RESEARCH ARTICLE Legume Research- An International Journal, Volume 47 Issue 8: 1377-1381 (August 2024)

Evaluation of High Harvest Index Urdbean (*Vigna mungo* L.) Varieties using Path Analysis in Various Crop Spacing under Rainfed Conditions in Tamil Nadu

P. Veeramani[1], K. Subrahmaniyan[1], S. Manickam[1]

10.18805/LR-5129

ABSTRACT

Background: One of the most valuable crops is black gram, which has a high nutritional value, a short growing season and is suitable for many different farming systems. This study aims to evaluate the high harvest index urdbean varieties using path analysis in various crop spacing under rainfed conditions in Tamil Nadu.

Methods: The experiments was carried out during three consecutive years (2016-2017, 2017-2018 and 20218-2019) of *Kharif* season at Agricultural Research Station, Tamil Nadu Agricultural University, Virinjipuram, Tamil Nadu. The experiments was laid out in factorial randomized block design with three replications.

Result: The pooled results of three years revealed that the urdbean variety VBN (Bg) 6 had the maximum seed yield of 691 kg ha^{-1}, whereas MDU 1 had the lowest seed yield of 536 kg ha^{-1}. When compared to other crop spacing, 20 cm × 10 cm had the maximum seed output of 683 kg ha^{-1}. The ideal plant spacing of 20 cm × 10 cm enhanced seed production by 38.0 percent and harvest index by 16 per cent when compared to the advised crop spacing of 30 cm × 10 cm.

Key words: Harvest index, Nodules, Path analysis, Spacing, Varieties.

INTRODUCTION

Among pulses, urdbean [*Vigna mungo* (L.) Hepper] is one of the most important crop grown in India. The importance of this crop than other pulse crop is by virtue of its high nutritional value, short duration, adaptability to all season and suitability to various cropping systems. India is the largest producer of pulses, accounting 22 per cent of world's pulse production. Leguminous crops integrate well in crop rotation and cropping systems because they fix and use atmospheric nitrogen while increasing soil fertility.

The amount of pulses produced falls well short of even the bare minimum required for per capita consumption. Therefore, it presents a significant problem for agricultural experts to supply the nation's rapidly expanding population with pulses. In India, pulses are produced on an area of 304 lakh ha^{-1}, producing 14.77 million tonnes at a productivity of 617 kg ha^{-1}. Tamil Nadu has a total of 8.32 lakh ha^{-1} of land planted with pulses, producing 3.67 lakh tonnes overall at a productivity of 441 kg ha^{-1}. Urdbean is produced on a 2.0 lakh ha^{-1} area in Tamil Nadu, with a total production of 0.88 lakh tonnes and a productivity of 425 kg ha^{-1}.

Because no systematic attempts have been made in the past to build a package of technology that may ensure high seed yield of this crop, its per hectare yield produced at farmers' fields is low. The persistent cultivation of old low potential cultivars, use of low seed rates and incorrect agronomic practises, such as crop spacing, are significant factors in the low average yield of urdbean on farmer's field. Among many other crop production constraints, appropriate varieties and crop spacing are the most important, which contribute substantially to the seed yield of urdbean. Many research studies also revealed that most of the growth and yield contributing attributes are significantly and positively correlated with the seed yield of many crop plants *viz*., chickpea (Arshad *et al*., 2004), urdbean (Siddique *et al*., 2006), soybean (Malik *et al*., 2007) and sunflower (Vahedi *et al*., 2010). Plant density can have a major effect on the final yield of most of the legumes and the general response of yield to increasing population is well documented.

Low productivity is caused by declining producing capacity on a daily basis, a lack of utilisation of improved varieties and improper spacing. The management of the optimal area made accessible to each plant is of the utmost importance in order to realise the highest yield potential of urdbean cultivated during the summer and rainy season. To achieve the appropriate spacing, a compromise must be found between the two factors of row and plant spacing. The required spacing is determined by the genotype's growth

[1]Tapioca and Castor Research Station, Tamil Nadu Agricultural University, Yethapur-636 119, Salem, Tamil Nadu, India.

