https://doi.org/10.61308/VFWH9152

Weed smothering efficiency of mulching types on groundnut (*Arachis hypogea* L.) productivity in the dry savanna region of Nigeria

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Citation: Shittu, E. A., Bassey, M. S., & Bello, T., T. (2024). Weed smothering efficiency of mulching types on groundnut (Arachis hypogea L.) productivity in the dry savanna region of Nigeria. *Bulgarian Journal of Crop Science, 61*(4), 90-101

Abstract: In order to increase groundnut productivity, a field experiment was carried out in the dry season of 2020 to assess the effectiveness of various mulching materials at suppressing weeds. The experimental treatments comprised of five mulching types; Control (no mulch), transparent polythene mulch, black polythene mulch, rice straw mulch and saw dust mulch) and three groundnut varieties (SAMNUT 23, SAMNUT 24 and SAMNUT 26). These were factorially combined and laid out in a Randomized complete block design with three replications. Findings revealed that mulching had a significant ($p < 0.05$) impact on crop qualities including canopy cover, chlorophyll content, pod yield, 100 kernel weight, and groundnut kernel yield as well as weed attributes like weed cover scores, weed density, weed dry weight, and weed control efficiency in both BUK and Wasai, respectively. The weed compositions were further grouped into various families comprising Poaceae (11), Euphorbiaceae (3), Amaranthaceae (4), Asteraceae (3), Cyperaceae (2), Cucurbitaceae, and Aizoaceae, each having one species with a different level of occurrence across the two locations. On the other hand, SAMNUT 26 significantly produced higher pod (2798 & 2119) and kernel yields (1198 & 1191), although SAMNUT 23 produced a heavier 100 kernel weight (55.51 & 54.52) at BUK and Wasai, respectively. In comparison to the other mulching types, applying black polythene mulch or transparent mulch lowered weed density and dry weight by limiting the amount of sunlight that the weeds got, preventing them from growing. Therefore, for dry season production of groundnut in the Sudan savannah ecology of Nigeria, mulching with black or transparent polythene film using the SAMNUT 26 variety was found to be effective in conserving soil moisture for optimum crop growth and development, while on the other hand, weed populations were suppressed.

Keywords: mulching; weed smothering efficiency; groundnut; productivity; savanna

INTRODUCTION

In order to meet the rising needs for more food, feed, fiber, and fuel that are being caused by the world's population, which is expanding at a rate of about 1.09% year. As a result, the agricultural sector is under additional pressure to produce ever-increasing yields. By 2050, the world's population is expected to exceed 9 billion, necessitating a doubling of agricultural output in order to feed this expanding population (Cheng & Matson, 2015; McGuire, 2015). The threat of diseases, pests, and weeds is just one of the many difficulties facing agriculture today, in addition to the changing climate, a severe lack of arable land and water resources, and these issues (Arslan et al., 2015; GFFA, 2015; FAO, 2016 a, b, c; FAO. FAO, IFAD & WFP, 2015). The negative impacts of weeds on cropland have been mitigated through decades of research and creative farming methods, but the issue has not yet been totally resolved. If not effectively controlled, weeds can have a negative effect on crop yields and quality by competing with crops for moisture, nutrients, space and sunlight (Hamuda et al., 2016; Kubiak et al., 2022; Vila et al., 2021). It has been demonstrated that weed infestation and a decline in agricultural yield are strongly correlated (DiTommaso et al., 2016; Storkey & Neve, 2018). Many other approaches have been tried to manage weeds, including manual hoe weeding, which has been used for centuries and is still employed by small-scale farmers in the tropics today. However, its link with tedium, cost, and relative shortage of labor during peak times becomes a disadvantage to its use. Mechanical methods are more cost-effective than manual hoe weeding, but they are less effective at removing weeds that are inside the rows crops and risk damaging crop stands if not used properly (Hamuda et al., 2016). On the other hand, the use of chemical weed control methods is linked to environmental contamination and the emergence of weed species that are resistant to it (Rodrigo et al., 2014). Weed management strategies that are better suited to the environment are required.

