The Bioscan 11(4): 2699-2702, 2016 (Supplement on Agronomy)
AN INTERNATIONAL QUARTERLY JOURNAL OF LIFE SCIENCES
www.thebioscan.com

EFFECT OF FYM, PHOSPHORUS AND PSB ON NUTRIENT CONTENT AND UPTAKE BY COWPEA [*VIGNA UNGUICULATA* (L.) WALP] ON LOAMY SAND

NEHA CHAUDHARY*, B. B. PATEL, R. P. PAVAYA, S. K. SHAH AND VIMAL KOTADIYA
Department of Agricultural Chemistry and Soil Science,
C.P. College of Agriculture, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar - 385 506
e-mail: nehakakvadiya@gmail.com

KEYWORDS
Cowpea
Yield
Farm Yard Manure
Phosphorus
PSB

Received on :
28.04.2016

Accepted on :
07.10.2016

***Corresponding author**

ABSTRACT

A field experiment was conducted during *kharif*, 2014 at Agronomy Instructional Farm, C.P. College of Agriculture, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar, Gujarat, to study the effect of FYM, phosphorus and PSB on nutrient content and uptake by cowpea (*Vigna unguiculata* (L.) Walp) on loamy sand. The result revealed that application of 40 kg P_2O_5/ha + PSB reflected in higher seed (1483 kg/ha) and stover (2197 kg/ha) yields. The maximum N, P, K, S, Fe and Zn content and uptake in seed, stover and total uptake were observed under application of 10 t/ha FYM and 40 kg P_2O_5/ha + PSB. The application of 40 kg P_2O_5/ha + PSB with FYM @ 10 t/ha noted significantly highest N, P_2O_5, K_20, S, Fe and Zn status in soil after harvest. Thus, from the present study it can be concluded that for securing higher yield of *kharif* cowpea should be fertilized with 40 kg P_2O_5/ha + PSB along with FYM @ 10 t/ha in loamy sand of north Gujarat.

INTRODUCTION

In India, the pulses crops are grown over an area of 26.28 million ha with an annual production of 18.09 million tonnes and productivity of 689 kg ha^{-1} (DE and S 2012). Cowpea seed play an important role in Indian diet, as it contain about 23.14 per cent protein on dry weight basis, which is more than double than that of cereal. It is used mostly as a pulse either as whole or as dal. It is also important for its green tender pods and properly cooked cowpea provides a tasty vegetable dish. In Gujarat, it is mainly grown in Sabarkantha, Banaskantha, Mehsana, Patan, Ahmedabad and Kheda districts. In Gujarat, cowpea is commonly known as "Chowli". In Gujarat, it is cultivated in 2.09 lakh hectares with an annual production of 1.14 lakh metric tonnes leading to average productivity of 546 kg ha^{-1} (DOA, 2012). Phosphorus is one of the important and major nutrients required by the crops and in many soils its availability limits the crop yields (Sepetoglu, 2002). In India, the consumption of phosphatic fertilizers is still less and it ranges between 4-5 million metric tonnes. Phosphorus is critical to cowpea yield because it is reported to stimulate growth, initiate nodule formation as well as influence the efficiency of the rhizobium-legume symbiosis (Haruna and Aliyu, 2011). It is required in large quantities in young cells such as shoot and root tips where metabolism is high and cell division is rapid. It also aids in flower initiation, seed and fruit development (Ndakemi and Dakora, 2007). Legumes are phosphorus loving plants; they require phosphorus for growth and seed development and most especially in nitrogen fixation which is an energy-driving process. Legumes can fix up to 11-20kgN /ha (Sanginga *et al*., 2000), but this is not achievable in the tropics because of low soil fertility and poor farming practices. Application of phosphorus is therefore recommended for cowpea production on soils low in phosphorus. Careful application of phosphorus fertilizer to legumes is geared towards enhancing not only their growth and yield, but also nitrogen fixation. In Nigeria, legumes do not receive any form of mineral phosphorus fertilizer, they therefore entirely rely on the natural available soil phosphorus and other nutrients for nitrogen-fixation and growth and this has resulted in lower yields (Singh *et al*., 2011).

