EFFECT OF POTASSIUM LEVELS ON THE GROWTH, YIELD AND YIELD ATTRIBUTES OF LENTIL

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ABSTRACT

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A split experiment was conducted at the Agronomy Field Laboratory, University of Rajshahi to study the effects of potassium levels on the growth, yield and yield contributing characters of lentil. The experiment comprised of three varieties viz. BARImasur-4, BARImasur-5 and BARImasur-6 and five potassium levels viz. 0, 15, 25, 35 and 45 Kg K ha^{-1}. The results revealed that among the three varieties, BARImasur-6 produced the highest seed yield (2.24 t ha^{-1}) and BARImasur-4 produced the lowest seed yield (1.79 t ha^{-1}). Grain and stover yield of all varieties were increased with the increase of potassium application up to 35 kg ha^{-1}. The highest grain yield (2.16 t ha^{-1}) was found at 35 kg K ha^{-1} and the lowest grain yield (1.61 t ha^{-1}) was exhibited from control potassium level and the highest stover yield (3.89 t ha^{-1}) was also found in 35 kg K ha^{-1} and the lowest (3.32 t ha^{-1}) was found in control potassium level. In case of interaction, the highest seed yield (2.58 t ha^{-1}) was produced by BARImasur-6 with 35 kg K ha^{-1}. Therefore, fertilization of all the varieties with 35 kg K ha^{-1} appeared as the best rate of potassium in respect of grain and stover yield. It can be suggested that farmers may be used BARImasur-6 with 35 kg K ha^{-1} for better grain and stover production of lentil.

Keywords: Lentil, potassium, yield attributes

INTRODUCTION

Bangladesh is an agro-based country where many crops are grown. Among them, pulses constitute the main sources of vegetable protein for people, especially the poor people of Bangladesh. They are also the best sources of protein for domestic animals. They also help to overcome the malnutrition, which is a serious health problem in Bangladesh that has been threatening to the whole nation. Lentil is grown about 1,54,000 ha, producing 1,16,000 tonnes of grain, with an average yield of 752 kg ha^{-1}, and contributes about 33% to the total pulses production (BBS, 2002). In Bangladesh, the daily per capita consumption of pulses is only 13.29 g, whereas World Health Organization has suggested 45 g per capita per day for a balanced diet (BARI, 1998). Approximately, 1,08,000 tons of pulses are imported in Bangladesh each year. But to meet the suggested requirement of pulses of 45 g per capita per day, the productions to be increased even more than three folds. Pulses being legumes, can fix atmospheric nitrogen free of cost through the nodule bacteria to the soil, which may reduce the extra input, cost of nitrogenous fertilizer for the crop plants. It is also used as cover crop to check the soil erosion.

Lentil (*Lens culinaris)* is an important pulse crop of Bangladesh, as it is an excellent source of easily digestible protein, which complements the staple rice diet in the country. Lentil contains about 11% water, 25% protein and 60% carbohydrates (Singh, 2001). It is also rich in calcium, iron and niacin. It is also delicious than other pulses. Among the pulses, its rank is second in production in Bangladesh. The total production of lentil in Bangladesh during 2007- 08 was 1.12 lakh m tons from an area of 1.26 lakh hectares (Anonymous, 2009). In spite of many advantages of lentil, the area coverage and the production are in declining trend. This trend is mainly because of pulses cannot compete with high yielding variety (HYV) cereals in terms of production and economic return and are thus being pushed to marginal lands where nutrient deficiencies are severe.

Due to favorable climate and soil, lentil can be grown successfully in Bangladesh. But the average yield of lentil in the country is low as compared with other leading lentil growing countries of the world. The low fertility of soil and non- judicious application of manures and fertilizers are considered to be the main factors for the poor yield of this crop in Bangladesh. To meet up the protein demand for the increasing population, lentil production needs to be increased.