Mulching, a method that appears to be an alternative, appears to assist retain soil moisture and temperature for a longer amount of time as well as control weed infestation (Lee & Thierfelder, 2017; Nichols et al., 2015; Ranaivoson et al., 2018). Different mulches, such as rice husk and black polythene sheet, are effective in conserving soil moisture by reducing water use by 3-11% and crop performance by 25%. Mulches can lessen the crop need for irrigation, and in some cases, they can completely do away with it (Ahmad et al., 2015; Kader et al., 2019). However, the kind of mulch used in the field affects how effectively weeds can be controlled by mulching. Therefore, this research was conducted to assess the effectiveness of various mulching types at suppressing weeds on the productivity of dry-season groundnut in the Sudan savanna ecology.

MATERIALS AND METHODS

2.1 *Experimental sites*

The experiment was conducted during the dry season of 2020 at the Teaching and Research Farm of Faculty of Agriculture, Bayero University, Kano (Lat. 11°58'N and Long. 8° 25' E, altitude of 457m above sea level) and at Institute for Agricultural Research (IAR) Experimental Station at Wasai, Minjibir LGA, Kano State (Lat. 12.14^{0}N and Longitude 8.67^{0}E, altitude of 441 m above sea level). Both experimental sites were situated within the Sudan savanna agro-ecological zone of Nigeria.

The soil at BUK was loamy sand, with particles size distribution of sand, clay and silt as (86.0%), (5.4%) and (8.6%), respectively. The soil nutrient status/chemical composition of the soil were (4.321 g kg^{-1}) organic carbon, (1.4 g kg^{-1}) total N, (5.887 mg kg^{-1}) available P. Exchangeable bases were 5.781, 2.729, 0.087, and 0.079 (cmol kg^{-1}) for Ca, Mg, K, and Na, respectively. Values for micronutrients were 4.65, 209.47, 170.00, and 90.21 (ppm) for Cu, Zn, Fe and Mn, respectively, with pH value of 6.6 while at Wasai the soil was characterized as sandy loam with particles size distribution of (84.4%) sand, (8.8%) clay and (6.8%) silt. The organic carbon, total N and available P were 3.2 g kg^{-1}, 1.2 g kg^{-1} and 5.6 mg kg^{-1}, respectively. Exchangeable bases values were 2.1, 0.3, 0.1 and 0.4 (cmol kg^{-1}) respectively, for Ca, Mg, K and Na. Micronutrients values were 3.92, 186.2, 212.59 and 66.68 (ppm) for Cu, Zn, Fe and Mn, respectively with CEC of (7.00 cmol kg^{-1}) and pH of 6.0.,

2.2 Treatments and Experimental Design

The treatments comprised of five mulching types (Control (no mulch)), transparent polythene mulch, black polythene mulch, rice straw mulch and saw dust mulch) and three groundnut varieties (SAMNUT 23, SAMNUT 24 and SAMNUT 26). Rice straw at 5 t ha^{-1} was uniformly spread as a carpet manually, transparent polythene and black colored polythene with 0.009 mm thickness was spread uniformly on the polythene mulch plots while saw dust at 2 t ha^{-1} was spread as carpet in saw dust treatment. The treatments were factorially combined and laid out in a Randomized complete block design with three replicates. The experimental area was divided into 15 gross plots of 4.5 m x 3 m. (13.5 m^2) with plot to replication distance of 0.5 m x 1 m.

2.3 Cultural practices

2.3.1 Land preparation

The field was cleared of all shrubs, stubble and crop residue from the previous cropping season prior to seed sowing. The field was sprayed with glyphosate at the rate of 2 kg a.i. ha^{-1} to get rid of the stubborn weed species. One week after herbicide application, debris were removed from the experimental site. Cow dung at 10 t ha^{-1} was applied during soil preparation. The land was then ploughed and harrowed before making ridges to provide a good tilth for seed emergence. This was followed by lining and pegging of the area into blocks and plots.

