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Effect of Nitrogen and Phosphorous on Yield and Protein Content of Lentil in Dryland Condition

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Abstract: In order to study the effect of different levels of nitrogen and phosphorus fertilizer on grain yield and protein content of lentil in dry conditions a factorial experiment based on randomized complete block with three replications was conducted in 2007. The treatments consist of nitrogen (0, 25 and 50 kg ha^{-1}) and phosphorus (0, 40 and 60 kg ha^{-1}). Nitrogen at the rate of 25 kg/ha increased number of filled pods per plant, grain yield, harvest index, percentage of grain protein and percentage of grain nitrogen. Also phosphorous application at the rate of 40 kg ha^{-1} increased percentage of grain protein and percentage of grain nitrogen. The results of this study showed that to obtain the optimal grain and protein yield in lentil under dryland condition, nitrogen and phosphorous level at 25 and 40 kg h^{-1} can be advised, respectively.

Key words: Lentil · Nitrogen · Phosphorous · Grain yield · Protein

INTRODUCTION

Lentil (*Lens culinaris* Medik) is a herbaceasous annual plant which originated from Middle East and a rich source of protein. Almost two-thirds of world populations are facing with food poverty and malnutrition. So any step in increasing the quantity and quality of agricultural products not only improves nutritional status of people in these communities but also enhances economic value of them. Thus, the increase food production to meet the needs of growing populations is inevitable. Nitrogen is critical element for increasing the quality of food crops. Nitrogen deficiency can be occurred frequently in everywhere therefore these elements should be comprised as a fertilizer. Nitrogen is necessary for tillering in cereals, increasing grain number and grain weight. Also application of suitable amount of this fertilizer in legumes increased pod number, seed number and seed weight [1]. Average grain yield of lentil is low. One of the main reasons for this problem is the inappropriate use or distribution of fertilizer [2]. Verma and Kalra [3] reported that lentil have good response to nitrogen fertilizer application rate of 20 kg per hectare. Depending on the species, stage of growth and organ of plant, the amount of nitrogen required for optimum plant growth is between two to five percent of dry weight [4]. Phosphorus is important macro elements for growth of legumes. It has important role in the formation of root nodules and this opinion has an important role in nitrogen fixation [5]. In vegetative growth stage, phosphorus is needed between 0.3 to 0.5 percent dry weights of plant. Phosphorus deficiency reduces the number of flowers and delayed flowers formation [4]. Adding phosphate to the soil increased yield of legumes. Studies have shown that nitrogen fertilizer application rate of 20 to 25 kilograms of fertilizer per hectare as a starter is necessary to achieve maximum plant growth. Using of 50 - 60 kg P/ha increased yield of legume significantly [6]. Numbers of filled pods are main components of seed yield that are influenced by the amount of fertilizer placed. Application of 20 - 80 kg P/ha in combination with 40 kg N/ha increased the number of filled pod lentil [7-10]. Determining the appropriate amount and mix of fertilizer nitrogen and phosphorus is important because that have a large role in increasing the performance of crops [7, 11, 12]. Other studies showed that percentage of lentil seed protein was increased by applying 40 - 60 kg P/ha [13-16].

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The purpose of fertilizer application in dryland agriculture lentils can be increase quality (percentage of protein) and quantity (seed yield) of products. So to achieve this objective, selecting the most appropriate levels of nitrogen and phosphorus fertilizer in each area is essential.

MATERIALS AND METHODS

This experiment was conducted at Agriculture Research Station of Ardabil in 2008. Average rainfall is about 400 mm and soil texture is clay loam with pH about 6.7. Data weathers during growth season are shown in Table 1. The field experiment was arranged in a factorial experiment based on a randomized complete block design with three replications. Factors are includes nitrogen and phosphorous fertilizer. Nitrogen was applied as urea form with three levels (0, 25 and 50 kg/ha) and also phosphorous was applied as super phosphate form with three levels (0, 40 and 60 kg ha^{-1}). Each plot comprised 5 rows of 5 long and spacing was 25 cm between rows and spacing was 3 cm between plants on rows. Plots and blocks were separated by 1.5 m unplanted distances. Lentil seeds were planted in the 3rd week of March. All fertilizer treatments were added at the time planting. Harvest samples were taken of 3 m long from the 3 middle rows for measuring harvest index and grain yield. Seed nitrogen content was determined by Kjeldhal methods.

Analysis of variances was performed using SAS computer software package. The main effects and introductions were tested using Duncan test.

