Advances in Environmental Biology, 4(3): 368-375, 2010
ISSN 1995-0756

This is a refereed journal and all articles are professionally screened and reviewed

ORIGINAL ARTICLE

Effect of Some Mulch Materials on Soil Physical Properties, Growth and Yield of Sunflower (*Helianthus Annuus, L*)

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Agele, S.O., Olaore, J.B. & Akinbode, F.A.: Effect of Some Mulch Materials on Soil Physical Properties, Growth and Yield of Sunflower (*Helianthus Annuus, L*)

Abstract: Field experiments were conducted to the suitability of some mulch materials for soil improvement and yield of sunflower (*Helianthus annuus*, L). It was hypothesized that application of mulch materials would improve soil properties and enhance growth and seed yield o sunflower. Experiments were conducted to evaluate these hypotheses, and the results supported our hypotheses (null,HO). Sunflower (Funtua local variety) was cultivated under bare-ground (control) and three mulch materials (black polythene sheet, dry grass and chromolaena shoot and dry teak leaves). The mulch materials were applied at 6 t ha^{-1} while black polythene sheet was spread to completely cover the soil surface. The application of mulch altered soil micro-environments around the plant. Compared with unmulched plots, mulching significantly improved soil moisture and soil temperature regimes, root and shoot biomass and leaf area development. However, across the mulch materials, sunflower grown under dry grass produced higher values of root (17 and 15 g) and shoot biomass (77 and 68 g), leaf area per plant (4.6 and 3.3 m^2) and increased seed yields (24 and 19 t ha^{-1}). Over the unmulched control, mulching using chromolaena shoots and teak leaves produced significant increases in total N (3.2 and 3.0 g g^{-1}) and organic matter (8.9 and 9.8 g g^{-1}) over dry grass and polythene sheet (2.7 and 2.2 g.g^{-1}; 8.3 and 6.9 g g^{-1}). The observed variations in soil chemical properties can be attributed to differences in the rates of N decomposition possibly driven by the quality of mulch materials measured in terms of C/N ratios. The application of mulch materials improved hydrothermal and fertility status required for optimal sunflower growth and yield. The results would be applicable to agricultural development of other sites with similar soils and climate.

Key words: Sunflower, mulching, moisture, temperature, nutrients, seed, tropics

INTRODUCTION

Sunflower, (*Helianthus annuus*, L), is an important oil-seed crop world wide, the production of sunflower as a suitable oil crop in Nigeria[20]. The economic importance of sunflower cannot be over - emphasized. The fresh green plant can be fed as silage or fodder to livestock. The seed which can be eaten raw or roasted contains 36 to 45 % oil depending on variety and can be used in salads, cooking, margarine, lubricant, paint vanishes and soap production[23]. The decorticated seed cake is a good source of protein for livestock (35%), especially when made from whole seed. Sunflower has deep tap root system, which develops down to 3m, with a proliferation of surface lateral roots; this makes the crop fairly drought resistant [21,28]. Although, sunflower is known to be drought resistant, water supply is a critical factor for oil formation. Inadequate water supply with or without the use of fertilizers results in reduced seed yield and oil content[11,21,28]. An important factor in the adaptation of a crop to different agro – ecological zones is the growth and yield performance of the crop in the different seasons of sowing. The high adaptation and yield of sunflower in south- western Nigeria has been reported by Ogunremi [23].

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These seasons are characterized by extreme soil conditions and environmental factors of growth such as temperature, moisture, light and air[4]. Fallowing and mulching are commonly used methods of residue management and hence nutrient recycling in tropical farming systems. Mulching is reported to ameliorate soil moisture deficits and extremely high soil temperature regimes [4,25], and eliminate compaction of ridges and mounds [6]. Mulching has also been shown to improve water infiltration, reduce evaporation and run-off, control weeds and improve soil structure [25]. The practicability of mulching large areas is questionable due to the large quantity of mulch required and the possibility of mulches harboring pests and diseases. However with the high rainfall during the wet season and the resulting heavy growth of vegetation that may be used as mulch in a small scale farms, mulching of sunflower crops appears to be an attractive possibility.

