Journal of AgriSearch 2(2): 88-93
Peer Reviewed Quarterly
ISSN : 2348-8808 (Print), 2348-8867 (Online)

Effect of Different Phosphorus Levels on Nutrient Content, Uptake and Economics of Urd bean under Custard Apple based Agri-Horti System

PRAVESH KUMAR*, SAURABH K PANDEY AND PRANAV KUMAR

Agricultural Research Farm of Rajiv Gandhi South Campus, (BHU) Barkachha, Mirzapur (UP), India

ARTICLE INFO

Received on : 18.01.2015
Accepted on : 08.05.2015
Published online : 01.06.2015

ABSTRACT

An experiment was carried out in kharif season of 2009 to investigate the effect of phosphorus on nutrient content, nutrient uptake and economics of urdbean under custard apple based agri-horti system. The treatments tested were six levels of phosphorus (0, 15, 30, 45, 60 and 75 kg P2O5/ha) in a randomized block design. Total nutrient uptake/ha was significantly highest with phosphorus application up to 75 kg/ha while cost of cultivation, gross return, net return and B:C ratio were also found maximum with same level of phosphorus application.

Keywords: Agri-horti system, custard apple, economics, nutrient content, phosphorus, urdbean

INTRODUCTION

Agri-horti system is the commonly preferred horticulture based agro forestry system in the *Vindhyan* region (Pal *et al.*, 2014). The fruit tree species grown in association with crops in this region are *aonla, ber*, citrus, custard apple, guava, *bael* etc. Agricultural crops like barley, mustard, linseed etc., during *rabi* season and pearl millet, maize, urd, mung, sesamum etc., are grown in first few years during *kharif* season (Singh *et al.*, 2013a). In intercropping, agricultural crops are normally grown between rows of fruit trees planted at a spacing of 5 to 7 meters apart. The agricultural crops provide seasonal revenue, while fruit trees are giving regular returns through production of fruits. Urdbean is a short duration crop and hence easily soluble fertilizer like phosphorus should be applied in the field (Pal *et al.*, 2014). The phosphorus requirements vary depending upon the nutrient content of the soil (Bose and Som, 1986). Phosphorus shortage restricts the plant growth and remains immature. Common diagnostic properties of phosphorus deficiency are a darker green leaf colour due to higher chlorophyll contents (often with red pigments from anthocyanins), reduced leaf extension and a higher root-to-shoot ratio, since root growth is much less affected by phosphorus deficiency than shoot growth (Wild, 1988; Marschner, 1995). A high phosphorus supply is needed for nodulation of legumes and hence phosphorus deficiency can also seriously reduce biological nitrogen fixation (Marschner, 1995).

Phosphorus availability is a limiting factor for plant production in many agricultural soils (Fairhurst *et al.*, 1999). In regions of the world without a history of use of phosphorus fertilizers, phosphorus deficiency is very common (Wild, 1988). A large portion of applied fertilizer phosphorus may be fixed to iron and aluminium oxides and is then not available for plant uptake (Pal *et al.*, 2014). These facts make sound phosphorus management imperative, especially in situations where funds for fertilizer purchases are limited, as in tropical smallholder agriculture. Agro forestry techniques can help to overcome some of these constraints (Buresh, 1999). However, because of generally low phosphorus concentrations in mulch materials, low atmospheric inputs and low release by mineral weathering, adequate applications of phosphorus fertilizers are necessary in permanent agriculture to ensure economic and ecological sustainability (Buresh *et al.*, 1997 and Newman, 1997). Hence, the present study was undertaken to find out the optimum level of phosphorus and economics of urdbean under custard apple based agri-horti system.