Potassium (K), as a plant nutrient is becoming increasingly important in Bangladesh and a good crop response to K is being reported from many parts of the country. Pulse crops showed yield benefits from potassium application. Improved potassium supply also enhances biological nitrogen fixation and protein content of pulse grains (Srinivasarao *et al*., 2003). Soil fertility was improved significantly with farmyard manure used either alone or in combination with NPK over that of initial soil status (Singh *et al.*, 2001). The supply of phosphorus and potassium to leguminous crops is necessary especially at the flowering and pod setting stages (Zahran *et al.*, 1998).

An improved variety is the first and foremost requirement for initiation and accelerated production program of any crop. Variety plays an important role in producing high yield of lentil because different varieties responded differently for their genotypic characters; BARI has developed some varieties of lentil. The present study was, therefore, undertaken to find out the effect of different rates of potassium on the yield of lentil.

MATERIALS AND METHODS

The experiment was conducted at the Agronomy Field Laboratory, University of Rajshahi, Rajshahi, during the rabi season from November, 2007 to March, 2008. The experimental treatment consisted of (a) three varieties, namely – BARImasur- 4, BARImasur-5 and BARImasur-6, and (b) five levels of potassium viz. 0, 15, 25, 35, 45 kg ha^{-1}. The experiment was laid out in a split – plot design with three replications having 45 unit plots. The size of each unit plot was 2.0 m x 1.5 m. The plot-to-plot distance was 0.5 m and block to block distance was 1.0 m. The varieties were assigned in the main plot and potassium levels to the sub-plots. The experimental land was opened with a power tiller on 21 November, 2007 and subsequently 3 to 4 ploughing and cross ploughing with country plough followed by laddering was done to achieve a good tilth. Weeds, stubbles and crop residues were removed. The corners of the land were spaded and the larger clods were hammered to break into small pieces. The unit plots were finally prepared on the day of seed sowing. The plots were fertilized with Urea, TSP and boron fertilizer @ 45, 85 and 1.5 kg ha^{-1} at the time of final land preparation. Potassium fertilizer was applied as per treatment at the time of final land preparation. The control plots received no potassic fertilizer. Seeds were sown on 22 November, 2007 maintaining a spacing of 25 cm apart with a seed rate of 30 kg ha^{-1}. Intercultural operations were done as and when necessary. Data on growth parameters and yield attributes were recorded. Five hills from each plot were randomly selected and uprooted after sowing for taking data on growth parameters like plant height, number of branches $plant^{-1}$, number of nodules $plant^{-1}$ and dry weight of plant at 20 days intervals beginning from 45 DAS to 85 DAS.

At maturity, five hills were randomly selected and uprooted from unit plot excluding border rows for collecting data on yield and yield contributing characters. After sampling, the crop from each plot (1 m^2) was harvested at full maturity to record the data on grain and straw yields. The collected data were analyzed statistically and means were adjudged by Duncan's Multiple Range Test (DMRT) and correlation was done by SPSS program (Gomez and Gomez, 1984).

RESULTS AND DISCUSSION

Growth parameters

Plant height

The Plant height was gradually increased day by day. The highest plant height (36.19 cm) was obtained from BARImasur-6 and the lowest plant height (33.78 cm) was found in BARImasur-4 at 85 DAS. The highest plant height (35.96 cm) was obtained at K_1 level at 85 DAS. It was noted that plant height increased up to 45 kg K ha^{-1} (K_3) level and then it was gradually decreased. i.e. when fertilizer further increased plant height decreased(Table 1). The interaction effect between variety and K levels was significant at 45 DAS (Table 3). At 45 DAS, the highest plant height (16.43 cm) was obtained from the interaction of V_1K_1, which was statistically identical to V_2K_3 and the lowest plant height was found in V_1K_0 that was similar to V_2K_0, V_1K_4 and V_2K_4. The obtained results are in partially agreement with that of Tariq *et al*. (2001).

