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Polynomial Response of Green Bean (*Phaseolus vulgaris* L.) Varieties To Nitrogen and Phosphorus Fertilizers Rates

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Abstract
Regression analysis was done to determine the polynomial response of the yield of green bean varieties to nitrogen and phosphorus rates suited to savannah ecology. Polynomial response of green bean (Phaseolus vulgaris L.) varieties to nitrogen and phosphorus rates showed a quadratic response in yield of Ex-Brown variety in 2009/2010 with optimum N rate at 45 kg N ha $^{-1}$ and a linear response for Dangora and Yar-Helina. Yield linearly increased in other years. A quadratic response in yield was observed with P application with on optimum P rate of 29.5 kg P ha $^{-1}$.More research on N fertilizer application to green bean or inoculation with Rhizobium phaseoli needs to be conducted in these Sudan savanna agro ecological zone of Nigeria to ascertain the optimum N requirement,and application of 22.5kg ha $^{-1}$ produced the optimum yield and is therefore recommended.
***Keywords**: Polynomial, Response, Phaseolus vulgarisL, Nitrogen, Phosphorus*

Introduction

Green bean (*Phaseolus vulgaris* L.)is one of the most widely grown among *Phaseolus*species, occupying more than 85% of production areas sown to all *Phaseolus* species in the world(Singh, 1992). Its cultivation dates back to at least 7000 years, as a staple food crop of Central and South America (Yamaguchi, 1983). The leaves are highly appreciated for their vitamin A content (Jansens, 1998). The pods are a superior source of calcium, iron, and vitamin C (Grubben, 1977). The crop is generally cultivated by small holder farmers on an average farm size of less than one hectare, where the use of fertilizer is limited or is not adopted, due to insufficient knowledge and doubts about the efficiency of fertilizers on the yieldincrease.Generally, growth and development of green bean depends on the variety and environmental factors like soil type, soil fertility, soil moisture, soil pH and temperature. Researches elsewhere showed that green bean varieties respond much better to the application of N and P fertilizers as yield increased from 0.5 t ha^{-1} without fertilizer to 2.2 – 3 t ha^{-1} with fertilizer application, because of the increase intensity of cropping which led to serious nutrient mining of the soil, through continuous crop removal and erosion without adequate compensatory replacement with fertilizers or organic manure. Rengel, (2002) recommended that in both temperate and tropical areas, farmers should apply minimal doses of fertilizers to stimulate growth and consequently yield. Messiaen (1992) recommended a complete fertilizer at the rate of 30:60:60: kg ha^{-1}in soils where *Rhizobium phaseoli* is usually present. In African soil, the N rate applied needs to be increased or inoculation with *Rhizobium phaseoli* will be required as *R. phaseoli* is often lacking in most tropical soils. The crop response also could be as a result of the absence of nodule forming bacteria in some soils (Brian, 1971; Messiaen, 1992). The N requirement for the production of green bean is different from other pulse crops, and the different varieties of green bean grown by farmers within the Sudan ecology nutrient requirements have not been made popular among the farmers and productivity remains limited due to little documented research report on the crop N and P nutrients requirement. The low fertility status of the soil in the Nigerian Savanna has been identified as the major factor limiting crop yield (Maurya, *et al*., 1995). Thus the need to apply fertilizer to the crop becomes imperative for optimum yield. Regression analysis was done to determine the polynomial response of the yield of green bean varieties to nitrogen and phosphorus rates suited to savannah ecology.

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°39`N; 08°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 (4 mx3 m). The experimental site in each of the three years research was cleared, harrowed to produce a fine tilt and then ridged at 75 cm apart with a tractor. The area was then marked out into plots with a length of 4 m and a width of 3 m (12 m^2). Each plot was separated from the other by a bund of 0.5 m.

