

FULL LENGTH RESEARCH PAPER

Influence of Phosphorus Fertilizer on the Development of Root Nodules in Cowpea (*Vigna unguiculata* L. Walp) and Soybean (*Glycine max* L. Merril).

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Received: February 2008

Accepted: May 2008

ABSTRACT

The investigation was carried out between October – December, 2004 in the Botanical garden of School of Technology, Kano with the aim to assess the influence of phosphorus fertilizer (P_2O_5) at 50kg/ha – recommended dose on the development of root nodules in two legumes, cowpea and soybean commonly grown in Kano State. The study involved Completely Randomized Design (CRD) with four replications on 100m² land splitted into four beds, two each for cowpea and soybean allocated for treatment and control respectively. Result of the nodules count obtained in soybean and cowpea have both shown significant ($P<0.005$) difference between the treated and control plots when statistically analyzed using T-test. The ratio of total number of nodules to number of effective nodules revealed 2:1 and 3:2 in soybean and cowpea treatments and 2:1 and 2:1 in soybean and cowpea controls respectively. It appeared that soybean responded more to p_2O_5 fertilizer than cowpea probably because of the harmattan season which might have affected cowpea since it is more sensitive to short photo period

Keywords: cowpea, soybean, root nodules, phosphorus fertilizer.

INTRODUCTION

Root nodules are basically small swellings on the roots of leguminous plants containing nitrogen fixing bacteria. The development of root nodules is one of the characteristic feature of the family fabaceae. The family fabaceae is the second largest family in the plant kingdom containing many crops such as cowpea, soybean, peas, groundnut etc. Cowpea and soybean have simple leave that are pinnately or palmately compounded. Cowpea was believed to have originated from central America but some workers believed that it originated from Asia or Africa (Danladi, 1992; Garget *et al.*, 1970). On

the other hand soybean was believed to have originated from south eastern Asia (Saye, 1990; Kaseem, 1991).

Cowpea and soybean are extensively grown in the world largely because of their important nutritious values. Nigeria is the largest producer of cowpea as of 1981 (Rachie, 1985) producing over 83.5 million metric tones. Cowpea production is declining in Nigeria and a substantial part of the cowpea production comes from the drier region of Nigeria (Singh *et al.*, 1997). An estimated 1.85 million tones was produced in 1996 and this was increased by about 2.26 million tones in 2000, 2.41 million

tones in 2002 (CBN, 2003). The bulk of Nigeria's cowpea is produced in the Sudan savanna belt (FMAWR & RD, 1989). The main cowpea producing states in Nigeria are in the north, mainly Kano, Kaduna, Katsina, Bauchi, Borno, Adamawa and Taraba states (Ayinde *et al.*, 2006).

Soybean production is also increasing at a fast rate in Nigeria because farmers have started to realize its value. Both cowpea and soybean have high protein contents. Cowpea contains about 20.7 - 23.2% while soybean has 29.6 - 50.3% protein (Kaseem, 1991).

The total global significance of legume fixed nitrogen is obviously great and impossible to define in strict quantitative terms. Two aspects of benefits accrue from the use of nodulated legumes as crop or as pasture plants. The first is the plant's independence of soil nitrogen which makes its cultivation very cheap. The second is the potentially improved nitrogen status of the soil on the consequent use of soybean and cowpea. Perhaps, according to Quispel (1974) a rounded guess of over 100 million metric tones of nitrogen annually has been estimated to accrue as a result of planting legumes.

Cowpea and soybean contribute in fixing of nitrogen (60-70kg per hectare) in soil for the next succeeding-crop (Rachie, 1985). Rhodes (1981) and Pillai *et al.* (1983) have showed that phosphate fertilizers application increased growth, vigor, quality and yield of cowpea to a certain level. Similarly, Hague *et al.*, (1980) observed the effect of 0,30,60 and 90kg P₂O₅ and 2,4 and 6kg Zn per hectare on the growth of soybean on Ngala soil. There was a positive linear effect of the rate of phosphorous on the number of root nodules.

Nigeria is a highly populated developing country and therefore, majority of its populace depends on food crops for their survival. Cowpea and soybean are the major and cheapest sources of plant proteins. Therefore, their production should be improved because of the shortage and high cost of animal proteins. Most crop plants require fertilizers especially nitrogenous fertilizers, for good growth and yield, making them very expensive to produce hence, there is need to explore plants that produce their own nitrogen and even improve soil nitrogen status.

Therefore, this study aims to determine the effect of phosphorus on the development of root nodules in cowpea and soybean and also compare the number of effective and ineffective nodules produced by the crops due to the phosphorus application.

MATERIALS AND METHODS

Experimental Site

The study was conducted in the Botanical Garden of the Department of Science Laboratory Technology, School of Technology, Kano between October and December, 2004. Kano is located in the Sudan savanna on Latitude 12° 11' N and Longitude 08° 7' E characterized by a mean annual rainfall of 602mm (IITA, 1999).

Experimental Design

A completely randomized design field experiment with four replications was adopted to determine the influence of phosphorus fertilizer on the development of root nodules in cowpea and soybean. A 100m² plot obtained in the departmental garden was cleared and four beds were prepared; two each for cowpea and soybean. One bed each was allocated for treatment and control in cowpea and soybean respectively.

