Gashua Journal of Irrigation and Desertification Studies
Available online at www.gjidsfugashua.org.ng
Maiden Edition: Vol 1, Nos. 1 & 2

YIELD AND YIELD COMPONENTS OF GREEN BEAN (*Phaseolus vulgaris* L.) VARIETIES RESPONSE TO NITROGEN AND PHOSPHORUS RATE

[1]Dauda, S. N,. [2]Amans, E. B., [2]Mani, H. and [2]Yahaya, R. A.
[1]Department of Horticulture and Landscape Technology, College of Agriculture lafia.
[2] Department of Agronomy, Ahmadu Bello University, Zaria, Nigeria,
Corresponding Author:**snaidauda@yahoo.com**

Abstract

Yield and yield components of green bean varieties response to nitrogen and phosphorus research was carried out at Kadawa irrigation research station of the Institute for Agricultural Research, Ahmadu Bello University Zaria, Nigeria during the 2009/2010, 2010/2011 and 2011/2012 dry season. The treatment consisted of three varieties of green bean (Ex-Brown, Dangora and Yar-Helina), four levels of nitrogen (0, 20, 40, and 60 kg N ha^{-1}) and three levels of phosphorus (0, 22.5, and 45 kg P ha^{-1}). Factorial combinations of varieties and nitrogen were assigned to the main plots, while P was assigned to the sub-plots, arrange in a split plot design and replicated three times. Dangora and Yar-Helina performed significantly better than Ex-Brown in most of theyield and yield components of green bean varieties. Application of nitrogen fertilizer increased yield and yield components significantly compared to the control and phosphorus fertilizer rates of 22.5 and 45 kg P ha^{-1} showed statistical similarities but performed better than the control. Farmers in sudan savannah ecological zone can adopt the application of 60 kg N ha^{-1} and 22.5 kg P ha^{-1} with Dangora or Yar-Helina varieties.

Keywords: *Yield, Yield component, Green Bean, Varieties, Nitrogen, Phosphorus*

INTRODUCTION

Nitrogen is essential for all biological process that occurs in the plant. A sub-optimal supply of N limits the expression of yield potentials of green bean varieties (Adelson *et al.*, 2000). Phosphorus promotes early flowering, crop maturity and is important in plant reproduction (Douglas and Philip, 2008). In Nigeria, there is a dearth of information on the nutrient requirement of green bean varieties to increase its productivity hence the low production of the crop. Scientific studies elsewhere have shown increase in yield of green with fertilizer application. Sa *et al.* (1982) reported that application of various fertilizer doses resulted in significant increase in pod number per plant, Nicolas *et al.* (2011) testing yield and nutritional quality of snap bean reported highest pod yield and pod number with the application of 200 kg N ha^{-1} compared to 100 and 0 kg N ha^{-1} and that pod length was not significantly affected. Begum *et al*. (2003) reported that highest fertilizer rate (90:50:120) produced the highest pod yield, pod length and pod weight. Tewari and Singh, (2000) recorded a non significant difference in number of days to 50% flowerings, due to P fertilization, but increased number of pods per plants,. Numan and Nuri, (2005) using P rates (0, 40, 60, and 80 kg ha^{-1}) reported that increasing P application on number of pods per plant was statistically significant. The research is to determine the yield and yield components of green bean varieties in response to nitrogen and phosphorus fertilizer rates application.

MATERIALS AND METHODS

The experiment was conducted at Kadawa Irrigation Research Station of the Institute for Agricultural Research, Ahmadu Bello University, Zaria, during the dry seasons of 2009/2010, 2010/2011, and 2011/2012. Kadawa is located at 11^{o}39`N; 08^{o}02’E at altitude of 500 m in the Sudan savanna ecological zone of Nigeria, The treatment consisted of three varieties of green bean

(Ex-Brown, Dangora and Yar-Helina), four levels of nitrogen (0, 20, 40, and 60 kg N ha^{-1}) and three levels of phosphorus (0, 22.5, and 45 kg P ha^{-1}). Factorial combinations of varieties and nitrogen were assigned to the main plots, while P was assigned to the sub-plots, arrange in a split plot design and replicated three times. The gross sub-plot area was 12 m^2 consisting of 4 rows of 4 m length and a width of 3 m. The net plot consisted of two inner rows of the gross-plot with net area of 6 m^2.The land was ploughed, harrowed, ridged 75 cm apart and intra-row spacing of 30 cm was adopted, soil samples were taken for physical and chemical analysis in accordance with Black (1965). Urea (46% N) and Single Super Phosphate (18% P_2O_5) was used as source of N and P fertilizer and was applied as per treatment to the plots. Nitrogen was split applied at two and six weeks after sowing (WAS) while the P doses were applied once at sowing and appropriate agronomic practices were carried out.