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

*E-mail: praveshkumar.agron@gmail.com

district Mirzapur (25° 10′ latitude, 82° 37′ longitude and altitude of 147 m above mean sea level) 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 42.1°C and minimum temperature in winter falls below 9.3ºC. The annual rainfall of locality was 1073.2 mm in 2009, of which nearly 88% is contributed by South West monsoon between July to September. The total rainfall during the crop duration was 288.5 mm; maximum and minimum temperature fluctuated between 34.6 and 14.6°C, and relative humidity between 81.9 and 61.5%. The experimental field had sand silt and clay 44.63, 30.10 and 25.13% and available N, P, K 137.2, 14.5 and 185.7 kg/ha respectively while pH was 6.5. The experiment was conducted in Randomized Block Design with six treatments which were replicated thrice. These treatments were different doses of phosphorus, that is 0 kg/ha (T1), 15 kg/ha (T2), 30 kg/ha (T3), 45 kg/ha (T4), 60 kg/ha (T5), and 75 kg/ha (T6). The fertilizer application was done with fixed doses of nitrogen at 22.6 kg/ha and potassium at 30 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. The custard apple variety "Mammoth" was planted at 5 m × 5 m distance. Black gram variety "PU-7" was sown as an intercrop. The seeds were sown manually in the furrow opened by *kudal* (Spade) at a row distance of 30 cm and plants were sown at a distance of 10 cm apart. Seed rate @ 20 kg/ha was used for proper maintenance of plant population. Recommended intercultural operations were applied.

The plant and grain samples at harvest were used for chemical analysis. The plant and grain were dried in an oven and grinded thoroughly in a grinding mixture. These were preserved in sealed and leveled container for chemical analysis. The plant samples from grain and stover yield were collected treatment wise at the time of harvest and chemically analyzed. Nitrogen was estimated by modified Kjeldahl method (Jackson, 1973). The phosphorus content in the digested plant samples was determined by vanadomolybdo-phosphoric acid yellow colour method using spectrophotometer at 660 nm wave length and the potassium content in the digested samples was determined by flame photometer after making proper dilutions (Jackson, 1973). The percentage nitrogen, phosphorus and potassium were multiplied with grain and stover yield in kg/ha to obtain respective nutrient uptake in kg/ha. Total nutrient uptake was calculated by summing up of all these nutrients in kg/ha.

The cost of cultivation was worked out by taking into consideration all the expenses incurred. The cost of fertilizers, plant protection chemicals and seed etc. were taken as per prevailing market prices. Gross income was worked out by multiplying grain and straw yields of the crop also with their prevailing market prices. Net return (Rs/ ha) and benefit: Cost ratio was calculated with the help of the following equations (Eq.1 & 2):

Net return (Rs/ ha) =

Gross return (Rs/ha) – Cost of cultivation (Rs/ha) [Eq.1]

$$\text{Benefit cost Ratio} = \frac{\text{Net Return (Rs)}}{\text{Cost of Cultivation (Rs)}} \quad \text{[Eq.2]}$$

RESULTS AND DISCUSSION

Growth and development of urdbean

Results summarized in Table 1 on growth and development revealed that growth parameters taken at different intervals showed increasing trends with progression towards maturity. Increasing trends were also observed due to increased doses of phosphorus. Highest growth recorded with 75 kg phosphorus/ ha though the differences were at par with 60 kg phosphorus ha-1 but significantly higher than remaining phosphorus levels in respect to plant height and total dry matter accumulation plant-1 except number of trifoliate leaf /plant where the differences were at par up to the level of 45 kg /haat maturity (Table 1).

Nitrogen content and uptake

Results showed that higher nitrogen content was found in grain as compared to stover at all the levels of phosphorus application (Table 2). Significantly highest nitrogen content was recorded in grain with 75 kg/ha phosphorus though the differences were not significant with 60 kg of phosphorus application while the rest of the levels were found significantly different with each other. In stover 75 kg/ha phosphorus being at par with 60, 45 and 30 kg/ha phosphorus estimated significantly higher nitrogen content than rest of the doses. Lowest nitrogen content was recorded in both grain and stover when no phosphorus was applied though the differences were not significant up to 45 kg of phosphorus application in case

Table 1: Effect of different phosphorus levels on growth parameters of urdbean at different DAS in custard apple based agri-horti system.