Collection and planting of seeds

An improved variety of cowpea, IT90K - 277-2 was collected from International Institute of Tropical Agriculture, Kano Station and soybean variety Sharu Local from Kano Agricultural and Rural Development Authority and sown on 18th October, 2004. at the rate of three to four seeds per hole and 25cm apart as recommended by Komolafe *et al.*, (1985). Seedlings started emerging 3 days after sowing. Watering was by irrigation. Germination count was taken at 3,4 and 5 days after planting. One week after germination, thinning was done leaving only two plants/stand and 50kg/ha phosphate fertilizer was applied in one bed each for cowpea and soybean respectively serving as treatment while the other bed served as control. Fertilizer was applied at the rate of 50kg/ha in a concentric circle around each plant.

Nodules Count

Four weeks after seedling emergence, data were collected by uprooting four plants from each bed and counting the number of nodules and the number of effective nodules. Effective nodules could be distinguished from the ineffective ones

by carefully washing the root and their attached hairs, the effective nodules look pink or light red while the ineffective ones appear white. On squeezing the nodules with hand effective nodules appear red/pink because it contains a pink pigment called legume-hemoglobin. The same procedure was repeated in both treatments and control plots at the 8th week after germination and at the end of flowering/bloom (12th week after planting).

Statistical Analysis

Data obtained were subjected to statistical analysis using paired T-test as suggested by Naye (1991).

RESULTS AND DISCUSSION

The result of the nodule count in the treated and control experiments in soybean and cowpea are shown in Tables 1 and 2 respectively. In soybean the total number of nodules was found to be 105 in the treated and 75 in the control plots (table 1). In cowpea on the other hand the total number of nodules was 91 in the treated and 68 in the control plots (Table 2).

T – test in both cases showed significant differences between the treated and the control. Both cowpea and soybean produced a significant ($P < 0.05$) difference in the number of effective nodules with total number of effective nodules of 60 and 40 in cowpea treated and control and the 49 and 37 produced by soybean treated and control plots respectively. The results showed the influence of phosphorus fertilizer in the development of root nodules in cowpea and soybean. For a long time the need to supply phosphorus fertilizer to legumes was considered to be of little importance probably because the role of phosphorus was not fully recognized.

However, it is evident that legumes need a lot of phosphorus, potassium and little nitrogen. The result also showed that phosphorus promoted the growth of both soybean and cowpea. This is in accord with the report of Cope and Hunter

(1967) that phosphorus stimulated growth and enhances the absorption of nutrients for rapid development and influence the availability of other nutrients such as nitrogen and potassium. This could be attributed to the role of phosphorus in cell division which enhances carbohydrate synthesis (Simpkins and Williams, 1988). Comparing tables 1 and 2, it is evident that phosphorus application increased the nodules population. This is at par with the report that high rate of phosphorus raised nodule number by a factor ranging from 2-22 in soybean depending on the variety, seasonal conditions and stage of development (Demoooy and Pesek, 1966). This has consequently shown that nodule development requires a good supply of phosphorus.

The result also showed that the number of nodules (both effective and ineffective) increased with stage of development and was found to be more in the presence of phosphorus. The result further indicated that soybean produced more nodules than cowpea. This could be attributed to the fact that the whole study was conducted during dry season which might have invariably affected the results obtained from cowpea because cowpea is more sensitive to the short photoperiods of the cold harmattan season than soybean which is a short day plant. From the result, it was observed that the ratio of total number of nodules to the number of effective nodules in soybean is roughly 2:1 (Table 1) while in cowpea, it was table 3:2. This showed that only half of the nodules formed are effective in soybean while the ratio was higher in cowpea.

CONCLUSION AND RECOMMENDATIONS

Phosphorus fertilizer increased nodule number as well as growth and development in both soybean and cowpea. Therefore farmers should be encouraged to be applying 50kg/ha Phosphorus fertilizer on legumes. It is therefore suggested that further research be intensified on the importance of leguminous crops pertaining their fertilizer requirements.

Table 1. Effect of phosphorous fertilizer on the development root nodules in Soybean

Stage of development	TREATMENT			CONTROL		
	4wks after germination (6-leaves)	8wks after germination (10-leaves)	After flowering (12wk)	4wks after germination	8wks after germination	after flowering (12wk)
Total number of nodules	16	38	51	11	19	45
Number of effective nodules	6	16	27	4	9	24
i. total no of nodules	105			75		
ii. total No. of effective nodules	49			37		
iii. ratio of total No. to No. of effective nodules	2:1			2:1		
Calculated t- value= 125.1						
Table t value= 2.78						
P<0.05						

Table 2. Effect of phosphorous fertilizer on the development root nodules in cowpea

Stage of development	TREATMENT			CONTROL		
	4wk after germination (6-leaves)	8wk after germination (10-leaves)	After flowering (12 wks)	4wk after germination	8wk after germination	After flowering (12 wks)
Total number of nodules	19	33	39	17	21	30
Number of effective nodules	10	21	29	09	11	20
i. total No. of nodules	91			68		
ii. total No. of effective nodules	60			40		
iii. ratio of total No. to No. of effective nodules	3:2			2:1		
Calculated t- value= 47.94						
Table t value= 2.78						
P<0.05						

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