Biological Forum – An International Journal 13(3a): 114-117(2021)

ISSN No. (Print): 0975-1130
ISSN No. (Online): 2249-3239

Influence of Spacing and Zinc Levels on Growth and Yield of Lentil (*Lens culinaris*)

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(Received 28 June 2021, Accepted 06 September, 2021)
(Published by Research Trend, Website: www.researchtrend.net)

ABSTRACT: A field experiment was conducted at Central Crop Research Farm, Department of Agronomy, SHUATS, Prayagraj, (U.P.) during *Rabi*-2020. The soil of experimental plot was sandy loam in texture, nearly neutral in soil reaction (pH 6.7). The objectives were to evaluate the effect of spacing and zinc levels on growth and yield of Lentil (*Lens culinaris)*. The experiment was laid out in randomized block design with nine treatment combinations consisted of three different spacing *viz.*, S_1(20 cm × 10 cm), S_2 (30 cm × 10 cm), S_3(40 cm × 10 cm) and three levels of Zinc *viz.*, Z_1 (4 kg ha^{-1}), Z_2 (6 kg ha^{-1}), Z_3 (8 kg ha^{-1}) which were replicated thrice. The result shown significantly higher plant height (48.08 cm), dry weight (11.01 g), number of branches/plant (3.90), number of nodules/plant (11.63) and yield attributes *viz.*, test weight (7.73 g), number of pods/plant (115.26), number of seeds/pod (2.57) were recorded higher with spacing of 40 cm × 10 cm along with the application of 8 kg Zn/ha while yield attributes viz. grain yield (1.54 t/ha) and harvest index (39.38) were recorded higher with spacing of 30 cm × 10 cm along with the application of 8 kg Zn/ha.

Keywords: Spacing, Zinc, Lentil, Yield, Crop.

INTRODUCTION

Lentil (*Lens culinaris* L.) is the second most important cool season legume crop in India (Ram and Punia, 2018). It covers an area of 1.32 million ha with a production of 1.18 million tons and productivity of 894 kg ha^{-1} (Directorate of Economics and Statistics, 2020). The major producing areas are situated in Uttar Pradesh (38.47 %), Madhya Pradesh (29.95%), Bihar (10.26%) and West Bengal (13.88%). Lentil plays an important role in the diet of developing world. Lentil contains about twice as much protein as cereals. It also contains all essential amino acids which are generally deficient in food grains (Elias *et al*., 1986; Thavarajah *et al.*, 2011). Lentils have the second highest ratio of protein per calorie of any legume after soybean. Lentil crop provide a variety of essential nutrients to a person's diet, containing high levels of protein (20-30%), minerals (2-5%), vitamin B9. Lentil is typically rich in micronutrients and has the potential to provide adequate dietary amounts, especially for Iron (Fe), Zinc (Zn), and Selenium (Se).

Spacing is one of the important characteristics which can be manipulated to attain the maximum production from per unit land area. Too wide spacing may not utilize the natural resources efficiently whereas narrower spacing may result in severe inter and intra-row spacing competition. Therefore there is a need to manipulate the spacing competition and to increase plant productivity. Optimum spacing can ensure proper growth of the aerial and underground parts of the plant through efficient utilization of solar radiation, nutrients, water, land as well as air spaces. Spacing for line sowing is recommended to maintain the required number of plant population and to undertake intercultural operations for harvesting a higher yield. Seed rate has a major bearing on the yielding ability of any crop. Substantial yield increase of lentil can be achieved by using optimum seed rate (Malik and Singh 1996).

Micronutrients are important for maintaining soil health and also increasing productivity of crops. The soil must supply micronutrients for desired growth and development of plants. Among micronutrients, Zinc is known to synthesize growth hormones in the plants and is a part of metallic component of many enzymes. It regulates auxin concentration in plants and helps in the synthesis of proteins and chlorophyll etc. It also promotes seed formation and maturity. Most of the Indian soils are deficient in zinc. The increased yield of lentil due to zinc application was reported earlier in Kashmir valley by Singh *et al*., (2003).

