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Effect of Different Phosphorus Levels and Varieties on Growth Attributes of Mungbean under Custard Apple-based Agri-Horti System

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ABSTRACT

Field experiment was carried out to evaluate the effect of different phosphorus levels on growth attributes of mungbean in custard apple based agri-horti system. In this experiment mungbean imposed in factorial randomized block design having three different levels of phosphorus (34, 46 and 58 kg P2O5/ha) and three varieties (HUM-12 Kavita and Samrat). The treatments were replicated thrice. The result showed that higher plant height, plant spread, maximum number of leaf and branches per plant, maximum dry weight were recorded with the application of 58 kg/ha phosphorous. Amongst the varieties HUM-12 recorded highest stem, leaf root and total dry matter/ plant. Result of the experiment revealed that the highest grain yield (919 kg/ ha) was obtained with 58 kg P2O5/ha and amongst the three tested varieties of mungbean at par differences found in custard apple based agri-horti system.

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INTRODUCTION

Agri-horti system is an improved indigenous cropping system in India for full utilization of the growing season and markedly increasing the return per unit area per unit time. In this system we can increase the total output from land by growing mainly short duration crops within the alleys of such as fruit crops (Kumar et al., 2015; Pal et al., 2014). Tree based cropping system have proved to be very successful in areas receiving less than 1000 mm rain fall with nine months of dry season (Singh, 1987).

Agri-horti system is one of the important components of agroforestry in which the integration of fruit crops in croplands is practiced. Aonla, ber, citrus, custard apple, guava etc. are major promising fruit crop suitable for agri-horti system. Fruit crops are first preference of farmers under agroforestry system due to short gestation period, regular income, risk cover and aesthetic value. Agri-horti system is an improved indigenous cropping system in India for full utilization of the growing season and markedly increasing the return per unit area per unit time.

Mungbean is a native to India and Southeast Asia and is still grown on a large acreage there. It often called green gram or golden gram (Mondal and Sengupta, 2019). It is becoming an important crop, as it is the best alternatives to meet the food needs of the large population of developing countries due to its, nutritional superiority and nitrogen fixing character. Mungbean (Vigna radiata L.) is a major caloric (347-Kcal food energy) and protein (22-24%) in Asia, especially for the vegetarian population (Raza et al., 2012). On an average, it fixes atmospheric nitrogen @ 300 kg/ ha annually (Sharar et al., 2001). Indian pulse production has been stuck in between 14 and 15 mt since mid-nineties, resulting in poor consumption (33 g/capita/day) during 2010 (Ali and Gupta, 2012). Mungbean can play the major role in national economy of India due to their wider adaptability, easy digestibility, better palatability and higher market price (Patil et al., 2003). Potential yield of mungbean can be achieved through optimum use of inputs and agronomic practices. Among the pulse crops, mungbean has special importance in intensive crop production of the country for its short growing period.

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Proper fertilization is essential to improve the productivity of mungbean. It can meet its nitrogen requirements by symbiotic fixation of atmospheric nitrogen. The nutrients which need attention are phosphorus (Nandal et al., 1987). Mungbean being a leguminous crop, requires adequate amount of phosphorus as well as apart from other nutrients it is directly involved in growth and development of plant.

Phosphorus is the second most critical plant nutrient but for pulse it assumes primary importance owing to its important role in root proliferation and overall plant growth (Thakur and Negi,1985). Phosphorus is the backbone of balanced fertilization in Indian agriculture. Phosphorus deficiency in soils is widespread and its use efficiency hardly exceeds 20 per cent. Out of 135 districts under pulses, soils in 68 districts are low and 62 districts are medium in available P status (Shweta and Malik, 2014). The application of phosphorus to pulse crop is one of the most important strategies to increase the productivity of pulses in India.