The experimental field was well prepared to be made relatively flat to enhance uniformity of treatments and to avoid slopping that could exert extraneous effect and influence validity of data.

2.3.2 Seed treatment and sowing

Prior to sowing, the seeds of the groundnut varieties were dressed with Apron Star at 10 g 4 kg^{-1} of seed and later sown to ensure the establishment of good plant stand by reducing the incidence of seed and soil borne pathogens. Two groundnut seeds of respective varieties (SAMNUT 23, SAMNUT 24 and SAMNUT 26) were sown at a depth of 5cm on ridges with 0.75 m and 0.30m for inter and inter row spacing, respectively on the 18th and 20th of March, 2020 dry season at BUK and Wasai locations, respectively.

2.3.3 Fertilizer Application

Basal application of 40 kg P_2O_5 in the form of Single Super Phosphate (SSP) and 20 kg K_2O was done prior to sowing.

2.3.4 Mulching Procedure

The polythene sheet was spread on the entire polythene plot just after sowing. Holes were made on the polythene mulch according to the plant spacing. The edge of the polythene film was buried in the soil on both sides to facilitate the protection of the film against damage by wind. The organic mulch was spread uniformly over concerned plots shortly after sowing. Care was taken not to disturb the organic mulch during irrigation

2.3.5 Irrigation scheduling

The crop was irrigated twice a week for the first two weeks and thereafter it was done once a week. Furrow irrigation method was adopted, water was pumped from a source (well) using a pumping machine.

2.3.6 Data collection and Data Analysis

Data were collected on crop aspect such as canopy cover, chlorophyll content, pod yield, 100 kernel weight and kernel yield. Similarly, weed specie compositions, weed cover score, weed density, weed dry weight and weed control efficiency were adequately computed and reported as weed parameters. For weed specie composition the weeds were harvested from the 1m^2 quadrant placed randomly once in each of the treatment plots at harvest. The harvested weed samples were identified, classified by species using Hand Book and other standard procedure described by Akobundu et al. (2016) and Rana & Rana (2018), respectively. The weeds were counted to get the number of individual species which was used to compute the weed density. Samples were further oven dried at 70^{0}c for 48 hours and weight at weed dry weight. The magnitude of weed reduction due to weed control treatment of mulching types was worked out by using the formula suggested by Mani et al. (1973) and expressed in percentage. All data generated from the field using standard agronomic procedure were subjected to analysis of variance using Genstat (17th Edition) where the 'F' test shows significance. The treatment means were separated using Student Newman-Keuls Test (SNK) at 5% probability level.

RESULTS AND DISCUSSION

Effect of mulching on weed attributes

Grasses, broadleaved and sedges weed species were observed to be associated with groundnut production in the experimental sites (Table 1). A total of twenty-five (25) weed species were identified, out of which twenty-one (21) species appeared in BUK experimental field. Four among the weed species were perennial in nature while the rest area annuals. Grasses were eleven (11), Broadleaf were twelve (12) and two (2) were sedges. Among the grasses, *Cynodon dactylon*, *Setaria viridis*, *Setaria verticillata, Digitaria sanguinalis,* and *Imperata cylindrica* are the most dominant weed species in both locations. The broadleaf weeds on the other hand, are consist of *Euphorbia sepens*, *Amaranthus hybridus, Trianthema portulacastrum, Amaranthus spinosus, Acalypha indica, Tridax procumbens, Chenopodium album, Alternanthera sessilis, Calystegia pellita, Xanthium orientale, Cucumis melo,* and *Euphorbia heterophylla.* The two sedges are

Table 1. Weed specie composition of groundnut varieties as affected by mulching at BUK and Wasia during 2020 dry season