Number of branches $plant^{-1}$

The number of branches did not differ significantly. Numerically the highest number of branches was recorded in BARImasur-4 at 45 and 65 DAS but 65 DAS BARImasur-5 produced the highest number of branches $plant^{-1}$. At 45 and 85 DAS, the lowest number of branches was found in BARImasur-6 but at 65 DAS, BARImasur-5 produced the lowest number of branches $plant^{-1}$. On the other hand, the highest number of branch (9.44) was recorded in K_1 level (15 kg K ha^{-1}) and the lowest number of branch (8.11) was recorded at K_0 level at 65 DAS (Table 1). The highest number of branches was recorded from the interaction of V_1K_4 and the lowest number of branches (7.0) was recorded in interaction V_2K_4 at 65 DAS (Table 3). Similar result was noticed by Tariq *et al.*(2001) in Mungbean.

Number of nodules $plant^{-1}$

The highest number of nodules (4.40) was produced by BARImasur-4 (V_1) and the lowest number of nodules (4.01) was produced by BARImasur-6 (V_3) at 85 DAS (Table 2). The highest number of nodules (7.0) was produced by K_1 level and the lowest number of nodules (5.56) was recorded in K_0 i.e. control at 85 DAS. Number of nodule was not significantly influenced by the effect of interaction at all sampling dates (Table 3). The highest number of nodule (8.0) was recorded from the interaction V_1K_2 and the lowest (5.0) was recorded from the interaction V_3K_0 (Table 3). Tariq *et al.*(2001) reported similar view in Mungbean.

Total dry weight $plant^{-1}$ (g)

The effect of variety on total dry weight $plant^{-1}$ was not significant at all sampling dates. The highest total dry weight $plant^{-1}$ (4.40 g) was recorded in V_1 and the lowest (4.01g) was recorded by V_3 at 85 DAS. The dry weight $plant^{-1}$ was not significant due to K level at all sampling dates. Numerically, the highest dry weight (4.52g) was produced by 25 kg K ha^{-1} (K_2) level and the lowest (4.08g) was recorded in 45 kg K ha^{-1} (K_4)

level at 85 DAS (Table 2). The highest dry weight (5.20g) was recorded from the interaction V_1K_2 and the lowest (3.87g) was recorded from the interaction V_3K_4 (Table 3). Ashraf and Zafar (1997) reported that biomass production decreased with decreasing K concentration.

Yield and yield contributing characters

Number of branches plant^{-1} varied significantly due to varieties. The highest number of branches plant^{-1} (11.12) was produced by the variety BARImasur-6 (V_3), which was identical to BARImasur-5 and the lowest number of branches plant^{-1} (8.86) was produced by the variety BARImasur-4 (Table 4). Different potassium levels showed significant variation in terms of number of branches plant^{-1}. The highest number of branches plant^{-1} (11.43) was produced at the potassium level K_2 (25 kg K ha^{-1}) and the lowest number of branches plant^{-1} (9.32) was produced at K_0 level i.e. when no potassium was applied (Table 5). The interaction effect of variety and potassium level on the number of branches plant^{-1} was not statistically significant. Numerically the highest number of branches plant^{-1} (13.05) was recorded in V_3K_2 combination and the lowest number of branches plant^{-1} (7.74) was recorded in V_1K_1 combination (Table 6).

The highest number of effective pods plant^{-1} was produced by BARImasur-6 (Table 4). The number of pods plant^{-1} significantly influenced by potassium rate. The highest number of pods plant^{-1} was obtained from 35 kg K ha^{-1} (Table 5). In respect of interaction, the highest number of pods plant^{-1} were observed in BARImasur-5 with 35 kg K ha^{-1} interaction(Table 6). Similar results were achieved by Tariq *et al.*(2001) in Mungbean.