Data were collected from five harvested tagged plants for assessment of yield and yield components. Pod length (cm) was determined by measuring five pods randomly picked and measured with a meter ruler while pod diameter (cm) was determined using a vernier calliper, number of pods per plant was recorded on per plant basis. Fresh pods weight per plant was determined by weighing the harvested tagged plant pods using a mettlertoledo, model SB16001. Fresh pod yield per hectare was obtained by converting the total net plot harvested fresh pods yield to per ha basis (kg ha^{-1}). The data collected were subjected to analysis of variance (ANOVA) for a split plot design as described by Snedecor and Cochran (1967). Duncan Multiple Range Test (DMRT) was used to separate treatment means (Duncan, 1955).

RESULTS AND DISCUSSION

The physical and chemical properties of the soil from 0 – 30 cm depth, for 2009/2010, 2010/2011 and 2011/2012 dry season at Kadawa are presented on Table 1.The soil of the experimental site during the three 3 years of experimentation was sandy loam, alkaline (pH of 7.8, 7.5 and 6.7), it is low in organic carbon, available phosphorus (P) and total nitrogen (N), the soil calcium (Ca) is medium in 2009/2010 but high in 2010/2011 and 2011/2012; the magnesium (Mg) and potassium (K) is in the low range with high sodium (Na) and medium range of cation exchange capacity (C.E.C.).

The influence of Nitrogen and phosphorus on number pods per plant is presented on Table 2. Dangora and Yar-Helina in 2009/2010 and combined mean were statistically similar but significantly produced more pods per plant than Ex-Brown. A non significant difference was observed among varieties in 2010/2011 but in 2011/2012, Dangora and Yar-Helina were statistically at par but produced significantly less number of pods per plant to Ex-Brown. The higher value for number of pods per plantinDangora and Yar-Helina over Ex-Brown could be due to the fact that the two varieties flowered early thus leading to adequate time for pod production and development; Anjani*et al*. (2009) reported that varieties with early flowering recorded higher green pods per plot than varieties late in flowering which showed decreased number of green pods. Application of nitrogen rates in 2009/2010, 2010/2011 and mean of the years produced significant increase in number of pods per plant. In 2011/2012, a non significant difference was observed between 40 and 60 kg N ha^{-1} which produced significantly more pods per plant to 20 kg N ha^{-1}, while 0 kg N ha^{-1} produced lower pods per plant in all the years and combined mean. The increased in number of pods with increased N rates was so because N application enhanced the chlorophyll content in plants thereby improving photosynthetic activity that promotes assimilate production which resulted in increment of the final yield.