Corresponding Author: P. Veeramani, Tapioca and Castor Research Station, Tamil Nadu Agricultural University, Yethapur-636 119, Salem, Tamil Nadu, India. Email: veera.agri@yahoo.com

How to cite this article: Veeramani, P., Subrahmaniyan, K. and Manickam, S. (2024). Evaluation of High Harvest Index Urdbean (*Vigna mungo* L.) Varieties using Path Analysis in Various Crop Spacing under Rainfed Conditions in Tamil Nadu. Legume Research. 47(8): 1377-1381. doi:10.18805/LR-5129.

Submitted: 06-03-2023 **Accepted:** 05-06-2023 **Online:** 05-07-2023

characteristics. So, maintaining spacing and variety is necessary for a higher yield. In order to assess the high harvest index urdbean varieties using path analysis in various crop spacing under rainfed conditions in Tamil Nadu, the current studies examined the production potential and growth behaviour of three urdbean varieties to different crop spacing under the prevailing environmental conditions.

MATERIALS AND METHODS

A field experiment was conducted during *Kharif* season on 2016, 2017 and 2018 at Agricultural Research Station, Tamil Nadu Agricultural University, Virinjipuram (12.9239°N, 79.0188°E) Tamil Nadu. The soil of the experimental site was loamy in texture. The experiments comprising three urdbean varieties (VBN (Bg) 4, VBN (Bg) 6 and MDU 1) and five plant spacing (15 cm × 10 cm, 15 cm × 15 cm, 20 cm × 10 cm, 20 cm × 15 cm and 30 cm × 10 cm) was conducted in a factorial randomized complete block design (FRBD) and replicated three times. The treatments were allotted randomly to each replication. The gross plot size was 5 m × 4 m and net plot size 4.7 m × 3.8. The crop was raised as per the recommended package of practices (TNAU 2016). The observations were recorded on 5 randomly selected plants from days to 50% flowering, days to maturity, plant height (cm), number of primary branches per plant, number of clusters per plant, number of pods per cluster, number of seeds per pod, seed yield per plant (g), 100-seed weight (g), biological yield per plant (g) and harvest index (%). Nodulation data in term of number and dry weight of nodules was recorded at 30 DAS sowing. Five plants selected randomly were uprooted, washed and nodules detached carefully. After counting the total number of nodules, there were dried to constant weight at 60°C for 48 hours and their weight was recorded. The periodical light intensity in each plot was measured in kilolux at 11 am, 1.30 pm and 4 pm and the percentage of shade was calculated as follows:

$$\text{Light intensity} = \frac{L1 - L2}{L1} \times 100$$

Where,

L1= Light intensity in the open condition.

L2 = Light intensity in the shaded condition.

All the plants from each field harvested and left for sun drying. After threshing, grain yield per field were recorded and converted to per hectare basis. Harvest index was calculated by using the following formula:

$$\text{Harvest index (\%)} = \frac{\text{Economic (Grain) yield (kg/ha)}}{\text{Biological (Grain+haulm) yield (kg/ha)}} \times 100$$

Path analysis at urdbean varieties bring out the cause and effect relationship among a system of variables and helps to measures the direct influence along each separate path in such a system. The varieties correlation coefficient of the above component characters with harvest index were partitioned into direct and indirect effects as per Deway and Lu (1959).

RESULTS AND DISCUSSION

Growth parameters

It is believed that having an ideal plant population is the key to having a higher yield. The largest plant population per unit area was produced by the 15 × 10 cm crop spacing (54) compared to the 15 × 15 cm crop spacing (36) and the 20 × 10 cm crop spacing (42). This occurred because of the plants' 20 cm × 10 cm crop spacing, which is too close for optimal crop accommodation in comparison to the wider 30 cm × 10 cm crop spacing. But there were little variations in plant populations across all kinds. The factors' interaction was found to be insignificant. While the germination of seeds was nearly identical for all kinds, types had no effect on the number of plants per unit area, demonstrating it as a physically regulated factor and not genetically controlled. The conditions needed for seed germination and subsequent plant growth and development were nearly identical across the field, giving all of the types an equal chance to take use of the soil and climatic resources. These findings concur with those made by Hussain *et al.* (2011).

