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Effect of Phosphorus, Sulphur and Zinc Level on Phenological Stages and Yield of Lentil under Southern Rajasthan

Research Article

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Abstract

The experiment was conducted during *rabi* season of 2021-21 and 2021-22 at the Rajasthan College of Agriculture, Maharana Pratap University of Agriculture and technology (MPUAT) Udaipur (Rajasthan). The objective is evaluating the performance of lentil under different phosphorus, sulphur and zinc levels. The treatments consisted of three factors *viz*. phosphorus levels (30, 40 and 50 kg P_2O_5 ha^{-1}) sulphur levels (15, 20 and 25 kg S ha^{-1}) and zinc fertilization (control and 0.5 % $ZnSO_4$). The experiment was laid out in factorial randomized block design with three replications. The resulted revealed that the application of 40 kg P_2O_5 ha^{-1}+20 kg S ha^{-1} with 0.5 % $ZnSO_4$ as foliar spray recorded minimum days to 50 % flower initiation, pod formation and maturity and higher seed, haulm and biological yield.

Keywords: Biological yield, Flower initiation, Haulm yield

Introduction

Lentil (*Lens culinaris* Medikus) is an old world legume and probably one of the first plant species to be domesticated. Dulled lentil contains 24-26% protein, 1.3% ash, 3.2% fiber and 57% carbohydrate [1,2]. It is also rich in vitamin C, riboflavin and minerals like calcium, phosphorus and iron. Among all the winter legumes, lentil has the highest concentration of vital amino acids (lysine, arginine, leucine, and other amino acids containing S) [3,4]. Thus, by balancing the amino acid and micronutrient content of the diet, lentils are seen as effective complements to cereal-rich foods in creating satisfying meals. In addition to their importance in food, lentils are used extensively in the agricultural sector, contributing to the sustainability of the industry. Although lentils have better nutritional value than cereals and are well adapted to local conditions, such as marginal soil, cultivation of lentils has recently been neglected by farmers, resulting in a slowdown in area and productivity compared to potential, which has decreased the food and nutrition security of millions of smallholder farmers and other farming communities [5,6]. Lentil farming is still practised as a subsistence crop in many countries, entirely due to the initiatives of impoverished farmers. If this trend keeps up, there is a serious risk that pulse farming could eventually go extinct. The so-called "hidden hunger" is caused by the two million or so people worldwide who suffer from one or more micronutrient deficiencies [7]. Deficits in zinc (Zn), one of the micronutrients, are a rising socioeconomic and public health concern, particularly in developing countries. Zn insufficiency is ranked 5th among the top 10 risk factors in developing nations and 11th among the top 20 risk factors globally for the development of illnesses and disorders. According to estimates, a third of the world's population is at danger of Zn deficiency, which is particularly common among young children under the age of five. The pulse seeds are a crucial component of the vegetarian diet in many developing countries. They contain the same amount of zinc as a non-vegetarian diet, but the micronutrients in the vegetarian diet are less bio available. Even while productivity

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grew, the micronutrient (Zn) content of several crops, including grain legumes, has decreased over the years, leading to insufficient dietary intake of Zn. The use of high-yielding varieties (HYVs) together with continual crop mining of soil micronutrients and lack of fertiliser replenishment, which causes them to be deficient in Zn, could be the cause of this trend. In light of this, the increased crop biomass accumulation would result in a dilution of the micronutrient concentrations in the aerial plant parts, lowering the quantity that would eventually be transferred to edible areas [8].

Assessing the performance of lentil under different fertility levels is need of movement to improve economic status of the farmers of southern Rajasthan. Because lentils can fix 8-14 kg N ha^{-1}, legume crops have a lower nitrogen need than non-legume crops. Phosphorus, in addition to nitrogen, is a crucial macro element for achieving optimal lentil quality and growth. It plays an important part in the production of nodules, which aid in nitrogen fixation. In addition to other nutrients, the soil's phosphorus, sulphur, and zinc levels are the key nutrient limiting factors that prevent lentil productivity from improving [1]. Phosphorus play major role in root growth and sulphur play major role in quality of seeds. The role of zinc is very important in reproductive phase of plants like fertilization and pollen grain formation, which is physiologically deficit in soils of South Rajasthan. Hence, evaluation of appropriate zinc dose through foliar spray in this crop is utmost important. Pulse crops cover 28.34 million hectares with production of 23.2 million tonnes, and produce 817 kg ha^{-1}, respectively (Directorate of Economics & Statistics, 2019-20). India ranked first in area (18.00 lakh ha) and second in production (11.00 lakh tonnes) with 39 and 22 per cent of the world's area and production, respectively.