Phosphorus (kg/ha)	Plant height (cm)				Number of trifoliate leaf/ plant				Total dry matter accumulation (g/plant)			
	15 DAS	30 DAS	45 DAS	Maturity	15 DAS	30 DAS	45 DAS	Maturity	15 DAS	30 DAS	45 DAS	Maturity
0	14.33	22.83	34.00	35.33	2.00	5.00	7.33	8.67	1.77	6.17	16.83	32.70
15	16.67	26.00	36.33	36.33	2.33	5.33	8.67	9.33	1.90	7.63	18.67	36.83
30	17.17	26.33	36.67	39.00	2.67	6.00	9.00	10.00	1.97	9.77	19.83	40.17
45	18.33	29.00	42.33	43.67	3.33	7.33	10.67	11.33	1.90	10.77	22.53	42.70
60	19.00	29.67	43.33	45.00	4.00	8.67	11.33	12.00	2.07	11.03	23.17	44.00
75	20.00	30.50	45.67	46.00	4.24	8.79	11.00	12.50	2.00	11.93	23.40	44.10
SEm±	0.57	0.56	0.92	1.21	0.28	0.29	0.35	0.49	0.09	0.44	0.60	0.31
LSD 0.05	1.81	1.77	2.90	3.80	0.88	0.92	1.10	1.54	0.29	1.37	1.90	0.96

of stover. Results revealed that soil applied phosphorus increased the nitrogen content in seed and stover as compared with control (Table 2). The maximum nitrogen content was recorded with highest dose of phosphorus might be due to the increase in nutrient contents in both grain and stover with increases application of phosphorus at optimum levels. These findings are also corroborated with the findings of Prajapati *et al.*, 2013 and Kumar *et al.*, 2014. Nutrient content increased due to better root system, higher dry matter production and higher availability of phosphorus in soil (Sharma *et al.*, 2008). Nutrient depletion from the soil is a function of nutrient content in plants. Nitrogen uptake was significantly highest with highest dose of phosphorus application while lowest with lowest dose of phosphorus application and each level was found significantly different with each other (Awomi *et al.*, 2012). Effects of phosphorus levels, showed the positive effect of phosphorus application on nitrogen uptake. This could be due to the overall improvement of plant growth and development as indicated by significant enhancement in crop biomass as a result of phosphorus application (Kumar *et al.*, 2014). These results are in conformity with those that report a significant increase in N uptake or their contents in the leaves or straw due to phosphorus application in chickpea (Walley *et al.*, 2005).

Table 2: Effect of phosphorus on nitrogen content and nitrogen uptake in grain and stover of urdbean under custard apple based agri-horti system.

Phosphorus Level (kg/ha)	Nitrogen Content (%)		Nitrogen Uptake (kg/ha)	
	Grain	Stover	**Grain**	**Stover**
0	3.38	2.18	14.94	37.08
15	3.48	2.26	19.56	43.57
30	3.50	2.28	24.05	49.80
45	3.58	2.31	26.28	54.35
60	3.60	2.68	31.10	71.90
75	3.62	2.69	34.64	76.42
SEm±	0.001	0.13	0.10	0.09
CD at 5%	**0.004**	**0.42**	0.31	0.30