Farmyard manure (FYM) is one of the important organic manures, which supplies a suitable mineral balance and improves nutrient availability by enzymes. FYM seems to act directly for increasing the crop yield either by acceleration of respiratory process with increasing cell permeability and hormonal growth action or by combination of all these processes (Gaur, 1991). It supplies nitrogen, phosphorus, potassium, sulphur and micronutrients like Fe, S, Mo and Zn etc, in available form to the plants through biological decomposition and improves physical-chemical properties of soil such as aggregation, aeration, permeability, water holding capacity, slow release of nutrients, increase in cation exchange capacity, stimulation of soil flora and fauna etc (Dick and Gregorich, 2004). The PSB like Pseudomonas and Bacillus also enhances the availability of phosphorus to the plant by converting insoluble phosphorus from the soil in the soluble form. More over use of this bio-fertilizer also reduced the environmental pollution caused by heavy use of chemical fertilizer. Therefore, in the present context, a judicious combination of organic, inorganic fertilizers and biofertilizers helps to maintain soil and crop productivity.

MATERIALS AND METHODS

A field experiment was conducted during *kharif* season of 2014 at Agronomy Instructional Farm, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar. Fourteen treatment combinations comprising of two FYM levels viz., 0 t/ha FYM (F_0) and 10 t/ha FYM (F_1) and seven treatments of phosphorus viz., P_1 (Only PSB), P_2 (20 kg P_2O_5/ha), P_3 (20 kg P_2O_5/ha+ PSB), P_4 (30 kg P_2O_5/ha), P_5 (30 kg P_2O_5/ha+ PSB), P_6 (40 kg P_2O_5/ha) and P_7 (40 kg P_2O_5/ha+ PSB) were evaluated in factorial randomized block design replicating three times. The soil of the experimental field was loamy sand in texture, low in organic carbon (0.17 %), available nitrogen (160.7 kg/ha) and available sulphur (8.50 mg/kg), medium available phosphorus (38.9 kg/ha), available iron (7.60 mg/kg) and available zinc (0.58 mg/kg) and high in available potash (286 kg/ha), with 7.6 soil pH. Other cultural practices were taken as per recommendations. Cowpea cultivar GC 4 was sown on 3^{rd} July behind the plough at row spacing of 45 cm @ of 18 kg seed/ha. The plants were spaced at 15 cm by thining after 25 day of sowing. PSB was inoculated with seed just before sowing as per treatments requirement. The crop was harvested in the second week of September. The representative dry samples of shoots and seeds were analyzed for ascertaining the nutrient (N, P, K, S, Fe and Zn) content and uptake. The N, P, K, S, Fe and Zn contents were analyzed by micro-Kjeldahl, Vanadomolydo phosphoric acid yellow-colour, flame Photometric method, Turbidimetric and DTPA extraction methods respectively. Available N, P_2O_5, K_2O, S, Fe and Zn content in soil were analyzed by alkaline permanganate, Olsen's method, Flame photometric, Turbidimetric method and DTPA extraction methods, respectively. The collected data for various parameters were statistically analyzed using Fishers' analysis of variance (ANOVA) technique and the treatments were compared at 5% level of significance.

RESULTS AND DISCUSSION

Effect of FYM

FYM application showed significantly better effect of grain and straw yield /ha as compare to control (Table 3). Application @ 10 t/ha (F_1) produced significantly higher seed (1392 kg/ha) and stover yield (2118 kg/ha) as compared to 0 t/ha FYM (F_0). The above findings are in complete agreement with earlier work of Kokani *et al*. (2015). These results clearly suggest that grain yield is an artifact of several yield components, which are dependent on source (photosynthates/metabolites/ nutrients) and sink (yield components particularly number of grains per spike and test weight) and improvement in all these aspects under the influence of organic fertilization resulted in realization of higher productivity in terms of grain and stover yield. While higher production of total biomass under FYM application seems to be on account of its profound influence on both vegetative and reproductive events of crop growth (Shete *et al*. 2010).

