SCREENHOUSE EVALUATION OF GROUNDNUT GENOTYPES FOR NITROGEN FIXATION AND MAIZE VARIETIES FOR NITROGEN UPTAKE EFFICIENCY

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ABSTRACT

Phosphorus is important in the symbiotic association with the bacteria rhizobium, there by fixing atmospheric nitrogen. Due to low availability of the fertility status of most savannah soils, the objectives of this research were therefore; to estimate biological nitrogen fixation by the groundnut genotypes under low and high phosphorus conditions and to determine the nitrogen uptake efficiency of some selected maize varieties. To achieve these objectives, a potted experiment was conducted in the screenhouse of the Department of Soil Science, Ahmadu Bello University Samaru, Zaria. The treatments consisted of a combination of five genotypes of groundnut namely; (Samnut 10, Samnut 11, Samnut 21, Samnut 22 and Samnut 23) and three varieties of maize (TZE, TZEE, and Obatampa). The groundnut genotypes had 60kg P2O5 ha-1 (13.2 mgP/kg soil) and 0kg P2O5 ha-1 (0 mgP/kg soil), the maize varieties had 75 kg P2O5 ha-1 (16.5 mgP/ kg soil) and 0 kg P2O5 ha-1 (0 mgP/ kg soil) levels. The treatments were repeated three times and laid down in a Completely Randomised Design. There was no significant difference in the amount of atmospheric nitrogen fixed by the groundnut genotypes. However, Phosphorus application significantly increased nitrogen fixation compared to the control, therefore 60kg P2O5 ha-1 is concluded for higher nitrogen fixation in the soil.The effect of maize varieties in relation to nitrogen uptake efficiency was significant statistically, this result shows that the varieties that grow and develop extra early takes up more nitrogen faster than the late varieties and early varieties.

Keywords: *Screenhouse, Genotypes, Nitrogen fixation*.

INTRODUCTION

Intercropping of legumes and cereals has been an old practice in tropical agriculture. The major aim of intercropping is to make maximum use of the resources like space, light and nutrients. (Sanginga *et al.*, 2001; Schulz *et al.*, Li *et al.*, 2003b; Ndakidemi, 2006), minimizing negative effects such as competition among the components, and also to improve the crop quality and quantity (Mpairwe *et al.*, 2002). Some other benefits include water quality control through minimal use of inorganic nitrogen fertilizers that contaminate the environment (Crew and Peoples., 2004). Studies have shown that legume-cereal mixtures produce higher grain yields than either crop grown alone (Rao and Mathuva, 2000; Olufemi *et al.*, 2001; Mpairwe *et al*; 2002; Dapaah *et al*., 2003). The yield increases in the legume-cereal mixtures were attributed to improve nitrogen nutrition of the cereal (e.g Maize) component and also to other unknown processes (Vanlauwe *et al.*, 2001; Connolly *et al.*, 2001; Sanginga *et al.*, 2001). In Nigeria, maize yield averages about 1.4 tons per hectare and this is only about 20% of the average in Canada and other parts of the world where intensive cereal production is carried out (Afolami and Fawole, 1991; FAO, 1999). Groundnut which is also referred to as peanut, (Arachis hypogea) is a dehiscent legume that is harvested from below the soil. Reports on biological nitrogen fixation (BNF) by grain legumes are well documented (Giller and Cadisch, 1995; Peoples et al., 2002) because of its importance as nitrogen source in agricultural ecosystems (Dakora and Keya, 1997).

Nitrogen (N) is the most limiting nutrient element for maize production (Sanginga, 2003) and it is essential for seed formation and maturity. A steady supply is needed during the early growth stage and this steady supply is provided by the action of soil microorganisms on the soil organic matter (SOM) or by application of inorganic fertilizers. It is however, a known phenomenon that savanna soils have low inherent fertility status, low water holding capacity, low organic matter, low cation exchange capacity (CEC), low total nitrogen and phosphorus, low water infiltration capacity, poor internal drainage due to poor structure (Lombin *et al.*, 1991; Jones and Wild, 1975), indicating that the soils have low productivity potential. This study was carried out to estimate biological nitrogen fixation by the groundnut genotypes under low and high phosphorus conditions as well as to determine the nitrogen uptake efficiency in some selected maize varieties.

