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EFFECT OF SEED RATE ON GROWTH, YIELD COMPONENTS AND YIELD OF MASH BEAN GROWN UNDER IRRIGATED CONDITIONS OF ARID UPLANDS OF BALOCHISTAN, PAKISTAN

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Abstract

A field experiment was carried out to investigate the effects of six different seed rates viz., 15, 17.5, 20, 22.5, 25 and 27.5 kg ha^{-1} on the growth, yield and yield attributes of mash bean *Vigna mungo* (L.) Hepper). This study was conducted for two consecutive years at the Agriculture Research Institute (ARI) under the existing semi-arid climatic, edaphic and water conditions of Quetta, Balochistan. Results revealed that plant population, pods plant^{-1}, grain yield plant^{-1} and grain yield ha^{-1} were significantly ($p<0.05$ influenced by varying seed rates. However, other mentioned growth and yield attributes did not respond significantly. Statistically and numerically a maximum yield plant^{-1} (20.98 g) and yield ha^{-1} (3120 kg) were obtained in applied seed @ 20 kg ha^{-1}. Whereas, the same was obtained for plant population and plant height in applied seed rate of 25 kg ha^{-1}. However, maximum number of branches plant^{-1} (4.22) was received for applied seeds @ 15 kg ha^{-1}. Therefore, seed @ 20 kg ha^{-1} seems optimum which could be due to the most desirable population or planting density in the existing environmental conditions of Quetta. Results further revealed that only plant population plot^{-1} (r=0.481), and yield plant^{-1} (r=0.569) were significantly and positively correlated with grain yield ha^{-1}, while all other remaining growth and yield attributes exhibited insignificant association with grain yield ha^{-1}. Hence these two parameters i.e., planting density and grain yield plant^{-1} should be given more consideration while deciding about selection criteria for mash bean under irrigated conditions of arid uplands of Balochistan.

Introduction

Mash bean [*Vigna mungo* (L.) Hepper] belongs to popular plant family Papillionaceae, and is among the most important pulse crops of the world. It has great value as food, fodder and green manure. In addition to improving the soil fertility, it is a cheap source of protein for direct human consumption. Chemical analysis of mash bean seed indicates that it contains 20-24% protein, 2.1% oil, 1-2% fats, carbohydrates and a fair amount of vitamin A and B (James, 1981). Thus it has a great potential to improve protein deficiency in human beings by providing a low cost protein. The crop not only fixes free atmospheric N_2 but also enriches the soil with N for the growth of succeeding crops (Sen, 1996). The economic product of mash bean is seed grain, which is a good source of dietary protein. This crop can be successfully grown on marginal lands where other crops perform poorly (Ghafoor *et al.*, 2003).

Worldwide yield of mash bean including Pakistan is very poor. In Pakistan it is the least researched crop among pulses despite its high nutritive and economic value due to which its area of cultivation and production have both gradually decreased. In Pakistan, this crop is grown over an area of 33,200 hectares with a total production of 15, 900 tones year^{-1} or 479 kg ha^{-1}. Though it is grown all over the country, but Punjab is the major mash producing province (Anon., 2006-07). Balochistan is one of the four provinces of

Pakistan by far the largest (44%) in total area of the country and the smallest in number of inhabitants (Anon., 1983). Based upon climate, soil and topography, province is divided into 5 ecological zones. The present field area i.e., Quetta falls in zone 4, a region with Mediterranian climate, having 15 to 30^0 N latitude and 53 to 66 E longitudes (Anees, 1980). In Balochistan mash bean is grown as a kharif crop on 1700 hectares land with a total production of 1200 tones or 706 kg ha^{-1}. Balochistan contribute 5.12% of the total country cultivation of mush bean (Anon., 2006-07).