Seeds were sown manually at the rate of two seeds per hole, at an intra-row spacing of 30 cm and inter-row spacing of 75 cm, 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. N was split applied at two and six weeks after sowing (WAS) by band placement while the P doses were applied once at sowing. Weeds observed on the experimental plot were controlled manually by hoeing at 3, 5 and 7 WAS in order to keep the plots weed free. The use of dimethoate at 1.5 kg a.i. ha^{-1} controlled Aphids (*Aphis craccivora*), Spider mites (*Tetranychus urticae*) and grasshoppers (*Zoonecerous variegatus*). Green coloured and immature pods (easily snap-break) were hand-picked while the seeds were small and before the seeds were large enough to cause the pod to bulge around the seed, since the market price is much lower when seed development is visible externally. Harvesting was done by hand picking from the net plot. Data were collected on fresh podweight per hectare. The data collected were subjected to analysis of variance (ANOVA) for a split plot design as described by Snedecor and Cochran (1967) and Little and Hills (1978). Duncan Multiple Range Test (DMRT) was used to separate significant mean differences among treatments (Duncan, 1955). In order to assess the type and magnitude of the relationship among the variables, polynomial responses of pods yield to the nitrogen and phosphorus rates were assessed using regression analysis according to Barr and Goodnight (1972). The formula as described by Reddy *et al.* (1975) was used to calculate the optimum levels of nitrogen and phosphorus.

Results and Discussion

The regression result showed a quadratic response in yield with an optimum N rate at 45.5 kg N ha^{-1} for Ex-brown, a linear response for Dangora and Yar-Helina in 2009/2010 (Fig 1). In 2010/2011, 2011/2012 and the combined mean data, yield linearlyincreased from the equations as seen in Figure 2, 3 and 4 respectively for all the varieties.There was a quadratic response in fresh pod yield ha^{-1} of green bean varieties tophosphorus rates in all the years and the mean data with an optimum P rate of 29.5 kg Pha^{-1} as shown in Figures 5 – 8 for 2009/2010, 2010/2011, 2011/2012 and the combined mean.

The linear response to N fertilizer application could be due to the low fertility of the soil as a result of increase intensity of cropping which led to nutrient mining of the soil, through continuous crop removal and erosion without adequate compensatory replacement with fertilizer or organic manure. Nitrogen is an important element for plant growth and biological processes that occur in the plant (Agbede, 2009). Sa *et al*. (1982) reported that application of various fertilizer doses resulted in significant increase in yield of green bean. Messiaen, (1992) reported that growth and development of green bean depends on variety, soil type, soil fertility and that green bean varieties respond much better to fertilizer application as yield increased from 0.5t ha^{-1} without fertilizer to 2.2-3t ha^{-1} with fertilizer application.The lack of nodules in green bean due to the absence of *Rhizobium phaseoli* could also be the probable reason also for the linear response to N application. Legumes are capable of obtaining most of their nitrogen requirement through symbiotic association with the *Rhizobium* bacteria. Nodulation is reported to be poor in green bean (Alves, 2002). Messiaen (1992) recommended complete fertilizer at the rate of 30:60:60 kg ha^{-1} in soils where *Rhizobium phaseoli* is present and that the N rate applied increased or inoculation with *R. phaseoli* in soils where *R. phaseoli* responsible for inoculation is lacking. The quadratic response in fresh pod yield ha^{-1} could be that the 22.5 kg P ha^{-1} seems to be sufficient to meet the crop nutrient requirements. Singh and Singh (2000) reported significant increase in yield due to increase in P fertilizer up to 22.16 kg ha^{-1}. However, because of the high demand of the crop additional applied N will upset the production cost, and could be profitable to the farmer.

Conclusion

It can be concluded that more research on N fertilizer application to green bean or inoculation with *Rhizobium phaseoli* needs to be conducted in these Sudan savanna agro ecological zone of Nigeria to ascertain the optimum N requirement since the response in this research were linear. Application of 22.5kg ha $^{-1}$ Phousphorus produced the optimum yield and is therefore recommended.