MATERIALS AND METHODS

The experiment was conducted during the *Rabi* season, 2020 at Central Crop Research Farm, Department of Agronomy, Sam Higginbottom University of Agriculture, Technology and Science (SHUATS), Prayagraj (U.P.). The Crop Research Farm is situated at 25°24' 42"N latitude, 81°50' 56"E longitude and at an altitude of 98 m above mean sea level. The experiment was laid out in Randomized Block Design that consisted of nine treatment combinations *viz.* T1 (20 cm × 10 cm + 4 kg Zn/ha), T2 (20 cm × 10 cm + 6 kg Zn/ha), T3 (20 cm x 10 cm + 8 kg Zn/ha), T4 (30 cm × 10 cm + 4 kg Zn/ha), T_5 (30 cm x 10 cm + 6 kg Zn/ha), T6 (30 cm × 10 cm + 8 kg Zn/ha), T7 (40 cm × 10 cm + 4 kg Zn/ha), T8 (40 cm × 10 cm + 6 kg Zn/ha), T9 (40 cm × 10 cm + 8 kg Zn/ha) which were replicated thrice. During the developing season, the mean week by week, most extreme and least temperature, relative humidity and rainfall were 37.17°C, 8.03°C, 95.00%, 38.14% and 4.72 mm, respectively. The field was uniformly irrigated one day before sowing. The RDF i.e. Nitrogen (20 kg ha^{-1}) was applied in the form of Urea, whereas Phosphorous (40 kg ha^{-1}) and Potassium (20 kg ha^{-1}) were applied through DAP and MOP. Zinc was applied in the form of Zinc sulphate monohydrate and was applied in each plot according to the treatment combinations before sowing along with fertilizers. Observations on growth parameters, yield attributes and yield of lentil, were recorded and their significance were tested by the variance ratio and F-value at 5% level of significance (Gomez and Gomez, 1984). Relative economics was calculated as per the prevailing market prices of the inputs and produced during *Rabi* season.

RESULTS AND DISCUSSION

A. Growth parameters

Growth parameters of Lentil, *viz.* plant height (cm), Dry weight (g), number of branches per plant, number of nodules per plant varied due to different spacing and Zinc levels are tabulated in Table 1. The treatment combination with spacing of 40 cm × 10 cm along with the application of 8 kg/ha Zinc resulted in significantly higher plant height (48.08 cm), Dry weight (11.01g), number of branches per plant (3.90), number of nodules per plant (11.63). Due to higher plant spacing all the natural resources including water, sunlight, nutrients and minerals were efficiently utilized by the plants and thereby enhanced individual plant performance was observed (Jadhaw and Singh 2016). Zinc is an important element for the synthesis of tryptophan, which is the pioneer for the synthesis of IAA (Indole acetic acid), a growth hormone, involved in stem elongation (Patel *et al*., 2007; Shahram and Gholamreza 2012). It is also considered to be a precursor for auxin synthesis, involved in nitrogen metabolism and several oxidation reduction reactions, stability of RNA and starch formation. Thus, it’s suitable supply effects in higher dry matter production, ultimately growth and development of plants. Parallel results were found by Meena *et al*., (2012); Mandal and Mazumdar (2001); Gendy and Derar (1995); Gupta and Gangwar (2012); Nasser *et al.*, (2008).

Table 1: Influence of spacing and Zinc levels on Growth attributes of Lentil.

Treatment	At Harvest			
	Plant Height (cm)	Dry weight (g $plant^{-1}$)	No. of branches/plant	No. of nodules/plant
T1: Spacing 20 cm × 10 cm + 4 kg/ha Zn	46.02	9.77	3.13	9.67
T2: Spacing 20 cm × 10 cm + 6 kg/ha Zn	46.84	9.84	3.20	9.97
T3: Spacing 20 cm × 10 cm + 8 kg/ha Zn	47.13	10.15	3.40	10.53
T4: Spacing 30 cm × 10 cm + 4 kg/ha Zn	46.50	9.94	3.20	9.90
T5: Spacing 30 cm × 10 cm + 6 kg/ha Zn	46.97	10.22	3.40	10.77
T6: Spacing 30 cm × 10 cm + 8 kg/ha Zn	47.70	10.72	3.60	11.23
T7: Spacing 40 cm × 10 cm + 4 kg/ha Zn	46.90	10.07	3.53	10.70
T8: Spacing 40 cm × 10 cm + 6 kg/ha Zn	47.84	10.65	3.80	11.37
T9: Spacing 40 cm × 10 cm + 8 kg/ha Zn	48.08	11.01	3.90	11.63
SEd (±)	0.42	0.26	0.19	0.40
CD (5%)	0.88	0.56	0.40	0.85