MATERIALS AND METHOD

The experiment was conducted in the screen house of the Department of Soil Science screen house, Faculty of Agriculture/Institute for Agricultural Research, Ahmadu Bello University, Samaru, Zaria. Located at Latitude 10011N, Longitude 70 38'E with an altitude of 686m asl. Sand was collected from a nearby river and sieved through a 2mm sieve. Three kilogram each of air-dried soil was weighed in 48 plastic pots of 18cm in diameter and 16cm deep. The sand sample was analysed for total nitrogen using Kjeldahl digestion method as described by Bremner and Mulvaney (1982).

The treatments consists of a combination of five genotypes of groundnut (Samnut 10, Samnut 11, Samnut 21, Samnut 22, Samnut 23) and a reference maize crop of three genotypes namely TZE, TZEE, and Obatampa, which are classified as early maturing, extra early maturing and late maturing respectively, to match the combination of the selected groundnut genotype Samnut 10 and Samnut 11, which is classified as late maturing (ICRISAT, 2007) , (IAR, 1990) and Samnut 21 and Samnut 22, which were classified as early maturing, and Samnut 23, which is classified as extra early maturing were used (ICRISAT, 2007). The crops were planted in the pots with the groundnut genotypes receiving 0 and 13.2 mg P2O5 kg-1 soil while the maize genotypes received 0 and 16.5 mg P2O5 kg-1. These gave a total of 16 treatments which were repeated three times in a Completely Randomised Design

Data collected from some of the post-harvest materials were used to calculate the phosphorus use efficiency (PUE), shoot N uptake, root N uptake, shoot P uptake, root P uptake, total N uptake, total P uptake and nitrogen fixed using N difference method.

These are shown in the formulae below:

Shoot N uptake = Shoot dry weight x Nitrogen concentration.

Root N uptake = Root dry weight x Nitrogen concentration.

Total N uptake = Shoot N uptake + Root N uptake.

Nitrogen Fixed = Total N uptake of groundnut genotype x Total N uptake of maize Genotype x. (Hardason and Damro, 1987).

Where x = Samnut 10, Samnut 11 and Obatampa = Late maturity.

x = Samnut 21, Samnut 22 and TZE = Medium maturity.

x = Samnut 23 and TZEE = Extra Early maturity.

These formulae were used in calculating the above mentioned parameters from the plant sample and other materials obtained from the harvest of the groundnut plants to be collected. All data collected were subjected to Analysis by standard ANOVA procedures for a complete randomised design for test of significance using SAS systems (SAS, 1999), treatment means were compared using the least significant difference test at 5% level of probability.

RESULTS AND DISCUSSION

The effect of groundnut genotypes and P levels on shoot N uptake are all shown in Table 1. The shoot N uptake of a plant is its ability to take up available nitrogen from the soil to its shoot (Hardason and Damro, 1987). The effect of groundnut genotypes on shoot N uptake was not significant statistically, which implies that the groundnut genotypes had the same level of N uptake in their shoot. The shoot N uptake in relation to P rate was statistically significant, this implies that 13.2 mgP/kg soil had higher level of N in the shoot of the plant than 0 mgP/kg soil respectively. Yayock and Yusuf, (1979) reported that for every 120kg of pod produced 75 kg N, 7 kg P, 42 kg k, 15 kg Ca, 6 kg Mg and 6 kg S would have been taken up by the crop, this is because of the interactive effect of N and P in which the interaction enhances the uptake of both nutrients, therefore higher uptake of shoot N (Malcolm and Mart, 1986). The interaction between the groundnut genotypes and the P rates were statistically not significant.

Table 1: Effect of genotypes and P levels on groundnut shoot N uptake, root N uptake, total N uptake and nitrogen fixed

Treatment	Shoot N uptake (g)	total N uptake (g)	nitrogen fixed (g)
Genotypes (G)			
Samnut 10	20.40a	22.00a	17.54a
Samnut 11	35.49a	37.27a	19.86a
Samnut 21	18.12a	19.84a	11.96a
Samnut 22	16.44a	17.04a	16.03a
Samnut 23	21.12a	21.60a	15.40a
SE	31.01NS	32.62NS	9.57NS
Phosphorus (P) Level mg/kg soil			
0	13.37b	14.77b	6.97b
13.2	31.26a	32.33a	25.34a
SE	12.46*	13.05*	3.83*
G X P Interaction			
SE	62.02	65.25	19.14
Significance	NS	NS	NS

*Means followed by dissimilar letters within the same treatment in a column are significantly different at 5% level of probability.
NS = Not significant at 5% level of probability.