The genetic makeup of plants and environmental conditions both significantly influence plant height. Table 1 provides information on plant height at maturity of three Urdbean varieties as influenced by various crop spacing. The findings show that crop spacing and different kinds greatly impacted plant height. The tallest plants were found in MDU 1, which had an average height of 36.7 cm. At harvest, the plants in VBN (Bg) 4 and VBN (Bg) 6 had average heights of 27.3 cm and 22.0 cm, respectively. The data in Table 1 also show that the plant height was significantly affected by different crop spacing and maximum plant height was observed at a plant spacing of 30 × 10 cm (30.2 cm) while the average plant height at maturity of 20 × 15 cm and 20 × 10 cm cm crop spacing were 29.3 cm and 28.2 cm, respectively. It was determined that there was no statistically significant interaction between crop spacing and variety. In contrast to dense populations, plants were able to grow to their greatest height because they were taking full advantage of the resources and sunlight that were available. The variety MDU 1's maximum plant height was observed; this variation may be a result of this variety's genetic makeup for this attribute. Maqsood *et al*. (1991) reported results that were almost identical.

Urdbean varieties differed significantly in nodul number as well as in nodule dry weight. The higher number and dry weight of nodule was recorded with VBN (Bg) 6 and therefore, with regards to the symbiotic efficiency, this variety had an edge over the others. The crop spacing did not significantly affect the number of nodules/plant (Table 1). Nodule dry weight was significantly influenced by crop spacing. The five crop spacing were at par but significantly superior in nodule dry weight to 20 × 10 cm crop spacing.

Although environmental factors can also affect the number of branches per plant and have a significant impact on increasing seed yield, branching is mostly a hereditary trait. Results from Table 1 show that crop spacing and variety

did not significantly alter the number of branches per plant. The VBN (Bg) 6 variety produced more branches per plant (5.2), whereas the VBN (Bg) 4 variety produced the fewest branches per plant (4.2). The plant produced more branches (5.2) in response to the crop spacing of 20 × 10 cm, although this effect was not statistically significant. At a row spacing of 15 × 10 cm, the lowest number of branches per plant (4.2) was generated. The fruit-bearing branches were also impacted by the inter-row spacing, which may have been caused by the changing availability of light, nutrients, *etc*. in the case of varying spacing. These results are in agreement with those of Khan (2000).

Yield parameters

The number of pods per plant significantly influences leguminous plant production performance. The quantity of pods per plant is finally taken into account when determining the urdbean plant's productivity. Table 2 reveals that the quantity of pods per plant varied significantly between cultivars. The VBN (Bg) 4 plant produced the most pods per plant (10.9). MDU 1 was the cultivar that produced the fewest pods per plant (8.9). The amount of pods per plant was not significantly affected by crop spacing. The quantity of pods per plant was not significantly changed by the interaction between cultivars and inter-row spacing.

Table 1: Plant growth characters of urdbean varieties as influenced by different spacing (Pooled data of 2016, 2017 and 2018).

Treatments	Number of plants/m^{-2}	Plant height at harvest (cm)	No. of nodules/plant	Nodules dry weight (mg/plant)	No. of branches/ plant at harvest	Dry matter production (g/plant) at harvest
Variety (V)						
VBN (Bg) 4	25	27.3	14.1	29.5	4.2	5.9
VBN (Bg) 6	27	22.0	14.6	30.7	5.2	5.1
MDU 1	23	36.7	13.7	27.1	4.9	6.2
S.Em±	0.82	0.92	1.01	2.30	0.37	0.48
CD (5%)	NS	1.88	2.09	4.71	NS	0.95
Spacing (S)						
15 × 10 cm	54	27.3	13.9	28.2	4.2	6.0
15 × 15 cm	36	28.1	15.4	33.2	4.8	6.4
20 × 10 cm	42	28.2	16.3	33.6	5.3	5.1
20 × 15 cm	24	29.3	15.0	31.3	4.5	5.4
30 × 10 cm	25	30.2	14.9	31.5	5.2	5.7
S.Em±	1.21	1.18	0.98	2.25	0.48	0.62
CD (5%)	2.44	2.38	NS	5.76	NS	1.26
Interaction (V × S)						
S.Em±	1.98	2.05	1.14	1.71	0.83	1.08
CD (5%)	NS	NS	NS	NS	NS	NS