This finding supported the observation reported by El-Awade (2011), who reported increase in number of pods with increased N rates. Also Begum *et al*. (2003) reported that highest fertilizer treatment (90:50:120) produced the highest pods ha^{-1} and that fertilizer treatments had significantly different effects on number of pods per plant. P rates of 22.5 and 45 kg P ha^{-1} in all the years were statistically similar but produced significantly more pods per plant compared to 0 kg P ha^{-1}, this could be that the application of 22.5 kg P ha^{-1} seems to be sufficient to meet the crop nutrient requirement, as further increase in the P level to 45 kg P ha^{-1} did not confer any benefit on any of the yield and yield components. Phosphorus is a component of nucleic acid; it plays a vital role in plant reproduction of which pod production is an important result (Douglas and Philips, 2008). Tewari and Singh (2000) reported significant increase in number of pods per plant due to increase in P fertilization up to 26.16 and 52.32 kg P.The interaction between variety and nitrogen on number of pods per plant (Table 3) shows that when the highest N rate at 60 kg N ha^{-1} was considered, it was observed that in 2009/2010,Yar-Helinas number of pods were statistically more than Dangora followed by Ex-Brown. In 2010/2011, number of pods per plant remained statistically similar among varieties. Application of 20 kg N ha^{-1} in both years significantly increased number of pods per plant among the varieties. A similar trend was observed when N was increased to 40 kg N ha^{-1} except Ex-Brown in both years which remained significantly unaffected. The increased in N to 60 kg N ha^{-1} significantly increased number of pods per plant of Yar-Helina in 2009/2010. Ex-Brown and Dangora in 2009/2010 and all the varieties in 2010/2011 exhibited a statistically similar number of pods per plant. At a fixed N rate of 0 kg N ha^{-1}, the varieties showed a significant variation in number of pods per plant in 2009/2010 while Ex-Brown was lower in pod number per plant. When 20 kg N ha^{-1} was considered, Ex-Brown in 2010/2011 had statistically more number of pods than Dangora. At a fixed N rate at 40 kg N ha^{-1}, Dangora and Yar-Helina had statistically similar number of pods per plant in all the years and more than Ex-Brown. The interaction between N and P on number of pods per plant in 2010/2011 (Table 4) revealed that application of 22.5 kg P ha^{-1} significantly increased number of pod at N levels of 0 and 60 kg N ha^{-1}. Further increase to 45 kg P ha^{-1} increased number of pods per plant at N rates of 20 and 40 kg N ha^{-1}. At fixed P rate of 0, 22.5 kg P ha^{-1} each increase in N rate from 0-20 and further increase to 40 kg N ha^{-1} significantly increased pod number per plant. Further increase in N to 60 kg N ha^{-1} increased number of pods per plant where 22.5 kg P ha^{-1} was applied, at 0 and 45 kg P ha^{-1} number of pods per plant remained significantly unaffected.

Table 5 shows the influence of nitrogen and phosphorus on pod length (cm) of green bean varieties. In all the years, Yar-Helina significantly resulted in longer pods than Dangora and then followed by Ex-Brown, this could be due varietal differences which was expressed under different environmental growing conditions. Increasing nitrogen rates in combined mean significantly increased pod length. Application of 20 and 40 kg N ha^{-1} were statistically similar and resulted in significantly longer pods than the control in 2011/2012 but significantly shorter pod length compared with 60 Kg N ha^{-1}, however 0 and 20 kg N ha^{-1} showed no significant difference in 2009/2010 and 2010/2011, with 40 kg N ha^{-1} producing significantly longer pods compared to the control but shorter pods to 60 kg N ha^{-1}, nitrogen fertilizer promotes growth. Begum *et al*. (2003) reported that fertilizer treatments had significantly different effects on pod length. In 2009/2010 and 2010/2011, P at 22.5 and 45 kg P ha^{-1}were statistically comparable and produced significantly longer pods than the control.

Increasing .phosphorous rates in 2011/2012 and in combined mean increased pod length significantly; There was no significant difference in pod diameter (cm) among the varieties in 2009/2010, 2011/2012 and the combined mean (Table 6). In 2010/2011, Dangora and Yar-Helina pod diameter were statistically similar and were thicker than Ex-Brown. In 2009/2010 and combined mean; 20, 40 and 60 kg N ha^{-1} were statistically similar but recorded significantly high pod diameterthan 0 kg N ha^{-1} in 2011/2012. However, in 2010/2011, 40 and 60 kg N ha^{-1} recorded statistically similar but higher pod diameter than 20 Kg N ha^{-1} and the control. Nitrogen promotes assimilate production which resulted in increment of the size and final yield.Application of P at 22.5 and 45 kg P ha^{-1} produced statistically comparable pod diameter in 2009/2010 but 45 kg P ha^{-1} produced significantly higher pod diameter than 0 kg P ha^{-1} Phosphorus rates showed no significant difference in pod diameter in 2011/2012.