Phosphorus content and uptake

No significant difference of phosphorus application was estimated among all the levels for phosphorus content in grain (Table 3). Similar results were also obtained by Dashadi *et al.* 2013. Phosphorus content in stover was found significantly highest with 75 kg/ha phosphorus application though the differences were not significant up to 30 kg/ha (Table 3). The phosphorus concentration in stover was significantly affected due to different treatments was reported by Prajapati *et al.*, 2013 and Kumar *et al.*, 2014. Increased nutrient content and uptake attributed to better root system, higher availability of phosphorus in soil and higher dry matter production. The similar results are also reported by Sasode (2008). Phosphorus uptake through grain was highest with highest level of phosphorus application and got significant difference at each level of phosphorus application while it was lowest with no phosphorus application (Table 3). Highest phosphorus uptake through stover was also estimated with highest level of phosphorus application though the differences were not significant with 60 kg/ha phosphorus application but significantly different with rest of the levels. Lowest value obtained with no phosphorus application though the difference was not significant with next level of phosphorus application. Judicious application of phosphorous significantly increased the nutrient uptake (Prajapati *et al.*, 2013 and Pal *et al.*, 2014).

Table 3: Effect of phosphorus on phosphorus content and phosphorus uptake in grain and stover of urdbean under custard apple based agri-horti system.

Phosphorus Level (kg/ha)	Phosphorus Content (%)		Phosphorus Uptake (kg/ha)	
	Grain	Stover	Grain	Stover
0	0.37	0.21	1.64	3.57
15	0.43	0.22	2.42	4.24
30	0.45	0.24	3.09	5.24
45	0.47	0.26	3.45	6.12
60	0.48	0.27	4.15	7.24
75	0.49	0.27	4.69	7.67
SEm±	0.06	0.001	0.003	0.29
CD at 5%	0.18	0.004	0.009	0.91

Potassium content and uptake

Significantly highest potassium content was estimated with 75 kg/ha phosphorus application even though the differences were not significant up to 30 kg/ha phosphorus application. In stover significantly highest potassium content was found with highest level of phosphorus application. Potassium uptake in grain and stover was found significantly highest and lowest with 75 kg and 0 kg/ha phosphorus application respectively (Table 4). Significant increase in potassium uptake due to increasing doses of phosphorus application was also reported by (Shankarlingappa *et al.,* 2000 and Kumar *et al.*, 2014).

Table 4: Effect of phosphorus on potassium content and potassium uptake in grain and stover of urdbean under custard apple based agri-horti system

Phosphorus Level (kg/ha)	Potassium Content (%)		Potassium Uptake (kg/ha)	
	Grain	Stover	Grain	Stover
0	0.73	1.55	3.23	26.37
15	0.74	1.56	4.16	30.08
30	0.76	1.57	5.22	34.29
45	0.76	1.57	5.58	36.94
60	0.78	1.58	6.74	42.39
75	0.78	1.63	7.46	46.31
SEm±	0.001	0.001	0.001	0.02
CD at 5%	0.004	0.004	0.004	0.08

Total nitrogen, phosphorus, potassium and total nutrient uptake

Significantly highest and lowest total nitrogen, phosphorus, potassium and total nutrient uptake were estimated with highest and lowest levels of phosphorus application respectively (Table 5). Increase in uptake of nutrients was attributed to higher concentration of nutrients as a result of increased availability of nutrients from soil and fertilizer (Shankarlingappa *et al.,* 2000). Nutrient uptake was recorded maximum with highest dose and it was significantly superior to its lower level and control. This was mainly due to higher biological production under these treatments which increased the nutrient uptake. Similar result was observed by Khan *et al.* (2002) who reported increased phosphorus uptake in mung bean with increasing rates of phosphorus up to 75 kg/ha. Jain *et al.* (2007) reported increased phosphorus concentration in soil solution subsequent to phosphorus fertilization in phosphorus deficient soil which resulted in greater utilization of phosphorus by mung bean. Singh and Singh (2012) also reported the highest uptake of phosphorus at 90 kg/ha phosphorus and lowest in the control in chickpea. Among various levels of P, the higher level could probably maintain the available phosphorus status in soil to facilitate its uptake at an optimum level. This increase in phosphorus uptake may be attributed to higher phosphorus content as well as grain and straw yields with higher dose of phosphorus. The results are in conformity with the findings of Kanwar and Paliyal (2002). Fatima *et al.* (2007) recorded increased soil fertility and uptake of N, P, and K due to the application of phosphorus fertilizer. Significant increase in total uptake of N, P and K due to phosphorus application was also reported by Dass (2008).

