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Effect of sulphur and zinc on growth and yield of lentil (*Lens culinaris* M.)

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Abstract
The experiment was conducted during the period from December to March, 2019-21 at Crop Research Farm, Department of Agronomy, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj to study the effect of sulphur and zinc on yield attributes and yield of lentil. The variety Krish-KLS-09-03 was used as test crop during this experiment. It consists of two factors: Factor A: Sulphur (3 levels); 15, 20 and 25 kg/ha and Factor B: Zinc (3 levels); 4, 5 and 6 kg/ha and one control plot. The experiment was conducted by following a randomized block design with three replications. The results revealed that treatment combination of S at 25 kg/ha + Zn at 6 kg/ha obtained highest in pods/plant (208.53), seeds/pod (1.67), test weight (26.17 g), seed yield (1.84 t/ha), stover yield (3.75 t/ha) and harvest index (32.57%), respectively. On the other hand, control plot showed least values among all of the above parameters. It may be defined that sulphur and zinc had a significant influence on the yield of lentil and 25 kg S and 6 kg Zn per hectare can be the optimum dose for attaining higher yield.

Keywords: Lentil, seed yield, stover yield, sulphur, zinc

Introduction

Lentil (*Lens culinaris*) is an important annual leguminous crop which is locally called "Masoor" belongs to the family Fabaceae. Human diet consists of vegetable protein in good amount. Lentil contains protein, carbohydrates, oils and ash at the rate of 23.25%, 59%, 1.8% and 0.2%, respectively along with iron, calcium, phosphorus and magnesium. A significant amount of vitamin A and B is also provided by lentil (Zafar *et al*., 2003) [1].

In India, lentil is being cultivated in an area of about 1.51 million hectares with a production of 1.56 million tonnes and an average productivity of 1032 kg/ha. Madhya Pradesh tops the list with the contribution of 41.05 per cent (0.64 million tonnes) to the total Indian lentil production. In India, Rajasthan top first in attaining productivity of about 1162 kg/ha, respectively. While, Uttar Pradesh contributes an area of about 0.48 million hectares with a 31.46 per cent to all over India which has the production of about 0.49 million tonnes (31.27 per cent to all over India) and productivity is 1026 kg/ha, respectively (Agricultural Statistics at a Glance, 2019). India stands second in production of lentil after Canada. The most lentil growing countries are India, Canada, Turkey, Bangladesh, Iran, China, Nepal and Syria.

Sulphur is an important secondary plant nutrient, plays a crutial role in various physiological processes in the plant in the formation of amino acids, synthesis of proteins and chlorophyll. It activates enzymes and involves in the metabolic activities of vitamins (biotin and thiamine) and part of co-enzyme A and pyrophosphate. Its deficiency can be responsible for poor flowering, fruiting and stunted growth. Pulses are reported to be second after oil seeds in requirement of sulphur (Tandon, 1991) [3].

Among micronutrients, zinc is responsible 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, 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). Zinc is very important in reproductive phase like fertilization and pollen grain formation as pollen grain contains a high amount of zinc. Most of the zinc is translocated to seeds during fertilization and lower application of zinc causes deficiency of zinc in the seed and also the seed yield is quietly reduced (Jenik and Kathryn, 2005) [5].

Keeping the above facts in view, the present experimentation was laid to find the response of lentil to various sulphur and zinc levels under eastern Uttar Pradesh condition.