Table 7 shows the influence of nitrogen and phosphorus fertilizer rates on fresh pod weight per plant of green bean variety. In 2010/2011 and the combined mean, Dangora and Yar-Helina were statistically similar but produced significantly heavier fresh pod per plant than Ex-Brown, however in 2011/2012, Ex-Brown and Dangora had more pod weight per plant than Yar-Helina. But in 2009/2010, Yar-Helina had significantly more pod weight per plant than Dangora while Ex-Brown had lower pods yield per plant. Application of 40 and 60 kg N ha^{-1} resulted in statistically similar weight of pods per plant in 2009/2010 and 2011/2012, but produced significantly heavier pod than 20 kg N ha^{-1} and lower weight with the control. Increasing nitrogen rates in 2010/2011 and combined mean significantly increased pod weight per plant. Phosphorus rates of 22.5 and 45 kg P ha^{-1} were statistically similar on pod weight but produced significantly heavier pods per plant than the control treatment in all the years, except in 2011/2012 where 45 and 0 kg P ha^{-1}were statistically similar. The effect of nitrogen and phosphorus on fresh pods yield ha^{-1} (kg) of green bean varieties is presented on Table 8. In 2009/2010 and the combined mean, Dangora had higher pod yield ha^{-1} than Yar-Helina which in turn out-yielded Ex-Brown in all the years except 2010/2011 where statistically similar pod yield was obtained between Ex-Brown and Yar-Helina. In 2011/2012, Dangora and Yar-Helina had statistically similar pod yield that was lower than for Ex-Brown, this result could be due to varietal differences. In all the years and combined mean, the result showed that application of nitrogen rate from 0-20, 20-40, and 40- 60 kg N ha^{-1} resulted in a corresponding increase in fresh pod yield ha^{-1}This result was so because N enhanced the chlorophyll content in plants, improving photosynthetic activity that promotes assimilate production which resulted in increment of the final yield. This finding supported the observation reported by El-Awade (2011), who reported increase in pod yield with increased N rates. Increasing phosphorus rate from 22.5 to 45 kg P ha^{-1} resulted in statistically similar fresh pod yield ha^{-1} that was more than for the control except for the combined mean where the control and 45 kg P ha^{-1} were also statistically at par, From the result, the application of 22.5 kg P ha^{-1} seems to be sufficient to meet the crop nutrient requirement,Tewari and Singh (2000) reported significant increase in number of pods per plant and yield due to increase in P fertilization up to 26.16 and 52.32 kg P. The interaction between nitrogen and phosphorus (Table 9) revealed that application of 22.5 kg P ha^{-1} significantly increased pod yield ha^{-1} at all N rates except 40 kg N ha^{-1} where the parameters remained significantly unaffected. Further increase to 45 kg P ha^{-1} increased pod yield ha^{-1}for all except 0 kg N ha^{-1} where the increased was not significant. At fixed

P rates of 0, 22.5 and 45 kg P ha^{-1}, each increase in N from 0-20 and further to 40 kg N ha^{-1} significantly increased pod yield ha^{-1}. Further increase in N to 60 kg N ha^{-1} increased pod yield only where 22.5 kg P ha^{-1} was applied, at 0 and 45 kg P ha^{-1}, pod yield remained significantly unaffected. The interaction between variety and phosphorus (Table 10) revealed that application of 22.5 kg P ha^{-1} significantly increased pod yield of Dangora and Yar-Helina and Ex-Browm remained unaffected. Further increased to 45 kg P ha^{-1} had no significant effect on pod yield of the varieties. At fixed rate of 0 kg P ha^{-1}, Dangora recorded significantly higher pod yield, and lower yield with Ex-Brown. At 22.5 kg P ha^{-1} significant increased yield of Dangora and Yar-Helina was recorded.

CONCLUSION

From the studies, good yield and yield components were obtained from Dangora and Yar-Helina, with the highest nitrogen fertilizer at 60 kg N ha^{-1} and phosphorus rates at 22.5 kg P ha^{-1}. Farmers in the sudan savanna ecological zone can adopt the application of nitrogen fertilizer at 60 kg N ha^{-1} and phosphorus rates at 22.5 kg P ha^{-1} with Dangora or Yar-Helina varieties.

REFERENCES

Adelson, P.A., Mercelo, G.T.J. and Dejaio, L.A.(2000). Growth and yield of common bean varieties at two soil phosphorus level, under biological nitrogen fixation. *PesquisaAgropecuariaBrasileira*.Vol 35 No.4, Brasilia.