Weed species	Life cycle	Family	Level of occurrence	
			BUK	Wasai
Broad leaves				
Acalypha indica L.	Annual	Euphorbiaceae	*	*
Alternanthera sessilis (L.) R.Br. ex DC.	Annual	Amaranthaceae	NA	*
Amaranthus hybridus L.	Annual	Amaranthaceae	**	***
Amaranthus spinosus L.	Annual	Amaranthaceae	*	*
Calystegia pellita (Ledeb.) G. Don	Annual	Asteraceae	NA	*
Chenopodium album L.	Annual	Amarnthaceae	*	*
Cucumis melo L.	Annual	Cucubitaceae	*	*
Euphorbia heterophylla L.	Annual	Euphorbiaceae	***	***
Euphorbia serpens Kunth	Annual	Euphorbiaceae	*	**
Trianthema portulacastrum L.	Annual	Aizoaceae	NA	*
Tridax procumbens L.	Annual	Asteraceae	**	***
Xanthium orientale L.	Annual	Asteraceae	*	*
Narrow leaves				
Brachiaria crucuformis (Sm.) Griseb.	Annual	Poaceae	***	**
Cynodon dactylon (L.) Pers.	Perennial	Poaceae	***	***
Dactyloctenium aegyptium (L.) *P.Beauv*	Annual	Poaceae	*	*
Digitaria ciliaris (Retz.) Koeler	Annual	Poaceae	NA	*
Digitaria sanguinalis (L.) Scop	Annual	Poaceae	***	**
Dinebra retroflexa (Vahl) Panz	Annual	Poaceae	*	*
Echinochloa colona (L.) Link	Annual	Poaceae	*	**
Eleusine indica (L.) Gaertn.	Annual	Poaceae	*	*
Imperata cylindrica (L.) P. Beauv	Annual	Poaceae	***	***
Setaria viridis (L.) P. Beauv	Annual	Poaceae	***	**
Setaria verticillata (L.) P. Beauv	Annual	Poaceae	**	*
Sedges				
Cyperus esculentus (L.)	Perennial	Cyperaceae	***	***
Cyperus rotundus (L.)	Perennial	Cyperaceae	***	***

*NA= Not available, *= present, 1-39% (low), **: 40-59% (moderate), ***: 60-100 (high).*

Cyperus escullentus and *Cyperus rotundus*. The weed compositions were further grouped into various families comprising Poaceae (11), Euphorbiaceae (3), Amaranthaceae (4), Asteraceae (3), Cyperaceae (2), Cucurbitaceae, and Aizoceae, each having one species with a different level of occurrence across the two locations.

This discovery was in line with that of Ahmed et al. (2020), who noted a diversity of weeds as a result of mulching application. In a similar vein, the findings of the weed species distribution supported those of Shittu & Bassey (2023) and Shittu (2023), who independently indicated that *Cynodon dactylon* and *Cyperus* spp. are among the noxious weeds invading farm lands in the savanna region of Nigeria with high density, hence necessitating efficient control measures in managing their noxiousness to avert reducing loss in crop yield.

Weed cover score was significantly affected by mulching types across the two locations (BUK and Wasai). Control plots significantly gave the highest weed cover score across the two locations while the remaining mulching types gave the lowest weed cover score (Table 2). Variety and interaction did not show any significant (P > 0.05) different in both locations. Similar pattern of result was also obtained for weed density across the locations, respectively.