Material and Methods

The experiment was carried out during *rabi*, 2020-21 at Crop Research Farm, Department of Agronomy, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj (U.P.) which is located at 25^0 24' 42'' N latitude, 81^0 50' 56'' E longitude and 98 m altitude above the mean sea-level. The experiment consisted of ten treatments which were replicated thrice in a randomized block design with three levels of sulphur *viz*. 15 kg, 20 and 25 kg/ha and three levels of zinc *viz*. 4, 5 and 6 kg/ha and one control plot separately. The treatment combinations which are T_1: S at 15 kg/ha + Zn at 4 kg/ha, T_2: 3 S at 15 kg/ha + Zn at 5 kg/ha, T_3: S at 15 kg/ha + Zn at 6 kg/ha, T_4: S at 20 kg/ha + Zn at 4 kg/ha, T_5: S at 20 kg/ha + Zn at 5 kg/ha, T_6: S at 20 kg/ha + Zn at 6 kg/ha, T_7: S at 25 kg/ha + Zn at 4 kg/ha, T_8: S at 25 kg/ha + Zn at 5 kg/ha, T_9: S at 25 kg/ha + Zn at 6 kg/ha and T_{10}: control plot. Fertilizers were applied as band placement for which 4-5 cm deep furrows were made along the seed rows with hand hoe. The nutrient sources were Urea, SSP and MOP to fulfill the requirement of nitrogen, phosphorus and potassium. Sulphur and Zinc were supplied as soil application to the respective plots based on their recommendations. Irrigation was based on the necessity and at the time of sowing. Yield attributes *viz.* pods/plant, seeds/pod, test weight, seed yield, stover yield and harvest index were recorded with standard basis of observation. The data was analysed statistically by using analysis of variance as applicable in Randomized Block Design (Gomez and Gomez, 1984) [6].

Results and Discussion

Yield attributes

Data in Table 1 revealed number of pods per plant recorded a significant difference among treatment combinations. However, number of pods (208.53/plant) recorded significantly higher in S at 25 kg/ha + Zn at 6 kg/ha which was followed by the treatment combinations of S at 25 kg/ha + Zn at 5 kg/ha and S at 20 kg/ha + Zn at 6 kg/ha (204.53 and 200.60/plant), respectively.

Data presented in Table 1 show that number of seeds per pod recorded at harvest stage was found non-significant effect among treatments. However, highest number of seeds (1.67/pod) were recorded in S at 25 kg/ha + Zn at 6 kg/ha. While lowest number of seeds per pod was observed in control plot (1.20/pod), respectively.

Data depicted in Table 1 indicated that significantly higher test weight (26.17 g) were recorded in S at 25 kg/ha + Zn at 6 kg/ha. While at par values was observed in S at 25 kg/ha + Zn at 5 kg/ha (25.72 g).

Improved availability of sulphur and favourable nutritional environment might have helped the plants at the peak growth period and flowering stages which ultimately increased the number of pods per plant, number of seeds per pod and test weight. Improved growth characters might have also resulted into the improved source sink relationship and sink size. An enhanced growth and higher dry matter accumulation due to application of zinc might have produced the bolder seeds. Zinc also leads to the higher protein content in seeds which further explains the production of bolder seeds. These results are in close conformity with those of Anil Abid Ali *et al.* (2017) [7]; Gayatri Sahu *et al.* (2017) [8].

Yield

As given in Table 2, the data show that there was a significant effect on treatment combinations of application of sulphur and zinc in relation to seed yield. Significantly higher seed yield was noticed in S at 25 kg/ha + Zn at 6 kg/ha (1.84 t/ha) which was on par with S at 25 kg/ha + Zn at 5 kg/ha, S at 20 kg/ha + Zn at 6 kg/ha and S at 20 kg/ha + Zn at 5 kg/ha (1.81, 1.70 and 1.69 t/ha), respectively. The synergistic effect of Zn and S may be due to utilization of large quantities of nutrients through their well-developed roof system and nodules which might have resulted in better plant development and ultimate yield at low initial status of available Zn and S content in the experimental soil. The seed yield of lentil is a function of the product of number of pods per plant, number of seeds per pod and test weight. The increase in the number of pods per plant and number of seeds per pod increased the seed yield of lentil. The above are under the findings of Ishrat Alam *et al.* (2020) [9]; Lakhan Singh *et al.* (2020) [10].