Anjani, K.; Singh, S. B.; Singh, V. (2009). Influence of nitrogen doses on growth and green pod yield parameters of French bean varieties under sub tropical area. *LegumeResearch* 32 (2): 142-144

Begum, A., Ahad,A;Kaisar, M.O. (2003). Effect of sowing dates and fertilizer treatments on the rproductive variability of French bean (*Phaseolus vulgaris*) *Pakistan Journal of Biological Science* 6 (22): 1897 – 1901

Black, C.A. (1965). *Methods, of Soil Analysis II: Chemical and Microbiological Properties*. American society of Agronomy, Madison, Wisconsin, Pp 1572.

Douglas, B.B., and Philips, T.D. (2008).Management phosphorus for crop production.Department of crop and soil sciences.Cooperativeextension.Penn State University.http/www.cas Psu.Edu.

Duncan, B.D. (1955). *Multiple Range and Multiple F.test* Biometrics. 11: 1 – 42.

El-Awade, M.E., El.Bassiony, A. M., Fawzy, Z.F., El-Nemr, M.A. (2011). Response of snap bean (*P. vulgaris* L.) plants to nitrogen fertilizer and foliar application with methionine and Tryptophan. *Nature and science* 9 (5): 87 – 94.

Nicolas, S.R., Jose, A.E.E, Maria, T.R.G., Eliseo, S.M. (2011). Yield and nutritional quality of snab bean in terms of bio-fertilization. *Tropical and Subtropical Agro Eco-system* 13: 347 – 355.

Numan, B., and Nuri, Y. (2005).The effect of different nitrogen and phosphorus doses and Bacterial inoculation on yield of field beans.*Journal of Agronomy* (4) 3; 207 – 215.

Sa, M.E., Buzitti, S. D., Morello, S. Deziderio, N.D., (1982). Effect of plant density and phosphate fertilizer on bean production: *Centro Nacional de Pesquisa. ArrozFeijao*, Pp 101 – 103

Snedecor, G.W. and Cochran, W.G. (1967).*Statistical Methods* 6thedn. Iowa state university press USA Pp 456.

Tewari, J.K. and Singh, S.S. (2000).Effects of nitrogen and phosphorus on the growth and seed yield of French bean (*P. vulgaria*).*Vegetable Science* 27: 172 – 175.

Table 1: Physical and chemical properties of the soil from 0-30 cm depth at the experimental site, during 2009/2010-2011/2012 dry seasons at Kadawa

Soil properties	2009/2009	2010/2011	2011/2012
Physical properties			
% sand	44	49	47
% silt	25	27	29
% clay	31	24	24
Textural class	Sandy loam	Sandy loam	Sandy loam
Chemical properties			
PH water	7.8	7.5	6.7
PH Cacl2	7.4	7.3	6.3
Organic Carbon (%)	0.63	0.72	0.80
Available P (mg kg^{-1})	6.9	8.3	10.8
Total N (g kg^{-1})	0.22	0.24	0.36
Exchangeable base (cMol kg^{-1})			
Ca	4.97	5.30	5.69
Mg	0.48	0.59	0.72
K	0.10	0.16	0.17
Na	2.80	2.34	0.47
C.E.C	9.0	8.20	7.10

Soil samples as analysed at Agronomy Department IAR/ABU, Zaria

Table 2: Effect of nitrogen and phosphorus on numbers of pod $plant^{-1}$ of green bean varieties during 2009/2010-2011/2012 dry seasons at Kadawa Irrigation station

Treatment	2009/2010	2010/2011	2011/2012	Combined Mean
Varieties				
Ex-Brown	38.07b	36.91	61.27a	45.41b
Dangora	76.76a	36.59	52.22b	55.26a
Yar-Helina	75.84a	39.13	48.52b	54.50a
SE±	1.908	1.025	1.827	1.511
Nitrogen rate (kg N ha^{-1})				
0	44.14d	21.67d	37.70c	34.50d
20	61.72c	33.04c	49.88b	48.21c
40	69.24b	45.53b	61.33a	58.04b
60	79.38a	51.92a	67.11a	66.14a
SE±	2.204	1.184	2.110	1.744
Phosphorus rate (kg P ha^{1})				

0	57.56b	32.22b	48.52b	46.10b
22.5	66.07a	39.14a	57.63a	54.28a
45	67.23a	41.27a	55.86a	54.78a
SE±	1.908	1.025	1.827	1.511
Interactions				
V x N	**	*	NS	NS
V x P	NS	NS	NS	NS
N x P	NS	*	NS	NS
V x N x P	NS	NS	NS	NS

Means followed by same letter(s) in a column and treatment group are not statistically different at 5% level of probability using DMRT. ** = Highly significant at 1% level of probability, * = Significant at 5% level of probability,NS = Not significant.