The difference in seed rates is of great importance for the yield, and other yield contributing attributes. As for as available literature is concerned, no any extensive work has been carried out about the effect of seed rate on the growth, yield and yield components of mash bean with special reference to the existing climatic conditions of Quetta. However, through out the subcontinent, number of researchers had worked out on the growth, yield and yield component of legumes. Gupta & Lal (1988) stated that increase in seed rate from 20 to 50 kg ha^{-1} significantly reduced branches $plant^{-1}$ and 1000 grain weight, but did not affect the plant height and yield of black gram. Imtiaz *et al.*, (1988) revealed that differences among seed rate of mash been were statistically significant as moderate seed rate (17.5-25 kg ha^{-1}) was much better than the lower (10-15.5 kg ha^{-1}) and higher (27.5-37.7 kg ha^{-1}) seed rates. Singh *et al.*, (1994) also exhibited greatest seed yields (1.22, 1.39 and 1.26 t) produced @ 20, 30 and 40 kg seeds ha^{-1}, respectively. Similarly Shah & Rahman (2009) concluded that seed rate had significant influence on yield and most growth attributes of rapeseed. They also stated that the yield tended to increase with an increase in seed rate up to 10 kg ha^{-1}, above which a slight decrease was noted. Majority of the researchers obtained the optimum grain yield of mash bean and other legumes by applying seed @ 18-20 kg ha^{-1} (Khan & Asif, 2001; Maqsood *et al.*, 2001; Ashraf *et al.*, 2003; Hayat *et al.*, 2008ab). Research studies also revealed that most of the growth and yield contributing attributes are significantly and positively correlated with the grain yield of many crop plants viz., mash bean (Mahmood-ul-Hassan *et al.*, 2003; Khan *et al.*, 2004), chickpea (Arshad *et al.*, 2004), mungbean (Siddique *et al.*, 2006), soybean (Malik *et al.*, 2006-07) and sunflower (Vahedi *et al.*, 2010). The optimum seed rate in pulses is the most important factor for realizing good yields. It has been observed that farmers still use lesser seed rates especially in mash beans and chickpea. This study was, therefore, initiated to determine the optimum seed rate in order to maximize the seed yield of mash bean grown under the existing edaphic and climatic conditions of upland Quetta, Balochistan, Pakistan.

Materials and Methods

This field experiment on mash bean *(Vigna mungo* L. Hepper) was carried out in 1st week of June, 2003 & 2004 at Agricultural Research Institute (ARI), Quetta with six different seed rates @ 15.0, 17.5, 20.0, 22.5, 25.0 and 27.5 kg ha^{-1}, respectively. Plot was laid out in a Randomized Complete Block Design (RCBD) with a size of 8 x 5 m. The number of replication for each seed rate was kept three. Before preparing the seed bed, the field was also treated with a constant dose of Di-Ammonium Phosphate (DAP) fertilizer @ 50 kg ha^{-1}. Certified seeds of local variety of mash bean were sown with hand drill machine @ 15.0, 17.5, 20.0, 22.5, 25.0 and 27.5 kg ha^{-1} and planted at a depth of 3-4 cm. These seed rates were then designated as T_1, T_2, T_3, T_4, T_5, and T_6, respectively. All recommended cultural practices were followed to maintain a healthy crop stand in the experimental trial. Five plants from each plot were randomly selected, and following data on growth, yield and yield components were recorded when they reached to their physiological maturity:- Plant population plot^{-1}, Plant height, Number of trifoliate plant^{-1}, Branches plant^{-1}, Harvest index (%), Pods plant^{-1}, Pod length, 1000 seed weight, Yield plant^{-1} and Yield ha^{-1}.

A composite soil sample from both year fields (before sowing & fertilizer application) for their physicochemical characteristics was also taken at a depth of 0-18 cm with the help of soil auger. Similarly, irrigation water samples from the relevant tube-well were also taken for their physical and chemical analyses following the procedure proposed by Anon., (1953). The soil of the study area was found medium textured (clayey loam), basic in reaction, salt free, having low organic matter, Na^+ & K^+ and with medium Ca^{2+}+Mg^{2+} contents. While water used for irrigation purpose was found fresh, having normal pH & EC, and also with good amount of ions viz., Na^+, Ca^{2+}, Mg^{2+} and Cl^- (Table 1).

Data obtained was statistically analyzed following the procedure as described by Steel & Torrie (1980). MSTAT-C computer software package was used for calculating the analysis of variance (ANOVA) and least significance difference test (LSD) to separate their mean values. Simple correlation coefficients (r) were also worked out for aforementioned entries following the procedure reported by Fisher & Yates (1953).

Results and Discussion

Data presented in Table 2 showed that in response to various levels of applied seed rates, most of the growth, yield and yield contributing attributes were statistically found non-significant ($p<0.05$). However, plant population plot^{-1}, pods plant^{-1}, yield plant^{-1}, and yield ha^{-1} were either highly ($p<0.01$) or slightly ($p<0.05$) significant.

1. Growth attributes

Plant population: Results pertaining to mean separation values (Table 2) showed that in response to different level of applied seed rates the plant population was significantly different and T_5 @ 25 kg ha^{-1} seed produced the highest plant population (1280.33 plot^{-1}) followed by T_6. However, the initial treatments of applied seed rates (T_1 to T_4) were found to be non-significant, and a minimum number of plants (349 plot^{-1}) were noted in case of T_1 @ 15 kg ha^{-1} seeds. This variation of plant population can be attributed to using different seed rates. These results are also in line with the observations recorded by Piggot & Farrel (1982) and Khan *et al.*, (2000) who reported that plant population in each trial ranged from 5-110 plants m^{-2} by changing seed rates.