The highest number of seeds pod^{-1} was observed in BARImasur-6 variety. Number of seeds pod^{-1} varied due to different potassium level. The highest number of seeds pod^{-1} was recorded in 35 kg K ha^{-1}(Table 4 and 5). In respect of interaction affect the highest number of seeds pod^{-1} was recorded in BARImasur-6 with 35 kg K ha^{-1} combination (Table 1). The weight of seed plant^{-1} was not significantly influenced by variety but significantly influenced in potassium level. The highest weight of seed plant^{-1} was observed in 25 kg K ha^{-1}**.** Tariq *et al.*(2001) obtained similar results in Mungbean

1000-grain weight was not significantly influenced by variety but highly significant with potassium level. The highest 1000- grain weight (22.42 g) was obtained from 35 kg K ha^{-1}. In case of interaction, the highest 1000-grain weight (23.24 g) was recorded in BARImasur-6 with 35 kg K ha^{-1}(Table 4.5& 6). These results were partially supported by Tariq *et al.*(2001).

The varietal variation was significant on seed yield. The highest seed yield (2.24 t ha^{-1}) was observed in BARImasur-6. Potassium rate was significantly influenced the seed yield. The highest seed yield (2.16 t ha-^{1}) and the lowest seed yield (1.61 t ha^{-1}) was recorded in 35 kg ha^{-1} and in control, respectively. In respect of interaction, the highest seed yield (2.58 t ha-^{1}) was obtained from BARImasur-6 with 35 kg K ha^{-1} (Table 4.5& 6). Azad *et al.* (1995) and Singh (1998) reported that seed yield of lentil increased with the increase of potassium levels.

The varietal variation was not significant on stover yield. The highest stover yield (3.86 t ha^{-1}) was produced by BARImasur-6 and the lowest (3.60 t ha^{-1}) was produced by BARImasur-4. Potassium rate was significantly influenced on the stover yield. The highest stover yield (3.89 t ha^{-1}) and lowest stover yield (3.32 t ha^{-1}) was recorded in 35 kg ha^{-1} and control level, respectively. In case of interaction, the highest stover yield (4.09 t ha^{-1}) was obtained from BARImasur-6 with 45 kg K ha^{-1} (Table 4, 5& 6).

Grain and Stover yield of all varieties were increased with the increase of potassium application up to 35 kg K ha^{-1}. Therefore, fertilization of all the varieties with 35 kg K ha^{-1} appeared as the best rate of potassium in respect of grain and stover yield. From this study, it may be suggested that farmers can used BARImasur-6 variety with 35 kg K ha^{-1} for better grain and stover production of lentil.

Table 1. Effect of variety and potassium levels on plant height and number of branches plant^{-1} of lentil

	Plant height (cm)			**Number of branches plant^{-1}**		
	45 DAS	65 DAS	85 DAS	45 DAS	65 DAS	85 DAS
Variety						
BARImasur-4	13.59	26.28b	33.78b	6.33	9.33	8.60
BARImasur-5	13.60	26.31b	33.03b	6.07	8.60	8.73
BARImasur-6	13.32	26.97a	36.19a	5.60	8.80	8.33
Level of significance	NS	*	*	NS	NS	NS
Potassium level (Kg K ha^{-1})						
0 (K_0)	12.74b	26.41	35.10a	5.33	8.11	8.33
(15) K_1	14.60a	27.32	35.93a	6.11	9.44	7.88
(25) K_2	13.01b	25.92	33.17bc	6.00	9.11	8.67
(35) K_3	14.50a	27.20	34.81ab	6.11	9.22	9.22
(45) K_4	12.67 b	25.73	32.64c	6.44	8.67	8.67
Level of significance	**	NS	**	NS	NS	NS
CV (%)	4.91	6.02	5.14	13.61	16.81	16.39

Table 2. Effect of variety and potassium levels on number of nodules per plant and total dry weight plant^{-1} of lentil