Weed dry weight was significant across the two locations (Table 3). Control significantly produced higher weed dry weight compared with the remaining treatments which though at par significantly produced lower weed dry weight in both locations, respectively. Variety and interaction did not show any significant difference on weed dry weight at both locations. On the other hand, weed control efficiency was significantly affected by mulching types only. Higher weed control efficiency (WCE) was recorded in black polythene though at par with the rest of the treatment while the control had the lowest WCE at BUK. While

Table 2. Effect of Mulch Type on Weed covers score and Weed density of Groundnut Varieties at BUK and Wasai during 2020 dry season

Treatment	Weed cover scores		Weed density (n/m^2)	
	BUK	Wasai	BUK	Wasai
Mulching (M)				
Black polythene	2.44^{b}	1.222^{d}	9.11^{d}	10.67^{c}
Transparent polythene	2.33^{b}	1.667^{d}	11.44^{b}	11.67^{c}
Saw dust	2.77^{b}	3.111^{b}	12.89^{bc}	16.00^{b}
Rice straw	2.44^{b}	2.333^{c}	12.44^{bc}	16.67^{b}
No mulching	4.77^{a}	4.222^{a}	20.44^{a}	22.44^{a}
P of F	<.001	<.001	<.001	<.001
SE (±)	0.1961	0.1835	0.642	0.869
Variety (V)				
SAMNUT 23	3.067	2.533	13.60	15.87
SAMNUT 24	2.867	2.733	13.47	15.07
SAMNUT 26	2.933	2.267	13.93	15.53
P of F	0.642	0.084	0.793	0.703
SE (±)	0.151	0.1422	0.498	0.673
Interaction				
M x V	0.151	0.098	0.340	0.542

Means followed by the same letter (s) within a column are not significantly different at 5% level of probability using SNK Test. Weed cover score= visual observation on a scale of 1=5, with 1as low weed cover while 5 highly covered.

at Wasai, the black and transparent polythene significantly resulted in highest WCE than Rice straw and Saw dust while control had the lowest WCE. The poor light transmittance in the black polyethylene mulch, which led to decreased photosynthetic activity of the weeds while greatly increased that of the crop, was the likely cause of the significant decrease in weed cover score, weed density, and weed dry weight recorded in black polythene mulch followed by the transparent polythene mulch.

Similar results were reported by Sakthivel (2019), who corroborated the decline in weed density and increase in WCE in black polythene mulch in mulberry leaf yield when compared to the control. In field-grown kale (*Brassica oleracea* var. s*abellica*). Gloeb et al. (2023) also demonstrated that mulch treatment, either before or after weed emergence, resulted in a 96% reduction in weed biomass. This, however, contradicts the findings of Bhattarai et al. (2023), which found that rice straw mulch had a greater WCE than black polythene mulch, and that weed population had decreased.

Effect of mulching on growth attributes of groundnut varieties

The effect of mulch type on the canopy cover of groundnut varieties is presented in Table 4. The canopy cover at BUK (6 & 9 WAS) and Wasai (6 WAS) was significantly influenced by the type of mulch. In comparison to the control plot, which produced a narrow canopy, applying black polythene mulch significantly ($P < 0.05$) resulted in the widest canopy cover at BUK. At 6 WAS, in Wasai, the black and transparent polythene mulch significantly ($P < 0.05$) gave the widest canopy cover than tother mulch types while control significantly resulted in the narrowest canopy cover. Variety and interaction on the other hand, had no significant effect on canopy cover across all the sampling period and locations, respective-

Table 3. Effect of Mulch Type on Weed dry weight and Weed control efficiency of Groundnut Varieties at BUK and Wasai during 2020 dry season

Treatment	Weed dry weight (g)		Weed control efficiency (%)	
	BUK	Wasai	BUK	Wasai
Mulching (M)				
Black polythene	14.23[c]	8.86[d]	71.87[a]	80.54[a]
Transparent polythene	18.52[bc]	14.16[c]	63.15[ab]	80.54[a]
Saw dust	18.58[bc]	21.04[b]	56.79[b]	62.45[b]
Rice straw	18.58[bc]	17.68[b]	63.26[ab]	66.34[b]
Control	50.31[a]	37.47[a]	0.63[c]	3.91[c]
P of F	<.001	<.001	<.001	<.001
SE (±)	1.838	1.163	0.309	2.504
Variety (V)				
SAMNUT 23	26.43	16.55	47.75	58.81
SAMNUT 24	23.42	15.65	53.67	58.77
SAMNUT 26	24.29	15.97	51.99	56.05
P of F	0.322	0.774	0.309	0.521
SE (±)	1.424	0.901	2.759	1.940
Interaction				
M x V	0.554	0.681	0.543	0.310

