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Effect Of Fertilizer And Genotype On Crop Quality And Profitability Of Groundnut In Morogoro, Tanzania

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Abstract: Soil degradation has adverse effects on the growth, development and yield, hence quality and profitability of agricultural produce, as such, appropriate utilization of fertilizer resources could enhance crop yield, thus quality and profitability of crops. This study focused on the contribution of fertilizer and genotype to some nutritional qualities and profitability of groundnut in an experiment laid out in a Randomized Complete Block Design (RCBD) at the Sokoine University of Agriculture Morogoro, Tanzania with three improved groundnut genotypes (Mangaka, Masasi and Pendo) using Minjingu mazao and DiAmmonium Phosphate as sources of Calcium and Phosphorus,respectively. Data was subjected to ANOVA using GENSTAT 14th software and means separation were made using Least Significant Difference (LSD) at 5% significance level. Results from the study showed significant influence of fertilizer and groundnut genotype on crop quality and profitability. Genotype x fertilizer interactions showed significant effect of calcium on kernel size, protein and oil contents of all genotypes, whereas the application of phosphorus significantly influenced yield and profitability. A value cost ratio (VCR) of >2.0 as obtained from the study is an indication that sustainable fertilizers use could enhance crop quality, hence profitability of groundnut. Further research involving fertilizer treatment combination in multi-locational trials, as well as other nutritional parameters of groundnut crop are suggested to determine specific recommendations for calcium and phosphorus as sustainable nutrient supply contribute to higher productivity of groundnut is crucial to curtailing nutrition security and farmers' income.

Key words: Crop Quality, Groundnut, Fertilizers, Profitability

1. Introduction

Groundnut (Arachis hypogaea L.) usually grown as a cash crop, also known as peanut, earthnut, monkey-nut or goober, is a self-pollinating, indeterminate, annual herbaceous legume crop[1].Groundnut serves as an important source of fats, protein and raw materials for the cosmetic and confectionary industries [2,3]. Degrading status of soil fertility in Africa accounts for 75% yield losses in legumes as many smallholder farmers, growing groundnut do not have appropriate and access to adequate input such as fertilizers to overcome this constraint[4].The average yield of groundnut in Tanzania, 0.96t/ha is far below the yield potential of 2 t/ha [5]. Reducing the yield gap calls for an understanding of abiotic and socio-economic constraints including low fertility status of soils, poor agronomic practices as well as availability and access to fertilizer and improved seed that limit production[6,7].Groundnut is an important oil crop in most African countries including Tanzania. In Tanzania, groundnut is among the important sources of vegetable oil next to Sunflower; besides it serves a source of food, raw materials for the local confectionery industry and farmers income; however, low production due to poor soil have been highlighted as constraints likely to affect farmers' income [8,9]. Adoption of quality seed, cost effective technologies and sustainable agronomic practices including appropriate use of fertilizer resources are major steps in enhancing groundnut production among smallholder farmers. To enhance groundnut crop quality and profitability the research was conducted investigate the response of groundnut crop quality to Ca and P nutrition, hence the economic return on such practices.

2. Materials and Methods

2.1 Field layout and experiment design

A field experiment was laid out at Sokoine University of Agriculture (SUA), Crop Museum situated at latitude 6° 45'' South and longitude 37° 40" East at 525 m.a.s.l in Morogoro municipality characterized by kaolinitic clay soils, which are well drained and mostly clay[10].The experiment was 9 factorial combination with four replications laid down in randomized complete block design. The factors were three groundnut genotypes (Mangaka, Masasi and Pendo) with two fertilizers,(Diammonium Phosphate and Minjingu mazao) used to supply P and Ca applied at rates of (0, 55, and 125 kg/ha),respectively. Application of P was done at planting as basal application,while Ca was applied at pegging stage. Soil samples were taken at the depth of 20 cm as described by[11]. and sent to the Department of Soil and Geological Sciences Laboratory for physical and chemical analyses,whereas soil physio-chemical ratings were done as prescribed by[11] land clearing and all agronomic practices were carried out as described by[12].

