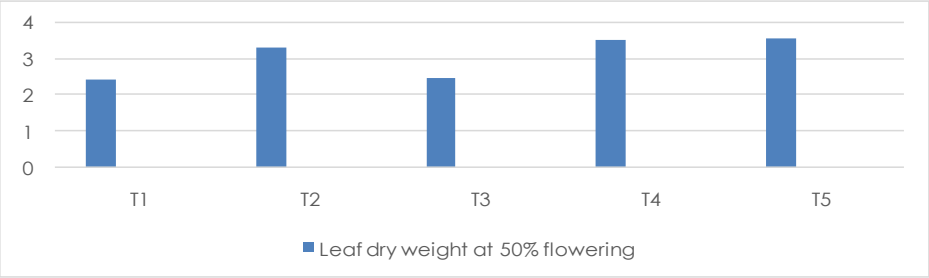


Fig.8 Effect of seed priming with botanicals on Pods per plant

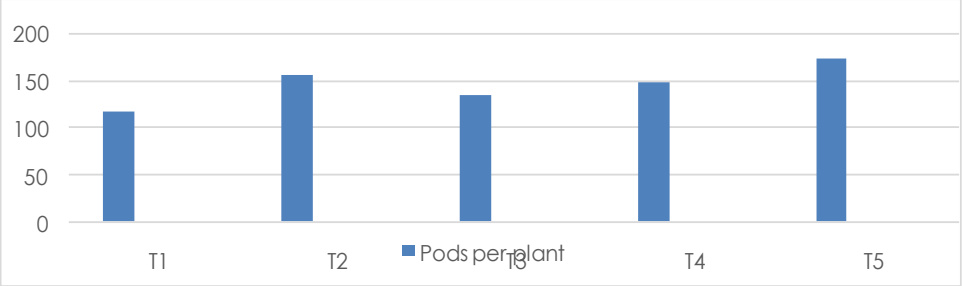


Fig.9 Effect of seed priming with botanicals on Seeds per pod

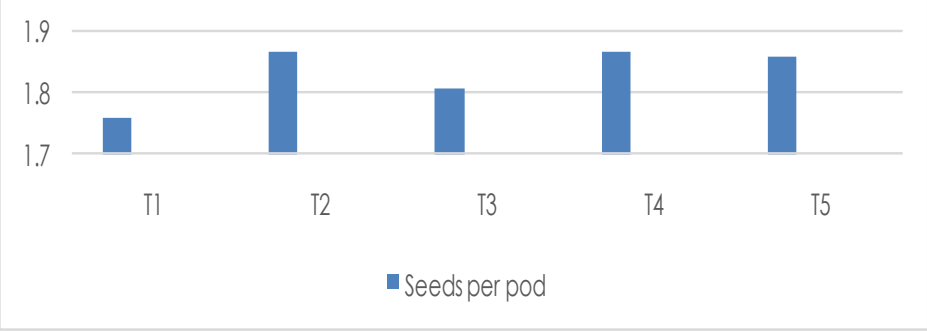


Fig.10 Effect of seed priming with botanicals on yield per plant

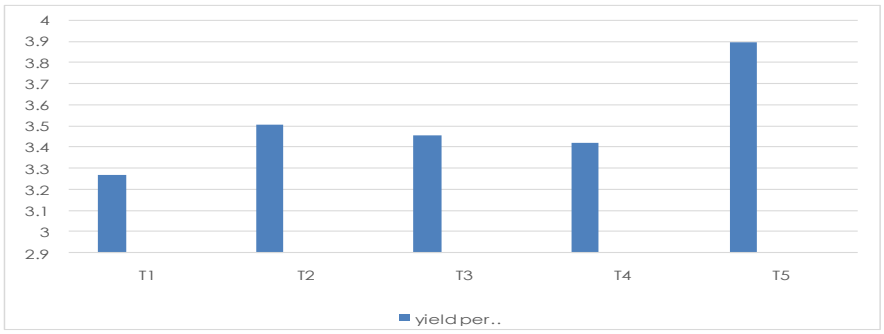


Fig.11 Effect of seed priming with botanicals on yield per plot

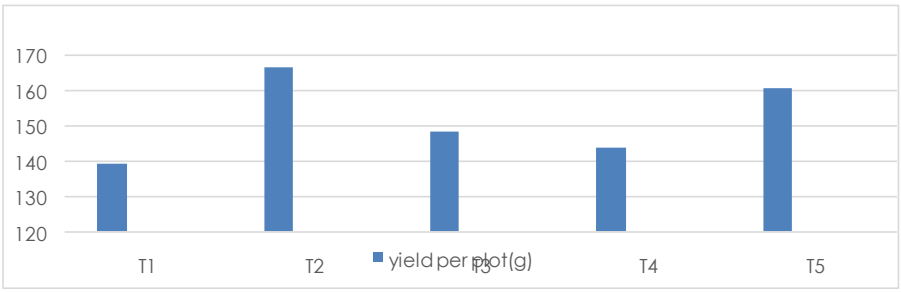


Fig.12 Effect of seed priming with botanicals on yield per hectare

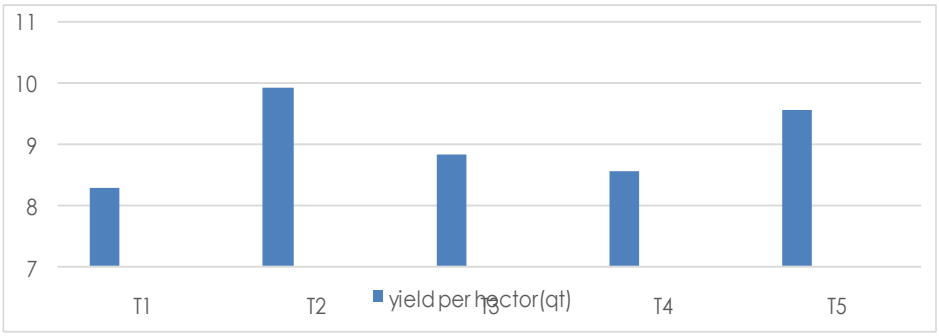
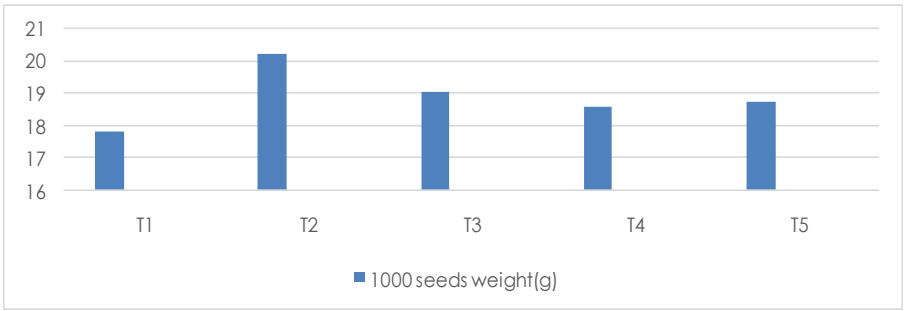


Fig.13 Effect of seed priming with botanicals on 1000 seeds weigh



1000 seeds weight (g)

The data on 1000 seeds weight, presented in Table 4.6 indicated significant differences between various treatments (Fig.13). Among the treatments, T_2 recorded significantly higher 1000 seeds weight (20.24 g), followed by T_3 (19.07 g), T_5(18.73 g) and T_4 (18.59 g).Whereas, minimum 1000 seeds weight (17.83 g) was found in T_1.

Organic farming is a production system which avoids or largely excludes the use of synthetically produced fertilizers, pesticides, growth regulators and livestock feed additives. To the maximum extent, possible organic farming system depend on upon crop rotations, crop residues, animal manures, legumes, green manures, off farm organic wastes, mineral bearing rocks and biofertilizers to maintain soil productivity, tilth and to supply plant nutrients and biological means to control insects, weeds and pests.

Growth parameters

The data with respect to germination, plant height, number of branches per plant, plant fresh weight and dry weight, leaf dry weight, stem dry weight and days taken to 50% flowering has shown significant differences due to seed priming with various botanicals. Seed priming with neem extracts resulted as maximum germination percentage (90.80%) in lentil. The result is in conformity with Ahmed *et al.,* (2014). He observed increased germination percentage in rice seeds, when treated with neem extract (1:1). Khatun *et al.,* (2010) also observed increased germination percentage in lentil seeds treated with neem leaf powder. Hasan *et al.,* (2005) found that extract of onion bulb and leaf extract of neem increased seed germination by decreasing the viral infection. The maximum plant height at 90 DAS was observed in seeds primed with onion extract, whereas number of branches increased due to seed priming with neem leaf extract. Similar results were observed by Janardhan (2014) in urdbean. Shinde (2012) also observed the similar results. Among the botanical extracts, significant differences in flowering was observed.