Table 2: Yield characters, yield and harvest index of urdbean varieties as influenced by different spacing (Pooled data of 2016, 2017 and 2018).

Treatments	No. of pods/plant	1000 seed weight (g)	Seed weight (g/plant)	Seed yield (kg/ha)	Straw yield (kg/ha)	Harvest index (%)
Variety (V)						
VBN (Bg) 4	9.3	43.1	1.45	556	1244	32
VBN (Bg) 6	10.9	44.2	1.85	691	933	43
MDU 1	8.9	43.8	1.56	536	1502	27
S.Em±	0.74	0.20	0.09	36	46	1.38
CD (5%)	1.51	0.61	0.19	73	94	2.83
Spacing (S)						
15 × 10 cm	8.3	42.5	1.44	624	1951	31
15 × 15 cm	9.2	43.2	1.53	555	1206	32
20 × 10 cm	10.8	43.4	1.80	683	1358	37
20 × 15 cm	8.1	43.2	1.65	455	793	34
30 × 10 cm	8.8	43.5	1.68	423	821	35
S.Em±	9.2	0.17	1.71	520	991	35
CD (5%)	0.95	0.51	0.12	46.2	59.1	1.8
Interaction (V × S)	NS	NS	NS	94.6	121.0	3.7
S.Em±	1.65	0.37	0.21	79.95	102.30	3.09
CD (5%)	NS	1.26	NS	162.1	209.60	NS

One crucial element that directly contributes to maximising potential yield recovery in leguminous crops is seed weight per plant. According to data on seed weight per plant provided in Table 2, different varieties had a substantial impact on seed weight per plant, while crop spacing as well as combinations of varieties and crop spacing had a non-significant impact. Variety VBN (Bg) 6 produced the most seeds per plant (1.82), whereas variety VBN (Bg) 4 produced the fewest (1.45 seeds per pod).

The final result of many physiological, biochemical, phenological and morphological activities occurring in the plant system is dry matter production and its transformation into economic yield. A variety's ability to produce seeds depends on how its genetic makeup interacts with the environment in which the plant grows. Results on seed yield (Table 2) showed that crop spacing, variety and combinations of these had a substantial impact on urdbean seed yield. Variety VBN (Bg) 6 produced the most seed yield (691 kg ha^{-1}) and produced the most pods per plant (17.33) and statistically, it was statistically equal to Variety VBN (Bg)-4, which produced an average of 17.09 pods per plant. The variety MDU 1 produced the least seed yield (536 kg ha^{-1}), statistically on par with VBN (Bg) 4, which produced 556 kg ha^{-1}. It might be brought on by genetic variations between the types. These results are remarkably consistent with those of Abbas (2000), who noted considerable variations in the output of various cultivars. Maximum seed yield (683 kg ha^{-1}) was achieved from a crop sown at a crop spacing of 20 × 10 cm, whilst the lowest seed yield (423 kg ha^{-1}) was obtained at an inter-row spacing of 30 × 10 cm. These outcomes are consistent with what Ali *et al*. (2010) found. It was discovered that there was a considerable interactive influence between crop spacing and variety. Highest seed yield was obtained when variety VBN (Bg) 6 was sown at a spacing of 20 × 10 cm. whereas the lowest seed yield recorded when sown variety MDU 1 at 30 × 10 cm. The main element affecting the yield was the number of plants per unit area. It also showed that the higher number of plants made up for the lower yields per plant in high density situations. The increased plant population and rise in the proportion of pods that generated more seed may be the cause of the higher grain production at closer spacing. Bhairappavar *et al*. (2005) reported similar outcomes as well. Similar findings by Davi *et al*. (1995) revealed that intra-row spacing reduction increased grain yield. Maintaining correct inter- and intra-row spacing is essential to maintaining an ideal plant population. Therefore proper plant spacing along with a sufficient plant population may boost urdbean crop output. Several researchers in the fields of soybean (Sekhan *et al*., 2002) and black gramme (Kumar and Sharma, 1989) have observed increases in seed production as population density has grown (Graterol and Montilla, 2003).