Data in Table 2 revealed that stover yield was significantly higher in S at 25 kg/ha + Zn at 6 kg/ha (3.75 t/ha) which was on par with S at 25 kg/ha + Zn at 5 kg/ha, S at 25 kg/ha + Zn at 4 kg/ha and S at 20 kg/ha + Zn at 6 kg/ha (3.52, 3.49 and 3.46 t/ha), respectively. There was an overall increase in plant growth characters *viz.* plant height and dry matter accumulation which might have increased the stover yield. Zinc plays an important role in the production of indole acetic acid, a growth hormone where results in higher value of auxin content which helps in increased growth and yield of the crop. The increased yield of lentil due to sulphur application at increasing levels have also been reported by Ishrat Alam *et al.* (2020) [9]; Lakhan Singh *et al.* (2020) [10]; Okbi Basma *et al.* (2018) [11].

Data in Table 2 revealed that harvest index obtained on the basis of seed yield and stover yield shown that there was no significant difference. However, highest harvest index (32.57%) was noticed in S at 25 kg/ha + Zn at 6 kg/ha and least was occurred in control plot (30.92%), respectively. Similar findings were also considered from Necat Togay and Dursun Parsak (2014); Gayatri Sahu *et al.* (2017) [8]; Okbi Basma *et al.* (2018) [11]; Sanjeev Kumar Chaubey *et al.* (2019) [13].

Table 1: Role of sulphur and zinc on yield attributing parameters of lentil at harvest

Treatments	Pods/plant	Seeds/pod	Test weight (g)
S at 15 kg/ha + Zn at 4 kg/ha	172.60	1.27	21.96
S at 15 kg/ha + Zn at 5 kg/ha	173.80	1.33	22.38
S at 15 kg/ha + Zn at 6 kg/ha	182.13	1.40	22.97
S at 20 kg/ha + Zn at 4 kg/ha	175.67	1.47	22.99
S at 20 kg/ha + Zn at 5 kg/ha	188.87	1.53	23.99
S at 20 kg/ha + Zn at 6 kg/ha	200.60	1.40	24.16
S at 25 kg/ha + Zn at 4 kg/ha	186.87	1.47	23.97
S at 25 kg/ha + Zn at 5 kg/ha	204.13	1.60	25.72
S at 25 kg/ha + Zn at 6 kg/ha	208.53	1.67	26.17
Control	167.47	1.20	21.67
F-Test	S	NS	S
S.Em+	6.43	0.11	0.66
CD (P=0.05)	19.10	-	1.95

Table 2: Role of sulphur and zinc on yield of lentil at harvest

Treatments	Seed yield (t/ha)	Stover yield (t/ha)	Harvest index (%)
S at 15 kg/ha + Zn at 4 kg/ha	1.54	3.25	31.18
S at 15 kg/ha + Zn at 5 kg/ha	1.57	3.28	31.83
S at 15 kg/ha + Zn at 6 kg/ha	1.61	3.30	32.52
S at 20 kg/ha + Zn at 4 kg/ha	1.63	3.25	30.98
S at 20 kg/ha + Zn at 5 kg/ha	1.69	3.43	31.34
S at 20 kg/ha + Zn at 6 kg/ha	1.70	3.46	31.76
S at 25 kg/ha + Zn at 4 kg/ha	1.62	3.49	32.04
S at 25 kg/ha + Zn at 5 kg/ha	1.81	3.52	31.43
S at 25 kg/ha + Zn at 6 kg/ha	1.84	3.75	32.57
Control	1.47	3.15	30.92
F-Test	S	S	NS
S.Em+	0.07	0.11	0.90
CD (P=0.05)	0.20	0.31	-

Conclusion

Based on the findings of experimentation in one season in a year, it is concluded that application of sulphur at 25 kg/ha as well as zinc at 6 kg/ha was found more helpful for attaining better yields in lentil under Eastern U.P. climatic condition.

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