The efficiency of nutrient recycling from residue management especially from residue mulch in tropical farming systems are predicated on activity of soil microbial population which result in decomposition of applied organic materials. Soil microorganisms play an important role in regulating soil fertility and transforming organic matter and their activity relies on the availability of decomposable materials [18,26,27]. Soil fertility enhancement due to mulching can be attributed to the promotion of microbial activity and consequent enhancement of the decomposition of organic materials. Hema *et al*. (1999) reported that the use of mulch materials with different C/N ratios (which vary from low/moderate to high) produced differences in N mineralization, C and N formation in soil. Our working hypothesis that application of mulch materials would improve soil properties and enhance growth and seed yield o sunflower. Experiments were conducted to evaluate our working hypotheses - would the application of mulch materials improve soil properties and enhance growth and seed yield of sunflower?. Therefore, the objectives of this study were to examine the suitability of mulching for the establishment of sunflower, investigate the impacts of the mulch materials on soil properties and relate these properties to the growth and yield of sunflower.

Material and methods

Two trials were conducted in the late season of 1999 and early season of 2000, at the Teaching and Research Farm of the Federal University of Technology, Akure, in the rainforest zone of south - western Nigeria. The soil at the site of study is a sandy loam Alfisol classified as clayey skeletal oxic- paleustalf (USDA – Soil Taxonomy Soil Survey Staff, 1999). The results of the chemical analysis of the soil at site of study before planting is presented in Table 1 while climatological data for the period of experimentation are shown in Table 2. An oil type sunflower, Funtua Local obtained from the University of Agriculture, Abeokuta, Nigeria, was planted on flat land that were cleared manually (reduced tillage accompanied by negligible disturbance of the soil) of fallow vegetation using cutlasses (matchets), on 21st September 1999 and 21st April 2000. Sunflower seeds were planted at an inter-row spacing of 90cm and 30cm intra-row spacing manually using simple hand held grain driller. Three weeks after planting, the plants were thinned to one plant per stand giving a plant population of 37, 037 plants/ha. All plots were manually weeded using a hand hoe before treatments were applied. Subsequent weeding was carried out as needed. In each year, treatments consisted of bare ground (control), application of air-dried shoot biomass of *Chromolaeana odorata*, dry elephant grass (*Pennisetum purpureum*), dry teak leaves (*Tectonia grandis*), and black polythene sheet. The black polythene sheet was spread out to completely cover the soil surface. Chromolaeana shoots, dry grass and teak leaves were applied at 6 t ha^{-1}. The treatments were assigned to plots using randomized complete block design (RCBD) and each treatment was replicated four times. The plots were 4 x 4 m with 1m guard rows between plots and the entire field plot measured 1911 m^2.

Three sampling points were located per treatment replicate from where soil samples were taken and bulked per plot, and three sub-samples were taken from such bulked samples per treatment for laboratory analysis. Particle size analysis was determined by hydrometer method using 50gms of 2mm sieved air-dried soil dissolved in water in a 200ml beaker. Readings were taking at 40 seconds and 2hours in the sedimentation cylinder. Soil samples were collected from the field using core samplers of dimension 8.5 diameter by 8.5 cm height, and five samples were collected from each treatment replicates (a total of 20 samples per treatment). Bulk density (g cm^{-3}) was calculated as the ratio of weight of oven dried soil (g) to the volume of soil (cm^3) (482.6 cm^3) contained in the core sampler. At fortnightly starting from 2 weeks after planting (WAP), soil temperature and soil moisture content were monitored. Soil temperature was measured at 5 cm depth using soil thermometers and measurements were made at 1500h. Soil moisture content expressed in percentage was determined by gravimetric method (oven-dried soil samples at 105 ºC for 24 hours) at soil depth of 10 cm. Composite soil sample was collected, air- dried and sieved using a 2 mm sieve for the determination of pH, organic matter content, Nitrogen (N), Phosphorous (P), Potassium (K), Calcium (Ca) and Magnesium (Mg). The pH of the soil was determined by using 1:1 water suspension by adding 10ml distilled water to 10g of soil and read on pH meter.

The organic matter content was determined by using dichromate oxidation method [34]. Nitrogen was determined by micro- kjeldahl apparatus [17] and the available phosphorous was extracted using Bray- P- 1 extraction [8] and read on Spectrophotometric device. Exchangeable K, was extracted using ammonium acetate [17] and it was determined on flame photometer while Ca and Mg were determined using the EDTA filtration method.