Plant height: Data concerned about mean values (Table 3) deciphered that in response to various seed rates plant height was statistically found to be non-significant ($P<0.05$). Numerically a maximum plant height (51cm) was recorded in T_5 (25 kg ha^{-1}) followed by T_6. This trend of field results is also in agreement with those of Gupta & Lal (1988); Staggenborg *et al.*, (1996), Yilmaz (2003) and Shah & Rahman (2009), but in disagreement with the results obtained by Khan *et al.*, (2000), Ayub *et al.*, (2002), Tonçer & Kizil (2004) and Zaman *et al.*, (2004). However, Khan *et al.*, (2000) also stated that seed rate of 20 kg ha^{-1} produced the tallest plants which did not differ statistically from applied seed @ 25 kg ha^{-1}, while minimum plant height (128.91 cm) by them observed where seed rate of 30 kg ha^{-1} was used.

Table 1a&b. Physical and chemical characteristics of soil and irrigation water used for the study of field grown mash bean (*Vigna mungo* L. Hepper).

Samples	a) Physical Characteristics								
	TSS (ppm)	pH	Ece (mS cm^{-1})	Organic matter (%)	Water holding capacity (%)	Sand (%)	Silt (%)	Clay (%)	Textural class
Soil	1995	8.3	3.06	0.76	37.85	22.88	49.15	27.96	Clay loam
CFC	-	*Basic	*Salt free	*Low	Medium	-	-	-	**Medium textured
Water	428	7.5	0.65	-	-	-	-	-	-
CFC	*Fresh	*Normal	* Normal	-	-	-	-	-	-

Samples	b) Chemical Characteristics									
	Na^+	K^+	Ca^{2+}	Mg^{2+}	Cl^-	NH_4^+	NO_2^-	NO_3^-	Fe^{2+}	PO_4	Cu^{2+}
	($meq\ L^{-1}$)					(mM)			(ppm)		
Soil	6.94	0.44	15.25	22.80	24.86	3.23	0.20	5.24	11.75	188	ND
CFC	*Low	*Low	*Medium	*Mediu	**Saline	-	-	-	-	-	-
Water	2.90	0.06	02.88	07.55	00.50	ND	0.03	0.40	03.24	60.65	ND
CFC	***Good	-	***Good	***Good	***Good	-	-	-	-	-	-

CFC = Categories for classification; ND = Not deducted; *and** following the soil classification of Kayani & Sheikh (1981) and Anonymous (1953), respectively. Similarly *, ** and *** followed the water classification of Hem (1973) and Davis & DeWiest (1966), respectively.

Table 2. Analysis of variance (ANOVA) for growth, yield and yield components of mash bean *(Vigna mungo* (L.) Hepper).

	Variable analyzed	Sum of squares	Mean squares	F-values at an error of 10 and dF. 5	Probabilities
1.	Plant population $plot^{-1}$	1758558.28	351711.656	44.2910	0.0000 **
2.	Plant height, cm.	136.569	27.314	1.8970	0.1819 ns
3.	Number of trifoliate	518.624	103.725	1.1401	0.4005 ns
4.	Branches $plant^{-1}$	4.797	0.959	2.0305	0.1593 ns
5.	Pod length, cm.	0.080	0.016	0.5800	ns
6.	Harvest index (%)	105.583	21.117	0.6103	ns
7.	Pods $plant^{-1}$	2809.781	561.956	5.0684	0.0142 *
8.	1000 seed weight, g	393.459	78.692	0.3412	ns
9.	Yield $plant^{-1}$, g	330.898	66.18	4.1204	0.0272 *
10.	Yield, kg ha^{-1}.	10219902.78	2043980.556	5.3857	0.0116 *

* and ** are slightly to highly significant at $p \leq 0.05$ and $p \leq 0.01$, respectively, while ns stands for non-significant at both level of probabilities.

Number of trifoliate and branches: Data regarding mean values (Table 3) enumerated that both number of trifoliate and branches plant^{-1} responded insignificantly in relation to receiving various applied seed rates. A maximum number of trifoliate leaves (34.67 plant^{-1}) are recorded in T_3 while maximum number of branches (4.22 plant^{-1}) were recorded in T_1. Dissimilar findings are also obtained by few other researchers like Gupta & Lal (1988), Yilmaz (2003), Tonçer & Kizil (2004), and Gama *et al.,* (2007).

