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Growth, productivity, nutrient uptake, mineral and protein contents of rajmash (*Phaseolus vulgaris*) as influenced by nitrogen application and genotypes under high hills dry temperate conditions of Himachal Pradesh

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Abstract

A field experiment was conducted for three consecutive *Kharif* seasons during 1998 - 2000 at Research Sub Station, CSK Himachal Pradesh Krishi Vishvavidyalaya, Leo (Kinnaur) to study the effect of nitrogen application on yield and quality of rajmash varieties (Jwala and Triloki) in an Entisols. The results revealed that the application of N significantly and positively influenced almost all the growth and yield attributes. Highest seed, straw and biological yield was recorded under 60 kg N ha^{-1}. Per cent increase in seed, straw and biological yield with the application of 60 kg N/ha over control was 99, 86 and 92, respectively. Similarly, nutrient uptake and N contents were increased significantly with the application of nitrogen during all the years. On an average, grain protein contents were increased by 18 per cent by applying 60 kg N/ha. Triloki out yielded Jwala by 76, 96 and 87 per cent with respect to seed, straw and biological yield, respectively.

Key words: *Phaseolus vulgaris*, N application, genotypes, seed yield, nutrient uptake.

Introduction

High hill region of Himachal Pradesh comprising of Kinnaur and Lahaul and Spiti districts, Pangi and Bharmaur regions of Chamba district have unique agro climatic features. The area is steeply sloping and has fragile agro-eco system. The area remains covered with snow in winter from November to March providing only 6-7 months for agricultural activities. The region is characterized by very low rainfall (20-30 cm/year), high snowfall (2-3 m/annum), sometimes mercury dipping below -30°C. Among the pulses, rajmash (*Phaseolus vulgaris*) is emerging as major cash crop of the area as it results in higher profit per unit area. However, farmers of this area are not harnessing full potential of this crop due to low fertility status and improper nutrient management. As rajmash is poor nodulating crop having poor nitrogen fixation capacity, therefore, its nitrogen requirement is high unlike other legumes (Kumar *et al.*, 1997 and Rana *et al.*, 2001)). Because high yielding varieties are recently introduced in high hills, therefore, it is imperative to evaluate their performance and assess their nitrogen requirement for better growth, development and ultimately productivity. Hence, the present investigation was carried out to identify the suitable cultivar and to examine the effect of N application on growth, yield attributes, productivity and quality parameters of this crop.

Material and Methods

The investigations were carried out in *Kharif* season (1998-2000) at the Research Sub Station CSKHPKV, Leo, Kinnaur, Himachal Pradesh (2741 m above mean sea level) which is situated in the high hills dry temperate zone. The soil of experimental site was sandy loam in texture with pH 7.5, medium in organic carbon (5.3 g/kg), low in available nitrogen (118 kg/ha), medium in available P (12 kg/ha) and available K (148 kg/ha). The cation exchange capacity of the soil is 6.4 c mol (p+) kg^{-1}. As per taxonomic classification, the soils are classified as *Typic Cryorthents*. In this area, monsoon fails to reach and rainfall is virtually negligible. The experiment consisting of two varieties (Triloki and Jwala) and four levels of nitrogen (0, 20, 40 and 60 kg/ha) was conducted in randomized block design. Each treatment was replicated thrice. Half dose of nitrogen and full amount of phosphorus and potassium was applied at the time of sowing. The remaining N was applied one month after sowing. The NPK were applied

in the form of calcium ammonium nitrate, single super phosphate and muriate of potash, respectively. The crop was raised under irrigated conditions following recommended package of practices. Growth and yield attributes were recorded on ten randomly selected plants. Crop productivity in terms of seed, straw and total biological yield was noted at the maturity. Seed and straw samples were taken at the time of harvesting, they were dried at60°C and were subjected to wet digestion and N, P and K contents were determined as per standard procedures (Jackson, 1973). The uptake was calculated by multiplying nutrient concentration with yield. To work out the total uptake, uptake by seed and straw was calculated separately and was later summed up. Grain protein contents were calculated by multiplying N content in grains with 6.25 factor. Data obtained were statistically analysed as per the procedure outlined by Gomez and Gomez (1984).