Sunflower plants were randomly sampled from two center rows per treatment replicate, in all five plants were tagged per replicate from which growth and yield characters were taken. Sunflower growth parameters were taken at 50% flowering when much of the growth processes have ceased and thus represent maximum possible value per plant[30] while yield parameters were determined five weeks after spearing (flower opening) as opined by Ogunremi [23]. Growth parameters measured include: 50% flowering date (defined as the number of days from sowing to 50% flowering). Plant height was measured as the distance from the ground level to the base of the receptacle when the plants had attained physiological maturity (change in the colour of the backs of the heads from green to lemon yellow). Stem girth was measured using a string wound around the stem just above ground level and measuring it out on a ruler. Leaf area per plant was determined by the non – destructive method for rapid estimation of sunflower leaf area genotypes with more than 95% accuracy using the equation

$$Y = 628 + 0.514nx \quad (1)$$

where y is the leaf area per plant, x is the leaf area of the specific leaf (for instance 8^{th} leaf), obtained by multiplying the total number of leaves per plant with 0.355 and round off to the nearest higher integer, and 'n' is the total number of leaves per plant [29].

Head diameter was determined in 10 randomly selected plants in each plot using string and ruler. Seed yield was taken from three middle rows at the center of each plot. Harvested heads were threshed and seed yield was expressed in kg ha^{-1}. Data on growth and yield components collected on treatment basis were subjected to analysis of variance (ANOVA) to determine the effect of the treatments on parameters measured. The treatment means were separated using Fisher's Least Significance Difference test (LSD) [32].

Table 1: Pre-planting soil properties at site of experiment (1999 and 2000)

	N (mg/kg)	P (mg/kg)	K (cmol/ kg soil)	Ca	Mg	Organic matter (g/kg)	pH water	Bulk density (g/m^3)
(1999)	0.38	5.93	1.36	0.84	1.24	3.51	6.4	1.27
(2000)	0.51	7.22	1.53	0.91	1.36	4.24	6.6	1.28

Table 2: Weather data during the period of the experiment (1999-2000)

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
Rainfall (mm)	0	1.4	33.2	53.5	97.9	205.1	268.7	253.6	211.9	179.4	17.8	5.1
Rel. humidity (%)	47	41	48	55	63	67	73	81	72	63	52	48
Min. Temp (°C)	17.9	20.6	22.3	22.9	21.3	20.8	21.2	20.8	21.5	21.8	20.9	19.5
Max. Temp.(°C)	31.8	32.6	33.3	32.9	31.6	30.3	29.6	28.7	29.6	30.3	31.7	30.6
Sunshine hours	189.3	217.4	225.7	194.6	189.3	161.9	108.7	89.5	96.3	147.2	209.1	158.6
Solar radiation ($MJ/m^2/day$)	43.5	45.8	48.6	50.3	48.5	39.3	37.8	41.4	43.6	45.7	47.5	44.8

RESULTS

Effect of Mulch on Soil Physical Properties:

There were fluctuations in soil temperature regimes between mulched plots and bare ground in both trials. Soil temperature observed in 1999 and 2000 were significantly reduced by mulching using teak leaves and dry grass (Fig. 1a and 1b). Teak leaf mulch tend to follow the trend obtained under dry grass mulch but gave lower values of soil temperature at both seasons. The mulch materials improved soil moisture status in both trials (Fig. 2a and 2b). However, dry grass and teak leaf increased soil moisture contents significantly over those obtained under polythene sheet mulch and control.

The impedance of rain water entrance into the soil by polythene sheet was reflected in the lower soil moisture status than under control. The use of different mulch materials of different quality (C/N ratio) produced variable effects on soil quality parameters (especially chemical properties).

Treatment effects were profound on soil nutrient status measured at crop maturity in terms of organic carbon, total N. Over the unmulched control, mulching using chromolaena shoots and teak leaves produced significant increases in total N and organic C over other treatments. The magnitude of organic carbon and N could have been due to increased microbial activity. The quality of the mulch materials measured in terms of C/N ratios varied, the highest C/N ratios were obtained under dry grass mixture.

The observed variations in soil chemical properties can be attributed to differences in the rates of N decomposition possibly driven by the quality of mulch materials measured in terms of C/N ratios.