Table 3:Interactions between varieties and nitrogen on number of pods per plant of green bean varietyat Kadawa Irrigation stationin 2009, 2010.

	Nitrogen rates (kg N ha^{-1})			
Treatments	0	20	40	60
Variety		**2009/2010**		
Ex-Brown	28.05f	38.14e	38.94e	47.15e
Dangora	60.14d	78.22bc	87.60b	81.82b
Yar-Helina	44.24e	68.81cd	81.20b	109.14a
SE+		3.359		
		2010/2011		
Ex-Brown	23.28de	36.47b	38.1b	49.79a
Dangora	19.18e	28.27cd	45.89a	53.04a
Yar-Helina	22.57de	34.39bc	46.62a	52.94a
SE+		2.584		

Means followed by same letter(s) are statistically similar at P<0.05

Table 4: Interaction between nitrogen and phosphorus on pods per plant of green bean varieties in 2010/2011 at KadawaIrrigation station

	Phosphorus rates (kg P ha^{-1})		
Treatment	0	22.5	45
Nitrogen rate (kg N ha^{-1}			
0	16.89f	21.98fg	26.16ef
20	27.64e	31.46e	40.03d
40	39.99d	42.35d	48.27bc
60	44.38cd	60.77a	50.62b
SE+		2.051	

Means followed by same letter(s) are statistically similar at P<0.05

Table 5: Effect of nitrogen and phosphorus on pod length (cm) of green bean varieties during 2009/2010-2011/2012 dry seasons at Kadawa Irrigation station

Treatment	2009/2010	2010/2011	2011/2012	Combined mean
Variety				
Ex-Brown	10.96c	10.22c	10.94c	10.71c
Dangora	11.66b	11.84b	12.46b	11.98b
YarHelina	14.14a	13.05a	13.64a	13.61a
SE±	0.120	0.090	0.072	0.062
Nitrogen rate (kg N ha^{-1})				
0	11.77c	11.23c	11.56c	11.52d
20	12.08bc	11.31c	12.47b	11.91c
40	12.34b	11.83b	12.31b	12.20b
60	12.82a	12.44a	13.05a	12.77a
SE±	0.319	0.104	0.084	0.07243
Phosphorus rate (kg P ha^{1})				
0	11.87b	11.27b	12.10c	11.75c
22.5	12.32a	11.83a	12.319b	12.15b
45	12.58a	12.01a	12.63a	12.41a
SE±	0.120	0.090	0.072	0.062
Interaction				
V x N	NS	NS	NS	NS
V x P	NS	NS	NS	NS
N x P	NS	NS	NS	NS
V x N x P	NS	NS	NS	NS

Means followed by same letter(s) in a column and treatment group are not statistically different at 5% level of probability using DMRT. NS = Not significant.

Table 6: Effect of nitrogen and phosphorus on pod diameter (cm) of green bean varieties during 2009/2010-2011/2012 dry seasons at Kadawa Irrigation station

Treatment	2009/2010	2010/2011	2011/2012	Combined Mean
Variety				
Ex-Brown	0.75	0.75b	0.77	0.75
Dangora	0.75	0,75a	0.76	0.76
Yar-Helina	0.74	0.76a	0.77	0.76
SE±	0.0094	0.0075	0.0099	0.005
Nitrogen rate (kg N ha^{-1})				
0	0.72b	0.69c	0.74b	0.72b
20	0.75ab	0.74b	0.79a	0.76a
40	0.76a	0.77a	0.79a	0.77a
60	0.76a	0.78a	0.76b	0.77a
SE±	0.011	0.011		0.006
Phosphorus rate (kg P ha^{1})				
0	0.73b	0.73b	0.78	0.75
22.5	0.76ab	0.76a	0.76	0.76
45	0.76a	0.75ab	0.76	0.76
SE±	0.09~~4~~	0.07~~5~~	0.09~~9~~	0.005
Interaction				
V x N	NS	NS	NS	NS
V x P	NS	NS	NS	NS
N x P	NS	NS	NS	NS
V x N x P	NS	NS	NS	NS

Means followed by same letter(s) in a column and treatment group are not statistically different at 5% level of probability using DMRT, NS = Not significant.