	Plant height (cm)			Number of branches plant^{-1}		
	45 DAS	65 DAS	85 DAS	45 DAS	65 DAS	85 DAS
Variety						
BARImasur-4	3.87a	5.4a	4.40	1.02	2.33	4.40
BARImasur-5	3.40b	5.0b	4.23	0.99	2.11	4.13
BARImasur-6	3.80a	5.07b	4.01	1.07	2.30	4.01
Level of significance	*	*	NS	NS	NS	NS
Potassium level (Kg K ha^{-1})						
0 (K_0)	3.56	5.11	5.56	0.99	2.18	4.15
(15) K_1	3.78	5.00	7.0	1.06	2.33	4.16
(25) K_2	3.78	5.22	6.56	1.06	2.33	4.52
(35) K_3	3.78	5.44	6.78	1.01	2.19	4.17
(45) K_4	3.56	5.00	6.56	1.03	2.21	4.08
Level of significance	NS	NS	NS	NS	NS	NS
CV (%)	7.05	22.81	19.19	7.10	16.38	17.30

In a column, figures having similar letter(s) or without letter (s) do not differ significantly as per DMRT
* Significant at 5% level of probability, ** Significant at1% level of probability
NS = Not significant, **CV =** Co-efficient of variation

Table 3. Interaction effect of variety and potassium levels on growth characters of lentil

Interaction of variety & K level	Plant height (cm)			Number of branches plant^{-1}			Number of nodules plant^{-1}			Total dry weight plant^{-1} (g)		
	45 DAS	65 DAS	85 DAS	45 DAS	65 DAS	85 DAS	45 DAS	65 DAS	85 DAS	45 DAS	65 DAS	85 DAS
V_1K_0	12.07 d	25.97	33.3	6.0	7.67	7.67a-c	3.33	5.33	6.0	0.97	2.25	4.06
V_1K_1	16.43 a	27.37	36.39	6.67	9.67	8.0a-c	4.33	4.67	7.67	1.05	2.48	3.96
V_1K_2	12.80 cd	24.33	33.22	6.33	9.67	10.0ab	4.0	6.33	8.0	1.08	2.39	5.20
V_1K_3	14.53 b	26.87	33.33	6.33	9.0	8.67a-c	4.0	5.33	7.0	0.95	2.06	4.56
V_1K_4	12.13 d	26.87	32.63	6.33	10.67	8.67a-c	3.67	5.33	7.0	1.08	2.46	4.23
V_2K_0	12.10 d	25.60	34.33	5.67	8.33	9.67a-c	3.67	5.33	5.67	0.96	2.16	4.27
V_2K_1	14.53 b	26.53	33.77	6.0	9.67	8.33a-c	3.33	5.67	7.0	1.05	2.30	4.53
V_2K_2	13.27 cd	27.20	30.10	5.33	9.0	8.67a-c	3.33	4.67	5.67	1.02	2.16	4.26
V_2K_3	15.93 a	27.73	35.57	6.67	9.33	10.0ab	3.39	5.67	6.67	0.98	2.13	3.96
V_2K_4	12.17d	24.46	31.40	6.67	6.67	7.0c	3.33	3.67	5.67	0.96	1.80	4.14
V_3K_0	14.07bc	27.67	37.67	4.33	8.33	7.67a-c	3.67	4.67	5.0	1.07	2.12	4.12
V_3K_1	12.83cd	28.07	37.63	5.67	9.0	7.33bc	3.67	4.67	6.33	1.08	2.21	3.99
V_3K_2	12.97cd	26.23	36.20	6.33	8.67	7.33bc	4.0	4.67	6.0	1.07	2.43	4.1
V_3K_3	13.03cd	27.00	35.53	5.33	9.33	9.0a-c	4.07	5.33	6.67	1.09	2.37	4.0
V_3K_4	13.70bc	25.87	33.90	6.33	8.67	10.33a	3.67	6.0	7.0	1.06	2.37	3.87
Level of significance	**	NS	NS	NS	NS	*	NS	NS	NS	NS	NS	NS
CV(%)	4.91	6.02	5.14	13.61	16.81	16.39	17.50	22.81	19.19	7.10	16.38	17.30
$S\bar{X}$	0.38	-	-	-	-	-	-	-	-	-	-	-

In a column, figures having similar letter(s) or without letter (s) do not differ significantly as per DMRT
NS = Not significant, CV = Co-efficient of variation

Table 4. Effect of different varieties on the yield and yield attributes of lentil

