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Yield and Economics of Moth bean [*Vigna aconitifolia* (Jacq.) Marechal] as Influenced by Different Varieties and Phosphorus Levels

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A B S T R A C T

A field experiment was conducted on moth bean during *kharif*, 2016 at Agronomy Farm, College of Agriculture, Bikaner. The experiment was laid out in randomized block design with three replications. The treatments consisted of four varieties namely, RMO 40, RMO 225, RMO 435 and RMO 257 and four levels of phosphorus viz., 20, 40, 60 and 80 P_2O_5 ha^{-1}. Variety RMO 257 recorded seed yield of 827 kg ha^{-1} and established its significant superiority over RMO 225 and RMO 435 in terms this respect over RMO 225 and RMO 435 by a margin of 21.6 and 30.8 per cent, respectively, nevertheless, variety RMO 40 was statistically at par with RMO 257, suggesting it to be an alternative variety for the region to be grown, as both the varieties being at par with each other, also recorded significantly higher net returns as compared to RMO 225 and RMO 435. Application of 40 kg P_2O_5 ha^{-1} significantly increased the seed yield by a margin of 39.7 and net returns over 20 kg P_2O_5 ha^{-1} and 207 per cent, respectively. Further increase in levels of phosphorus was not found beneficial.

Introduction

Among the leguminous *kharif* crops of arid western Rajasthan, moth bean [*Vigna aconitifolia* (Jacq.) Marechal] is of utmost significance due to its drought and heat tolerance characteristics. Above and beyond assured production under harsh and hostile arid environment, the crop conventionally supports dietary requirement of local people to a great extent by offering a range of edible products such as dried seeds, mature and immature green pods vegetable. Traditional preparations of moth bean like dal, kheech, papad, bhujia, mangori, etc. as a part of their food habits also fulfill the nutritional need of local people well, as it contains 22–24 per cent high quality protein along with high amount of essential amino acids particularly lysine and leucine and also certain vitamins (Kumar and Singh, 2001). Bikaneri bhujia, given identity to Bikaner in world trade, also carries the distinction of having a geographical indication tag from 2010 onwards. The credit of such recognition goes to one and only moth bean crop of this region, flour of which is used for the preparation of such a savory. The arid districts of Rajasthan are privileged to have moth bean as a traditional crop. It would not be out of place to mention that out of 85 per cent of moth bean area in Rajasthan, 93 per cent is confined to just 12 arid districts of the state. In Rajasthan, with an area of 9.27 lakh

hectares and production of 2.67 lakh tones, the crop exhibits the productivity of 288 kg ha^{-1} (Krishi Rajasthan, 2015), which is still low in arid districts (about 200 kg/ha). During recent past, however, need based and deliberate attempts yielded success of desired level in developing the varieties of this hardy crop more productive and adaptive to harsher and more hostile environment. Quite a large variation in yielding performance of moth bean genotypes has been reported across the region and within the region among different years (Anonymous 2013, 2014, 2015 and 2016). Such variations convincingly demonstrate presence of genotype-environment interactions in moth bean and reasonably demand to evaluate the relative performance of different varieties particularly under changing climate scenario. The role and importance of phosphorus applications to pulse crops have long been recognized and is regarded as an essential prerequisite in the production of these leguminous crops. Phosphorus is not only essential for the development of root system but also plays a vital role in the formation of energy rich bond phosphates like Adenosine di phosphate (ADP), Adenosine tri phosphate (ATP), nucleoproteins, phospholipids, etc. It is also essential for the growth of bacteria responsible for nitrogen fixation. However, supply of phosphorus is more important than that of nitrogen because of nitrogen is fixed by the bacteria lodged in the root nodules of plant. Phosphorus application to moth bean has also been justified even in low-rainfall years because of its ability to improve yield under water-limited conditions (Garg *et al.*, 2004)

Materials and Methods

The field experiment was conducted at Agronomy Farm, Collage of Agriculture, Swami Keshwanand Rajasthan Agricultural University, Bikaner during *Khari*f session of 2016. The soil of the experimental field was loamy sand in texture, alkaline in reaction, poor in organic carbon, low in available nitrogen and low in phosphorus but medium in available potassium. The experiment was laid out in randomized block design (R.B.D.) with three replications. Treatments are consisted of four varieties of moth bean viz. RMO 40, RMO 225, RMO 257 and RMO 435 and four levels of P_2O_5 viz. 20 kg ha^{-1}, 40 kg $ha^{-}1$, 60 kg ha^{-1} and 80 kg ha^{-1} thus making 16 factorial combinations in all. As per treatment seed of different varieties duly treated with Rhizobium culture was sown @ 20 kg/ha in lines spaced at 30 cm at a depth of 5 cm by "Kera" method in open furrows. For evaluating growth and yield attributes, five plants were randomly selected in each plot from the sampling rows and tagged permanently. At maturity, experimental crop was harvested from the net plot. The boarder rows were harvested separately. Threshing was done manually by beating and trampling the pods of each plot separately and grains were collected in numbered bags. After winnowing, cleaned seeds were weighted to record grain yield and expressed as kg ha^{-1}. Nutrient content and protein content in grain was determined by using standard methods.

