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Full Length Research Paper

An assessment on variation among genotypes of kersting's groundnut in Northern Ghana

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A study was carried out on Kersting's groundnut, which was collected from fourteen communities in Northern Ghana, to evaluate the growth and yield potential of sixteen genotypes having three seed colours white, black and mottled. Some growth parameters were taken, and among these parameters, only leaf area index showed significant differences among colour types (P<0.05) and genotypes (P<0.05). In general, white-coloured and mottled genotype seeds performed better than black seeded genotypes. Pod number and nodule number per plant were not significantly different among the genotypes. However, 100-seed weight and seed yield showed variation among colour types and also genotypes. Yields ranging from 192 to 688 kg/ha were obtained. The relatively good performance exhibited by white and mottled seeded genotypes and variation in yield offer opportunities for varietal improvement of the crop and required research attention.

Keywords: Kersting's groundnut, *Macrotyloma geocarpum,* legume, growth, genotypes.

INTRODUCTION

Kersting's groundnut *(Macrotyloma geocarpum* (Harms) Maréchal and Baudet) also known as geocarpa groundnut, Hausa groundnut, or Kersting's groundnut, is an annual herbaceous crop of minor economic importance in sub-Saharan Africa, tolerant of drought, with a growth habit similar to that of the peanut. It is also the third subterranean legume after groundnut and Bambara groundnut. It is a rare but interesting legume that could be exploited to contribute to the food security needs of Northern Ghana. It is an indigenous crop cultivated in parts of West Africa for food (Buah and Huudu, 2007; Aremu *et al*., 2006; Baudoin and Mergeai, 2001). It belongs to the family Fabaceae. Flowers are formed in pairs and after fertilization the developing ovary, which is positively geotropic, is buried by carpophores like that of the groundnut, *Arachis hypogea* (Tindall, 1983). Mature pods contain edible bean-like seeds of high caloric value and a promising alternate source of high quality protein food and feed for the tropics (Obasi and Agbatse, 1994). There are variations in seed colour; white, brown and mottled depending on the type of genotype which can be used for crop improvement (Adu-Gyamfi *et al.,* 2011). In the savanna areas of West Africa such as Nigeria, Mali, Burkina Faso, Niger, Benin, and Togo, it is commonly grown as a minor legume crop. Some of its wild ancestors are found in Ubangi, Saharia, and Cameroon (Duke *et al*., 1977).

On a dry basis, seeds contain 24.7% protein (g/100 g seed), 2.3% fat, 49.6% carbohydrate, 10.3% fibre, 2.8% ash and traces of vitamins and minerals (Duke *et al*, 1977). Kersting's groundnut seeds are either boiled or grounded into flour for the preparations of local foods much like the consumption of cowpea. The milled seed flour can also be used as soup thickener especially by low-income groups. Sometimes due to its comparative scarcity and its high food nutrients, it is eaten only by chiefs and men as in Benin (Duke *et al*., 1977). A suspension of the flour-water mixture is used to induce vomiting especially in children when one takes in poison

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(Duke *et al*., 1977). The leaves serve as vegetables whilst the stovers serve as livestock feed. It is adapted to poor soil conditions where most other crops would fail (Amujoyegbe *et al*, 2007)

Although it produces a very palatable and nutritious bean-like seeds, it is an under-exploited legume (Adu-Gyamfi *et al*., 2011, Bayorbor *et al*., 2010). The yield potential is very low and this may be due to inappropriate agronomic practices and lack of improved varieties. It could also be due to its susceptibility to weevil infestation during storage, which renders the seeds unviable in the next growing season. Despite its economical importance as a protein substitute to reduce malnutrition in developing countries, it has gained little research attention over the years. The crop seems to be becoming endangered in many communities, including the main producing areas, and is likely to disappear from the food basket if nothing is done to rescue it. It has been listed among the most neglected and underutilized crops (IPGRI, 2001). Vital information on its agronomic aspect is therefore limited and difficult to trace.