Harvest index (%) and path analysis

The physiological productive potential of a crop variety is gauged by the harvest index. It is a crop plant's capacity to transform dry materials into a profit. It measures the ratio of biological yield to seed yield, therefore cultivars with higher biological yield and lower seed yield than others would have higher harvest index values. The production efficiency will increase when the harvest index value increases or vice versa. The calculated values of harvest index presented in Table 2 indicate that varieties differed significantly on account of conversion efficiency of assimilates. The maximum value of harvest index (43%) was obtained with the variety VBN (Bg) 4. The minimum harvest index value (27%) was obtained from variety MDU 1. These findings are in agreement with by Taleei *et al.* (1999) who also reported significant differences in harvest index among different varieties. Crop sown at crop spacing of 20 × 10 cm gave maximum highest harvest index (37%) while lowest harvest index (31) was obtained at crop spacing of 15 × 10 cm.

The maximum positive variety correlation was found between the harvest index and leaf area index at 100% flowering, however the direct effect of leaf area index at 100% flowering was minimal and negative (-0.172). The indirect effect of the leaf are index at 100% flowering through the leaf are index at 50% flowering accounts for 80% of this connection. Pod clusters per plant indirectly influenced these features by 19%. The correlation has decreased by 17% as a result of the negative direct effect (Table 3). The contribution of pod length and grains per pod was quite minimal, compared to the 10% indirect influence of pods per plant.

Pod length and harvest index had a 74.2 per cent correlation. Indirect contributions from grains per pod and leaf area index at 50% flowering was 47.2% and 16.3%, respectively, while the direct contribution of pod length to the harvest index was 37.1%. The indirect impact of other factors was minimal. The harvest index and grains per pod variety association was 52.6% and its direct impact was

Table 3: Direct (diagonal) and indirect effects of different correlated characters towards seed yield per plant.

Parameters	Clusters of pod/ plant	Pods/ plant	Pod length	Grains/ pod	Leaf area index at 50% flowering	Leaf area index at 100% flowering	Total correlation
Clusters of pod/plant	-0.193	0.167	0.078	0.029	0.521	0.201	0.824
Pods/plant	-0.241	0.131-	0.005	0.110	0.841	-0.135	0.701
Pod length	-0.058	-0.002	0.256	0.121	0.345	0.028	0.727
Grains/pod	-0.049	0.147	0.351	0.099	0.048	-0.068	0.532
Leaf area index at 50% flowering	-0.134	0.155	0.134	0.0006	0.712	-0.210	0.654
Leaf area index at 100% flowering	0.206	0.101	-0.038	0.032	0.861	-0.172	1.071

moderately positive (19.1 per cent). According to the path analysis, the primary factors impacting the harvest index in urdbean varieties, both directly and indirectly, are the leaf area index at 50% flowering.

CONCLUSION

The results of the current experiments indicate that variety VBN (Bg) 6 outperformed the other varieties in terms of performance and crop spacing of 20 × 10 cm produced noticeably better results in terms of seed yield and harvest index. In order to increase urdbean output, it is therefore advised that urdbean variety VBN (Bg) 6 be cultivated preferable in crop spacing of 20 × 10 cm under rainfed condition of Tamil Nadu.

ACKNOWLEDGEMENT

The author thankfully acknowledge the Agricultural Research Station, Tamil Nadu Agricultural University, Virinjipuram, Tamil Nadu for providing all the necessary and required facilities to conduct the research.