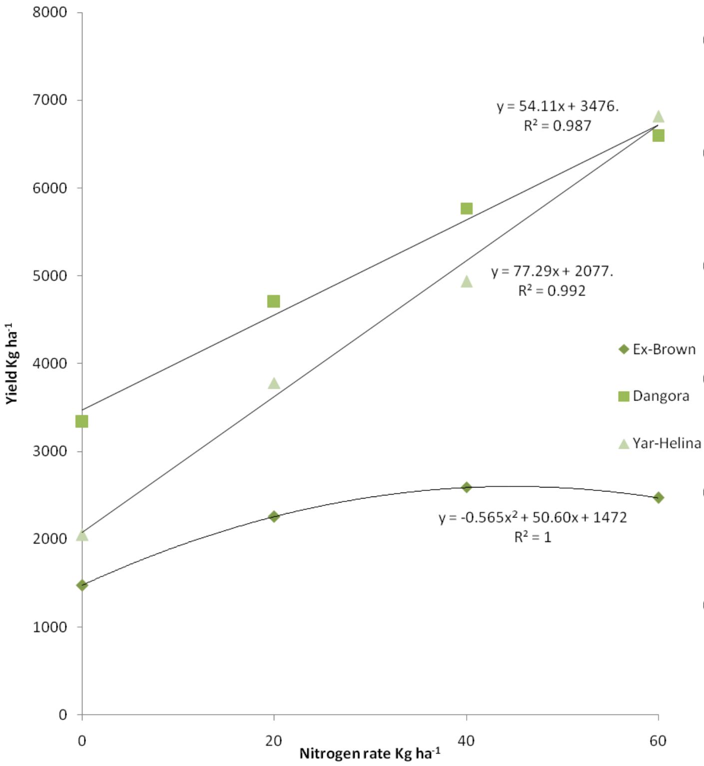

Figure I: Regression of pod yield of green bean varities to nitrogen rate in 2009/2010

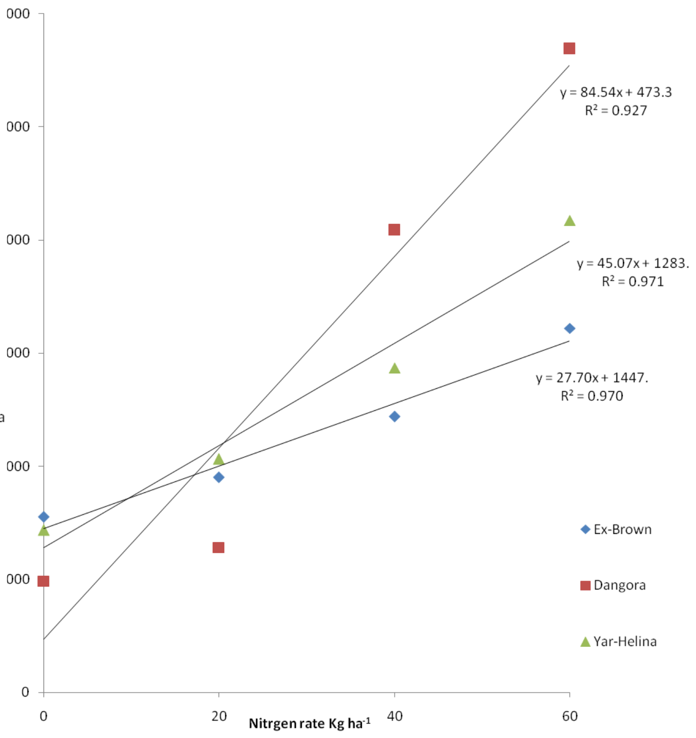

Figure II: Regrssion of pod yield of green bean varieties to nitrgen rate in 2010/2011