The objective of the study was to evaluate genotypes collected to determine if variations exist among them that could form the basis for future improvement work.

MATERIALS AND METHODS

Location and Climate of the Study Area

The evaluation of growth and yield potential of Kersting's groundnut genotypes was done between July and November 2005 at Nyankpala in the Northern region of Ghana.

Nyankpala is located on latitude 9°25'N, longitude 00°58'W and altitude 183m. The area has a mono modal mean annual rainfall of 1043 mm, mean annual temperature of 28.3° C. The soil is an Alfisol under USDA classification and savannah ochrosol under the Ghanaian system of classification (NAES, 1984).

EXPERIMENTAL DESIGN

Randomized complete block design was used to lay out the experiment, with an experimental unit consisting of a ridge of 1.6 x 5 m. A distance of 0.5 m separated two experimental units and blocks were separated by 1 m. The treatments consisted of 16 genotypes of Kersting's groundnut. The genotypes derived their names from the villages they were collected from. The seeds of the genotypes were sown on the ridges at two seeds per hole at a planting distance of 20 x 40 cm. The treatments were replicated three times. Sowing was done on the 30th of June, 2005. (Table 1).

Measurements

Data were collected from the two central rows leaving the outside rows and first plants at the beginning of each row to serve as borders. Leaf area index (LAI) was estimated at 6 weeks after planting (WAP). Samples of leaves were taken from the top, middle and lower parts of five sampled plants per plot. Leaves taken from these parts of each plant were perforated using the perforator to obtain diskettes, designated as (m). All leaves on each plant were then taken and weighed including the diskettes and designated as (M). This was done for all the five plants and the mean taken. The formulae below was then used to calculate leaf area (LA)

$$LA = \frac{M \times \prod r^2 \times \text{Number of diskettes}}{m}$$

The total leaf area was then divided by the ground cover of stand (P) to obtain the leaf area index, that is LAI= LA/P.

Counting of the nodules on the roots was also carried out at 6 and 8 WAP. Five plants sampled from each plot were uprooted and the numbers of nodules per plant counted. The mean value of samples was then recorded for each plot. The uprooted plants were then used to determine fresh and dry shoot weights. Fresh shoot weight was recorded by weighing five plants without the roots from each plot. The shoots were then dried in an oven at 80^{o}C for 48 hrs for dry weight determination. Harvesting was done 123 days after planting by digging up and removing matured pods from 15 plants in each plot. Five plants from each plot were randomly selected and the mean numbers of nuts per plant were computed. The nuts from all the 15 plants were sun-dried, threshed and winnowed to obtain the pure seeds. The seed were weighed and converted to kg per hectare to obtain seed yield. Hundred seeds from each plot were weighed to determine 100 seed weight.

Data Analysis

Genstat statistical software was used for analysis. The data collected were analyzed based on colour types and individual genotype to obtain variance. The treatment means were separated using the Least Significant Difference (LSD).

RESULTS

Leaf Area Index (LAI) of Kersting's Groundnut Genotypes

On the basis of the seed colour, the LAI of the genotypes were significantly different ($P< 0.05$). White (3.99) and mottled (4.49) genotypes had significantly

Table 1. Genotypes of Kersting's Groundnut Used in the Evaluation.

Colour of Genotype			
Mottled		Black	White
Nakori	Jefisi	Heng black	Boli
Funsi	Dasimah	Najuong	Nakpanduri
Dowie	Heng red mottled	Puffeun	
Sigiri	Heng milk mottled	Dugulatuk	
Nakpanwie		Gbangu	

Table 2. Leaf Area Index (LAI) of Kersting's Groundnut Genotypes Six Weeks after Planting

Genotype	LAI	Genotype	LAI
Nakori	3.67	Sigiri	5.57
Funsi	4.89	Najuong	4.27
Dowie	5.38	Puffeun	2.57
Jefisi	2.61	Dugulatuk	2.64
Dasimah	2.46	Heng black	4.36
Heng Red mottle	5.58	Gbangu	2.02
Heng milk mottled	4.84	Boli	4.64
Nakpanwie	5.37	Nakpanduri	3.34
LSD (0.05)	**1.21**		

Table 3. Fresh Shoot Weight (FSW) and Dry Shoot Weight (DSW) (g) of Sixteen Kersting's Groundnut Genotypes between 6 and 10 Weeks after Planting.