Conflict of interest

The authors have no conflicts of interest to declare. All co-authors have seen and agree with the contents of the manuscript and there is no financial interest to report. We certify that the submission is original work and is not under review at any other publication.

REFERENCES

Abbas, S. (2000). Effect of various levels of phosphorus on growth and yield of two mungbean cultivars. M.Sc. Thesis. Deptt. Agron. Univ. Agri. Faisalabad.

Ali, M.A., Abbas, G., Mohy-ud-Din, Q., Ullah, K., Abbas G. and Aslam M. (2010). Response of Mungbean (*Vigna radiata*) to phosphatic fertilizer under arid climate. Journal of Animal and Plant Sciences. 20(2): 83-86.

Arshad, M., Bakhsh, A. and Ghafoor, A. (2004). Path coefficient analysis in chickpea (*Cicer arietinum* L.) under rainfed conditions. Pakistan Journal of Botany. 36: 75-81.

Bhairappanavar, S.T., Jaydeva, H.M., Gowda, T.H. and Shivanna, S. (2005). Effect of nutrients and spacing on the yield of Urdbean under late sown condition. Legume Research. 28(1): 48-50.

Crop Production Guide (CPG)-Agriculture, (2020). Tamil Nadu Agricultural University, Coimbatore.

Davi, D., Kumar R. and Khippal, A. (1995). Effect of different intra-row spacing on the growth of pigeon pea and urdbean intercropping. Discovery and Innovation. 9(1-2): 47-51.

Dewey, D.I. and Lu, K.H. (1959). A correlation and path-coefficient analysis of components of crested wheatgrass seed production. Agronomy Journal. 51: 515-518.

Garaterol, Y. and Montilla, D. (2003). Effects of row spacing and plant population on performance of two indeterminate soybean cultivars. Bioagro. 15(3): 193-199.

Hussain, F., Malik, A.U., Haji, M.A. and Malghani, A.L. (2011). Growth and yield response of two cultivars of mungbean (*Vigna radiata* L.) to different potassium levels. Journal of Animal and Plant Sciences. 21(3): 622-625.

Khan, A. (2000). Studies on determining comparative yield potential of mungbean cultivars. M.Sc.Thesis. Deptt. Agron. Univ. Agri., Faisalabad.

Kumar, A. and Sharma, B.B. (1989). Effect of spacing and seed rate on root growth, nodulation and yield of urdbean (*Phaseolus mungo*). Indian Journal of Agricultural Sciences. 59(11): 728-729.

Malik, M.F.A., Ashraf, M., Qureshi, A.S. and Ghafoor, A. (2007). Assessment of genetic variability, correlation and path analyses for yield and its components in soybean. Pakistan Journal of Botany. 39: 405-413.

Maqsood, M., Zamir, S.I., Akbarb, N. and Zaidi M.M. (1991). Comparative study on phonology, growth and yield of different mungbean (*Vigna radiate* L.) varieties. International Journal of Agriculture and Biology. 1: 116-117.

Sekhon, H.S., Singh, G. and Brar, J.S. (2002). Effect of population density and planting geometry on the growth and yield of mungbean [*Vigna radiata* (L.) Wilczek] genotypes. Environment and Ecology. 20(4): 897-901.

Siddique, M., Malik, M.F.A. and Awan, S.I. (2006). Genetic divergence, association and performance evaluation of different genotypes of mungbean (*Vigna radiata*). International Journal of Agriculture and Biology. 8: 793-795.

Taleei, A.R., Bandeh, N.K. and Gholamie, B. (1999). Effect of sowing date on grain yield, yield components and percentage of protein in green gram cultivars. Iranian Journal of Agriculture Science. 29(4): 7510758.

Vahedi, B., Gholipouri, A. and Sedghi, M. (2010). Effect of planting pattern on radiation use efficiency, yield and yield components of sunflower. Recent Research in Science and Technology. 2: 38-41.