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INFLUENCE OF WEED MANAGEMENT STRATEGIES ON PROXIMATE COMPOSITION OF TWO VARIETIES OF GROUNDNUT (*ARACHIS HYPOGAEA* L.)

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Abstract
Information on the use of rice straw mulch for weed control to limit herbicide use and its effect on nutritional contents of the groundnut seed is scanty. Field experiment was conducted in 2011 at Lafiagi, Kwara State, a Southern Guinea savanna zone of Nigeria to evaluate the impact of weed management strategies on proximate composition of two varieties (Samnut 10 and MK 373) of groundnut seeds. Experimental layout was a split plot randomized complete block design with three replications. The treatments include: Pendimethalin at 1.5 l/ha; Pendimethalin at 1.5 l/ha + one hand weeding at 6 Weeks After Sowing (WAS); Rice straw mulch at 0.1m depth; Rice straw mulch at 0.1m depth + one hand weeding at 6 WAS Two hand weeding at 3 and 6 WAS; Weed free check (positive control) and Weedy check (negative control). The results revealed that there were significance differences in all the proximate parameters assessed except the moisture content. Regardless of all the treatments investigated, percentage moisture content, ash content, crude fibre, crude fat, crude protein and carbohydrate in both varieties ranged between 4.63-4.90, 2.45-3.10, 7.55-8.39, 43.67-48.33, 26.43-35.13 and 4.99-10.27% respectively. Rice straw mulch + one weeding at 6 WAS significantly ($p<0.05$) increased crude protein, and ash content over all other treatments except the weed free check. The enhancement of protein and minerals content of groundnut seed by this treatment could be promising agronomical practices for meeting the nutritional needs of man in Africa as well as limiting the use of herbicide.

Keywords: rice straw mulching, Pendimethalin, proximate composition, groundnut

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1. INTRODUCTION

Groundnut (*Arachis hypogaea* L.) is an important oil seed crop widely grown in the tropical and sub-tropical parts of the world. According to United States Department of Agriculture USDA (2009), Nigeria ranked the fourth on the list of total world production. In Nigeria, it is a major snacks food that goes well with cassava flakes (Obi *et al*., 2008 In Ghana, a local soup called "nkate nkwan" is prepared from crushed groundnuts. In between meals, its seeds are consumed either boiled or roasted as refreshment. In 2003, the US food and drug administration reported that eating 1.5 ounces (43g) per day of most nuts including groundnut as part of a diet low in saturated fat and cholesterol, may reduce the risk of heart disease (Alper and Maltes, 2003).

In recent times, studies have shown that groundnut has metabolic benefits in terms of inhibiting metabolic dysfunction associated with obesity and metabolic syndrome (Coates and Howes, 2007). According to Achu *et al*., (2005) consuming groundnut seeds will help to supplement the nutrients of the staple carbohydrate foods of the poor who cannot afford enough proteins food of animal origin. In general, groundnut seeds contain 44-56% oil and 22-30% protein on a dry seed basis and it is a rich source of minerals (phosphorus, calcium, Magnesium and Potassium) and Vitamins (E, K and B group) (Savage and Keenan, 1994).

Weeds have consistently been one of the major constraints faced by the farmers in the production of groundnut. For instance, uncontrolled weed has been reported to cause significant yield loss which is as high as 51% (Etejere *et al*., (2013). Aside from yield reduction, Manickam *et al*., (2001) had observed that unweeded control plot registered the lowest N, P and K uptake of 169.4, 3.6 and 52.2 kg/ha by crop, respectively. To combat

the menace posed by the weeds, small holder farmers in Africa rely heavily on the use of herbicide and hand weeding to achieve higher yield. Recently, limiting on herbicide use because of its hazardous effect on the environment or total shift to more environmentally friendly weed control alternative such as natural mulch is gaining more attention (Abouziena *et al*., 2008). The use of plant materials as mulch for weed control has been found to be safe for human health and environmental friendly compared to the use of herbicides. The consequence of this is production of a safe food product on account of low input of agrochemicals (Weon, *et al*., 2011). In Nigeria, several studies have been documented on the effects of different weed control methods on growth and yield of different crops that involved the of use of plant materials such as grass clips, saw dust, wood chip and straw (Awodoyin *et al*., 2007; Okore *et al*., 2010). However, information on the use of different weed control practices on the proximate composition of crops is scanty. It is against this background the present investigation was carried out to find out if the use of rice straw mulching in comparison to pendimethalin herbicide and hand weeding with the view of limiting herbicide use could have any effect on the nutritive value of two varieties of groundnut (Samnut 10 and MK 373).