Varieties	Number of branches plant^{-1}	Number of effective pods plant^{-1}	Number of seeds pod^{-1}	Weight of seeds plant^{-1} (g)	1000 grain weight (g)	Seed yield (t ha^{-1})	Stover yield (t ha^{-1})
BARImasur-4	8.86b	158.49	1.66	6.17	20.75	1.79b	3.65
BARImasur-5	10.48a	175.29	1.66	6.31	21.69	1.87b	3.60
BARImasur-6	11.12a	176.77	1.69	6.73	21.54	2.24a	3.86
Level of significance	**	NS	NS	NS	NS	*	NS
CV (%)	13.86	13.58	8.32	6.54	5.41	7.53	7.79

Table 5. Effect of different potassium levels the on yield and yield attributes of lentil

Potassium Level	Number of branches plant^{-1}	Number of effective pods plant^{-1}	Number of seeds plant^{-1}	Weight of seeds plant^{-1} (g)	1000- grain weight (g)	Seed yield (t ha^{-1})	Stover yield (t ha^{-1})
0 (K_0)	9.32c	139.18c	1.42d	5.66d	20.05c	1.61c	3.32c
(15) K_1	9.62bc	162.69b	1.65bc	6.26c	21.43ab	1.84b	3.65ab
(25) K_2	11.43a	179.62ab	1.78ab	6.93a	21.67ab	1.93b	3.54bc
(35) K_3	10.81ab	192.52a	1.91a	6.69ab	22.42a	2.16a	3.89a
(45) K_4	9.58bc	176.89ab	1.59c	6.48bc	21.07bc	1.91b	3.69ab
Level of significance	*	**	**	**	**	**	**
CV (%)	13.86	13.58	8.32	6.54	5.41	7.53	7.79

In a column, figures having similar letter(s) or without letter (s) do not differ significantly as per DMRT
* Significant at 5% level of probability ** Significant at 1% level of probability
NS = Not significant, **CV =** Co-efficient of variation

Table 6. Interaction effect of variety and potassium level on the yield and yield attributes of lentil

Interaction of variety x K level	Number of branches plant^{-1}	Number of effective pods plant^{-1}	Number of seeds pod^{-1}	Weight of seed plant^{-1} (g)	1000- grain weight (g)	Seed yield (t ha^{-1})	Stover yield (t ha^{-1})
V_1K_0	8.02	131.95	1.45	5.30	19.28	1.60	3.53
V_1K_1	7.74	141.60	1.65	5.84	21.14	1.71	3.55
V_1K_2	10.37	173.12	1.69	7.06	21.24	1.93	3.68
V_1K_3	9.27	176.75	1.89	6.54	21.66	2.07	4.04
V_1K_4	8.94	169.05	1.61	6.11	20.41	1.68	3.36
V_2K_0	9.60	127.75	1.48	5.72	20.22	1.57	3.15
V_2K_1	10.58	176.75	1.63	5.93	21.69	1.88	3.74
V_2K_2	10.85	183.05	1.81	6.67	22.40	1.86	3.38
V_2K_3	10.87	201.27	1.88	6.67	22.38	2.09	3.84
V_2K_4	10.48	187.62	1.47	6.57	21.81	1.98	3.88
V_3K_0	10.33	157.85	1.32	5.96	20.65	1.90	3.52
V_3K_1	10.55	169.73	1.68	7.00	21.47	2.19	3.82
V_3K_2	13.05	182.70	1.85	7.05	21.36	2.23	3.80
V_3K_3	12.34	199.55	1.95	6.88	23.24	2.58	4.03
V_3K_4	9.31	174.0	1.67	6.75	21.0	2.30	4.09
Level of significance	NS	NS	NS	NS	NS	NS	NS
CV(%)	13.86	13.58	8.32	6.54	5.41	7.52	7.79

In a column, figures having similar letter(s) or without letter (s) do not differ significantly as per DMRT
NS = Not significant CV = Co-efficient of variation

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