The application of FYM @ 10 t/ha (F_1) was recorded that significantly maximum N, P, K, and S content in seed (3.797, 0.615, 1.74, and 0.248%) and stover (0.675, 0.235, 2.54, and 0.092 %) compared to 0 t/ha FYM (F_0), respectively (Table 1) (Jat and Ahlawat, 2010). In case of uptake of N, P, K, and S, 10 t/ha FYM (F_1) recorded higher uptake by seed, stover and total uptake by the crop than 0 t/ha FYM (F_0).Total N, P, K, and S uptake by 10 t/ha FYM (F_1) was 9.92, 17.96, 21.81 and 19.03 per cent higher than 0 t/ha FYM (F_0) respectively (Table 2). Application of 10 t/ha FYM (F_1) recorded higher uptake Fe and Zn by seed, stover and total uptake by the crop than 0 t/ha FYM (F_0) (Table 3). An application of FYM @ 10 t/ha increased total Fe and Zn uptake by 8.8 and 17.3 per cent than 0 t/ha FYM (F_0), respectively (Jat *et al*., 2012). Improved nutritional status in plant parts under FYM application primarily seems to be on account of enrichment of these nutrients in soil, secondly it can be attributed to their efficient extraction per translocation in the plant system due to enhanced activities of roots on

Table 1: Nutrient content by cowpea as influenced by different treatments

Treatment	N content (%)		P content (%)		K content (%)		S content (%)		Fe content (mg/kg)		Zn content (mg/kg)	
	Seed	Stover	Seed	Stover	Seed	Stover	Seed	Stover	Seed	Stover	Seed	Stover
[A] Levels of FYM (F)												
F_0 : 0 t/ha	3.706	0.658	0.547	0.212	1.35	2.26	0.216	0.081	116.11	101.11	12.99	7.80
F_1 : 10 t //ha	3.797	0.675	0.615	0.235	1.74	2.54	0.248	0.092	117.98	101.84	15.54	7.93
S.Em.+	0.025	0.006	0.007	0.003	0.02	0.03	0.003	0.0011	1.27	0.63	0.17	0.10
C.D.(P=0.05)	0.071	0.017	0.021	0.010	0.05	0.08	0.008	0.0031	NS	NS	0.51	NS
[B] Levels of phosphorus (P)												
P_1 : PSB	3.683	0.590	0.489	0.194	1.48	2.32	0.208	0.077	117.00	100.55	13.88	7.56
P_2 : 20 kg P_2O_5/ha	3.693	0.613	0.498	0.203	1.51	2.34	0.212	0.079	117.02	100.78	13.98	7.84
P_3 : 20 kg P_2O_5/ha + PSB	3.727	0.618	0.525	0.207	1.54	2.36	0.220	0.084	117.05	101.72	14.10	7.88
P_4 : 30 kg P_2O_5/ha	3.748	0.672	0.572	0.221	1.55	2.39	0.233	0.088	117.07	101.78	14.40	7.94
P_5 : 30 kg P_2O_5/ha + PSB	3.765	0.695	0.612	0.238	1.57	2.45	0.247	0.091	117.08	101.85	14.50	7.95
P_6 : 40 kg P_2O_5/ha	3.817	0.730	0.678	0.244	1.58	2.47	0.249	0.093	117.07	101.83	14.49	7.94
P_7 : 40 kg P_2O_5/ha + PSB	3.825	0.745	0.696	0.255	1.59	2.49	0.253	0.094	117.06	101.82	14.48	7.93
S.Em.+	0.046	0.011	0.014	0.006	0.03	0.05	0.005	0.002	2.38	1.18	0.33	0.18
C.D.(P=0.05)	NS	0.031	0.040	0.018	NS	NS	0.014	0.006	NS	NS	NS	NS
CV %	4.45	3.39	4.96	5.78	4.02	4.34	4.39	4.90	4.27	5.30	4.80	4.82