RESULTS AND DISCUSSION

Analysis of variance showed that the effect of phosphorus fertilizer on the adjective natal growth period in the 5 percent level is significant (Table 2). It seems with phosphorous application rate of 40 $kgha^{-1}$, can be preventing from delaying in flower formation and also can be prevent from reducing flower number per plant. Application the rate of 40 kg Pha^{-1} increased the reproductive growth period. These results are in agreement with those obtained by Khaladbarin and Slamzadeh [4]. Application of 40 $kgha^{-1}$phosphorous fertilizer of 40 $kgha^{-1}$ increased reproductive growth period by 12% compared to control, which increased the effective period of grain filling (Table 3). It seems in legumes, such as lentil that have unlimited growth, flowering earlier and longer reproductive growth period have large role in increasing grain yield. Daynard and Tanner [17] reported that with adding each one day to reproductive growth period, the grain yield will increase by 3 %. Nitrogen application at the rate of 25 kg ha^{-1} increased number of filled pods per plant by 26 and 25% compared with control and 50 kg/ha, respectively (Table 3). The maximum seed yield related to 25 kg h^{-1} of nitrogen fertilizer. Analysis of variance showed that only main effect of nitrogen has been effected on grain yield ($p<0.05$). Nitrogen application at the rate of 25 kg/h increased grain yield by 38 % compared to control, but had no significant difference with 50 $kgNha^{-1}$ (Table 3). Dat also in Table 3 indicated that application nitrogen at of the rate of 25 $kgha^{-1}$ increased the harvest index.

Table 1: Data weathers during growth season

month	Minimum temperature mean (°c)	Maximum temperature mean (°c)	Precipitation (mm)	Minimum relative humidity (%)	Maximum relative humidity (%)
March	1.35	9.93	2.5	69.67	97.35
April	5.5	17.45	0.85	60.3	92.83
May	10.4	25.29	0.82	58.6	89.38
June	11.96	22.96	0.14	68	94.41
July	13.06	27.16	0.14	58.3	88.22

Table 2: Results of analysis of variance of studied traits

Source of variation	d.f	Duration of reproductive growth period	Number of filled pods per plant	Grain yield	Harvest index
Rep. (R)	2	0.0003 ^{ns}	0.003 ^{ns}	0.001^{ns}	0.028 ^{ns}
Nitrogen (N)	2	0.001^{ns}	0.04 *	0.091 *	3.53 *
Phosphorous (P)	2	0.006 *	0.019 ^{ns}	0.029 ^{ns}	0.24 ^{ns}
N×P	4	0.002 ^{ns}	0.016 ^{ns}	0.030 ^{ns}	2.53 ^{ns}
Error	16	0.002	0.014	0.034	1.66
CV (%)	---	3.66	9.61	5.98	19.57

ns, * and ** no significant, significant in %5 and %1 probability level respectively

Table 3: Means comparison of effect of nitrogen and phosphorous on studied traits

Treatments	Levels of treatments (kg/h)	Duration of reproductive growth period (day)	Number of filled pods per plant	Grain yield (kg/h)	Harvest index (%)
	0	28.55 a	15.24 b	1027.9 b	35.52 b
Nitrogen	25	28.55 a	20.62 a	1653 a	51.46 a
	50	29.77 a	15.39 b	1380.9 ab	48.16 ab
	0	27.33 b	16.28 a	1184. 6 a	43.71 a
Phosphorous	40	30.88 a	18.86 a	1466.5 a	44.59 a
	60	28.66 ab	20.31 a	1410.8 a	46.84 a

Means with similar letters has no significant difference at %5 probability level

Table 4: Results of analysis of variance of studied traits

Source of variation	d.f	Seed nitrogen percent	Seed protein percent
Rep. (R)	2	0.006 ns	0.23 ns
Nitrogen (N)	2	0.78 **	30.89 **
Phosphorous (P)	2	0.29 **	11.38 **
N×P	4	0.06 ns	2.26 ns
Error	16	0.03	1.16
CV (%)	---	4.28	4.22

Table 5: Means comparison of effect of nitrogen and phosphorous on studied traits

Treatments	Levels of treatments (kg/h)	Seed nitrogen percent	Seed protein percent
	0	3.74 b	23.41 b
Nitrogen	25	4.21 a	26.39 a
	50	4.28 a	26.8 a
	0	3.98 b	24.88 b
phosphorous	40	4.29 a	26.83 a
	60	3.97 b	24.89 b

Means with similar letters has no significant difference at %5 probability level

Table 4 indicate that nitrogen fertilizer has been significantly effected on seed nitrogen and protein percent ($p<0.01$). Also main affected of phosphorous fertilizer has been significantly affected on same traits. But the interaction between nitrogen and phosphorous fertilizers had no significant effect on all traits. It seems that in dry land condition the absorption of gross nitrogen could be limited due to water deficit, which results from increasing osmotic potential in root medium. Because the highest nitrogen uptake occurred with 25 $kgNha^{-1}$, as sequence the nitrogen and protein percentage of grain obtained. The highest value in this level of nitrogen indicated significant difference with control, which are in agreement with those obtained by Togay *et al*. [16], Zeidan *et al*. [14], Stevenson *et al.* [15], Bekele and Hofner [18], Hoseney [19]. In addition application of 40 $kgha^{-1}$ of phosphorous increased grain protein and nitrogen contents by 8 % higher than control, therefore can be conclude that the nitrogen fertilizer can increase phosphate absorption and also phosphorous led to increasing in protein percentage of grain.

The highest value of protein and nitrogen percentages of grain and also grain yield and grain protein yield obtained at 25 kg/h nitrogen and 40 kg/h phosphorous. Therefore nitrogen and phosphorous at the rate of 25 and 40 $kgha^{-1}$, respectively recommended for dry land lentil in this area.

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