Results and Discussion

Growth and yield attributes

The results in table 1 revealed that different growth and yield attributes viz. plant height, branches/plant, pods/plant and pod length registered significant increase with the application of N up to 60 kg N/ha. As N plays a vital role in crop nutrition as a component of many biomolecules (ribonucleic acid, deoxyribonucleic acid, protein, chlorophyll and enzymes etc.) involved in photosynthesis, respiration and other metabolic processes having direct impact on vegetative and reproductive phases (Mengel and Kirkby, 1996), the improvement in different growth and yield parameters is understandable. These results corroborate the findings of Sahu *et al.* (1994), Verma and Saxena (1995) and Rana *et al.* (2001). As regards the different genotypes, the performance of Triloki was better as compared to Jwala. However, the genotypes did not differ significantly with respect to pod length.

Crop productivity

A critical examination of the data presented in Table 2 indicated that application of nitrogen improved the seed, straw and total biological yield significantly and consistently. Highest grain and straw yield were recorded under 60 kg/ha during all the years of experimentation. Per cent increase in seed yield with the application of 60 kg/ha over control was 63, 117 and 123 during 1998, 1999 and 2000, respectively. The increase in productivity of rajmash crop due to N application may be attributed to improved growth and yield attributes as was also observed by Srinivas and Rao (1984), Singh (1987) and Thakur *et al.* (1999). At low level of N, plant might not be able to meet N requirement ultimately resulting in stunted growth and reduced yield . At higher level of N, crop absorbed sufficient amount of N, resulting in higher productivity. Regarding the performance of different genotypes, it was found that Triloki out yielded Jwala with respect to seed, straw and total biological yield during all the years under study. Triloki out yielded Jwala by 71, 86 and 98 kg/ha during 1998, 1999 and 2000, respectively.

Nutrient uptake

Marked increase was recorded in nutrient uptake with the application of N (Table 3). The uptake of N and P increased significantly and consistently with the application of nitrogen up to 60 kg/ha. However, the K uptake recorded significant increase with the application of N only up to 40 kg/ha. The increase in N uptake due to application of 60 kg/ha over the control was 104, 119 and 153 per cent in 1998, 1999 and 2000, respectively.

Table 1. Growth and yield attributes of rajmash as influenced by nitrogen application and genotypes

	Plant height (cm)			Branches/Plant			Pods/Plant			Pod length (cm)		
	1998	1999	2000	199 8	1999	200 0	1998	1999	2000	1998	1999	2000
N levels (kg/ha)												
0	36.2	35.7	31.3	9.8	8.9	8.1	7.2	7.1	6.6	9.1	8.3	8.9
20	46.9	43.2	46.6	11.9	12.1	12.9	8.8	9.2	9.4	10.9	10.9	10.7
40	51.8	51.2	52.3	13.7	14.3	14.9	10.1	10.3	10.3	12.5	12.7	12.9
60	55.2	56.5	57.1	15.1	16.4	16.8	11.7	11.5	11.8	13.1	13.6	14.1
CD (P=0.05)	2.4	2.0	3.2	0.8	1.2	1.1	0.7	1.0	0.8	0.5	0.7	0.8
Genotypes												
Triloki	54.1	55.2	56.2	13.5	14.9	15.2	10.5	11.6	11.9	12.8	11.1	11.7
Jwala	52.6	54.8	54.2	11.1	12.3	13.6	9.9	10.2	10.8	11.3	10.6	10.9
CD (P=0.05)	0.90	NS	1.3	0.5	0.7	0.6	NS	0.7	0.4	0.3	NS	NS

Table 2. Seed, straw and biological yield (kg/ha) of rajmash as influenced by nitrogen application and genotypes

	1998			1999			2000		
	Grain yield	Straw yield	Biol. yield	Grain yield	Straw yield	Biol. yield	Grain yield	Straw yield	Biol. yield
N levels (kg/ha)									
0	809	889	1698	683	745	1428	675	795	1470
20	1045	1123	2168	1107	1196	2303	1137	1239	2376
40	1209	1269	2478	1323	1416	2739	1361	1443	2804
60	1321	1364	2685	1485	1560	3045	1506	1586	3092
CD (P=0.05)	80	89	157	92	112	204	84	107	188
Genotypes									
Triloki	1131	1188	2319	1193	1372	2565	1219	1341	2560
Jwala	1060	1114	2174	1107	1212	2319	1121	1233	2354
CD (P=0.05)	50	59	92	65	72	123	52	69	114