Genotypes	FSW 6 WAP	DSW 6 WAP	FSW 8 WAP	DSW 8 WAP	FSW 10 WAP	DSW 10 WAP
Nakori	29.0	11.9	58.0	30.6	87.0	45.9
Funsi	38.1	13.6	51.0	24.7	81.6	39.5
Dowie	31.0	10.7	57.0	30.9	83.8	45.4
Jefisi	38.5	13.1	56.0	28.2	81.5	41.0
Dasimah	51.1	14.8	82.0	44.7	116.4	63.5
Heng red mottled	24.3	9.6	45.0	21.7	68.4	33.0
Heng milk mottled	27.9	10.9	67.0	26.0	107.2	41.6
Nakpanwie	28.1	8.4	57.0	30.6	82.7	44.4
Sigiri	32.8	11.8	60.0	32.1	97.2	52.0
Najuong	28.2	11.3	51.0	30.5	82.6	49.4
Puffeun	26.1	12.0	63.0	47.3	109.6	69.3
Dugulatuk	15.9	6.8	35.0	23.8	61.3	41.7
Heng black	29.0	10.7	36.0	17.3	54.0	28.5
Gbangu	27.4	11.0	43.0	22.8	67.5	36.7
Boli	27.0	10.8	60.0	28.5	94.2	42.5
Nakpanduri	22.3	9.2	89.0	39.7	160.2	71.8
LSD (0.05)	**30.2**	**6.5**	**37.7**	**37.8**	**86.8**	**42.5**

higher LAI than the black genotypes (3.17). However, the mottled genotypes were not significantly different from the white coloured genotypes in LAI. The LAI of the individual genotypes showed significant differences ($P < 0.05$) (Table 2).

Fresh and Dry Shoot Weight af Kersting's Groundnut Genotypes

On the basis of colour, there were no significant differences ($P>0.05$) among the genotypes in fresh and dry shoot weight. The individual genotypes did not exhibit significant differences in their fresh and dry shoot weight (Table 3)

Nodule and Pod Number of Kersting's Groundnut Genotypes

There were no significant differences ($P>0.05$) among the colour types in nodule numbers in both 6 and 8