Means followed by the same letter (s) within a column are not significantly different at 5% level of probability using SNK Test.

ly. When compared to different types of mulch at 6 WAS in Wasai, the black and transparent polythene mulch significantly ($P < 0.05$) produced the widest canopy cover, while control significantly produced the narrowest canopy cover. On the other hand, variety and interaction had no significantly impact on canopy cover during any of the sampling periods or sites, respectively. At both locations, there was a considerable impact of the type of mulch on the amount of chlorophyll (Table 5). At both locations, the application of black produced significantly ($P < 0.05$) higher leaf chlorophyll content than the control plot, which resulted in lower chlorophyll content. However, other treatments led to increased chlorophyll content at 9 WAS at BUK and Wasai, respectively, even though they had statistically similar effects. Chlorophyll content was not ($P > 0.05$) significantly influenced by variety or interaction**.** The significantly higher canopy obtained in the black polythene mulch, transparent polythene mulch, and rice straw mulch could be attributed to the treatment's appropriate moisture retention, which boosted the plant's photosynthetic activity. The results of Sun et al. (2018), Yang et al. (2018) and Xu et al. (2020), who independently documented the effectiveness of various mulching types in enhancing crop water use and crop productivity, were in agreement with this conclusion. In a similar vein, Gitelson et al. (2015) stated that the higher total photosynthetically active radiation received by the canopy could account for the increased leaf chlorophyll content produced by such treatment, which has the potential to affect crop performance in a particular ecology (Féret et al., 2017).

Effect of mulching on yield character of groundnut varieties

Pod yield was significantly affected by mulching types across the locations (Table 5). At BUK,

Table 4. Effect of Mulch type on Canopy cover and Chlorophyll content of Groundnut Varieties at BUK and Wasai during 2020 dry season

Treatment	Canopy cover (cm)				Chlorophyll content	
	BUK		Wasai		BUK	Wasai
	Weeks after sowing (WAS)					
Mulching (M)	6	9	6	9	9	9
Black Polythene	66.61[a]	93.31[a]	59.70[a]	64.34	66.79[a]	65.89[a]
Transparent Polythene	54.71[b]	83.87[b]	58.55[a]	60.43	58.7[b]	59.08[b]
Saw Dust	47.69[c]	74.75[c]	49.17[b]	60.69	54.18[b]	58.76[b]
Rice Straw	43.54[c]	69.55[c]	42.49[b]	61.97	57.9[b]	58.04[b]
Control	31.89[d]	46.92[d]	37.02[c]	57.57	50.98[c]	57.17[c]
P of F	0.001	0.001	0.001	0.115	0.965	0.954
SE (±)	0.630	0.665	0.956	1.020	0.0001	0.0001
Variety (V)						
SAMNUT 23	49.15	71.02	50.19	56.69	58.59	59.82
SAMNUT 24	49.03	74.57	52.69	67.21	57.65	58.79
SAMNUT 26	48.49	75.45	51.28	63.09	56.98	60.75
SE (±)	0.378	0.399	0.573	0.612	0.579	0.572
P of F	0.944	0.117	0.361	0.098	0.572	0.491
Interaction						
M x V	0.995	0.278	0.640	0.112	0.051	0.081

Means followed by the same letter (s) within a column are not significantly different at 5% level of probability using SNK Test

Black polythene significantly gave the highest pod yield (2831 kg) which was also at par with transparent polythene, saw dust and rice straw compared with the control that gave the lowest pod yield. However, at Wasai, Black polythene significantly gave the highest (2377 kg) pod yield compared with the remaining mulching materials that gave lower pod yield while control gave significantly the lowest pod yield. Variety showed significant difference across the locations. At BUK, SAMNUT 26 variety significantly gave the highest pod yield while SAMNUT 24 and SAMNUT 23 gave the lowest pod yield. Similar trend was equally observed at Wasai.