Among many other crop production techniques, appropriate varieties are the most important, which contribute substantially to the growth and yield of mungbean (Khan et al., 2001). Previous 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., chickpea (Arshad et al., 2004), Mungbean (Siddique et al., 2006), soybean (Malik et al., 2007) and sunflower (Vahedi et al., 2010). The whole scenario clearly reflects that due emphasis must be given to these parameters so that the threats to the management practices which reduce yield per unit area can be encountered. Therefore, the present study was initiated to find out the suitable variety of mungbean (Vigna radiata L.) under agro-climatic conditions of Vindhyan regions.

MATERIALS AND METHODS

The experiment was carried out at the Agronomy Farm of Rajiv Gandhi South Campus, Barkachha (BHU), Mirzapur which is situated in Vindhyan region of district Mirzapur (25º 10' latitude, 82º 37' longitude) occupying over an area of more than 1000 ha where variety of crops like agricultural, horticultural, medicinal and aromatic plants are grown. Vindhyan soil comes under rainfed and invariably poor fertility status. This region comes under agro-climatic zone III A (semi-arid eastern plain zone). The climate of Barkachha is typically semi-arid, characterized by extremes of temperature both in summer and winter with low rainfall and moderate humidity. Maximum temperature in summer is as high as 39.8 ºC and minimum temperature in winter falls below 9ºC. The annual rainfall of locality was 209 mm, of which nearly 90 per cent is contributed by South West monsoon between July to September. The total rainfall during the crop duration was 104.2 mm; maximum and minimum temperature fluctuated between 32.9 ºC and 21.3 º C, and relative humidity between 86.5 and 55.9 per cent. The soil of the experimental field was sandy loam in texture with low drainage. It was acidic in reaction, poor in nitrogen as well as phosphorus and potash. The experiment was conducted in Factorial Randomized Block Design two factors having three levels which were replicated thrice. These treatments were different doses of phosphorus viz. 34, 46 and 58 kg/ha. These treatments were different doses of phosphorus viz. 34, 46 and 58 kg/ha. The fertilizer application was done with fixed doses of nitrogen @ 20 kg/ha and phosphorus at 40 kg/ha. Phosphorus application was done according to the treatments. All the nutrients were applied as basal and the sources of N, P and K were Urea, DAP and MOP respectively. Varieties under study was HUM-12, Kavita and Samrat. The seeds were sown manually in the furrow opened by kudal at a row distance of 30 cm as per treatment. Seed rate 20 kg/ha was used for proper maintenance of plant population. A plant spacing of 10 cm within the row was maintained by thinning done about 10 days after sowing. First weeding was done manually by khurpi at 20 days and second weeding 30 days after sowing to control weeds. To protect the crop, mainly from leaf caterpillar, Kranti (Carpet hydrochloride 50% SP) @ 250 ml/ha was sprayed at 25 days after sowing. The biometric observations on growth attributes were recorded at an interval of 15 days i.e. 15th, 30th, 45th days after sowing and at maturity. Growth attributes i.e, plant height, number of trifoliate leaf per plant, number of branch per plant, number of root nodule per plant and dry matter accumulation per plant were measured.

RESULTS AND DISCUSSION

Effect of Phosphorus

Phosphorus levels affected the plant height significantly at 15 DAS and at maturity. Highest plant height was obtained with the application of 58 kg P2O5/ ha which was at par with 46 kg P2O5/ ha but significantly higher with 34 kg P2O5/ ha at both the stages. Plant spread was significantly affected with phosphorus levels only at 15 DAS where 58 kg P2O5/ ha was significantly maximum with 34 kg P2O5/ ha (Table 1). This was due to the fact that plant height is a genetically controlled factor so the height of different varieties does not remain equal. As for the effect of environmental factors on plant height is concerned it could not be neglected but the selection of proper cultivar manages the influence of environment. These results are in corroborated with the findings of Ali (1994) who also reported difference of plant height in different maize cultivars. Mir et al. (2013) reported that among different phosphorus levels, phosphorus @ 60 kg/ recorded comparatively higher plant height. Different levels of phosphorus doses affected the number of leaf/ plant significantly at maturity where 58 kg P2O5/ ha was significantly more with 34 kg P2O5/ ha. Number of branch/ plant was significantly affected by phosphorus levels at 45 DAS and at maturity where application of 58 kg P2O5/ ha was distinctly superior to loser rates of application (Table 2). Mir et al., (2013) reported that among different phosphorus levels, phosphorus @ 60 kg/ recorded comparatively higher number of leaf/ plant and number of branch/ plant.