3. Data Collection and Analysis

Crop quality data including 100- kernel weigh were recorded whereas analyses for Crude protein and Oil content were done at the Food Science and Technology laboratory at SUA. A random selection of air dried kernels at 15% moisture content were taken from the harvested plants to the Food Science and Technology laboratory at SUA for crop quality data including 100-kernel, Crude protein and Oil content as described by[13,14] and standard Soxhlet extraction procedure [15], respectively. Value -Cost Ratio (VCR)[16] was used to determine the ratio between the value of the additional crop yield and the cost of inputs taking into consideration the cost of seed, fertilizers, labor and the average price of groundnut on the local market. VCR = Σy_i x p_1 $\Sigma x i p_2$ Where: y_i = extra yield produced due to input (kg/ha) p_1= value of extra yield produced ($/kg);xi = input applied (kg/ha) p_2= cost of input ($/kg). Value cost ratio was further rated as follow: VCR = 1: yield may be increased but no financial incentive to adopt new practice VCR = 2: farmers earn profits VCR = >2: Minimum acceptable level for adoption of new practice by farmers. Data collected were subjected to analysis of variance (ANOVA) using GENSTAT released version 14th edition and declared significant at P < 0.05 using the following statistical model as described by[17].The mean separation test was done using Duncan Multiple Range Test (DMRT) at P≤ 0.05.

4. Results

Detailed physico-chemical analyses of soil for the study are shown in Table 1.

***Table** 1(a): Physical characteristics and macro nutrient status of soil at experimental site.*

A. Physical (%)	Chemical Macro Nutrients /Rating[1]	
Sand - 49.2	pH	5.9 - M/A*
Clay - 42.72	Organic Carbon	0.07 -VL
Silt -8. 08	Total Nitrogen	0.18 -VL
Textural Class: Sandy clay	Organic Matter	0.12 -VL
	C : N ratio	1:1.25-VL
	Extractable P	0.048 - L
	C : N ratio	1:1.25-VL

**soil nutrient status rating as prescribed by Landon, 1991. L= low, H= high, VL= very low, VH= very high*

***Table 1(b):** Exchangeable cations and micronutrients levels of soil at experimental site.*

Exchangeable Cations cmol$_c^{(+)}$		Micronutrients (mg/kg) Rating[1]	
Calcium 27. -	VH *	Iron	31.7 - VH
Magnesium 186.6	- VH	Manganese	92.0 - VH
Potassium 2.16	- H	Cooper	13.0 - VH
Sodium 5.4	- VH	Zinc	24.6 - VH

**soil nutrient status rating as prescribed by Landon, 1991. L= low, H= high, VL= very low, VH= very high*

4.1 Effect of Fertilizer Application and genotype on Yield and Profitability

It was revealed from the study that the application of fertilizer had significant influence on yield, with an observed increased VRC under P,thus affecting profitability Table 2.

***Table 2:** Influence of fertilizer yield profitability of groundnut.*

Treatment (Fertilizer type)[1]	Kernel yield (kg/ha)	Market price ($/kg)[2]	Gross income ($/kg)	Net income ($/ha)	VCR*
Control	1327	1.63	2 163.0	2 163.0	0.00
DAP	1 760	1.63	2 868.9	1 968.9	2.2
Minjingu mazao	1 505	1.63	2 453.2	840.7	0.5

Fertilizer type, based on available sources of P and Ca [2]Price based on the observed market price in the study area in USD *Currency conversion was based on the banking exchange rate of US$1: 2000 Tanzanian Shillings at the time of the study.

4.2 Crop quality

Groundnut genotype significantly (P=0.001) influenced 100- kernel weight with Masasi proving superior compared to the lowest as observed in Pendo. Whereas the application of P and Ca significantly (P=0.004) influenced 100- kernel weight Figure1(a-b). Significant (P=0.001) effect of genotype on crude protein content was observed with Pendo recording 32.4% increase in crude protein content compared to Mangaka (28.5%). Groundnut oil content was significantly (P=0.001) influenced by genotype and recorded in the order of Pendo (44.2%), Masasi (43.3%) and Mangaka (41.4%). Whereas application fertilizer had no effect on oil content of groundnut Figure 1(a-b).

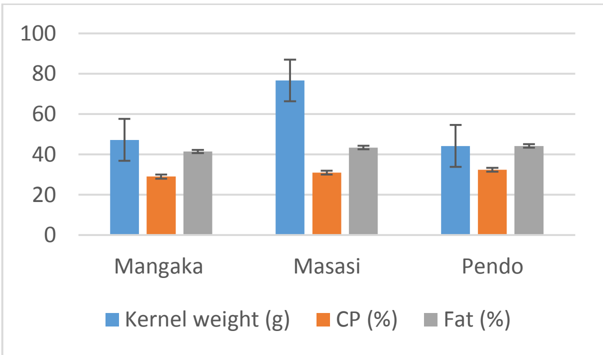

***Figure1 a.** : Influence of groundnut genotype on crop quality.*

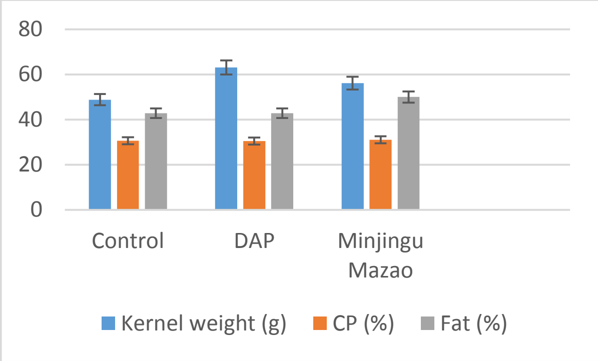

***Figure 1(b)** : Influence of fertilizer type on groundnut crop quality.*

4.3 Genotype x Fertilizer interaction

Findings from the study showed significant interaction effect, with kernel weight of Masasi crude protein content of Mangaka and oil content of Pendo been influenced by Minjingu