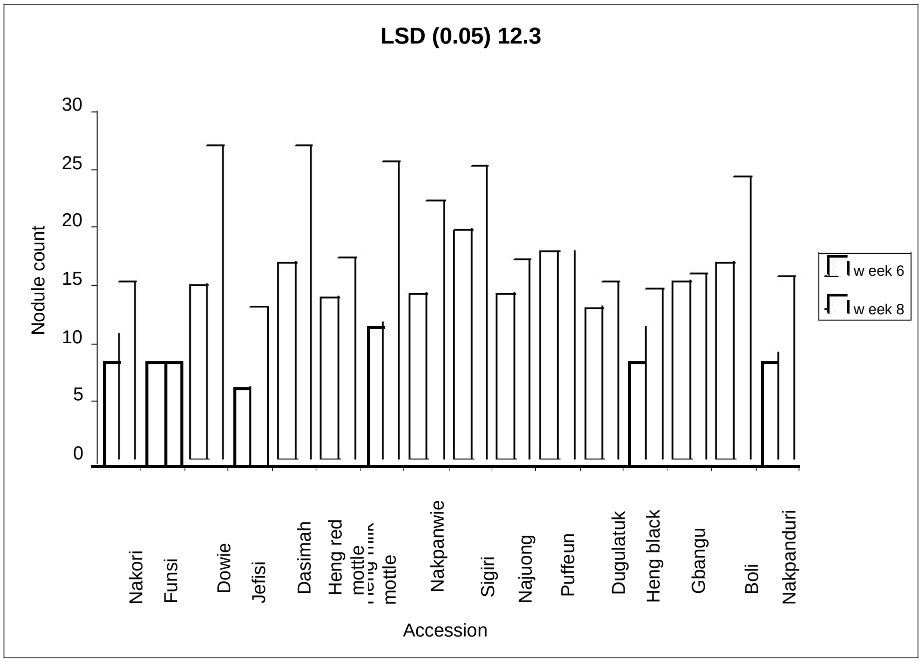

Figure 1. Number of Nodules Formed by Kersting's Groundnut Genotypes 6 and 8 Weeks after Planting

Table 4. Number of Pods per Plant Formed by Kersting's Groundnut Genotypes

Genotype	Pod number	Genotype	Pod number
Nakori	81.0	Sigiri	93.0
Funsi	77.0	Najuong	91.1
Dowie	123.0	Puffeun	87.0
Jefisi	75.0	Dugulatuk	64.0
Dasimah	102.0	Heng black	78.0
Heng red mottled	157.0	Gbangu	83.0
Heng milk mottled	106.0	Boli	113.0
Nakpanwie	129.0	Nakpanduri	100.5
LSD (0.05)		**84.4**	

WAP. The nodules per plant formed by black, mottled and white colour genotypes were 14.4, 13.1 and 14.2 respectively for 6WAP. The corresponding nodule numbers for 8WAP were 16.3, 20.4 and 20.0 for black, mottled and white colour respectively. There were no significant differences (P>0.05) among the individual genotypes in nodule number at the two periods the nodule counts were made; significant differences existed only at P=0.06 (Figure 1). However, the number of nodules formed significantly increased (P<0.05) from week 6 (13.5) to 8 (19.1) after planting.

There were no significant differences among the colour groups in the number of pods formed. The numbers of pods formed by black, mottled and white colour types were 90, 95 and 124 respectively. The individual genotypes did not show significant variation in the number of pods formed (Table 4).

Yield Components of Kersting's Groundnut Genotypes

Based on colour type, there were significant differences among the types in their 100-seed weight. White seeds (15.0 g) were heavier than black seeds (12.4 g). Mottled seeded genotypes (13.1 g) were not significantly different from white and black seeded genotypes in terms of 100 seed weight.

Table 5. Seed Yield Components of Kersting's Groundnut Genotypes

Genotype	100-seed weight (g)	Seed yield Kg/ha	Genotype	100-seed weight (g)	Seed yield Kg/ha
Nakori	11.61	457	Sigiri	15.42	654
Funsi	13.96	616	Najuong	11.38	382
Dowie	15.62	651	Puffeun	10.48	278
Jefisi	12.67	418	Dugulatuk	13.99	410
Dasimah	11.65	327	Heng black	14.72	568
Heng red mottled	13.24	646	Gbangu	10.03	192
Heng milk mottled	15.49	676	Boli	15.08	688
Nakpanwie	10.23	657	Nakpanduri	14.98	477
LSD (0.05)	**2.5**	**121.6**		**2.5**	**121.6**