Table 1: Plant height and plant spread (cm) at various stages of crop growth as influence by phosphorus level and varieties of mungbean under custard apple based agri-horti system.

Treatments	Number of leaf/ plant				Number of branch/ plant			
	15 DAS	30 DAS	45 DAS	Maturity	15 DAS	30 DAS	45 DAS	Maturity
Phosphorus (kg/ha)								
34	1.8	4.6	6.3	3.4	-	1.4	2.1	2.2
46	1.9	5.2	6.6	4.1	-	1.7	2.5	2.7
58	2.0	5.4	7.3	4.7	-	1.9	3.3	3.7
S.Em. +	0.08	0.5	0.5	0.4	-	0.18	0.25	0.27
CD at 5%	NS	NS	NS	1.2	-	0.54	0.74	0.81
Variety								
Samrat	2.0	5.1	6.9	4.1	-	2.2	3.1	3.4
Kavita	1.9	4.6	6.2	3.5	-	1.2	1.9	2.0
HUM-12	1.9	5.5	7.2	4.6	-	1.6	2.8	3.2
S.Em. +	0.08	0.5	0.5	0.4	-	0.18	0.25	0.27
CD at 5%	NS	NS	NS	NS	-	0.54	0.74	0.81

Dry matter accumulation in stem recorded significantly highest value with 58 kg P2O5/ ha than 34 kg P2O5/ ha at all the stages except at 15 DAS. Leaf dry matter was found significantly highest in 58 kg P2O5/ ha than 34 kg P2O5/ ha at all the stages of crop growth (Table 3). Significant difference observed between the highest and lowest dose of phosphorus at all the stages except at 30 DAS where they were found at par for root dry matter while for pod dry matter phosphorus dose of 34 kg were at par with 46 kg P2O5/ ha but at the maturity all the phosphorus levels were significantly different amongst themselves (Table 4). Total dry matter was significantly highest with the application of 58 kg P2O5/ ha followed by 46 and 34 kg P2O5/ ha at all the stages except 30 DAS where it was being at par with 46 kg P2O5/ ha produced significant difference with the lowest dose. Significant differences recorded amongst different doses of phosphorus where 58 kg P2O5/ ha found highest followed by 46 and 34 kg P2O5/ ha (Table 5). Plant dry weight of blackgram was influenced by the application of both phosphorus. Mir et al. (2013) reported that among different phosphorus levels, phosphorus @ 60 kg/ha recorded comparatively higher growth.

Growth characters viz., plant height, plant spread, number of leaf/ plant, number of branch/ plant and dry matter improved markedly with phosphorus application particularly at later stage of observation. Phosphorus is a structural component of cell constituents and metabolically active compounds plays an important role in plant metabolism. Being constituents of sugar phosphates ADP and ATP it is involved in energy transpiration. Phosphorus is also involved in basic reaction of photosynthesis. Moreover, as constituent of chromosomes it stimulates cell division and is necessary for meristematic growth. This suggests the role of phosphorus in rapid growth and developments of plants.

Table 2: Number of leaf/ plant and number of branch/ plant at various stages of crop growth as influence by phosphorus level and varieties of mungbean under custard apple based agri-horti system.