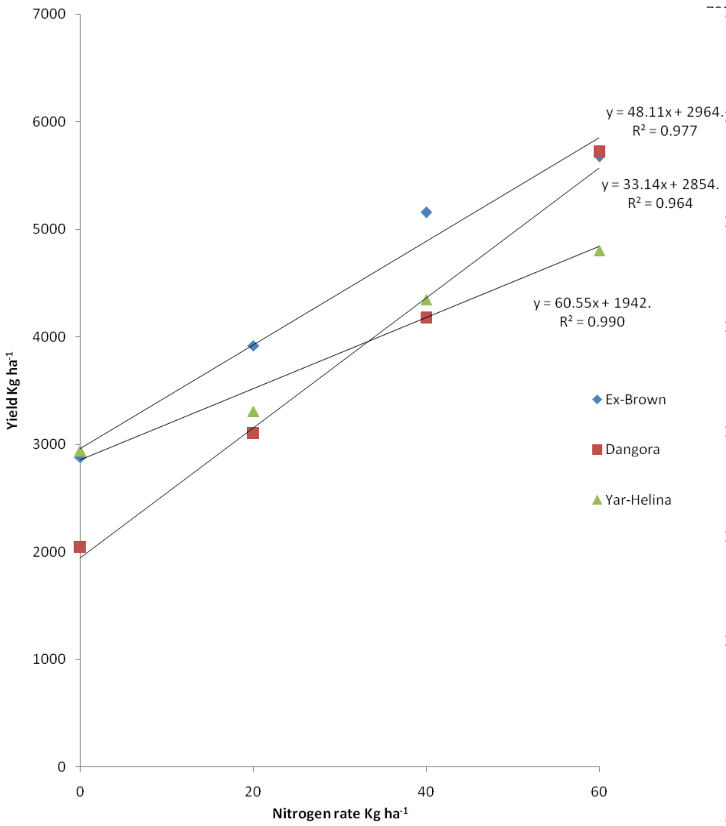

Figure III : Regression of pod yield of green bean varirties to nitrgen rate in 2011/2012

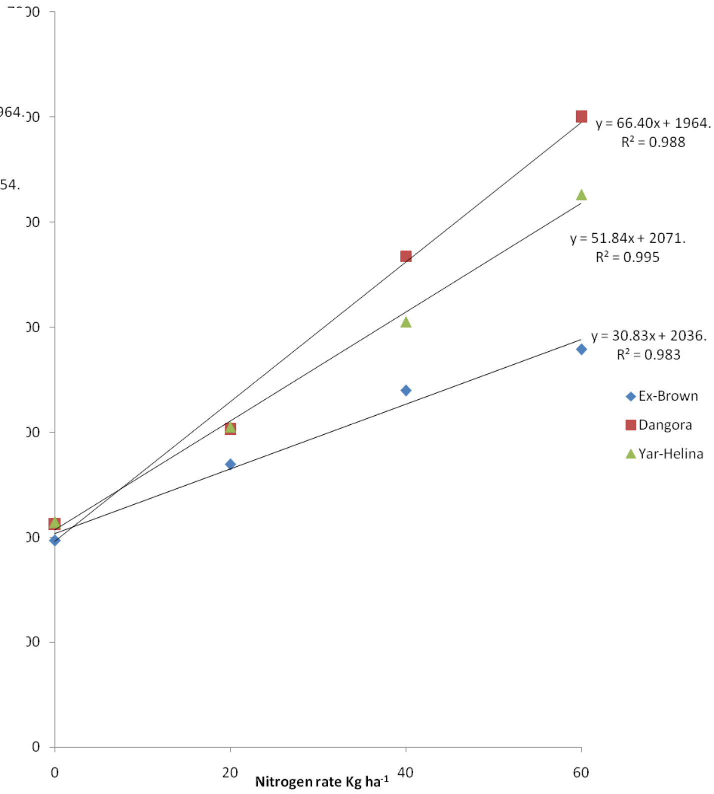

Figure IV: Regrssion of pod yield of green bean varieties to nitrogen rate. Combined mean