2. Yield components

Pods length: Data regarding mean values (Table 3) showed that pods length was statistically non-significant (P<0.05) in response to different applied seed rates. However, numerically a maximum pod length (4.30 cm) was noted in T_4 (i.e., seed @ 22.5 kg ha^{-1}). This is also in accordance with the results explained by some other researchers (Mehmud *et al.,* 1997; Kumar *et al.,* 1997), but contradictory with those of Ihsanullah *et al.,* (2002) and Yilmaz (2003).

Harvest index: Data of the harvest index also depicted insignificant response in relation to various seed rates. However, greatest value of harvest index i.e., 58.27% was produced in T_5 @ 25 kg seeds ha^{-1} (Table 3). This is substantially in agreement with the observations recorded by some of the researchers (Quresh & Ahmed, 1984; Singh *et al.,* 1994). However, significant differences are noted in various legumes by most of the researchers. Jan *et al.,* (2000) studied that mungbean seed @ 10 kg ha^{-1} had maximum harvest index (22.01%), while seed @ 20 kg ha^{-1} seems optimum. Ashraf *et al.,* (2003) also stated that in relation to inoculation and NPK application the said crop exhibited significant variation for harvest index. Similar significant variation in harvest index occurred between various other legumes sown using uniform seed rates of 25 kg ha^{-1}. A maximum harvest index was produced by rice bean and minimum (42.64%) by mash bean (Nadeem *et al.,* 2004).

Pods plant^{-1}: Plant growth behavior can be determined by number of pods per plant. The number of pods plant^{-1} was significantly affected by different seeding rates. The results revealed that maximum number of pods plant^{-1} (67.33) was obtained from T_3 seeding rates which was followed by relatively lower number of pods per plant^{-1} (43.56) from seeding rats of T_1 (Table 3). Whereas, minimum number of pods plant^{-1}(29.66) was obtained from seeding of T_5, which could be attributed to greater planting density. Similar trend of results have also been obtained by Phalwan & Hussain (1983) and Khan *et al.,* (2000) in mungbean and ricebean, respectively. They reported that seed @ 20 kg ha^{-1} gave the maximum number of pods (127.3 plant^{-1}), which was statistically similar with seed @ 25 kg ha^{-1}. Whereas seed @ 30 kg ha^{-1} gave the minimum number of pods (120.1 plant^{-1}). The decreasing trend of pods plant^{-1} with increasing seed rate could be attributed to the competition existing between the populated crops for the sake of nutrients uptake. These results are in line with the findings of Pookpokdil & Pataradil (1993) for mungbean and black gram, who also reported that decreasing number of pods plant^{-1} with increasing plant density.

1000-seed weight: Data indicated that1000-seed weight did not influenced by varying seed rates (Table 3). Numerically a maximum 1000-seed weight (58.73 g) is obtained in T_4 followed by T_3 (57.69 g). Whereas T_2 i.e., seed @ 17.5 kg ha^{-1} gave the minimum 1000-seed weight (45.98 g). These results are in line with Quresh & Ahmed (1984); Yilmaz (2003) and Tonçer & Kizil (2004). While contradicted with the findings received by Gupta & Lal (1988) and Khan *et al.,* (2000) who reported that different plant densities influenced significantly the 1000-seed weight of black gram and rice bean, respectively.

Table 3. Effect of various seed rates on growth, yield and yield contributing parameters of mash bean *(Vigna mungo* (L.).

Seeds @ (kg ha^{-1})	Plant population $plot^{-1}$	Plant height, (cm)	Number of trifoliate	Branches $plant^{-1}$	Pod length, (cm)	Harvest index (%)	Pods $plant^{-1}$	1000 seed weight (g)	Yield $plant^{-1}$ (g)	Yield (kg ha^{-1})
T_1 = 15.0	349.00 c	41.67	23.11	4.22	4.10	51.39	43.56 a	54.82	9.34 b	793.33 c
T_2 = 17.5	523.33 bc	45.55	20.78	3.00	4.16	56.36	43.44 b	45.98	14.74 ab	1919.16 b
T_3 = 20.0	596.00 bc	44.89	34.67	4.00	4.14	53.22	67.33 a	57.69	20.98 a	3120.00 a
T_4 = 22.5	622.66 bc	46.11	27.67	3.45	4.31	52.47	42.45 b	58.73	13.76 ab	2155.83 ab
T_5 = 25.0	1280.33 a	51.00	18.33	2.89	4.12	58.27	29.66 b	49.77	8.31 b	2892.50 ab
T_6 = 27.5	987.00 ab	46.56	22.11	4.00	4.19	55.98	30.11 b	57.51	10.21 b	2345.80 ab
Grand mean	726.386	45.963	24.445	3.593	4.170	54.615	42.758	54.083	12.890	2204.437
CV (%)	12.27	8.26	39.03	19.15	3.97	10.77	24.63	28.08	31.10	27.95
LSD ($p \leq 0.05$)	512.7	6.903	17.35	1.25	0.298	10.70	19.16	27.628	7.291	1121
LSD ($p \leq 0.01$)	729.2	9.819	24.67	1.779	0.425	15.22	27.25	39.297	10.37	1594