2. MATERIALS AND METHODS

Description of the experimental site

A field experiment was conducted at Lafiagi Kwara State (latitude 8°, 50" N and longitude 5°, 25" E) located in the southern Guinea savanna ecological zone of Nigeria. Climatologically, the rainfall received during the cropping season between May and September of 2011 was 1137.0 mm with 58 days of rainfall. The rainfall distribution pattern was monomodal and spread heavily between August and September. The mean minimum and maximum temperatures ranged from 23.2-24.5°C and 33.1-35.8 °C respectively. The range of mean daily relative humidity taken at 9.00 a.m. that prevailed during the cropping season ranged from 88.5% to 94.7%.The composite soil of the experimental site at 0.15m depth was loamy sand with low organic matter (0.65%), moderate in available nitrogen (0.25 %) and low in Effective Cation Exchange Capacity (ECEC) (6.86 cmol/ka) with slightly acidic pH (6.30) in water. Weed species that were considered to be preponderant include *Daniellia oliveri (*Rolfe) Hutch & Dalz, *Cochlospermum planchoni* Hook f. and *Cleome viscosa* Linn.

Proximate analysis of rice straw

The straw sample used as mulch was analysed for both macro and micro nutrient. The organic matter and organic carbon was also determined as depicted below: Total nitrogen (N) by micro-Kjeldahl (Bremmer, 1996; Jones, 1991). Total phosphorus (P) in milligram per litre was determined by the ammonium molybdate/vanadate yellow colour method following ternary acid-perchloric-nitric – sulphuric-acid wet digestion (Anderson and Ingram, 1993). Total boron (B) in milligram per litre was determined by Axomethine hydrogen method following ternary acid digestion (Jones, 1991). Total cations: calcium (Ca) ,magnesium (Mg), copper (Cu), iron (Fe), manganese (Mn) and zinc (Zn) were determined by Atomic Absorption Spectrophotometer. Elements such as sodium (Na), and Potassium (K) were analysed using flame photometry after wet digestion with perchloric-sulphuric ternary acid (Anderson and Ingram 1993). Total sulphur in Milligram per litre was determined by turbidimetry following digestion of the rice straw with a nitric-perchloric –hydrochloric ternary acid mixture. Organic matter and ash content using ash method as described by (Okalebo, et al., 2002) Finally, Organic carbon was determined by modified Walkley-Black method as detailed by Nelson and Sommers (1996).

Experimental design and treatments

The plots lay out was split plot design where the varieties represent the main plot and weed

control strategies the subplot. The field dimension was 24m by 22m containing forty two plots. These were arranged in a completely randomized block design with three replications. Each plot measured 3.2m by 3.0m consisting of four rows separated by 0.4m alley. Specifically, the following seven treatments were applied: Pendimethalin at 1.5 l/ha; T_1 =Pendimethalin at 1.5 l/ha + one hand weeding at 6 Weeks After Sowing (WAS); Rice straw mulch at 0.1m depth; Rice straw mulch at 0.1m depth + one hand weeding, Two hand weeding at 3 and 6 WAS; Weed free check (positive control) and Weedy check (negative control).

Field planting

The field were mechanically ploughed, harrowed and ridged on 23rd May 2011. Healthy seeds of the groundnuts varieties obtained at College of Agriculture Mokwa (Niger State) in Nigeria, were selected for sowing on 25th May 2011. Two seeds were sown per hole at depth of 0.04-0.05m with in row spacing of 0.1m. Prior to planting, seeds were treated with seedrex (33% permethrin + 15% carbonderzine + 12% chlorothalonil) at the rate of 4kg of seeds/10g to prevent soil borne diseases. Thereafter, no further after care was carried out. Pendimethalin was applied with Knapsack sprayer of 20 liters capacity two days after planting (27th May 2011). The delivery rate was 600 l/ha after proper calibration using time- volume method (Akobundu, 1987).

Rice straw was laid at depth of 0.1m in the furrow the same date herbicide was sprayed. Weeding was carried as appropriate as stated in the treatments detailed. Harvesting was done when the leaves were turning yellow from each experimental unit by carefully uprooting the plants. Soil adhering to the pods was removed by washing in a container filled with water. The developed pods in each experimental unit or treatment were air dried under the shade to 12% moisture level (Myklestad, 2006) and thereafter bagged, labeled and hanged on window to receive fresh air.