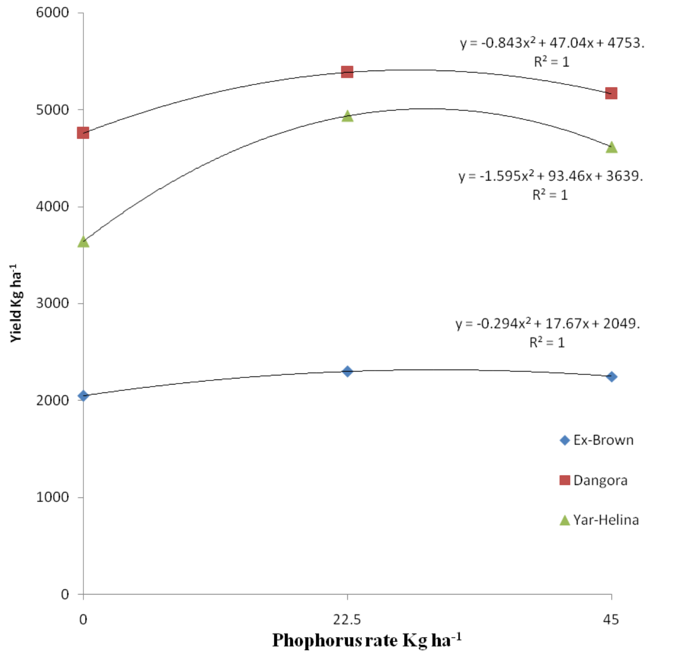

Figure V: Regression of pod yield of green bean varieties to phosphorus rate in 2009 /2010

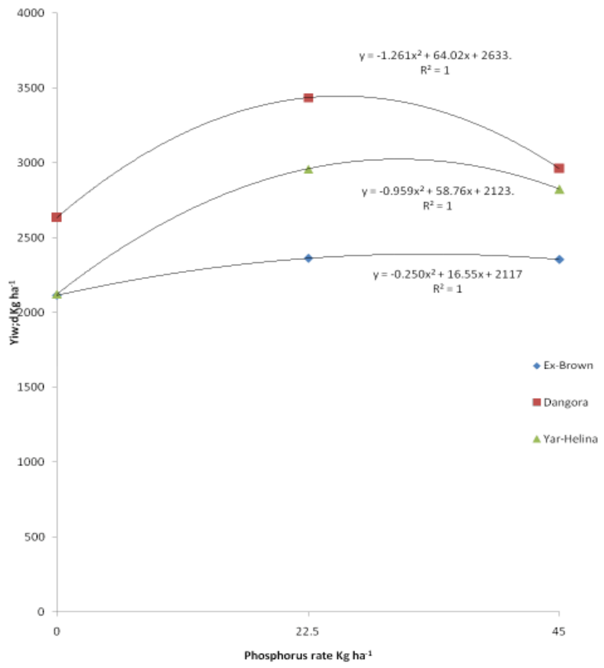

Figure VI: Regression of pod yield of green bean varieties to phosphorus rate in 2010/2011

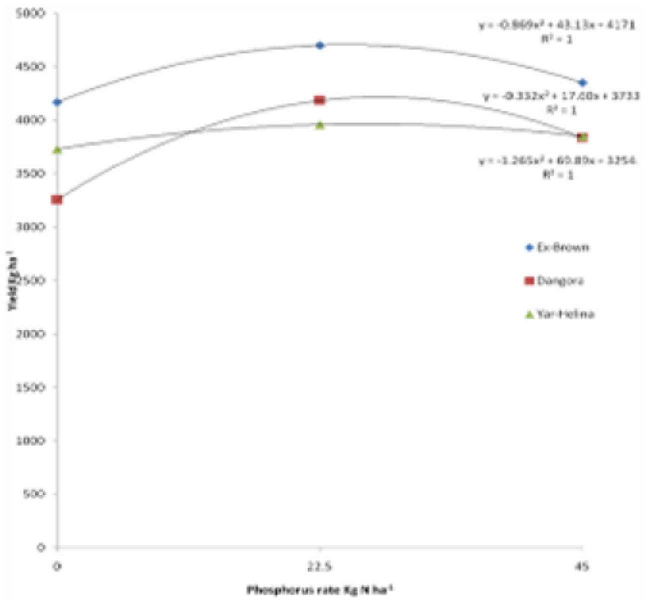

Figure VII: Regression of pod yield of green bean varieties to phosphorus rate in 2011/2012