Figures followed by the same letter(s) within a column are statistically non-significant ($P \leq 0.05$).

Table 4. Correlation coefficient (r) studies of various agronomic traits of field-grown mash bean [*Vigna mungo* (L.) Hepper.

Variables number	1	2	3	4	5	6	7	8	9
2	0.532 *								
3	-0.280 ns	-0.149 ns							
4	-0.257 ns	-0.493 *	0.462 ns						
5	0.397 ns	0.198 ns	0.186 ns	-0.175 ns					
6	-0.526 *	-0.326 ns	0.370 ns	0.289 ns	-0.460 ns				
7	-0.052 ns	0.255 ns	0.058 ns	0.073 ns	-0.149 ns	0.097 ns			
8	-0.033 ns	0.041 ns	0.449 ns	0.262 ns	0.123 ns	0.164 ns	0.140 ns		
9	-0.407 ns	-0.224 ns	0.380 ns	0.120 ns	-0.174 ns	0.778 **	-0.083 ns	-0.130 ns	
10	0.481 *	0.361 ns	0.145 ns	-0.145 ns	0.181 ns	0.325 ns	-0.091 ns	-0.009 ns	0.569 *

* and ** significant at $p<0.05$ and $p<0.01$ respectively, and ns stands for non-significant. Variables # (1) plant population $plot^{-1}$, (2) plant height, cm (3) number of trifoliate $plant^{-1}$, (4) number of branches $plant^{-1}$, (5) harvest index, %, (6) pods $plant^{-1}$, (7) pods length, cm (8) 1000 seed weight, g (9) yield $plant^{-1}$ g, and (10) yield kg ha^{-1}

3. Yield

Results pertaining to mean separation values (Table 3) showed that in relation to various level of applied seed rates, both the yield plant^{-1} and yield ha^{-1} were positively significant ($p<0.05$). Maximum yield plant^{-1} (20.97 g) and yield ha^{-1} (3120 kg) was obtained in T_3 (20 kg ha^{-1}) level of applied seeds. The result also suggests that moderate seed rate produced maximum grain yield, beyond that non-significant change in grain yield was observed. Therefore, seed @ 20 kg ha^{-1} seems optimum which could be due to the most desirable population or planting density in the existing environmental conditions of Quetta. In the light of literature reviewed, present findings are in conformity with the findings obtained by most of the researchers for various legumes and oil seeds (Imtiaz *et al.*, 1988; Jan *et al.*, 2000; Khan & Asif, 2001; Maqsood *et al.*, 2001; Biswas *et al.*, 2002; Ashraf *et al.*, 2003; Hayat *et al.*, 2008ab; Shah & Rahman), but are in disagreement with few other investigators (Gupta & Lal, 1988; Singh *et al.*, 1994).

4. Correlation

The correlation coefficient (r) studies revealed that only plant population plot^{-1} (r=0.481) and yield plant^{-1} (r=0.569) were significantly and positively correlated with grain yield ha^{-1}. While all other remaining growth and yield attributes exhibited non-significant association with grain yield ha^{-1}. Whereas pods plant^{-1} also exhibited highly significant and positive association with grain yield plan^{-1} (r=0.778), but not with yield ha^{-1} (Table 4). These findings are not in accordance with the results obtained by other researchers for most of the legumes (Mahmood-ul-Hassan *et al.*, 2003; Achakzai & Kayani 2004; Arshad *et al.*, 2004; Siddique *et al.*, 2006; Malik *et al.*, 2006 & 2007). They stated that grain yield had positive significant and positive correlation with plant height, number of branches and pods plant^{-1}, 1000 grain weight and biological yield. While, in present study high direct effects were contributed only by yield plant^{-1} and planting density. Therefore, these two parameters should be given more consideration while deciding about selection criteria for mash bean under irrigated conditions of arid uplands of Balochistan.

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