Table 7: Effect of nitrogen and phosphorus on fresh pod weight plant^{-1}(g) of green bean varieties during 2009/2010-2011/2012 dry seasons at Kadawa Irrigation station

Treatment	2009/2010	2010/2011	2011/2012	Combined Mean
Variety				
Ex-Brown	98.99c	85.43b	165.52a	116.65b
Dangora	229.73b	111.36a	157.63a	166.24a
Yar-Helina	284.01a	109.29a	134.53b	175.90a
SE±	7.052	5.265	7.344	6.158
Nitrogen rate (kg N ha^{-1})				
0	132.32c	52.50d	101.49c	95.43d
20	198.88b	76.17c	132.06b	135.70c
40	233.24a	124.12b	177.27a	178.21b
60	252.56a	155.34a	199.43a	202.44a
SE±	0.127	6.080	8.480	7.110
Phosphorus rate (kg P ha^{1})				
0	184.06b	86.12b	136.55b	135.58b
22.5	210.39a	105.04a	167.05a	160.83a
45	218.28a	114.93a	154.08ab	162.43a
SE±	7.025	5.2658	7.344	6.158
Interaction				
V x N	NS	NS	NS	NS
V x P	NS	NS	NS	NS
N x P	NS	NS	NS	NS
V x N x P	NS	NS	NS	NS

Means followed by same letter(s) in a column and treatment group are not statistically different at 5% level of probability using DMRT. NS = Not significant.

Table 8: Influence of nitrogen and phosphorus on fresh pod yield ha^{-1} (kg) of green bean varieties during 2009-2011 dry seasons at Kadawa Irrigation station

Treatment	2009/2010	2010/2011	2011/2012	Combined Mean
Variety				
Ex-Brown	2198.7c	2278.3b	4407.8a	2961.6c
Dangora	5099.8a	3009.6a	3759.4b	3956.3a
YarHelina	4396.5b	2635.6b	3848.b	3627.0b
SE±	73.43	130.33	135.50	107.01
Nitrogen rate (kgNha^{-1})				
0	2286.9d	1324.6d	2077.4d	2620.6d
20	3580.3c	1748.9c	2923.7c	3441.8c
40	4432.0b	3131.4b	4041.0b	4559.7b
60	5294.1a	4359.7a	5017.7a	5399.3a
SE±	84.80	150.50	123.57	156.41
Phosphorus rate (kg P ha^{1})				
0	3547.2b	2291.1b	3185.9b	3719.4b
22.5	4048.5a	2715.8a	3670.4a	4246.8a
45	4099.2a	2916.6a	3688.6a	4049.9ab
SE±	73.43	130.33	135.50	107.01
Interaction				
V x N	NS	NS	NS	NS
V x P	**	NS	NS	NS
N x P	**	NS	NS	NS
V x N x P	NS	NS	NS	NS

Means followed by same letter(s) in a column and treatment group are not statistically different at 5% level of probability using DMRT. **Highlysignificant at 1% level of probability, NS = Not significant.

Table 9: Shows the Interaction between nitrogen and phosphorus on pod yield of green bean varieties kg ha^{-1} in 2009/2010 at Kadawa Irrigation station

	Phosphorus rates kg P ha^{-1}		
Treatment	0	22.5	45
Nitrogen rates (kg N ha^{-1})			
0	1846.1h	2266.0g	2748.5fg
20	3537.7e	3091.5f	4111.5d
40	4219.6cd	4316.3cd	4759.9b
60	4585.2bc	6520.2a	4776.7b
SE+		146.87	

Means followed by same letter(s) are statistically similar at 5% level of probability

Table 10: Show the Interaction between variety and phosphorus on pod yield of green bean varieties kg ha^{-1} in 2009/2010 at Kadawa Irrigation station

	Phosphorus rates kg P ha^{-1}		
Treatment	0	22.5	45
Variety			
Ex-Brown	2248.9e	2049.1e	2297.9e
Dangora	4753.4c	5161.7ab	5384.2a
Yar-Helina	3639.2d	4934.7bc	4615.5c
SE+		127.20	

Means followed by same letter(s) are statistically similar at 5% level of probability