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# Growth and productivity of Moth bean [*Vigna aconitifolia* (Jacq.) Marechal] in response to different varieties and phosphorus levels

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## Abstract
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 $P_2O_5$ $ha^{-1}$. In terms of various growth attributes as compared to RMO 225 and RMO 435, the variety RMO 257 recorded significantly higher values for plant height at harvest (45.81 cm), dry matter accumulation at harvest (10.93 g $plant^{-1}$), branches at harvest (8.25), leaf area index at 40 DAS (3.54). 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. In terms of various growth parameters viz., plant height at harvest, dry matter accumulation at harvest, branches at harvest, LAI at 40 DAS, nodules $plant^{-1}$ beneficial effects of phosphorus application were noticed only up to 40 kg $P_2O_5$ $ha^{-1}$ and the level of phosphorus also significantly increased the seed yield by a margin of 39.7. Further increase in levels of phosphorus was not found beneficial.

**Keywords:** Moth bean, *Vigna aconitifolia*.

## 1. 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) [9]. 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) [1, 2, 3, 4]. 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) [6]

## Material and Methods

The field experiment was conducted at Agronomy Farm, Collage of Agriculture, Swami Keshwanand Rajasthan Agricultural University, Bikaner during *Kharif* 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 characters, 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 $ha^{-1}$.

## Results and Discussion

### Effect of varieties

In later stages, growth attributes were significantly affected under the influence of different varieties tried, namely, RMO 40, RMO 225, RMO 257 and RMO 435. Significantly increased plant height, number of branches per plant, leaf area index, and dry matter accumulation were recorded for the variety RMO 257 over RMO 225 and RMO 435, but, it (RMO 257) did not differ significantly from RMO 40 in respect of all these characters except, leaf area index in which it excelled all the other varieties. The superior performance of RMO 257 in comparison to other varieties may be attributed to its highest leaf area index and genetic build up as well. The highest leaf area index, well sustained by its semi-spreading nature and supported by congenial environmental conditions, gave boost to photosythate accumulation by trapping the solar radiation more effectively than other varieties. Dry matter accumulation per plant further support this contention. It is obvious that this variety (RMO 257), developed with full potential of its yielding capacity, thus resulted in vigorous plant growth, whereas variety RMO 225 and RMO 435 could not achieve that pace, may be due to their genetic makeup. Variations in different growth attributes among different varieties of moth bean have also been reported by Kandpal *et al.* (2006) [7, 8], Meena (2007) [12] and Nehra and Sharma (2008) [14]. 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. 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 [7, 8], Arora *et al.* (2008) [5], Patel *et al*. (2008) [15], etc. support our findings.

### Effect of phosphorus levels

Significant increase in plant height, number of branches per plant, LAI, dry matter accumulation per plant was noted with the application of increasing levels of phosphorus over 20 kg $P_2O_5$ $ha^{-1}$ at the later stages of plant growth. These results are in accordance with the findings of Yadav and Jakhar (2001) [18], Ram and Dixit (2001) [16] and Luikham *et al.*, (2005) [11]. The favourable effects of phosphorus on these growth components have long been recognized. The reason to such stimulating effect of phosphorus may be assigned to the fact that phosphate is a constituent of many intermediate products of legume crops and considered as an essential constituent of all living organisms and plays an important role in conservation and transfer of energy in metabolic reactions of living cells including biological energy transformations. Thus, application of increasing levels of phosphorus may have enhanced cell division, root elongation and proliferation of roots. Thereby more absorption of nutrients and moisture from deeper layers of soil could have taken place. Several reports indicate that cell division is increased with application of phosphorus, as a result of which growth is enhanced in legume (Sharma *et al.*, 2003, Nadeem *et al.*, 2004, etc.) [17, 13]. Root nodulation has been found to be increased significantly with the application of 40, 60 and 80 kg $P_2O_5$ $ha^{-1}$ over 20 kg $P_2O_5$ $ha^{-1}$. Beneficial effects of phosphorus on the nodulation of legume have been well documented (Nadeem *et al.*, 2004, Kumar and Sharma, 2005, etc.) [13, 10]. 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.

## 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 $ha^{-1}$, 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 as further increase in levels of phosphorus i.e. 60 and 80 kg $P_20_5$ $ha^{-1}$ did not bring about significant improvement in yield.

**Table 1:** Effect of varieties and phosphorus levels on growth attributes of moth bean

| Treatment | Plant height at harvest (cm) | Dry matter accumulation at harvest (g plant$^{-1}$) | Leaf area index at harvest | Branches plant$^{-1}$ at harvest |
|---|---|---|---|---|
| Varieties | | | | |
| RMO 40 | 43.82 | 10.44 | 1.71 | 7.92 |
| RMO 225 | 39.50 | 9.07 | 1.67 | 6.77 |
| RMO 257 | 45.81 | 10.93 | 1.68 | 8.25 |
| RMO 435 | 39.60 | 7.58 | 1.62 | 5.12 |
| S.Em.± | 1.26 | 0.33 | 0.07 | 0.27 |
| CD(*p*=0.05) | 3.64 | 0.95 | NS | 0.79 |
| Phosphorus levels (kg $P_2O_5$ ha$^{-1}$) | | | | |
| 20 | 34.59 | 8.47 | 1.59 | 5.27 |
| 40 | 44.13 | 9.60 | 1.62 | 7.45 |
| 60 | 44.59 | 9.66 | 1.68 | 7.60 |
| 80 | 45.42 | 10.29 | 1.78 | 7.73 |
| S.Em.± | 1.26 | 0.33 | 0.07 | 0.27 |
| CD(*p*=0.05) | 3.64 | 0.95 | NS | 0.79 |

**Table 2:** Effect of cultivars and levels of phosphorus on yields and harvest index of moth bean

| Treatment | Seed yield (kg ha$^{-1}$) | Straw yield (kg ha$^{-1}$) | Biological yield (kg ha$^{-1}$) | Harvest index (%) |
|---|---|---|---|---|
| Varieties | | | | |
| RMO 40 | 799 | 1912 | 2711 | 29.94 |
| RMO 225 | 680 | 1854 | 2534 | 26.90 |
| RMO 257 | 827 | 1945 | 2772 | 30.14 |
| RMO 435 | 632 | 1748 | 2380 | 26.66 |
| S.Em.± | 30 | 72 | 93 | 0.78 |
| CD(*p*=0.05) | 87 | NS | 268 | 2.24 |
| Phosphorus levels (kg $P_2O_5$ ha$^{-1}$) | | | | |
| 20 | 551 | 1344 | 1895 | 28.96 |
| 40 | 770 | 1865 | 2635 | 29.60 |
| 60 | 805 | 2097 | 2902 | 27.80 |
| 80 | 812 | 2153 | 2965 | 27.28 |
| S.Em.± | 30 | 72 | 93 | 0.78 |
| CD(*p*=0.05) | 87 | 207 | 268 | 2.24 |

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