Proximate analysis of air dried groundnut seed

In each treatment, shelled groundnut seeds in both varieties (Samnut 10 and MK 373) were ground using hammer mill and analysed for proximate compositions (moisture, ash, crude fibre, crude fat and crude protein) following the standard methods of Association of Official Analytical Chemists (AOAC, 2000). Moisture contents were determined by heating five grams (5.0g) of well mixed ground sample in an oven (Gravity Convection Oven) at 103^{o}C for five hours to a constant weight.

Ash content was determined by incinerating 5.0g of well mixed ground sample using hammer mill machine in a muffle furnace at 600^{o}C for 3 hours until a light-grey ash was produced. Crude fibre was determined by extracting 5.0g of the ground sample with hexane in a thimble for six hours to free the sample of fat. Thereafter, 200 ml of 1.25% sulphuric acid was added to three grams (3.0g) of the free fat to remove the digestible nutrient in the fat. The resulting mixture was filtered in a Buchner funnel.

The residue on the filter paper was in a muffle furnace at 600^{o}C for 30 minutes cooled in a desiccator and weighed. Crude fat determination was achieved by extraction procedure. Five grams of the ground sample was extracted with 150 ml petroleum ether as solvent in a Soxhlet extractor at a boiling point of 60-80^{o}C.

The extraction was done for 6 hours with moderate boiling using elecrothermal heater. Crude protein was determined by the Kjeldahl method by weighing out 1 g of the ground sample into Kjeldahl flask. The crude protein was calculated by a multiplying factor (% N x 6.25). Carbohydrate was determined by difference.

This was achieved by subtracting the sum of moisture, ash, protein, crude fat and crude fibre percentage from hundred.

It should be noted that each of the foregoing proximate parameters was done in triplicates.

Table 1: Proximate composition of rice straw

Parameter	Concentration	Unit
Organic Matter	76.00 %	%
	Macro nutrient	
Nitrogen (N)	1.05	%
Phosphorus (P)	1170.00	mg/kg
Potassium (K)	1.50	%
Calcium (Ca)	470.30	mg/kg
Magnesium (Mg)	321.00	mg/kg
Sodium (Na)	0.11	%
Sulphur (S)	392.40	mg/kg
Organic carbon (c)	1.06	%
	Micro nutrient	
Iron (Fe)	500.75	mg/kg
Copper (Cu)	19.25	mg/kg
Zinc (Zn)	335.25	m/kg
Manganese (Mn)	115.75	mg/kg
Boron (B)	4.06	mg/kg

Data analysis

Data were analysed using Univariate Analysis of Variance under general linear model of Statistical Package for Social Science (SPSS) software version 17. Means were separated using Duncan Multiple range Test (DMRT) at 5% level of probability.

3. RESULTS AND DISCUSSION

Proximate composition of rice straw

Data pertaining to nutrient contents of rice straw is shown in Table 1. The results showed that the organic carbon is moderate C (1.06 %), with moderate nitrogen concentration N (1.05). The rice straw has high organic matter (76.0%). The carbon to nitrogen (C/N) ratio is 1:1, a clear indication that the material can decompose rapidly. The straw is very rich in phosphorus (1170.00mg/kg), rich in calcium, Ca (470.30 mg/kg), sulphur, S (392.40 mg/kg), magnesium Mg (32.50 mg/kg), iron, Fe (500.75mg/kg), zinc, Zn (335.25 mg/kg). Other mineral elements such as potassium K (1.50%), sodium Na (0.11%), manganese, Mn (115.75 mg/ha) copper, Cu (19.25 mg/kg) boron B (4.06 mg/kg) are relatively low. The foregoing results indicated that rice straw used as mulch in this experiment aside from suppressing weed growth is also rich in organic matter and other mineral elements such as phosphorus, nitrogen, sulphur, and magnesium, iron that are necessary for plant growth. Therefore in discussion these results these factors should be taking into consideration

Effect of weed control strategies on proximate composition of air dried groundnut seeds

Moisture

Proximate analysis of air dried groundnut seeds with respect to moisture revealed no significant differences due to weed control strategies (Table 2). In both varieties, the moisture ranged between 4.63-4.90%. The moisture contents agreed with that of NAS (1980) of 5.0% but differed to that of Musa *et al.*, (2010) which ranged between 6.6-8.9% among different varieties studied. The variation could be attributed to varietal difference as well as agronomic practices used to raise the crop. Low moisture content recorded in this study compared to other varieties suggests that Samnut 10 and MK 373 would have longer shelf life regardless of weed control methods.