The use of botanical extracts recorded less days to produce 50% flowers when compared to control. Janardhan (2014) also noted that treatment with botanical extract including neem leaf extract taken 2-3 days less from control to flowering. The stem dry weight at the day of 50% flowering was higher due to seed priming with ginger, whereas leaf dry weight was higher in seeds primed with onion extract.

Yield parameters

The data with respect to pods per plant, seeds per pod, yield per plant and yield per hectare has shown significant differences due to seed priming with various botanicals i.e. neem leaf extract, castor oil, ginger extract and onion extract.

The seed priming with onion bulb extract was resulted as maximum pods per plant, whereas seed priming with neem leaf extract and ginger extract were resulted as maximum seeds per pod. Shinde (2012) and Janardhan (2014) have also found the similar results in seed treatment with neem leaf extract. The increase in yield attributes also increased seed yield in plants.

The maximum seed yield per plant and seed yield per hectare were observed when seed treated with neem leaf extract. It resulted as 19.90% increase in yield when compared to control. Pradhan *et al.,* (2015) also revealed that neem leaf treated seeds of paddy have outstanding seed yield. Similar results were recorded by Shinde (2012) in mungbean. He

used the botanicals viz., Lantana camara, *Azadirachta indica* and cassia tora and found that all spraying treatments increased seed yield of mungbean over control. The data with respect to 1000 seeds weight revealed that seed priming with neem leaf extract have higher test weight when compared to control.

It may be concluded from the present investigation that the use of botanical extracts *i.e.* neem leaf extract, castor oil, ginger extract and onion extract for seed priming can be done to obtain superior growth and yield in lentil. The seed priming with 50% extract of garlic inhibits germination due to the presence of Allicin. However, the maximum yield was obtained when seeds were primed with neem leaf extract (50%).

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