Treatments	Stem dry matter (g/plant)				Leaf dry matter (g/plant)			
	15 DAS	30 DAS	45 DAS	Maturity	15 DAS	30 DAS	45 DAS	Maturity
Phosphorus (kg/ha)								
34	0.26	2.77	5.06	6.73	0.31	6.56	9.04	6.99
46	0.28	2.81	6.12	8.0	0.36	7.96	11.11	7.47
58	0.33	3.28	7.84	9.57	0.55	8.60	13.56	9.45
S.Em. +	0.03	0.15	0.55	0.69	0.04	0.68	0.92	0.49
CD at 5%	NS	0.47	1.66	2.06	0.12	2.04	2.75	1.46
Variety								
Samrat	0.28	2.31	6.54	7.99	0.28	7.11	12.31	6.88
Kavita	0.29	3.24	5.57	8.3	0.49	8.0	9.58	7.65
HUM-12	0.30	3.31	6.91	8.01	0.45	8.0	11.82	9.37
S.Em. +	0.03	0.15	0.55	0.69	0.04	0.68	0.92	0.49
CD at 5%	NS	0.47	NS	NS	0.12	NS	NS	1.46

Increasing levels of phosphorus application up to 58 kg P2O5/ ha markedly improved functional leaf/ plant particularly at later stages. Watson (1952) reported that higher leaf count may be due to production of leaf from maximum growing points. Leaf expansion is revealed to the extension of epidermal cells and this process might be particularly impaired in phosphorus deficient plants for various reasons viz. low phosphorus content of epidermal cells (Treeby et al., 1987) and decrease in root hydraulic conductivity (Radin, 1990). According to Lauer et al. (1989) photosynthetic efficiency per unit chlorophyll is much higher in phosphorus sufficient plants. This might have helped the greater production of photosynthates at higher rates of phosphorus application and consequently the better growth and dry matter accumulations.

The better growth parameters at higher rates of phosphorus application helped in realizing improved grain yield/ha. Better plant growth measured in terms of higher plant height, plant spread, number of trifoliate leaf and dry matter accumulation in different plant parts and whole Table 1 to 5) might have led the plants to produce higher grain yield under 58 kg P2O5/ ha. Similar findings reported by Athokpam et al. (2009). The higher grain yield with the application of highest dose compared to lower doses indicated that the vegetative growth had positive association with grain yield. Similar results were also reported by Bhat et al. (2005).

Table 3: Dry matter accumulation (g/plant) in stem and leaf at various stages of crop growth as influence by phosphorus level and varieties of mungbean under custard apple based agri-horti system.

Treatments	Stem dry matter (g/plant)				Leaf dry matter (g/plant)			
	15 DAS	30 DAS	45 DAS	Maturity	15 DAS	30 DAS	45 DAS	Maturity
Phosphorus (kg/ha)								
34	0.26	2.77	5.06	6.73	0.31	6.56	9.04	6.99
46	0.28	2.81	6.12	8.0	0.36	7.96	11.11	7.47
58	0.33	3.28	7.84	9.57	0.55	8.60	13.56	9.45
S.Em. +	0.03	0.15	0.55	0.69	0.04	0.68	0.92	0.49
CD at 5%	NS	0.47	1.66	2.06	0.12	2.04	2.75	1.46

Treatments	Stem dry matter (g/plant)	Leaf dry matter (g/plant)						
	15 DAS	30 DAS	45 DAS	Maturity	15 DAS	30 DAS	45 DAS	Maturity
Variety								
Samrat	0.28	2.31	6.54	7.99	0.28	7.11	12.31	6.88
Kavita	0.29	3.24	5.57	8.3	0.49	8.0	9.58	7.65
HUM-12	0.30	3.31	6.91	8.01	0.45	8.0	11.82	9.37
S.Em. +	0.03	0.15	0.55	0.69	0.04	0.68	0.92	0.49
CD at 5%	NS	0.47	NS	NS	0.12	NS	NS	1.46

Effect of Varieties

The yield of a crop is the result of the successful completion of the growth and development activities in individual plant, which in turn, would depend upon genetic potential of the variety and the environmental condition. Real potential of the variety could be exploited to its maximum with several agronomic manipulations which alters the micro environment of the crop. Therefore, to realize the maximum potential under a set of agro-climatic conditions, it is essential that various factors of plant environment should be maintained at optimum level.

On par differences were observed for plant height and plant spread amongst all the varieties at all the crop growth stages (Table 1). For number of branch/ plant Samrat though remained at par with HUM-12 both produced significantly more than Kavita at 45 DAS and at maturity (Table 2). Stem dry matter due to varieties found non-significant at all the stages except 30 DAS where HUM-12 being at par with Kavita recorded significantly highest than Samrat.