Table 2. Proximate composition of groundnut air dried seeds (Samnut 10 and MK 373) in 2011 cropping season

	Treatment	Moisture	Ash	Crude fibre	Crude fat	Crude protein	Carbohydrate
				%			
Samnut 10	T_1	4.73^{a}	2.55^{de}	8.09^{c}	47.27^{bc}	29.00^{d}	8.36^{c}
	T_2	4.67^{a}	2.64^{c}	9.01^{a}	47.73^{b}	30.03^{bc}	5.61^{e}
	T_3	4.83^{a}	2.51^{e}	8.11^{c}	47.90^{b}	26.43^{f}	10.27^{a}
	T_4	4.90^{a}	2.87^{b}	9.12^{a}	46.43^{d}	30.77^{a}	6.13^{e}
	T_5	4.90^{a}	2.45^{f}	7.93^{d}	48.33^{a}	27.17^{d}	9.22^{b}
	T_6	4.83^{a}	2.99^{a}	8.01^{c}	46.20^{d}	30.40^{ab}	7.51^{d}
	T_7	4.87^{a}	2.56^{d}	8.39^{b}	47.77^{cd}	29.40^{cd}	8.01^{cd}
	Mean	4.82	2.65	8.89	47.23	29.02	7.87
	p-value	0.51	<0.001	<0.001	<0.001	<0.001	<0.001
	SEM	0.03	0.04	0.10	0.18	0.34	0.35
MK373	T_1	4.87^{a}	2.59^{d}	7.88^{bc}	44.17^{b}	32.70^{d}	7.80^{b}
	T_2	4.63^{a}	2.71^{c}	8.34^{a}	43.83c	33.73c	7.30^{b}
	T_3	4.87^{a}	2.55^{e}	7.61^{c}	44.33^{b}	31.27^{e}	9.55^{a}
	T_4	4.87^{a}	2.86^{b}	8.16^{ab}	44.13^{b}	34.10^{b}	6.96^{b}
	T_5	4.77^{a}	2.45^{f}	7.55^{c}	44.70^{a}	31.37^{e}	9.09^{a}
	T_6	4.83^{a}	3.10^{a}	8.27^{a}	43.67^{a}	35.13^{a}	4.99^{c}
	T_7	4.80^{a}	2.62d	7.88^{bc}	44.20^{b}	32.87^{d}	7.67^{b}
	Mean	4.80	2.70	7.95	44.15	33.02	7.62
	p-value	0.199	<0.001	<0.001	<0.001	<0.001	<0.001
	SEM	0.02	0.05	0.07	0.07	0.29	0.33

Within a column, means of each variety followed by the same letter s are not significantly different at $p<0.05$. T_1= Pendimethalin at 1.5 l/ha; T_2= Pendimethalin at 1.5 l/ha + one hand weeding at 6 WAS; T_3= Rice straw mulch; T_4= Rice straw mulch + one hand weeding at 6 WAS; T_5 = Two hand weeding at 3 and 6 WAS; T_6 = Weed free check (positive control); T_7 = Weedy check (negative control).

Moisture content is of importance in storage because the lower the moisture contents of food material, the higher the keeping quality (Ajayi and Adedire, 2007). In spite of no significant differences, plots raised under rice straw mulch + one hand weeding at 6 WAS had the highest moisture content in their seeds (Table 2). The results showed that retention of soil moisture by rice straw mulch coupled with reduced weed competition reflected in moisture contents of the seeds in plant receiving this treatment.

Ash

The percentage ash content was significantly affected due to weed control methods and variety (Table 2). In both varieties the ash content ranged from 2.45-3.10% and it is similar to the report of (Grosso and Guzman, 1995) and (Atasie *et al.*, 2009) which indicated that ash content among 29 cultivars of groundnut was between 2.4-2.7% and 3.08% respectively. Significant higher ash content was recorded in weed free check and rice straw mulch + one hand weeding at 6 WAS over all other treatments (Table 2). This trend could be attributed to reduced weed competition for limited resources most important the nutrients. Straw mulch as shown in Table 1 is rich in mineral elements such as phosphorus, sulphur, magnesium as well as organic matter and as such could account for higher ash content recorded in rice straw mulch + one hand weeding at 6 WAS

under reduced weed competition. Ash content to some extent is indicative of mineral content (Musa *et al*., 2010). Regardless of weed control strategies MK 373 had higher ash content than Samnut 10 (Table 2). The difference so observed could be due to differential genetic constitution.