Results and Discussion

Effect of varieties

Variety RMO 257 excelled all the remaining varieties namely, RMO 40, RMO 225 and RMO 435 in respect of number of pods per plant but, the difference with variety RMO 40 was not significant in this respect. In terms of other yield attributes viz., number of grains per pod, grain weight per pod and test weight studied, though all the varieties were statistically at par, yet RMO 257 slightly edged over others in these parameters. This might be due to the characteristics of this variety that reflected in increased vegetative

growth. The growth characters play a vital role in various metabolic processes primarily that result in increased flowering and fruiting thereby improving pods per plant. These findings confirmed the results of Meena (2007) and Nehra and Shrama (2008). Variety RMO 257 also established it significant superiority over RMO 225 and RMO 435 in terms of seed yield, closely followed by RMO 40. The differential behaviour among the genotypes may be explained primarily on the basis of variation in their genetic makeup and secondly their differential behaviour under different agroclimatic conditions. Increased growth and yield attributing parameters observed with variety RMO 257 during crop growth period, in turn, played a crucial role in yield formation of this variety and accorded it superiority over others. It is pertinent to note that in terms of straw yield, all the varieties did not differ significantly from one another yet, in their biological yields considerable variations have been noticed that established variety RMO 257 superior to RMO 225 and RMO 435. This might be due to the fact that excess assimilates stored in the leaves and later their efficient translocation in to seeds at the time of senescence, ultimately led to higher seed yield of RMO 257 and RMO 40. Reports of Kandpal *et al.*, 2006; Arora *et al.*, (2008); Patel *et al.*, (2008), etc. support our findings (Table 1).

Effect of phosphorus levels

It is evident that in comparison to 20 kg P_2O_5 ha^{-1}, all the other levels of phosphorus brought about significant improvement in number of pods per plant, number of grains per pod and grain weight per pod, however, successive doses beyond 40 kg P_2O_5 ha^{-1} failed to bring about significant improvement in these attributes. The regulatory functions of phosphorus in photosynthesis and carbohydrate metabolism of leaves can be considered as one of the major factors that governs plant growth particularly during reproductive phase. The availability of phosphorus during this period regulates starch/sucrose ratio in the source and sink. Probably, this effect of phosphorus on partitioning is also responsible, in part, for the insufficient supply of photosynthates to the nodulated roots of legumes grown under phosphorus deficient soils. Seed yield was found to be increased significantly with increase in phosphorus levels up to 40 kg P_2O_5 ha^{-1}, successive increase in phosphorus levels up to 80 kg P_2O_5 ha^{-1}, however, could not bring about significant improvement in seed yield. This might be due to concomitant performance of crop in terms of number of pods per plant, number of seeds per pod and grain weight per pod.

Economics

Net returns (Rs.ha^{-1})

Variety RMO 257 recorded the highest net returns of Rs13412 ha^{-1} which is significantly higher than that recorded with RMO 225 and RMO 435. Variety RMO 40 was at par with RMO 257 in this respect. And when compared with level 20 kg P_2O_5, though at the other levels gave significant increment in net monetary returns application of beyond 40 kg ha^{-1} failed to record significant increment in net returns (Table 2).

B.C. ratio

Variety RMO 257 recorded the highest B:C ratio (1.68) followed by RMO 40, RMO 225 and RMO 435.And the lowest B:C. ratio was recorded with the application of 60 kg P_2O_5 ha^{-1} which was closely followed by level 40 kg P_2O_5 ha^{-1}.

Table.1 Effect of varieties and phosphorus levels on yield attributes: number of pods plant^{-1}, number of grain pod^{-1}, grain weight, and test weight of moth bean

Treatment	Number of pods plant^{-1}	Number of grain pod^{-1}	Grain weight (mg)	Test weight (g)
Varieties				
RMO 40	32.20	5.77	143.00	26.71
RMO 225	27.43	5.40	138.67	27.47
RMO 257	32.92	5.53	143.67	27.63
RMO 435	26.32	5.20	135.08	27.74
S.Em.±	1.49	0.16	3.29	0.40
CD(*p*=0.05)	4.30	NS	NS	NS
Phosphorus levels (kg P_2O_5 ha^{-1})				
20	21.77	5.00	127.58	27.01
40	31.48	5.68	144.00	26.96
60	33.07	5.67	144.25	27.88
80	32.55	5.55	144.58	27.70
S.Em.±	1.49	0.16	3.29	0.40
CD(*p*=0.05)	4.30	0.45	9.50	NS

Table.2 Effect of cultivars and levels of phosphorus on yields and economics of moth bean

Treatment	Seed yield (kg ha^{-1})	Straw yield (kg ha^{-1})	Net Returns (Rs. /ha)	B:C ratio
Varieties				
RMO 40	799	1912	12376	1.63
RMO 225	680	1854	8068	1.40
RMO 257	827	1945	13412	1.68
RMO 435	632	1748	6179	1.31
S.Em.±	30.	72	1148	-
CD(*p*=0.05)	87	NS	3315	-
Phosphorus levels (kg P_2O_5 ha^{-1})				
20	551	1344	3804	1.21
40	770	1865	11686	1.61
60	805	2097	12539	1.63
80	812	2153	12006	1.57
S.Em.±	30	72	1148	-
CD(*p*=0.05)	87	207	3315	-

In conclusion, the present investigation has led to the inference that variety RMO 257 is superior to RMO 225 and RMO 435 as it (variety RMO 257) recorded significantly higher seed yield of 827 kg ha^{-1} and net monetary returns of Rs 13412 ha^{-1}, closely

followed by RMO 40, which can also be an alternative choice for the cultivation of moth bean in the region. As well as application of phosphorus @ 40 kg ha^{-1} found better as compared to other levels in terms of seed yield (770 kg ha^{-1}) and net returns (Rs.11686 ha^{-1}) as further increase in levels of phosphorus i.e. 60 and 80 kg P_2O_5 ha^{-1} did not bring about significant improvement in yield and net returns.

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