100 seed weight was equally significant due to mulching types. Control significantly gave the lower 100 seed weight while the remaining mulching types resulted in higher 100 seed weight at both locations, respectively. Variety was significant in both locations where Samnut 23 significantly produced higher 100 seed weight compared with Samnut 26 that significantly produced the lowest 100 seed weight.

Kernel yield was significantly affected by mulching types. Black polythene mulch was highly significant ($P \leq 0.01$) and resulted in highest (1208 kg) kernel yield compared with other mulch types that resulted in lower kernel yield though higher than control that produced the lowest (887 kg) kernel yield in BUK. However, at Wasai, the black polythene and transparent polythene mulch were highly significant ($P \leq 0.01$) and produced the highest kernel yield (1157 & 1132 kg) compared with the no mulch that resulted in the lowest kernel yield (854 kg). Variety was also significant where SAMNUT 26 produced the highest (1198 & 1191 kg) kernel compared with the SAMNUT 23 that gave the lowest kernel yield at BUK and Wasai, respectively. The significant increase in pod yield, 100 seed weight,

Table 5. Effect of Mulch Type on pod yield, 100 seed weight and kernel yield of Groundnut Varieties at BUK and Wasai during 2020 dry season

Treatment	Pod yield (Kg ha^{-1})		100 seed weight (g)		Kernel yield (Kg ha^{-1})	
	BUK	Wasai	BUK	Wasai	BUK	Wasai
Mulching (M)						
Black polythene	2831^{a}	2377^{a}	51.44^{a}	49.71^{a}	1208^{a}	1157^{a}
Transparent polythene	2590^{ab}	2031^{b}	50.78^{a}	49.19^{a}	1180^{b}	1132^{a}
Saw dust	2422^{b}	1890^{b}	50.16^{a}	48.71^{a}	1122^{c}	1061^{b}
Rice straw	2323^{b}	1913^{b}	48.78^{a}	47.11^{a}	1109^{c}	1037^{b}
No mulching	1961^{c}	1179^{c}	44.48^{b}	42.92^{b}	887^{d}	854^{c}
P of F	<.001	<.001	0.003	0.002	<.001	<.001
SE (±)	110.347	62.875	1.217	1.169	6.16	12.17
Variety (V)						
SAMNUT 23	2165^{b}	1714^{b}	55.51^{a}	54.52^{a}	956^{c}	917^{c}
SAMNUT 24	2314^{b}	1803^{b}	52.07^{b}	50.20^{b}	1150^{b}	1131^{b}
SAMNUT 26	2798^{a}	2119^{a}	39.80^{c}	37.87^{c}	1198^{a}	1191^{a}
P of F	<.001	<.001	<.001	<.001	<.001	<.001
SE (±)	85.47	48.70	0.943	0.905	4.77	9.43
Interaction						
M x V	0.745	0.102	0.554	0.781	<.001	0.050

Means followed by the same letter (s) within a column are not significantly different at 5% level of probability using SNK Test.