Effects of Mulch on Growth and Seed Yield Characters of Sunflower:

Root dry weight increased significantly under dry grass mulch in 1999 by 15.1 % while in 2000, both dry grass and black polythene sheet mulches significantly increased dry root weight by 22.58% and 9.29% over bare ground respectively (Table 3 and 4). Mulching also significantly increased shoot dry weight/plant by 41.1 %, 37.97 % and 33. 8 % under dry grass, dry teak leaf and black polythene sheet mulch respectively in 2000. Non-significant increases of 25.8 %, 3.4 % and 23.03 % in shoot dry weights respectively were obtained in 1999 in plots mulched with dry grass, teak leaves and black polythene sheet. Root/shoot ratio gave similar non-significant values in both trials with the highest values obtained on bare ground plots. Plant height values in the early season (2000) were more than double those obtained in the late season crop of sunflower (1999). Mulching did not exert significant effect on plant height. Conversely, sunflower stem girth values were about 1.25 – 23 % greater in the late season crop. Mulching with dry teak leaves reduced sunflower stem girth compared with that of the black polythene sheet mulched plot in 1999.

Mulched sunflower crops gave significantly higher leaf area than bare ground. Increasing order of values of leaf area production in mulched plots are; dry teak leaf, black polythene sheet and dry grass.

The mulch enhanced leaf area production followed by improved shoot biomass development in both trials. The attainment of 50% flowering days was significantly delayed in plots mulched with dry grass and polythene sheet by about 5-8 days in 1999.

A non-significant delay of about 2-6 days was obtained in 2000 in all mulched plots. Consequently crop maturity was significantly prolonged under dry grass and black polythene sheet mulched plots by about 7-11 days and 12-14 days in 1999 and 2000 respectively. Increases in mean head diameter was observed in all mulched plots. Dry grass had the highest values of head diameter (15-18 cm) in 1999 and 2000. Number of seeds/plant and percentage of large seeds were relatively increased by mulching. Harvest index (HI) values were however higher with the use of dry grass mulch in both trials.

There were no significant increases in seed yield at either season (Table 3) The highest seed yield values (2564.80 and 2149.46 kg ha^{-1}) were obtained in plots mulched with chromolaena and dry grass over that of dry teak leaf mulch and bare ground respectively. Same trends in the values of seed yield were obtained for the 1999 and 2000 experiments.

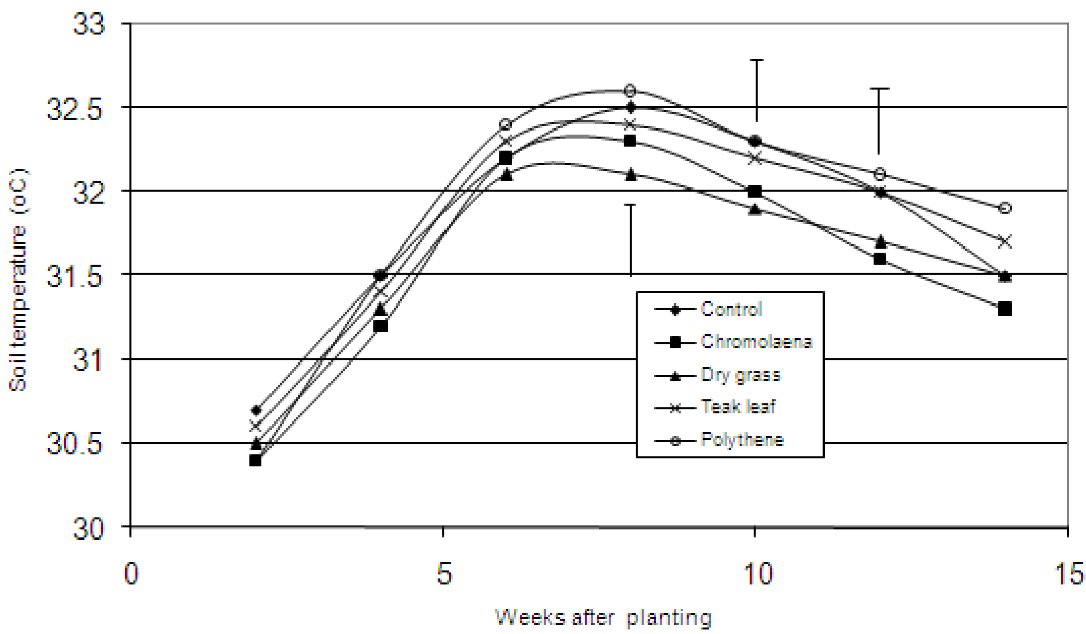

Fig. 1: Effect of mulch materials on soil temperature (1500h), late season sun flower,1999. Vertical bars represent LSD values (P = 0.05).

