INTERNATIONAL JOURNAL OF AGRICULTURE & BIOLOGY
1560–8530/2002/04–1–120–122
http://www.ijab.org

Determining Suitable Stand Density and Phosphorus Level for Improving Productivity of Rice Bean (*Vigna umbellata*)

M. ASGHAR MALIK, S.H. SHAH, M. FARRUKH SALEEM AND M. SAJID JAMI
Department of Agronomy, University of Agriculture, Faisalabad–38040, Pakistan

ABSTRACT

Investigations to determine suitable level of stand density and phosphorus for obtaining maximum production of rice bean were carried out. The treatments comprised three stand densities i.e. 45 x 15 cm, 45 x 20 cm, 60 x 15 cm and 60 x 20 cm and two phosphorus levels i.e. 90 and 120 kg P_2O_5 ha^{-1}. The results revealed that yield components namely, pods $plant^{-1}$, grains pod^{-1}, 1000-grain weight and grain yield were affected significantly by different stand density and the maximum grain yield (1758.96 kg ha^{-1}) was obtained by 45 x 20 cm pattern. Application of 90 kg P ha^{-1} was found to be suitable for yield advantage while 120 kg ha^{-1} showed a positive effect on increasing seed protein concentration.

Key Words: Stand density; Phosphorus; Rice bean; Seed yield; Protein content

INTRODUCTION

The nutritive value of rice bean (*Vigna umbellata* L.) is exceptionally high. It has great yield potential and under good management practices, it can produce 30 q ha^{-1} seeds and 33-82 q of dry herbage ha^{-1} (Mukherjee *et al*., 1980). However, due to poor soil fertility, improper stand density and mismanagement of resources particularly imbalanced use of fertilizers, its yield is quite below than normal. Nitrogen and Phosphorus are the two essential plant nutrients. Nitrogen increases vegetative growth while phosphorus favours root development, reproductive growth and fastens maturity. Application of N alongwith adequate amount of P improves the grain yield (Tomar *et al.*, 1984). Prasad and Bhol (1994) reported that yield of *V. umbellata* decreased with increasing spacings (30, 45 or 60 x 10 cm). But, Borah (1994) concluded that nine cultivars of rice bean gave similar seed yield with spacings of 30 x 10 cm and 45 x 10 cm. Niklyaev (1975) concluded that mineral fertilizer increased seed yield and protein content from 1.4 to 2.0 times in case of pulses. Hence, there is a need to develop an appropriate production technology of rice bean particularly in relation to optimum planting density and fertilizer management.

The present study was planned to determine the effect of different stand densities and phosphorus levels on the growth, yield and quality of rice bean under the agro-ecological conditions of Faisalabad.

MATERIALS AND METHODS

A field experiment was conducted at the Agronomic Research Area, University of Agriculture, Faisalabad during the year 1998. The soil was a sandy clay loam with 0.06% nitrogen and 6.0 ppm available phosphorus. The experiment was laid out according to RCBD under split plot arrangement with three replicates keeping stand density and phosphorus levels in the main and sub-plots, respectively. The net plot size was 3.6 x 6.0 m. Different stand densities were 45 x 15 cm (S_1), 45 x 20 cm (S_2), 60 x 15 cm (S_3) and 60 x 20 cm (S_4) and the phosphorus levels were 90 kg (P_1) and 120 kg ha^{-1} (P_2). Seeding was done with the help of a single row hand drill using 30 kg seed ha^{-1} and a basal dose of N @ 40 kg ha^{-1} was applied in the form of Urea. All other agronomic practices were kept normal and uniform for all the treatments. The crop was harvested on December 5, 1998 when about 85% pods had reached to maturity. Observations recorded during the course of study using the standard procedures were plant height (cm), number of pods per plant, number of grains per pod, 1000-grain weight (g), grain yield (kg ha^{-1}) and seed protein content (Jackson, 1962). Data collected were analysed statistically using Fisher's analysis of variance technique and Least Significant Difference (LSD) test at 5% probability was applied to compare the differences among treatments' means (Steel & Torrie, 1984).

RESULTS AND DISCUSSION

Data presented in Table I indicate that both the stand density and phosphorus levels had significant effect on plant height of rice bean. Maximum plant height (143.95 cm) was recorded in S_1 (45 x 15 cm), which significantly differed from rest of the treatments. The treatments S_2 (45 x 20 cm) and S_3 (60 x 15 cm), statistically at par with each other, produced plants with intermediate height, the minimum plant height (126.65 cm) was, however, found in S_4 (60 x 20 cm) treatment. Greater plant height in treatments with less spacing can be attributed to more plant competition for available resources especially for light. In case of phosphorus, effect on plant height, the comparison of treatment means shows that the phosphorus level P_2 (120 kg P_2O_5 ha^{-1}) produced statistically higher plants than the treatment P_1 (90 kg P_2O_5 ha^{-1}). Iqbal (1995) and Manzoor

Table I. Effect of stand densities and phosphorus on growth and yield parameters of rice bean