Dry matter accumulation in leaf found significant at 15 DAS and maturity only. At maturity HUM-12 got significantly highest leaf dry matter than remaining varieties (Table 3). Dry matter in root was found significantly different at 45 DAS only, where Samrat and Kavita were found at par with each other produced significantly lower dry matter than HUM-12. Differences due to varieties were found non-significant for pod dry matter at 45 DAS and maturity (Table 4).

Table 4: Dry matter accumulation (g/plant) in root and pod at various stages of crop growth as influence by phosphorus level and varieties of mungbean under custard apple based agri-horti system.

Treatments	Root dry matter (g /plant)	Pod dry matter (g /plant)						
	15 DAS	30 DAS	45 DAS	Maturity	15 DAS	30 DAS	45 DAS	Maturity
Phosphorus (kg/ha)								
34	0.10	0.52	1.19	1.49	-	-	2.16	4.7
46	0.11	0.57	1.39	1.64	-	-	2.79	6.0
58	0.14	0.64	1.71	1.90	-	-	4.68	7.36
S.Em. +	0.01	0.05	0.15	0.14	-	-	0.40	0.42
CD at 5%	0.04	NS	0.46	0.41	-	-	1.20	1.27
Variety								
Samrat	0.1	0.53	1.50	1.58	-	-	3.49	6.34
Kavita	0.13	0.55	1.06	1.63	-	-	2.64	5.56
HUM-12	0.12	0.65	1.73	1.82	-	-	3.50	6.16
S.Em. +	0.01	0.05	0.15	0.14	-	-	0.40	0.42
CD at 5%	NS	NS	0.46	NS	-	-	NS	NS

Kavita being at par with HUM-12 produced significantly highest total dry matter than Samrat at 15 and 30 DAS while it was significantly lowest with remaining varieties at 45 DAS. At maturity HUM-12 produced significantly highest total dry matter than both the varieties. The total dry matter production in variety indicates the potential for yield, but its mobilization towards the grain yield is an important factor for economic yield. It is the function of crop growth rate in total growth period and is related with grain yield. The capacity of a plant to produce dry matter depends upon size and duration of the photosynthetic apparatus, i.e. leaf but it also depends upon the genetic potential of the varieties have more capability to translocate the assimilates towards economic yield due to differential response of the different varieties. This might be attributed to genetic variation among different mung bean cultivar. Non-significant differences recorded due to varieties for grain yield (Table 5).

Table 5: Total dry matter accumulation (g/plant) at various stages of crop growth and grain yield (kg/ha) as influence by phosphorus level and varieties of mungbean under custard apple based agri-horti system.

Treatments	Total dry matter accumulation (g/plant)	Grain yield (kg/ha)			
	15 DAS	30 DAS	45 DAS	Maturity	
Phosphorus (kg/ha)					
34	0.63	9.12	17.74	20.19	448
46	0.76	11.43	21.28	23.05	683
58	1.07	12.54	27.82	28.16	919
S.Em. +	0.04	0.50	1.28	0.83	37
CD at 5%	0.13	1.50	3.84	2.51	113
Variety					
Samrat	0.72	10.05	24.03	22.67	665
Kavita	0.93	11.77	18.86	23.07	656
HUM-12	0.81	11.27	23.95	25.66	729
S.Em. +	0.04	0.50	1.28	0.83	37
CD at 5%	0.13	1.50	3.84	2.51	NS

CONCLUSION

The result showed that higher plant height, plant spread, maximum number of leaf and branches per plant and maximum dry weight were recorded with the application of 58 kg/ha phosphorous. Amongst the varieties HUM-12 recorded highest stem, leaf root and total dry matter/ plant. Result of the experiment revealed that the highest grain yield (919 kg/ ha) was obtained with 58 kg P2O5/ha and any variety of mungbean under the experimentation could be selected in custard apple based agri-horti system.

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