Total N uptake

The effect of groundnut genotypes and P levels on total N uptake is shown in Table 1. The total N uptake of a plant is the sum total of the root N uptake and the shoot N uptake (Hardason and Damro, 1987), the effect of total N uptake and the groundnut genotypes was not significant statistically. This implies that the total N uptake level by each groundnut genotype was the same statistically. The effect of P levels on total N uptake was significant statistically. Application of 13.2 mgP/kg soil had a higher total N uptake than 0 mgP/kg soil because of the interactive effect of N and P in which the interaction enhances the uptake of both nutrients, therefore the higher uptake of total N (Malcolm and Mart, 1986). The interaction between the groundnut genotypes and P rates was not significant statistically.

Nitrogen fixation

The effect of groundnut genotypes and P levels on nitrogen fixation is shown in Table 1. The effect of the groundnut genotypes in relation to N fixed was not significant statistically. This is due to the genotypic characteristics of the genotype being the same in terms of N fixation. The application of 13.2 mgP/kg soil gave the highest amount of N fixed. This observation corroborates the findings of Bellido *et al.*, (2001). They applied 0, 50, and 80 kgP/ha on cowpea crop and found out that the application levels of 50, 80 kgP/ha had a higher levels of atmospheric N fixation. This is because groundnut is a heavy P feeder and it requires P for most of its physiological and metabolic processes that helps enhance its growth and development, therefore the application of P at 13.2 mgP/kg soil is necessary for increased atmospheric nitrogen fixation within the genotypes selected. The interaction between the P rates and groundnut genotypes in relation to N fixed was not significant statistically.

Nitrogen uptake efficiency

The effect of maize varieties in relation to nitrogen uptake efficiency was significant statistically (Table

2) with Tzee having the highest mean, while Tze and Obatampa had the same mean statistically. This due to the inherent characteristics of the varieties being different, e.g Tzee is the extra early variety, Tze is the early variety and obatampa is the late variety, this result show that varieties that grow and develop extra early takes up more nitrogen faster than late varieties and early varieties. This work corresponds to the work of Lemcoff and Loomis (1994A) which states that a steady supply of nitrogen is needed during the early growth stage and this steady supply is provided by the action of soil microorganisms on the soil organic matter (SOM) or by application of inorganic fertilizers. Therefore this shows that if maize requires nitrogen at a steady supply at an early stage of development, then the extra early varieties will require nitrogen at a higher rate, hence this work shows Tze having a higher nitrogen uptake efficiency. Therefore early and late varieties of maize like Tze and Obatampa can be sown in regions where there are moderate to low plant nutrient, e.g. Northern guinea savannah region of Nigeria, or Derived savannah region of Nigeria. Tze variety of maize which is the extra early variety can be planted in areas of Nigeria where there is less rainfall, very low plant available nutrient, example; the Sudan savannah region in Nigeria because most of the soil in that region have been leached away and it is also sandy, hence less fertile. The result also shows that p application was not significant to nitrogen uptake efficiency (Table 2). This is because nitrogen is the most limiting nutrient element for maize production (Sanginga, 2003). Therefore the effect of p is hence not significant. The interaction of maize varieties and p level was also not statistically significant (Table 5).

Table 2. Effect of varieties and P levels on nitrogen uptake efficiency of maize

Treatment	Nitrogen uptake efficiency
Varieties (V)	
Tze	5.65b
Tzee	10.24a
Obatampa	4.98b
SE	1.62*
Phosphorus (P) Level mg/kg soil	
0	6.57a
16.5	7.35a
SE	1.34^NS^
V X P Interaction	
SE	2.31
Significance	NS

*Means followed by dissimilar letters within the same treatment in a column are significantly different
at 5% level of probability.
NS = Not significant at 5% level of probability.

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