Table 5: Effect of phosphorus on nitrogen, phosphorus potassium and total nutrient uptake of urdbean under custard apple based agri-horti system.

Phosphorus Level (kg/ha)	Total Nitrogen Uptake (kg/ha)	Total Phosphorus Uptake (kg/ha)	Total Potassium Uptake (kg/ha)	Total Nutrient Uptake (kg/ha)
0	52.02	5.21	29.59	86.82
15	63.13	6.66	34.24	104.02
30	73.84	8.33	39.51	121.68
45	80.63	9.57	42.52	132.72
60	103.01	11.39	49.13	163.53
75	111.07	12.36	53.77	177.20
SEm±	0.002	0.001	0.17	1.84
CD at 5%	0.008	0.004	0.55	5.78

Economics

All the economic parameters viz. cost of cultivation, gross return, net return and B: C ratio were found maximum when the highest dose of phosphorus was applied (Table 6). Contrastingly the lowest economic parameters were recorded when no phosphorus was applied. Singh *et al.* (2013b) also documented the higher economic parameters with higher doses of phosphorus application.

Table 6: Effect of phosphorus on economics of urdbean under custard apple based agri-horti system

Phosphorus Level (kg/ha)	Cost of Cultivation (Rs/ha)	Gross Return (Rs/ha)	Net Return (Rs/ha)	B: C Ratio
0	10037	14452	4415	1.44
15	10373	17906	7533	1.73
30	10709	21543	10834	2.01
45	11045	23056	12011	2.09
60	11381	26966	15585	2.37
75	11726	29607	17881	2.52

CONCLUSION

On the basis of above studies it is concluded that for the best monetary benefit phosphorus should be applied @75 kg/ha in the urdbean under custard apple based agri-horti system of *Vindhyan* region.

REFERENCES

Awomi TA, Singh AK, Kumar M and Bordoloi LJ. 2012. Effect of phosphorus, molybdenum and cobalt nutrition on yield and quality of mungbean (*Vigna radiata* L.) in acidic soil of Northeast India. *Indian Journal of Hill Farming* **25**(2):22-6.

Bose TK and Som MG. 1986. Vegetable crops in India. Naya Prokash, Calcutta-Six. India. 102.

Buresh RJ, Smithson PC and Hellums DT. 1997. Building soil phosphorus capital in Africa. In: Buresh, R.J., Sanchez, P.A. and Calhoun, F. (eds) *Replenishing Soil Fertility in Africa*. Soil Science Society of America, Madison, Wisconsin. 111-49.

Buresh RJ. 1999. Phosphorus management in tropical agroforestry: current knowledge and research challenges. *Agroforestry Forum* **9**: 61-6.

Dashadi M, Hossein M, Radjabi R, and Babainejad T. 2013. Investigation of effect different rates Phosphorus and Zinc fertilizers on two cultivars Lentil (Gachsaran and Flip92-12L) in irrigation complement condition. *Int J Agri Crop Sci.* **5** (1): 1-5.

Dass A. 2008. Effect of agronomic factors on nutrient content and uptake, dry matter accumulation and yield of chickpea (*Cicer arietinum*) on farm conditions. *Internat. J. Agric. Sci*. **4**(1):83-7.

Fairhurst T, Lefroy R, Mutert E and Batjes N. 1999. The importance, distribution and causes of phosphorus deficiency as a constraint to crop production in the tropics. *Agroforestry Forum* **9**: 2-7.

Fatima Z, Zia M, Chaudhary MF. 2007. Interactive effect of *Rhizobium* strains and P on soybean yield, nitrogen fixation and soil fertility. *Pak J. Bot.* **39**: 255-64.