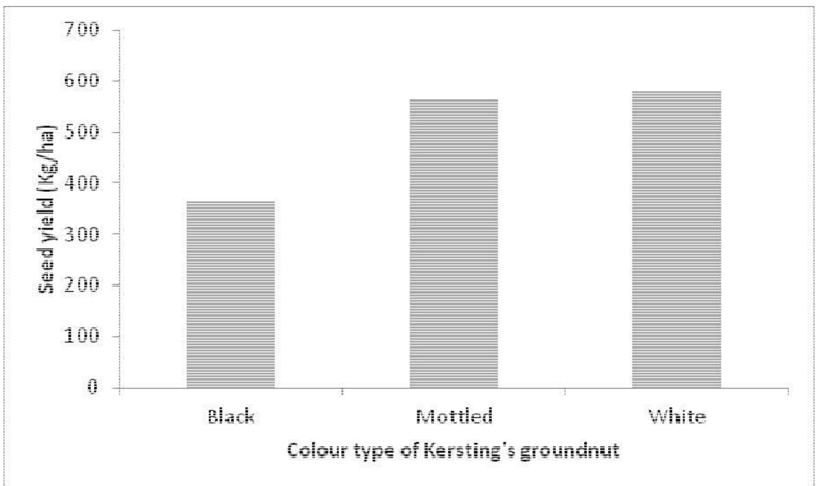

Figure 2. Seed Yield of Kersting's Groundnut Colour Types 123 Days after Planting

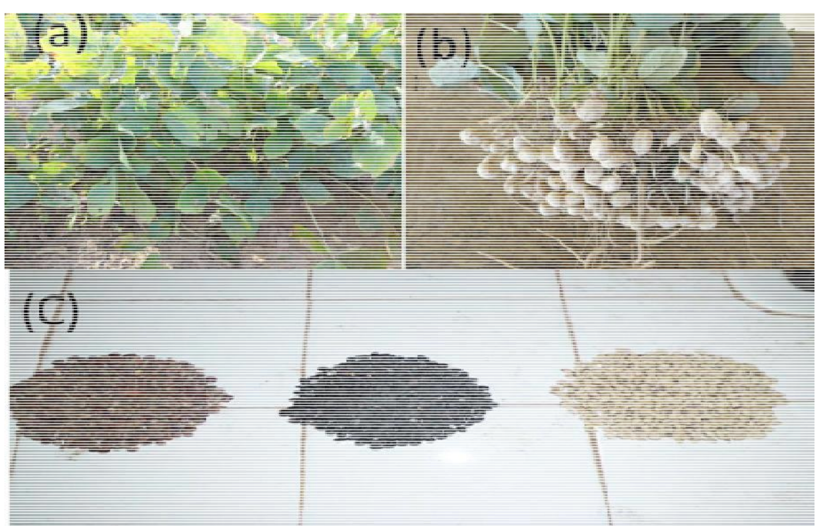

Figure 3. Kersting's groundnut (a) plants growing on the field, (b) pods after harvesting and (c) different seed colour types

Statistically, there were significant differences (P<0.05) among the genotypes in terms of 100-seed weight. 100-seed weights of nine genotypes (Funsi, Dowie, Heng red mottled, Heng milk mottled, Sigiri, Dugulatuk Heng black, Boli and Nakpanduri) were significantly higher than seven genotypes (Nakori, Jefisi, Dasimah, Nakpanwie, Najuong, Puffeun and Gbangu) (Table 5). Within the former group, there were no significant differences among them however, in the latter group Jefisi genotype produced heavier seeds than Gbangu genotype (Table 5).

There were significant differences (P<0.05) among the colour types of the genotypes in seed yield (Figure 2). White seeded genotypes yielded significantly more seeds than mottled and black seeded genotypes. Mottled seeded genotypes produced more seeds than the black coloured genotypes.

When seed yield variation was assessed on individual genotype basis, it was found that there were significant differences among them. White seeded genotype, Boli, produced the highest yield (Table 5). Boli's yield was not significantly different from yield obtained by Funsi, Dowie, Heng red mottled, Heng milk mottled, Nakpanwie, Sigiri and Heng black, the only black genotype among the top 8 (Table 5). Nakpanduri, another white seeded genotype was not significantly different from yields recorded for Nakori, Jefisi, Najuong and Dugulatuk (Table 5). Yields obtained from genotypes in this immediate group were significantly lower than those obtained in the former group.