Table 2: Nutrient uptake by cowpea as influenced by different treatments

Treatment	Nuptake (kg/ha)			Puptake (kg/ha)			Kuptake (kg/ha)			Suptake (kg/ha)		
	Seed	Stover	Total	Seed	Stover	Total	Seed	Stover	Total	Seed	Stover	Total
[A] Levels of FYM (F)												
F_0 : 0 t/ha	47.80	12.73	60.54	7.10	4.09	11.19	17.45	43.59	61.04	2.80	1.58	4.38
F_1 : 10 t //ha	52.86	14.35	67.21	8.65	4.99	13.64	24.25	53.82	78.07	3.46	1.96	5.41
S.Em. +	1.36	0.32	1.46	0.21	0.10	0.24	0.59	1.05	1.36	0.09	0.05	0.11
C.D.(P=0.05)	3.96	0.94	4.25	0.60	0.30	0.71	1.71	3.05	3.95	0.25	0.14	0.32
[B] Levels of phosphorus (P)												
P_1 : PSB	43.78	10.81	54.60	5.83	3.53	9.36	17.69	42.65	60.34	2.48	1.41	3.89
P_2 : 20 kg P_2O_5/ha	45.73	11.71	57.44	6.17	3.87	10.04	18.69	44.62	63.31	2.62	1.52	4.13
P_3 : 20 kg P_2O_5/ha + PSB	47.90	12.06	59.96	6.75	4.06	10.82	19.82	45.86	65.68	2.83	1.64	4.47
P_4 : 30 kg P_2O_5/ha	49.65	13.46	63.11	7.60	4.44	12.05	20.66	47.93	68.58	3.09	1.77	4.87
P_5 : 30 kg P_2O_5/ha + PSB	53.32	14.55	67.87	8.64	5.02	13.66	22.32	51.72	74.03	3.51	1.93	5.43
P_6 : 40 kg P_2O_5/ha	55.13	15.83	70.96	9.78	5.29	15.07	23.00	53.51	76.51	3.60	2.02	5.63
P_7 : 40 kg P_2O_5/ha + PSB	56.81	16.35	73.16	10.33	5.58	15.91	23.75	54.66	78.41	3.77	2.08	5.85
S.Em. +	2.55	0.61	2.74	0.39	0.20	0.46	1.10	1.96	2.54	0.16	0.09	0.20
C.D.(P=0.05)	7.42	1.76	7.95	1.13	0.57	1.33	3.21	5.71	7.39	0.46	0.26	0.59
CV %	10.64	9.40	8.99	10.38	9.03	7.73	11.11	8.47	7.68	10.70	10.68	8.72

Table 3: Nutrient uptake, available N, P_2O_5, K_2O, S, Fe and Zn in soil and yield of cowpea as influenced by different treatments

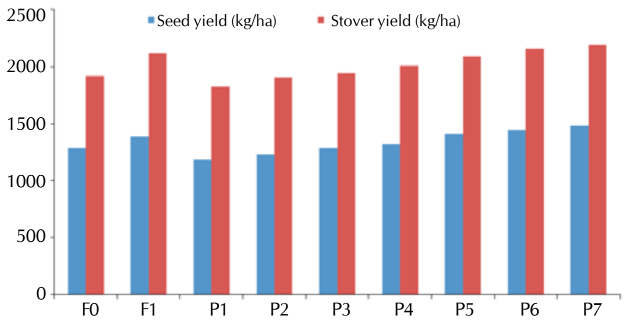
Treatment	Feuptake (g/ha)			Znuptake (g/ha)			Available nutrients insoil (kg/ha)						Seed yield (kg/ha)	Stover yield (kg/ha)
	Seed	Stover	Total	Seed	Stover	Total	N	P_2O_5	K_2O	S	Fe	Zn		
[A] Levels of FYM (F)														
F_0 : 0 t/ha	149.72	194.65	344.38	16.78	15.05	31.82	168.88	36.78	245.78	8.65	6.53	0.491	1288	1923
F_1 : 10 t //ha	164.10	213.55	377.66	21.70	16.80	38.50	175.40	38.72	246.82	9.08	7.04	0.542	1392	2118
S.Em.+	4.45	5.00	7.64	0.65	0.44	0.92	2.23	0.60	3.49	0.07	0.09	0.007	35.32	44
C.D.(P=0.05)	12.93	14.54	22.20	1.89	1.27	2.69	6.48	1.74	NS	0.20	0.27	0.021	102.68	129
[B] Levels of phosphorus (P)														
P_1 : PSB	138.95	183.96	322.91	16.59	13.82	30.41	162.96	32.21	227.06	8.52	6.61	0.492	1187	1828
P_2:20 kg P_2O_5/ha	144.81	192.14	336.96	17.33	14.96	32.29	170.86	38.52	250.90	8.76	6.77	0.495	1238	1908
P_3:20 kg P_2O_5/ha + PSB	150.72	197.94	348.65	18.32	15.47	33.80	166.92	37.70	238.69	8.89	6.79	0.501	1288	1945
P_4:30 kg P_2O_5/ha	155.36	204.45	359.81	19.14	15.95	35.08	169.33	38.53	249.97	8.90	6.82	0.516	1325	2008
P_5:30 kg P_2O_5/ha + PSB	165.67	209.44	375.11	20.69	16.70	37.38	178.40	39.12	255.27	8.95	6.85	0.538	1415	2096
P_6:40 kg P_2O_5/ha	169.02	219.98	389.00	21.00	17.12	38.12	172.41	37.38	244.25	8.99	6.83	0.537	1442	2161
P_7 : 40 kg P_2O_5/ha + PSB	173.86	220.82	394.68	21.60	17.46	39.06	184.14	40.79	257.97	9.03	6.82	0.536	1483	2197
S.Em.+	8.32	9.36	14.29	1.22	0.82	1.73	4.17	1.12	6.52	0.13	0.17	0.013	66.08	83
C.D.(P=0.05)	NS	NS	41.54	3.54	2.37	5.02	12.12	3.26	18.96	NS	NS	NS	192.10	241
CV %	11.13	9.62	8.31	13.3	10.75	10.32	3.21	2.27	3.95	3.03	5.31	5.41	10.36	8.61