Table 3.Nutrient uptake (kg/ha) by rajmash as influenced by nitrogen application and genotypes

	N uptake			P uptake			K uptake		
	1998	1999	2000	1998	1999	2000	1998	1999	2000
N levels (kg/ha)									
0	25.2	23.8	20.9	5.65	5.33	4.67	18.6	17.1	15.3
20	41.7	43.3	44.9	8.71	8.96	9.08	24.8	26.8	27.1
40	47.2	49.6	51.2	10.21	10.78	11.39	37.6	40.9	42.3
60	51.6	54.1	55.9	11.82	12.22	12.79	43.1	44.1	46.9
CD (P=0.05)	3.1	4.2	2.8	0.93	0.76	0.71	6.1	5.0	6.9
Genotypes									
Triloki	44.5	46.7	48.3	9.08	10.53	10.93	33.2	34.9	36.8
Jwala	42.3	44.3	44.9	8.91	9.92	10.03	29.6	31.2	33.1
CD (P=0.05)	NS	NS	NS	NS	NS	NS	2.8	2.3	3.1

Similarly, respective values with respect to P uptake were 109, 129 and 173 per cent. Per cent increase in K uptake due to the application of 40 kg N/ha over control was 102, 139 and 176 during 1998, 1999 and 2000, respectively. The favourable effect of nitrogen fertilization on nitrogen and phosphorus uptake was also earlier reported by Parmar *et al.* (1999). Such a significant improvement in the uptake of nitrogen, phosphorus and potassium may be ascribed to well ramified root system due to adequate supply of nitrogen which helped the plants in enhanced nutrient and water absorption and ultimately influencing vegetative and reproductive phases of the crop positively (Stevenson *et al.*,1990) Among the genotypes, Triloki recorded higher nitrogen, phosphorus and potassium uptake values but the differences were significant only in case of potassium uptake.

Nutrient and protein contents

The application of nitrogen increased the content of nitrogen in grains significantly during all the years of experimentation. It is pertinent to mention that each increment in N levels resulted in significant improvement over the proceeding one. It was further observed that though contents of phosphorus and potassium were increased with the addition of nitrogen but it could not attain the level of significance (Table 4).

Similarly, protein content was also increased substantially with the application of nitrogen. Highest contents were recorded under the treatment 60 kg N/ha during all the years under study. As regards the variation in mineral and protein contents among the genotypes, it was found that contrary to yield performance, higher nitrogen and protein contents were found in case of Jawala variety as compared to Triloki.

Table 4. Nutrient and grain protein contents of rajmash as influenced by nitrogen application and genotypes

Treatments	Nitrogen (%)			Phosphorus (%)			Potassium (%)			Protein (%)		
	1998	1999	2000	1998	1999	2000	1998	1999	2000	1998	1999	2000
N levels (kg/ha)												
0	3.08	3.05	3.01	0.62	0.59	0.60	0.71	0.73	0.72	19.25	19.06	18.81
20	3.25	3.31	3.29	0.68	0.69	0.66	0.74	0.76	0.75	20.31	20.68	20.55
40	3.45	3.49	3.46	0.71	0.73	0.70	0.79	0.78	0.80	21.38	21.81	21.63
60	3.53	3.60	3.64	0.73	0.73	0.71	0.80	0.82	0.81	22.06	22.50	22.75
CD (P=0.05)	0.10	0.09	0.12	NS	NS	NS	NS	NS	NS	0.80	0.92	0.86
Genotypes												
Triloki	3.31	3.38	3.35	0.67	0.68	0.66	0.75	0.77	0.76	20.69	21.13	20.94
Jwala	3.39	3.49	3.44	0.68	0.70	0.69	0.77	0.81	0.80	21.19	21.81	21.50
CD (P=0.05)	0.04	0.04	0.06	NS	NS	NS	NS	NS	NS	0.30	0.36	0.38

However, these two varieties did not differ significantly with respect to phosphorus and potassium contents.

The study suggested that adequate N nutrition (60 kg/ha) is essential to harness full yield potential of this crop in high hills zone of Himachal Pradesh. Regarding genotypes, Triloki is suitable for cultivation in this region.

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