DISCUSSION

Leaf Area Index and Shoot Growth of the Genotypes

The genotypes showed variation in LAI. The mottled genotypes produced higher LAI followed by the white seeded genotype. The ability to produce more leaves in a unit area in those genotypes may be inherent genetic attribute. The LAI of the the Kersting's groundnut measured in this study was between 2.02 and 5.58 which is similar to LAI reported elsewhere for the crop (Bayorbor *et al.,* 2001). They measured LAI of Kersting's groundnut at 6 WAP and obtain LAI in the range of 2.4 and 4.5. Working with some Kersting's groundnut genotypes some of which were included in this study, Bayorbor *et al*. (2010), reported LAI of 2.02-2.90 for twelve genotypes. Shibles and Weber (1965) reported that a LAI of 3.2 was required for 95% light interception and 95% dry matter production in soybean a related crop legume to Kersting's groundnut. Biomass production (shoot fresh and dry weight) did not show variation in the Kersting's groundnut genotypes though Bayorbor *et al*. (2001) observed variation with planting distance.

Nodule and Pod Number of the Genotypes

Between 6 and 8 weeks after planting nodule number increase was 29%. Nodule number did not vary among the individual genotypes and colour types. The 10-27 nodules per plant was lower than the 30-45 obtained by Bayorbor *et al*. (2001) though determined at 10 weeks after planting. In another study (Bayorbor *et al*., 2010) the range of nodule number per plant reported for similar genotypes of Kersting's groundnut was 10.33-23.80. It therefore appears that variation does not exist in the nitrogen fixation ability of the genotypes.

The number of pods per plant has been suggested as a selection criterion for increasing yield of grain legumes because of its high and positive correlation with yield (Safari, 1978; Bennet *et al*. 1977). Pod number did not vary among the genotypes on individual basis and colour types. Pod number per plant vary from 43-157 which is in agreement with Bayorbor *et al*.(2010) but in contrast with an earlier report by Bayorbor *et al*. (2001) which states that pod number vary with planting distance and obtained pods between 23.9 and 56.9.

Seed Yield and 100-Seed Weight

Seed yield varied among the genotypes and colour types. White seeded genotypes yielded better than the mottled and black genotypes. 100-seed weight also showed that white seeded genotypes performed better in yield than the black seeded genotypes. Visual observation shows that the black and mottled seeded genotypes were bigger than the white types. It was therefore surprising that the white genotypes recorded higher 100-seed weight. Probably the mass per volume ratio favoured the white and mottled genotypes more than the black genotypes. The yield by the colour types appear to correlate with leaf area index. Yields obtained in this study were between 192 kg/ha and 688 kg/ha. Yield of 500 kg/ha or lower has been reported (Duke *et al*., 1977). Bayorbor *et al*. (2001) reported yield between 296 and 520 kg/ha while in a latter publication (Bayorbor *et al*. 2010) they obtained higher yield range 635-1876 kg/ha. Under traditional farming system yield is low. According to Bampuori (2007) the practice of weeding only once may have greatly contributed to the lower mean yields of 178, 250, and 124 kg/ha for the white, black, and mottled cultivars, respectively in Upper West region of Ghana. The differences in yield of colour types reported by Bampuori (2007) were not significant. The result obtained in this study suggests that wide variation exist in the yielding ability of the genotypes which can be used as the basis for improvement of the crop.

CONCLUSIONS

Apart from LAI, variations in growth parameters were not significant among the genotypes. Nodulation, which was used as a measure of nitrogen fixation ability, was not significant among the genotypes. Some genotypes gave higher seed yield compared with reported yield of the crop. 100-seed weight followed the pattern of seed yield. Variation therefore existed in the colour types. The white and mottled seeded genotypes gave higher yields. These two resemble cowpea and will have appeal to consumers. Varietals improvement of these two Kersting's groundnut types is therefore recommended.

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