Material & Methods

The experiment was conducted during *rabi* season for two consecutive years i.e. 2021-21 and 2021-22 at Instructional Farm (Agronomy), Rajasthan College of Agriculture, Maharana Pratap University of Agriculture and technology (MPUAT) Udaipur (Rajasthan), which is situated at 24°35'N latitude, 74°42'E longitude and at an altitude of 581.13 meters above mean sea level. This region falls under agro-climatic zone IVa (Sub-humid Southern plain and Aravali hills) of Rajasthan. The experiment was laid out in factorial randomized block design with three replications. The treatments consisted of three factors *viz.* phosphorus levels {(i) 30, (ii) 40 and (iii) 50 kg P_2O_5 ha^{-1}} sulphur levels {(i) 15, (ii) 20 and (iii) 25 kg S ha^{-1}and zinc fertilization {(i) control and (ii) 0.5 % $ZnSO_4$}. The perusal of data show that maximum and minimum mean weekly temperature during crop period ranged between 24.5^{0}C to 33.7^{0}C and 6.9^{0}C to 16.3^{0}C, respectively during year 2020-21. The corresponding fluctuations during second year (2021-22) of experimentation were 23.8^{0}C to 31.4^{0}C and 3.3^{0}C to 12.4^{0}C. Thereafter from middle of February to end of crop season there was steep increase in average maximum and minimum temperature. The mean weekly relative humidity ranged between 56.6 to 94 per cent and 65.7 to 94.2 per cent during 2020-21 and 2021-22, respectively. The total rainfall received during 2020-21 and 2021-22 was 972.6 and 822.2 mm, respectively. Excess rainfall was recorded over the average rainfall during both the years' of investigation. The bright sunshine hours varied from 0.7 to 8.1 per day during 2020 and from 0.8 to 9.2 per day during 2021 season. The soil at the experimental site was clay loam in texture and had slightly alkaline in reaction for both years (pH 7.9 and 8.3). During both of the investigational years, i.e. 2020-21 and 2021-22, the soil had low levels of available nitrogen (286.1 and 289.3 kg ha^{-1}), medium in available phosphorus (18.3 and 21.2 kg ha^{-1}), but high levels of available potassium (335.6 and 349.6 kg ha^{-1}), low level of sulphur (10.18 and 10.57 mg kg^{-1}), and high levels of available zinc (1.86 and 1.94 ppm). The entire dose of phosphorus and gypsum was applied at sowing below the seed in furrows. Zinc was applied through zinc sulphate as foliar spray at 55 DAS. When lentil reached physiological maturity-roughly when 70-80 percent of the pods started to turn brownish yellow and begin drying-they were manually harvested using a sickle and recorded as yield. The days to 50% flowering initiation trait was scored as the number of days from sowing date to the stage at which 50% of plants in a plot had flowering. The days to 50% pod formation was determined by recording the number of days up to which a plant had 50% of the immature pods or about 50% of the plants in the plot had formed pods. The traits of days to 50% maturity was recorded as the number of days from sowing date to the appearance of a mature dry pod on a primary branch. It was recorded before harvesting of the crops when color of the 50% plants changed from green to golden yellow and brown. The field data obtained for 2 years were pooled and statistically analyzed using the F-test. Test of significance of the treatment differences were done on the basis of t-test. The significant difference between treatment means were compared with critical differences at 5% levels of probability.

Results & Discussion

Phenological stages

Phosphorus level: Perusal of the data showed that the days to 50 % flower initiation, pod formation and maturity varied significantly with different level of phosphorus application (Table 1). The increased level of phosphorus also numerically decreased the number of days to 50 % flowering, pod formation and maturity. Among them application of 40 kg P_2O_5 ha^{-1} took significantly minimum days to initiate 50 % flowers initiation, pod formation and maturity during both the years of experiments. The application of 40 kg P_2O_5 ha^{-1} and 50 kg P_2O_5 ha^{-1} were statistically at par with each other. The results are in conformity with the findings of [4,9].

Sulphur level: Data showed that the days to 50 % flower initiation and maturity varied significantly with different level of sulphur application (Table 1). The increased level of sulphur also numerically decreased the number of days to 50 % flowering and maturity. Among them application of 20 kg S ha^{-1} took significantly minimum days to initiate 50 % flowers initiation and maturity during both the years of experiments. The application of 20 kg S ha^{-1} and 25 kg S ha^{-1} were statistically at par with each other. The difference in number of days to 50 % pod formation found non-significant with sulphur application. Comparable findings were reported by [5,6,8].

Zinc level: The data on the days to 50 % flower initiation, pod formation and maturity recorded and presented in Table 1.The application of 0.5 % $ZnSO_4$ as foliar spray at 55 DAS significantly influenced the days to 50 % flower initiation and maturity during both the years of experimentation as compare to control. The

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Table 1: Effect of phosphorus, sulphur and zinc levels on phonological stage of lentil.