Jackson, ML. 1973. Soil chemical analysis. Prentice Hall of India Pvt. Ltd., New Delhi. 498.

Jain AK, Kumar S, Panwar JDS. 2007. Response of mungbean (*Vigna radiata*) to phosphorus and micronutrients on N and P uptake and seed quality. *Legume Res.* **30** (3): 201-4.

Kanwar K and Paliyal SS. 2002. Influence of phosphorus management and organic manuring on uptake and yield of chickpea (*Cicer arietinum). Annals of Agricultural Research New Series* **23**(4): 642-5.

Khan MA, Aslam M, Tariq-Sultan, Mahmood IA. 2002. Response of phosphorus application on growth and yield of inoculated and un-inoculated mungbean (*Vigna radiata*). *Int J Agric Biol.* **4**(4): 523-24.

Kumar P, Kumar P, Singh T, Singh AK and Yadav RI. 2014. Effect of different potassium levels on mungbean under custard apple based Agri-Horti system. *African Journal of Agricultural Research* **9** (8): 728-34.

Marschner H. 1995. *Mineral Nutrition of Higher Plants*. Academic Press, London, 889.

Newman EI. 1997. Phosphorus balance of contrasting farming systems, past and present. Can food production be sustainable? *Journal of Applied Ecology* **34**: 1334-47.

Pal A, Kumar P, Singh RP and Kumar P. 2014. Effect of different Phosphorus Levels on Urd Bean under Custard Apple based Agri-Horti System. *Journal of AgriSearch* **1**(1): 30-4.

Prajapati JP, Singh RP, Kumar S, Kushwaha JK and Yadav PK. 2013. Yield and nutrient uptake of mungbean (*Vigna radiata* (L.) Wilczek). *Agriculture for Sustainable Development* **1**(1): 49-51.

Sasode DS. 2008. Response of mungbean [*Vigna radiata* (L) Wilczek] to fertility levels and sulphur sources application. *Agricultural Science Digest* **28** (1): 18-21.

Shankarlingappa BC, Shivraj B and Vishwanath KP. 2000. Interaction effect of phosphorus and sulphur on nutrient uptake of nitrogen, phosphorus potassium and sulphur by cowpea. *Karnataka J. of Agric. Sci.* **13**(2): 295-8.

Sharma R, Dahiya SS, Singh M, Malik RK and Singh D. 2008. Effect of sulphur and phosphorus interactions on growth and nutrient content in green gram. *Haryana Agricultural University Journal of Research* **38**(1/2):41-7.

Singh AK, Kumar P and N Chandra**.** 2013a. Studies on yield production of mung bean (*Vigna radiate*) sown at different dates. J. *Environ. Biol*. **34:** 1007-11.

Singh D and Singh H. 2012. Effect of phosphorus and zinc nutrition on yield, nutrient uptake and quality of chickpea. *Ann. Pl. Soil Res.* **14**(1): 71-4.

Singh R, Malik JK, Thenua OVS and Jat HS. 2013b. Effect of phosphorus and bio-fertilizer on productivity, nutrient uptake and economics of pigeonpea (*Cajanus cajan*)+Mungbean (*Phaseolus radiatus*) Intercropping System. *Legume Research* **36** (1): 41-8.

Walley FL, Kyei-Boahen S, Hnatowich G and Stevenson C. 2005. Nitrogen and phosphorus fertility management for *desi* and *kabuli* chickpea. *Can J Plant Sci.* **85**: 73-9.

Wild A. 1988. Plant nutrients in soil: phosphate. In: Wild, A. (ed.) *Russell's Soil Conditions and Plant Growth*. Longman, Harlow, 695–742.

Citation:

Kumar P, Pandey SK and Kumar P.2015. Effect of Different Phosphorus Levels on Nutrient Content, Uptake and Economics of Urdbean under Custard Apple based Agri-Horti System. *Journal of AgriSearch* **2**(2): 88-93