B. Yield attributes

Yield attributes such as number of pods $plant^{-1}$, number of seeds pod^{-1}, test weight (g) exhibited significant variation during the experimental period due to different spacing and Zinc levels (Table 2). The yield attributing characters like, number of pods $plant^{-1}$, number of seeds pod^{-1}, test weight (g) showed significant result for the spacing of 40 cm × 10 cm along with the application of 8 kg/ha Zinc. Zinc improved translocation of photosynthates towards reproductive system and thereby enhancing the yield of the crop. Better photosynthetic activity also may have resulted in better translocation of photosynthates from source to sink due to less crop competition between the plants which might have led to higher yield attributes. These finding are similar to those reported by Krishnareddy and Ahlawat (1996); Parmar and Nema (2002); Meena *et al.*, (2006) and Marschner, (2012).

C. Yield

The data pertaining to yield is presented in Table 2. Grain and Straw yield varied considerably significant due to different spacing and Zinc levels. Spacing of 30 cm × 10 cm along with the application of 8 kg/ha Zinc recorded significantly higher grain yield (1.54 t/ha) and Harvest Index (39.38 %) while straw yield was recorded significantly higher with the spacing of 40 cm × 10 cm along with the application of 8 kg/ha Zinc.

Application of Zinc levels with suitable spacing improve grain yield. Although 40 cm × 10 cm spacing recorded higher growth attributes due to less plant competition, the individual plant performance could not compensate the optimum plant population present in the spacing 30 cm × 10 cm. Zinc application also might have increased the enzymatic activity which might have supported the translocation of assimilates towards the sink efficiently thereby resulting in increased yield. Similar results were reported by Khurana *et al*., (1998); Chaubey *et al*., (1999); Broadly *et al*., (2007).

Table 2: Influence of spacing and Zinc levels on yield attributes and yield of Lentil.

Treatment	Yield attributes and yield					
	No. of pods/plant	No. of seeds/pods	Test weight (g)	Grain yield (t/ha)	Straw yield (t/ha)	Harvest Index (%)
T1: Spacing 20 cm × 10 cm + 4 kg/ha Zn	76.70	1.70	15.34	1.10	2.17	33.63
T2: Spacing 20 cm × 10 cm + 6 kg/ha Zn	79.90	1.93	16.14	1.27	2.20	36.59
T3: Spacing 20 cm × 10 cm + 8 kg/ha Zn	82.36	2.10	16.21	1.38	2.29	37.60
T4: Spacing 30 cm × 10 cm + 4 kg/ha Zn	105.83	2.03	17.01	1.16	2.21	34.42
T5: Spacing 30 cm × 10 cm + 6 kg/ha Zn	106.86	2.23	17.34	1.29	2.30	35.93
T6: Spacing 30 cm × 10 cm + 8 kg/ha Zn	109.73	2.40	17.78	1.54	2.37	39.38
T7: Spacing 40 cm × 10 cm + 4 kg/ha Zn	108.80	2.07	17.37	1.07	2.58	29.31
T8: Spacing 40 cm × 10 cm + 6 kg/ha Zn	112.26	2.33	17.97	1.20	2.72	30.61
T9: Spacing 40 cm × 10 cm + 8 kg/ha Zn	115.26	2.57	18.35	1.33	2.89	31.51
S.E.d (±)	0.86	0.19	0.70	0.09	0.03	1.28
CD.(5%)	1.83	0.39	1.49	0.18	0.06	2.71

CONCLUSION

On the basis of study, it can be concluded that for obtaining higher yield in Lentil, the treatment combination of spacing 30 cm × 10 cm along with the application of 8 kg/ha Zinc was found more productive with highest grain yield, maximum net returns and B:C ratio because of the optimum plant population and better individual plant performances together.

Acknowledgments. I express gratitude to my advisor Dr. Umesha C. and all the faculty members of Department of Agronomy, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj for constant support and guidance to carry out the whole experimental research study.

Conflict of Interest. None.

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How to cite this article: Swargiary, S., Umesha C. and Dwivedi, N. (2021). Influence of Spacing and Zinc Levels on Growth and Yield of Lentil (*Lens culinaris*). *Biological Forum – An International Journal, 13*(3a): 114-117.