Crude fibre

Percentage crude fibre was significantly affected under different weed control methods and variety (Table 2). It ranged between 7.55-9.12%. Percentage crude fibre recorded in this study is high compared to the report of (Atasie *et al*., 2009) and (Satish and Shrivastava, 2011) who reported crude fibre values of 3.70% and 1.15% respectively in groundnut varieties. The differences so observed could be linked to genetic constitution, climate and varietal differences. However, the high crude fibre recorded in this study regardless of the weed control treatments further indicate the ability of groundnut to maintain internal distension for a normal peristaltic of the intestinal tract; a physiological role which fibre plays. Diets low in crude fibre is undesirable as it could cause constipation and that such diets have been associated with diseases of colon like piles, appendicitis and cancer (Atasie *et al*., 2009). As observed in this study, crude fibre was significantly higher in treatments such as weed free check, pendimethalin at 1.5 l/ha + one hand weeding at 6 WAS and rice straw mulch + one hand weeding at 6 WAS over all other treatments (Table 2). This further suggests that consuming crop raised organically is very good for human health. Varietal differences indicate that Samnut 10 had higher crude fibre than MK 373. The reason for the difference is similar to what was adduced for ash content.

Crude Fat

Crude fat content for which the crop is mainly grown differed significantly due weed control methods and variety (Table 2). In both varieties, it ranged from 44.13-48.33%. The results are in agreement with other varieties of groundnut seeds (Gupta and Shrivastava 2004; Thakur *et al*., 2005; ,Atasie *et al*., 2009; Shanwad *et al*., 2010; Satish and Shrivastava, 2011). Percentage crude fat was higher in two hand weeding at 3 and 6 WAS and sole rice straw mulch over all other treatments (Table 2). As observed in this study, regardless of weed control methods Samnut 10 had higher crude fat than MK 373 with mean values of 47.23% and 44. 17% respectively (Table 2). The results showed that, both are good source of oil. However, in term of amount oil per unit weight of seeds, Samnut 10 would be preferred to MK 373. The variation in fat content could be due to genetic variation Musa *et al*., (2010) had observed variation in fat content in different varieties of groundnut.

Crude protein

Crude protein content was significantly influenced due to weed control methods and variety (Table 2). In both varieties, it ranged from 26.43-35.13%. The results compares well with other cultivars or varieties of groundnut according to (Grosso and Guzman, 1995; Atasie et al., 2009; Musa *et al*., 2010 22] who reported crude protein of 26.3-30.9%, 38.61% and 19.7-31.3% respectively. In both varieties, significant higher crude protein was recorded in weed free check and rice straw mulch + one handing at 6 WAS over all other treatments (Table 2). The increase in crude protein in rice straw mulch + one hand weeding at 6 WAS could be due to utilization of nutrients such as sulphur, nitrogen that are necessary for protein synthesis as a result of reduced weed competition (data not shown). Straw used in this study has 1.05 % of nitrogen and 335.25 mg/kg of sulphur (Table 1). Straw mulch has been found to reduce N loss especially by reducing volatilization (Bhagat and Verma et al., 1991). It has also been observed that mulched treatments showed significantly greater total uptake of nitrogen, phosphorus and potassium than corresponding unmulched ones (Acharya and Sharma 1994; Muhammed *et al*., 2009) . In the same vein, proline content of groundnut was significantly enhanced due to polythene mulch Mahalle *et al*., (2002). Regardless of weed control methods, percentage mean crude protein was higher in

MK 373 (33.02%) than Samnut 10 (29.02%) (Table 2). The observed difference is as a result of genetic constitution (Musa *et al*., 2010). The high protein content as shown in this study makes groundnut a good source of food supplement for man and livestock most importantly MK 373. Groundnut probably contain protein at a level comparable to that in cowpea (23-30%) (Ngoddy and Ihekoronye 1985) even higher as observed in this study when rice straw mulch + one hand weeding at 6 WAS is used as weed control management.

Carbohydrate

Percentage carbohydrate recorded by difference was significantly affected due to weed control and variety (Table 2). It ranged from 4.99-10.27% (Table 2). The observed values differed from the report of Atasie *et al*., (2009) who reported 1.81% value of carbohydrate. The difference might be attributed to genetic variation, climate as well as agronomic practice. Significant highest carbohydrate was recorded in sole rice straw mulch over all other treatment. In potato, increase in starch content was recorded with paddy straw mulch than unmulched plots (Dixit and Majumdar, 1995). Generally, carbohydrate value by difference in this study is very low compared to crude fat and protein which further show that groundnut is more of body building food.

4. CONCLUSIONS

The results of this study had shown that proximate composition of groundnut seed was affected by different weed managements strategies studied with exception of moisture contents. However, the use of rice straw followed by one hand weeding at 6 WAS aside from its weed control efficiency could be a promising agronomical practice for increasing crude protein and mineral contents of the seeds in the test crops. Raising crop using this technique will go a long way in reducing agrochemical input as well as meeting the nutritional needs of man and livestock.

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