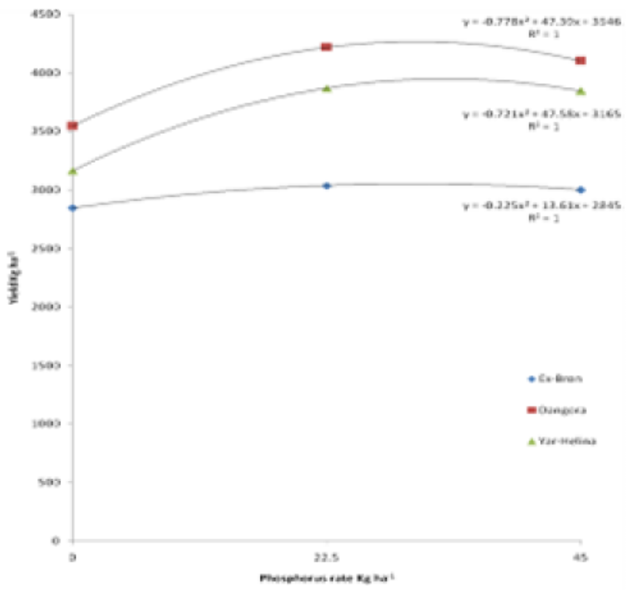

Figure VIII: Regression of pod yield of green bean varieties to phosphorus rate. Combined mean

References

Agbede, O.O. (2009). *Understanding Soil and Plant Nutrition*. Salmon press and co. limited, Keffi, Nasarawa State, Nigeria Pp 1 – 259.

Alves, V.G. (2002). Repostadofeijoeiro.A doses de nitrogenio no plantioecoberturae. ainoculacao de sements com rizobia 46F Disertacao (Mestrado, emfitotecnia) curso de posgraduacaem Agromia, Universidade federal de lawras

Barr, A.J. and Goodnight, J. H., (1972).Auser Guide to the Statistical Analysis System. Department of statistics North cardenas state university. Pp107 – 114

Brian, F. (1971).*Crop production: Cereals and legumes*. Academic Press, London and New York Pp 303 – 319.

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

Grubben, G. J., H., (1977). Leguminous vegetables in: *Tropical Vegetables and Their Genetic Resources*, H. D. Tindall and J. T. Williams, eds., International Board Plant Genetic Research (IBPGR) Rome pp65-68

Jansens, N. F., (1998). *Plant Breeding Methodology*, Wiley Inter science, New York, pp 676

Little, T.M. and Hill, F.J. (1978).*Agricultural Experimentation: Design and Analysis*. John Willey and sons, Inc. New York P 350.

Maurya, P. R..; Kilgori, J. S., Amans, E. B.; Adeoti, A. A.; Shebayan, J. A. Y. (1995). *Crop Production Manual VEWS Guide*, Sokoto Agricultural Development Project Nigeria 134 Pp

Messiaen, C.M. (1992). *The Tropical Vegetable Garden*. Macmillan Press Ltd. London and Basingstoke Pp 283 – 299.

Reddy, R.S., Ahmed, M.K., Cheri, A.V. (1975).Polynomial response of CSH-1 sorghum to varying levels of nitrogen and phosphorus. *Journal of research* APAU, iv (3 and 4): 81 – 83.

Rengel, Z., (2002). Breeding for better symbiosis. *Plant and soil* 245: 147 – 162.

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

Singh A.K. and Singh, S.S. (2000). Effects of planting dates, nitrogen and phosphorus levels, contributing characters in french bean. *Legume Research*, 23:33 – 36.

Singh, S.P. (1992). *Development in Plant Breading. Common Bean Improvement in the Twenty First Century*.Klumer Academic publishers, NeitherlandsPp 409.

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

Yamaguchi, M. (1983).*World Vegetables Principles: Production and Nutritive Values*. Elias Harwood Limited Publishers chichester, England. Pp 267 – 270.