Table 3: Effects of mulch materials on soil chemical properties at crop maturity (late season,1999 and rainy season 2000 experiments)

Soil parameters	Teak leaf	Dry grasses	Chromolaena shoot	Polythene sheet	Control (bare ground)	LSD (0.05)
Late season (1999) experiment						
pH (water)	6.3	6.3	6.2	6.3	6.2	---
Bulk density ($g.cm^{-3}$)	1.29	1.28	1.30	1.31	1.33	0.07
Organic carbon ($g.g^{-1}$)	5.2	4.8	5.7	4.0	4.2	1.2
Total carbon ($g.g^{-1}$)	36.6	32.1	38.4	30.2	31.3	2.34
Organic matter ($g.g^{-1}$)	8.9	8.3	9.8	6.9	7.2	1.84
Total N ($g.g^{-1}$)	3.0	2.7	3.2	2.7	2.6	0.7
Total P ($mg.g^{-1}$)	11.0	10.7	11.4	9.4	10.3	1.4
CEC	19.3	18.7	20.1	17.3	18.4	1.53
C/N ratio	1.73	1.78	1.77	1.48	1.62	0.27
Rainy season (2000) experiment						
	Teak leaf	Dry grasses	Chromolaena shoot	Polythene sheet	Control (bare ground)	LSD (0.05)
pH (water)	6.5	6.4	6.5	6.3	6.3	----
Bulk density (gcm^{-3})	1.28	1.31	1.30	1.32	1.30	0.04
Organic carbon ($g\ g^{-1}$)	5.4	5.0	5.8	4.3	4.6	1.3
Total carbon ($g\ g^{-1}$)	37.2	35.3	39.6	30.4	31.8	2.52
Organic matter ($g\ g^{-1}$)	9.3	8.6	9.9	7.4	7.9	1.7
Total N ($g\ g^{-1}$)	3.2	3.0	3.4	2.8	2.7	0.8
Total P ($mg\ g^{-1}$)	11.4	10.5	11.5	9.5	10.7	1.53
CEC	23.5	21.2	24.9	20.2	20.8	2.1
C/N ratio	1.7	1.6	1.7	1.5	1.6	0.21

Table 4: Effects of mulch materials on growth and seed yield characters of sunflower (late season,1999 and rainy season 2000 experiments)

Late season (1999) experiment						
Soil parameters	Teak leaf	Dry grasses	Chromolaena shoot	Polythene sheet	Control (bare ground)	LSD (0.05)
Root dry weight (g)	15.5	17.8	18.2	16.9	15.1	1.7
Shoot dry weight (g)	66.1	83.1	86.2	81.3	68.3	11.2
Root/shoot	0.23	0.22	0.25	0.19	0.22	0.05
Plant height (m)	1.29	1.18	1.31	1.24	1.31	0.15
Stem girth (cm)	4.6	4.7	4.9	4.9	4.1	0.7
Leaf area (m^2)	4.0	5.38	5.41	4.62	3.29	1.1
50% flowering (days)	78	86	88	83	79	5.2
Head diameter (cm)	14	18	18.4	16.4	16.1	3.5
Number of seeds $plant^{-1}$	1127	1143	1272	1022	1011	18.4
100 seed weight (g)	6.5	9.6	10.3	7.9	9.2	0.3
Seed yield (t/ha)	21.7	26.5	28.1	20.8	18.7	0.9
Harvest index	0.4	0.46	0.49	0.41	0.40	0.2
Rainy season (2000) experiment						
Soil parameters	Teak leaf	Dry grasses	Chromolaena shoot	Polythene sheet	Control (bare ground)	LSD (0.05)
Root dry weight (g)	16.2	18.1	19.3	17.8	15.1	2.1
Shoot dry weight (g)	94.9	97	98.4	92.1	68.8	13.8
Root/shoot	0.17	0.19	0.21	0.2	0.21	0.05
Plant height (cm)	2.77	2.72	2.98	2.91	2.65	0.5
Stem girth (cm)	4.0	3.93	4.1	4.0	3.88	0.4
Leaf area (m^2)	3.96	4.73	4.88	4.56	3.58	0.39
50% flowering (days)	80	84	86	82	78	7.3
Head diameter (cm)	14.1	15.0	15.6	14.2	13.4	3.5
Number of seeds $plant^{-1}$	656	767	784	671	620	95.3
100 seed weight (g)	5.3	6.5	6.8	5.5	5.1	1.3
Seed yield ($t\ ha^{-1}$)	20.7	22.3	23.6	21.1	18.3	0.8
Harvest index	0.31	0.34	0.36	0.33	0.34	0.1