Treatments	Days to 50% flower initiation			Days to 50% pod formation			Days to 50% maturity		
	2020-21	2021-22	Pooled	2020-21	2021-22	Pooled	2020-21	2021-22	Pooled
Phosphorus level (kg ha^{-1})									
30	77.63	78.08	77.85	106.13	102.97	104.55	131.13	129.52	130.33
40	73.78	74.22	74.00	100.72	98.89	99.81	126.39	126.45	126.42
50	72.39	74.11	73.25	97.77	98.44	98.11	122.22	124.89	123.55
S.Em ±	0.287	0.305	0.209	0.764	1.129	0.682	0.968	0.974	0.687
CD (P=0.05)	0.824	0.877	0.591	2.197	3.245	1.924	2.782	2.799	1.938
Sulphur level (kg ha^{-1})									
15	75.60	76.94	76.27	102.38	101.55	101.96	126.82	129.66	128.24
20	74.30	74.52	74.41	100.91	99.47	100.19	126.47	125.74	126.10
25	73.89	74.95	74.42	101.34	99.28	100.31	126.45	125.45	125.95
S.Em ±	0.287	0.305	0.209	0.764	1.129	0.682	0.968	0.974	0.687
CD (P=0.05)	0.824	0.877	0.591	NS	NS	NS	NS	2.799	1.938
Zinc level									
Control	75.25	76.81	76.03	103.25	100.92	102.08	128.07	128.14	128.10
0.5 % $ZnSO_4$	73.95	74.13	74.04	99.84	99.28	99.56	125.09	125.76	125.43
S.Em ±	0.234	0.249	0.171	0.624	0.922	0.557	0.790	0.795	0.561
CD (P=0.05)	0.872	0.716	0.482	0.872	NS	1.571	0.872	2.286	1.582

Table 2: Effect of phosphorus, sulphur and zinc levels on seed, haulmand biological yields of lentil.

Treatments	Seed yield (kg ha^{-1})			Haulm yield (kg ha^{-1})			Biological yield(kg ha^{-1})		
	2020-21	2021-22	Pooled	2020-21	2021-22	Pooled	2020-21	2021-22	Pooled
Phosphorus level (kg ha^{-1})									
30	1604	1606	1605	3352	3374	3363	4956	4980	4968
40	1731	1779	1755	3752	3813	3797	5511	5592	5552
50	1789	1790	1790	3835	3853	3827	5591	5643	5617
S.Em ±	24	27	18	55	62	41	61	67	46
CD (P=0.05)	69	78	51	159	179	115	177	194	129
Sulphur level (kg ha^{-1})									
15	1623	1648	1635	3439	3422	3430	5062	5070	5066
20	1714	1736	1725	3739	3783	3761	5453	5519	5486
25	1788	1792	1790	3756	3835	3795	5543	5627	5585
S.Em ±	24	27	18	52	62	41	61	67	46
CD (P=0.05)	69	78	51	149	179	115	177	194	129
Zinc level									
Control	1666	1689	1677	3510	3556	3533	5176	5245	5211
0.5 % $ZnSO_4$	1750	1762	1756	3779	3804	3791	5529	5566	5547
S.Em ±	20	22	15	42	51	33	50	55	37
CD (P=0.05)	56	64	42	122	147	94	144	158	105

application of 0.5 % $ZnSO_4$ as foliar spraytook significantly minimum days to initiate 50 % flowers initiation, pod formation and maturity. The similar findings were recorded by [4,5].

Seed and Haulm Yield

Phosphorus level: The data on seed yield revealed significant differences due to various levels of phosphorus application (Table 2). Significantly higher seed, haulm yield and biological yield (1755, 3797 and 5552 kg ha^{-1}) were recorded with the application of 40 kg P_2O_5 ha^{-1} (P_2) being at par with 50 kg P_2O_5 ha^{-1}(P_3). The magnitude of increases in seed, haulm and biological yield due to P_2 were 9.34, 12.9 and 11.75 per cent respectively as compared to 30 kg P_2O_5 ha^{-1} (P_1). The similar findings were recorded by [2,12].

Sulphur level: Increase in seed and haulm yield of lentil could be attributed to the favorable effect of higher level of sulphur application. Maximum seed yield (1725 kg ha^{-1}), haulm yield (3761 kg ha^{-1}) and biological yield (5486 kg ha^{-1}) were recorded with 20 kg S ha^{-1}(S_2), which was found at par with 25 kg S ha^{-1} (S_3) and significantly higher over 15 kg S ha^{-1} (S_1). The magnitude of increases in seed, haulm and biological yield due to S_2 were 5.50, 9.65 and 8.29 per cent as compared to S_1 treatment and reported same results [2,3].

Zinc level: Zinc application has significant effect on seed and haulm yield of lentil. Maximum seed yield (1756 kg ha^{-1}), haulm yield (3804 kg ha^{-1}) and biological yield (5547 kg ha^{-1}) were recorded with 0.5 % $ZnSO_4$ as foliar spray, which was significantly higher over control. The magnitude of increases in seed, haulm and biological yield due to 0.5 % $ZnSO_4$ as foliar spray were 4.71, 7.30 and 6.44 per cent as compared to control treatment. The similar findings were recorded by [10,11].

Conclusion

From the above findings, it could be concluded that under prevailing agro climatic conditions of zone IVa (Sub-Humid Southern Plain and Aravali Hills) of Rajasthan, lentil crop fertilized with 40 kg P_2O_5 $ha^{-1}$and 20 kg S ha^{-1} along with 0.5 % $ZnSO_4$ as foliar spray is recommendable option for achieve higher productivity, profitability and quality.

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