***Table 3:** Interaction effect of genotype and fertilizer type on kernel weight, oil and protein contents of groundnut.*

Treatment effect	Kernel weight (g)	%Crude Protein	%Fats
Mangaka x control	46.6bcd	32.32 c	43.18c
Mangaka x DAP	46.9cd	40.50 d	43.70d
Mangaka x Minjingu mazao	48.4 d	40.60 d	43.25cd
Masasi x control	54.9e	28.80 a	41.00 a
Masasi x DAP	98.5 g	28.40 a	40.90a
Masasi x Minjingu mazao	76.5f	28.30 a	42.40 b
Pendo x control	43.2a	30.45 b	43.65d
Pendo x DAP	45.3abc	30.55 b	44.15e
Pendo x Minjingu mazao	44.1ab	32.00 c	44.90f
Mean	56.0	32.43	43.01
SE ±	1.71	0.45	0.30
Cv (ab) %	3.1	1.45	0. 70
P- value	0.001	0.001	0.001

**Means in the same column and factor followed by the same letter are not significantly different at $P \leq 0.05$ according to Duncan Multiple Range Test*

5. Discussion and Conclusion

Soil analysis report from the study area revealed that the soil was sandy clay loam with a bulk density of 1.2g/cm^3 which is considered an optimum bulk density for most crops[18] (Lal and Shukla, 2004). Soil pH at the experimental site was 5.9, considered favourable for groundnuts[19].Low soil nitrogen content (0.18% T.N) at the experimental site was an indicator associated with the history of continuous cultivation with little or no addition of organic or inorganic fertilizers. Though not required in large quantities by legumes, soil available nitrogen is essential for vegetative growth as such, addition of nitrogen fertilizers at low rate as a starter dose to leguminous crops such as groundnut is necessary especially where soil nitrogen content is low[20]. Groundnut genotype and fertilizer had significant influence on kernel weight similar to findings by [21] who reported increased kernel weight with application of Ca (Table 2). An observed significant influence of P and Ca at 50 and 110 kg/ha, respectively on crop quality and yield by increasing yield from 1000 to 3000 kg/ha[22] . Significant genotype x fertilizer interaction was recorded with Masasi been significantly influenced by the application of P, which validates findings by[23]. The study observed significant influence of fertilizer and genotype on oil content of groundnut. Such findings are similar to findings made by [3]. The interaction effect of fertilizer x genotype revealed that Pendo was significantly influenced by the application of Ca The result showed that fertilizer had no significant influence on protein content while significant effect of groundnut on protein content was observed in Pendo Table 2. The finding is contrary to findings from studies results by other researchers showing that fertilizer application increased the protein content of groundnut [23, 24, 25]. (Genotype x fertilizer observed from the study showed significant interaction effect of fertilizer on Mangaka with the application of Ca was contrary to findings by[25] who reported significant interaction effect of groundnut varieties and phosphorus. VCR analysis was conducted focusing on the extra benefit derived from application of DAP and Minjingu mazao as sources of P and Ca respectively. Crop requirement for Ca and the cost of meeting crop nutrient demand outweighed the cost of 55 kg P/ha from DAP as the cost of P from DAP almost doubled the cost of Ca from Minjingu mazao. Similarly, gross return and VCR increased with application of DAP whereas application of Minjingu mazao resulted into a lower gross return and VCR of $2 453.2and 0.5, respectively similar to findings by [9]. Plant nutrient availability is strongly affected by fertility status of the soil and it determines the quantity of nutrients to be supplied for optimum yield. Crop quality, including kernel size and oil content of all groundnut genotypes responded to fertilizer, crude protein content was not affected by application of either Ca or However genotype x fertilizer interaction showed the response of all genotype. Profitability of fertilizer use was heavily dependent on the application of P as it affected kernel yield and subsequently proved to be a limitation to groundnut profitability in the study area. Masasi and Pendo proved to show performance superiority. Treatment combination of both Ca and P at different rates/ratios could set the basis for evaluating and recommendation of genotype with high protein and oil contents as well as optimum fertilizer rates for enhanced productivity and profitability.

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