and kernel yield generated by black polythene mulch followed by transparent polythene mulch could be attributed to the mulching types' ability to retain moisture, which increased the crop's ability to use water efficiently when there was less weed cover and density. This new discovery supported the findings of Iqbal et al. (2021), who observed that mulching resulted in improved water usage efficiency in cotton in an arid region, which translated to fewer irrigation cycles. Other researchers (Torres-Olivar et al., 2018; Ahmad et al., 2020; Li et al., 2020; El-Metwally et al., 2022) reported increasing the water holding capacity of mulch plots, maximizing the water use efficiency of arable crops due to effective mulching. This resulted in increased crop yield. This, however, runs counter to the findings of Bhattarai et al. (2023), who claimed that rice straw mulch increased groundnut yields in comparison to black polythene mulching. On the other hand, significant pod yield and kernel yield obtained in SAMNUT 26 and higher 100 seed weight in SAMNUT 23 varieties in both locations could be attributed to less competition availability for adequate growth resources between the crop and the weeds, which enables the varieties to explore their genetic make-up for producing higher yield potential of crop varieties. This result was consistent with that of Shittu et al. (2023), who found that SAMNUT 23 had heavier seeds than SAMNUT 22 and SANMUT 14 when assessed under weed-free conditions because of their genetic makeup, which allows them to generate larger seeds.

Interaction between mulching type and variety was highly significant at BUK and significant at Wasai (Table 5). Application of black polythene and transparent polythene in SAMNUT 26 was highly significantly ($P \leq 0.01$) and produced the highest kernel yield compared with the rest of the interaction effects that resulted in lower kernel yield. However, it was closely followed by black polythene and transparent polythene in SAMNUT 24 compared with the rest of the interaction effects that resulted in decrease kernel yield at BUK. However, at Wasai, application of black

Table 6. Interaction between Mulch Type and Variety on kernel yield Groundnut Varieties at BUK and Minjibir during 2020 Dry Season

Mulching	BUK		
	Variety		
	SAMNUT 23	SAMNUT 24	SAMNUT 26
Black polythene	1041^{e}	1250^{b}	1331^{a}
Transparent polythene	1020^{e}	1208^{c}	1311^{a}
Saw dust	977^{f}	1188^{cd}	1203^{cd}
Rice straw	973^{f}	1164^{d}	1190^{cd}
No mulching	770^{g}	937^{f}	955^{f}
SE (±)	10.66		
	Wasai		
Black polythene	1000^{g}	1192^{bc}	1278^{a}
Transparent polythene	988^{gh}	1166^{cd}	1244^{ab}
Saw dust	947^{gh}	1096^{df}	1163^{b-e}
Rice straw	931^{gh}	1072^{f}	1092^{def}
No mulching	723^{i}	908^{h}	925^{gh}
SE (±)	21.09		

Means followed by the same letter (s) within a column are not significantly different at 5% level of probability using SNK Test.

polythene in SAMNUT 26 was significant (P < 0.05) and resulted in higher kernel yield though at par with transparent polythene in SAMNUT 26 compared with the remaining interaction effects. The significant interaction between mulching and variety that led to SAMNUT 26 producing higher kernel yields in both locations with black polythene and transparent polythene mulch could be attributed to the successful weed suppression attained by the mulching types, which allow the SAMNUT 26 variety to utilize the available moisture conserved for optimum dry matter production. According to studies by Sathyamurthy et al. (2017), Massa et al. (2019) and Iqbal et al. (2020), mulch plots boosted plant productivity by suppressing weed growth.

CONCLUSION

Mulching had a substantial impact on crop qualities including canopy cover, chlorophyll content, pod yield, 100 kernel weight, and groundnut kernel yield as well as weed attributes like weed cover scores, weed density, weed dry weight, and weed control efficiency. On the other hand, SAMNUT 26 significantly produced higher pod and kernel yields, although SAMNUT 23 produced a heavier 100-kernel weight. In comparison to the other mulching types, applying black polythene mulch or transparent mulch lowered weed density and dry weight by limiting the amount of sunlight that the weeds got, preventing them from growing. Thus, it was discovered that mulching with black or transparent polythene film using the SAMNUT 26 variety was effective in preserving soil moisture for the best crop growth and development, while on the other hand, weed populations were reduced in both locations, making it possible to grow groundnuts in the dry season in the Sudan savannah ecology of Nigeria.

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Received: March, 12, 2024; *Approved:* June, 27, 2024; *Published:* August, 2024