account of pivotal role of FYM on maintenance of better physico-chemical and biological properties of the soils. Similar results were also reported by Shankar *et al.* (2014) and Kokani *et al.* (2015). Application of 10 t/ha FYM (F_1) was recorded significantly increase in available N, P_2O_5, K_2O, S, Fe, and Zn were to the tune of 10.47, 3.14, 2.9, 4.7, 7.24 and 9.4 per cent, respectively over 0 t/ha FYM (F_0) (Table 3). It is imperative that the increase in soil nutrient content and enhancing physico-chemical as well as biological properties of the soil due to addition of 10 t/ha FYM.

Effect of phosphorus

Phosphorus application significantly increased grain and straw yield with the increase in P levels upto 40 kg P_2O_5/ha. The increase in grain yield was 19.95 per cent in 40 kg P2O5/ha over control (Table 3). This might be due to significantly increase in P availability and uptake resulted profuse nodulation leading to greater symbiotic N fixation which in turn has positive effect on photosynthesis then on yield/ha. Response of phosphorus was also reported by Chaudhari *et al*. (2016).

N content in seed was non significant but N content in stover was significantly due to phosphorus treatments. Maximum N content in stover and uptake of N in seed and stover were significantly registered when crop fertilized with 40 kg P_2O_5/ha + PSB (P_7), the similar result found by Prasad *et al*. (2014). P and S content and uptake were affected significantly due to different phosphorus treatments (Table 2). Maximum P and S content and uptake in seed and stover were significantly registered when crop fertilized with 40 kg P_2O_5/ha + PSB (P_7). K and Zn content in seed and stover was did not significant effect but K and Zn uptake in seed and stover were significantly registered when crop fertilized with 40 kg P_2O_5/ha + PSB (P_7) (Table 2 & 3). The increase in content and uptake by seed and stover might be due to increased yield of seed and stover under treatment P_7 (40 kg P_2O_5/ha + PSB). The higher removal of nutrients with this treatment might be due to better development of root and shoot with this treatment resulted in higher nutrient uptake. These results are in accordance with the results of those reported by Dekhane *et al.* (2011) and Jat *et al*. (2013). Various levels of phosphorus significantly influenced the N and P status of soil (Table 3) after the harvest of cowpea. Significantly higher values of available N (205.75 kg/ha), and P_2O_5 (59.18 kg/ha) in soil after harvest of cowpea were recorded with P_7 (40 kg P_2O_5/ha + PSB) (Table 3). This might be due to higher quantity of FYM along with bio fertilizers



F_0 : 0 t/ha, F_1: 10 t//ha, P_1: PSB, P_2: 20 kg P_2O_5/ha, P_3: 20 kg P_2O_5/ha + PSB, P_4: 30 kg P_2O_5/ha, P_5: 30 kg P_2O_5/ha + PSB, P_6: 40 kg P_2O_5/ha, P_7: 40 kg P_2O_5/ha + PSB

Figure 1: Seed and stover yield of cowpea as influenced by different treatments

viz. PSB resulted in buildup of nutrients in the soil. Similar results were also reported by Chaudhari *et al.* (2016) revealed that phosphorus management improved the residual soil fertility after greengram to a greater extent and the gain in organic carbon, total nitrogen and available P_2O_5 over the initial soil nutrient content.

REFERENCES

Chaudhari, S. N., Thanki, J. D., Chaudhari, V. D., Varma, Chanchal 2016. Yield attributes, yield and quality of black greengram (*Vigna radiata* L.) as influenced by organic manures, biofertilizer and phosphorus fertilization. *The Bioscane*. **11(1):** 431-433.