Treatments		Plant height (cm)	Number of pods plant^{-1}	Number of grains pod^{-1}	1000-grain weight (g)	Grain yield (Kg ha^{-1})	Seed protein content (%)
A	**Stand density**						
S_1	(45 x 15cm)	143.95a*	126.85b	6.77bc	58.42b	1501.15c	22.48 ^{NS}
S_2	(45 x 20cm)	136.20b	138.20a	7.17a	63.40a	1758.86a	21.43
S_3	(60 x 15cm)	133.50b	135.80a	6.97ab	59.90b	1615.55b	21.43
S_4	(60 x 20cm)	126.65c	120.40c	4.43c	55.83c	1227.35d	21.05
LSD at 0.05 =		3.287	2.509	0.35	1.86	91.38	–
B	**Phosphorus levels**						
P_1	(90kg P_2O_5 ha^{-1})	134.07 b	128.07 b	6.97^{NS}	59.82 ^{NS}	1582.34a	21.07b
P_2	(120kg P_2O_5 ha^{-1})	136.07 a	132.60 a	6.70	59.06	1468.15b	22.14a
LSD at 0.05 =		1.54	1.18	–	–	62.23	0.95

* Any two means not sharing a letter in common differ from each other at 5% probability level

(1997) also reported that phosphorus application caused a significant increase in height of rice bean plants over control. Similarly, the table reflects that different levels of stand density and phosphorus produced highly significant effect on number of pods plant^{-1}. Maximum number of pods (138.20) plant^{-1} were obtained in S_2 (45 x 20 cm) treatment, while the minimum number of pods (120.40) plant^{-1} were noted in S_4 (60 x 20 cm) treatment. With application of higher phosphorus level i.e. P_2 (120 P_2O_5 kg ha^{-1}), the pods plant^{-1}, though not differing statistically, were more (132.6) than that of P_1 (90 P_2O_5 kg ha^{-1}) treatment which gave 128.07 pods plant^{-1}. It is because the better supply of phosphorus resulted in increased photosynthetic activity, decreased premature drop of flowers and young pods and ultimately more number of pods per plant were produced. These results are supported by Gowda and Gowda (1978), Shabbir (1982) and Patel *et al*. (1984) who have also reported an increase in pods plant^{-1} with increased phosphorus. Stand density had significant effect on grains per pod while, however, effect of phosphorus was found to be non-significant. S_2 (45 x 20 cm) exhibited maximum number of grains pod^{-1} (7.167) but did not differ statistically from that of S_3 (60 x 15 cm) treatment producing 6.97 grains pod^{-1}. The treatment S_4 (60 x 20 cm), however, produced minimum (4.43) number of grains pod^{-1}. These results are in line with those of Zahoor (1991) who also reported that grains pod^{-1} were significantly influenced by stand density in gram. However, the effect of phosphorus on this parameter was found to be non-significant. Whereas, in contrast, Manzoor (1997) in case of rice bean and Yasin (1981) in case of mung bean were of the view that grains pod^{-1} were significantly influenced by phosphorus increase. Data presented in Table I further show that varying stand densities had highly significant effect on 1000-grain weight, however, effect of different phosphorus applications was found to be non-significant. Maximum 1000-grain weight (63.40 g) was recorded in case of S_2 (45 x 20 cm), which differed significantly from rest of the treatments. Performance of S_1 and S_3 was, however, statistically similar. Whereas, minimum 1000-grain weight (55.83 g) recorded in S_4 (60 x 20 cm). These results are, however, partially in line with those of Manzoor (1997) in case of rice bean and Patel *et al*. (1984) in case of mung bean, as they reported that phosphorus had significant effect on 1000-grain weight. Moreover, both the factors under study i.e. stand density and phosphorus levels influenced the grain yield significantly. Among the stand densities, S_2 (45 x 20 cm) produced significantly higher grain yield (1758.96 kg ha^{-1}) than other treatments. The minimum grain yield (1227.35 kg ha^{-1}) was obtained in case of S_4 (60 x 20 cm). The higher seed yield in S_2 could be attributed to positive effect of this treatment on all yield contributing factors under study such as number of pods plant^{-1}, number of grains pod^{-1} and 1000-grain weight. Phosphorus also had significant effect on the grain yield where P_1 (90 kg P_2O_5 ha^{-1}) seemed to perform better by producing 1582.3 kg ha^{-1} than P_2 (120 kg P_2O_5 ha^{-1}). Thus, it is clear that phosphorus increases the grain yield upto certain limit. P_2 (120 P_2O_5 kg ha^{-1}) produced significantly higher protein concentration (22.14%) as compared to P_1 (90 P_2O_5 kg ha^{-1}) giving 21.06% protein. These findings are fully supported by Iqbal (1995) who concluded that there was a linear increase in protein content of rice bean with each successive dose of fertilizer application while Biship *et al*. (1976) reported that NPK application had non-significant effect on protein content of bean seeds. Therefore, it can be concluded that the best suited phosphorus dose was 90 kg ha^{-1} for increasing grain yield and 120 kg ha^{-1} for improving seed protein content.

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(Received 16 June 2001; Accepted 30 November 2001)