Dekhane, S. S., Khafi, H. R., Raj, A. D. and Parmar, R. M. 2011. Effect of bio fertilizer and fertility levels on yield, protein content and nutrient uptake of cowpea. *Legume Research*. **34(1):** 51-54.

DE and S. 2012. Directorate of Economics & Statistics, Department of Agriculture and Cooperative, New Delhi.

Dick, W. A. and Gregorich, E. C. 2004. Developing and maintaining soil organic manure levels. (In) Managing soil quality Challenging Modern Agriculture, pp.103-20.

DOA 2012. Gujarat state area, production and yield of pulses. *Margdarshika,* Directorate of Agriculture, Gujarat State, Krishi Bhavan, Sector 10-A, Gandhinagar.

Gaur, A. C. 1991. *Bulky Organic Manures and Crop Residues*. In : Fertilizers, organic matter recyclable wastes and bio-fertilizers, H.L.S. Tandon, Fertilizer development and consultation Organization, New Delhi. pp. 29-35.

Haruna, I. M. and Aliyu, L. 2011. Yield and economic returns of sesame (Sesamum indicum .L.) as influenced by poultry manure, nitrogen and phosphorus at Samaru, Nigeria. *Elixir Agric.* **39:** 4884-4887.

Jat Ram, A., Arvadia, M. K., Tandel, Bhumika., Patel, T. U. and Mehta, R. S. 2012. Response of saline water irrigated greengram (*Vigna radiata*) to land confugaration, fertilizers and farmyard manure in Tapi command area of South Gujarat. *Indian J. Agronomy*. **57(3):** 270-274.

Jat, R. A. and Ahlawat, I. P. S. 2010. *Effect of organic manure and sulphur fertilization in pigeonpea (Cajanus cajan) + groundnut (Arachis hypogaea) intercropping system. Indian J. Agronomy*. **55(4):** 276-281.

Jat, S. R., Shivram, A. C., Kuri, B. R., Prajapati, K. 2013. Effect of phosphorus and sulfur levels profitability, nutrient content and uptake of cowpea (*Vigna ungiculata* (L.) walp). *Environment & Ecology*. **31(2):** 488-491.

Kokani, J. M., Shah, K. A., Tandel, B. M. and Bhimani, G. J. 2015. Effect of FYM, phosphorus and sulphur on yield of summer blackgram and post harvest nutrients status of soil. *The Bioscan*. **10(1):** 379-383.

Ndakidemi, P. A. and Dakora, F. D. 2007. Yield components of nodulated cowpea (Vigna unguiculata (L.) Walp) and maize (Zea mays) plants grown with exogenous phosphorus in different cropping systems. *Aust. J. Exp. Agric.* **47:** 587-590.

Prasad, S. K., Singh, M. K. and Singh, J. 2014. Response of rhizobium inoculation and phosphorus levels on mungbean (*Vigna radiata)* under guava-based agri-horti system. *The Bioscan*. **9(2):** 557-560.

Sanginga, N., Lyasse, O, and Singh, B. B. 2000. Phosphorus use efficiency and nitrogen balance of cowpea breeding lines in a low P soil of the derived savanna zone in West Africa. *Plant and Soil*. **220:** 119-128.

Shankar, M. A., Maruthi, S. G. R., Nagamani, M. K. 2014. Micro-nutrient management for soil fertility, nutrient uptake and productivity of greengram (*Vigna radiata*) and finger millet (*Eleusine coracana*) under semiarid Alfisols. *Indian J. Agronomy*. **59(2):** 306-316.

Shete, P. G., Thanki, J. D., Adhav, S. L. and Kushare, Y. M. 2010. Response of *rabi* greengram (*Vigna radiata* L.) to land configuration and inorganic fertilizer with and without FYM. *Crop Research-An International J.* **39(1/2/3):** 43-46.

Singh, A., Baoule, A. L., Ahmed, H. G., Aliyu, U. and Sokoto, M. B., 2011. Influence of phosphorus on the performance of cowpea (Vigna unguiculata (L.) Walp) varieties in the sudan savannah of Nigeria. *Agric. Sci.* **2:** 313-317.

Sepetoglu, H. 2002. Grain legumes. Department of Field Crops, Faculty of Agriculture, University of Ege, Publication: 24/4, zmir, Turkey.