DISCUSSION

It was hypothesized that application of mulch materials would improve soil properties and enhance growth and seed yield of sunflower, this hypothesis was supported by our results. In this study, mulching ameliorates soil moisture deficits and temperature regimes. Black polythene sheet mulch maintained a relatively higher soil temperature range in both trials. Lowest soil temperature status was obtained under dry grass mulch at both seasons. Soil moisture content improved considerably following decreases in soil temperature in plots mulched with dry grass and teak leaves. The result agrees with the findings in literature[1,4]. These authors reported the effect of mulching on soil moisture conservation and reduction in soil temperature regimes. Other studies from agricultural fields from the humid tropics had shown that mulching ameliorates soil moisture deficits and temperature regimes, improves water infiltration, reduce evaporation and run – off and improves soil structure[25], and eliminate compaction of ridges and mounds (Aina 1979). Lower soil moisture contents observed under black polythene sheet mulch were similar to those of unmulched plots. This could be as a result of high soil temperature enhanced soil moisture evaporation and increased water run-off on plastic surface via reduced infiltration of rainfall. The favourable hydrothermal regimes observed in mulched plots is similar to previous findings on mulching [25,4]. Root biomass development was greater under mulch than bare ground. This result agrees with the result of Adeoye[2]. Dry grass and black polythene sheet mulches had outstanding performance on root dry weight. High root biomass development could promote soil water extraction to meet the demand for assimilate production from the high above ground biomass[14]. The improved soil moisture and soil temperature regimes enhanced root development possibly through greater soil moisture and nutrient uptake, which favoured shoot biomass development in mulched plots. The supra- optimal soil temperature regimes in addition to low soil moisture status of the late season could be linked to lower biomass yield of sun-flower during this period.

The quality of applied mulch materials had profound effects on soil chemical properties, which were related to contents of organic carbon and N (potentially mineralisable N) in materials applied. In this study, plots in which mulches with low C/N ratios were applied had higher mineral N and organic C. Hema *et al*. (1999) reported that the addition of organic wastes with low C/N ratio increased inorganic N in soil in addition to higher microbial biomass C in soil. In another study, Paul and Mannan[26] obtained higher microbial C and N formation through addition of straw of high C/N ratio. The efficiency of nutrient recycling from applied crop/plant residues (mulch) is predicated on activity of soil microbial population which results from the decomposition of the applied materials.

Therefore, the soil fertility enhancement by mulch obtained in this study can be attributed to the promotion of microbial activity and consequent decomposition of organic materials. Mulch materials can change the biological properties of the soil with consequences on soil fertility[19]. Soil microorganisms play an important role in regulating soil fertility and transforming organic matter, and their activity relies on the availability of decomposable materials[26,27]. Soil organic matter is a key factor in maintaining long-term soil fertility. Increases in sunflower yield may be attributed to increases in soil organic matter (SOM) pool from the decomposition of the applied mulches.

The similar root/shoot ratio obtained in both mulched and un-mulched plots agrees with the findings of Agele *et al.* [4]. The authors did not find significant difference in tomato root/shoot ratio between bare-ground and plots mulched with 12 kg ha^{-1} of grass. Roots and shoots perform distinct but almost symbiotic functions. Reduction in nutrient supply to the shoot caused by root competition reduced the efficiency of the shoots and hence the plants ability to compete for photosythetically active radiation (PAR) this in turn will reduce the flow of assimilates to the roots and hence its reduced growth [4]. Plant height in the early season crop was greater than that of the late season crop.

Improved vigour of growth increased the susceptibility of the early season sunflower crop to wind damage at physiological maturity as was observed in this study. Increased plant height and reduced stem girth could favour lodging (Chui and Shibles 1984). Mulching materials on decomposition would increase soil nutrients (organic matter and total nitrogen), enhanced microbial activities and macro aggregate formation [3,7]. The ease of decomposition of mulch has effects on crop and soil properties depending on the plant species from which mulch is derived.

Leaf area/plant was not significantly affected by mulching. Improved leaf area development could reduced evaporative loss, increased infiltration probably due to increased soil biological activities as a result of lower soil temperature were reported by Olasantan [25] and Zamman and Choudhuri [34]. Enhanced radiant energy utilization under improved leaf area for dry matter and fruits yield increases was observed by Agele *et al.[4]* for mulched tomato in south - west Nigeria. The delay in the attainment of 50 % flowering days and days to maturity in all mulched plots could be attributed to the favourable soil moisture and soil temperature regimes. Earliness to flowering and head maturity was however obtained in sunflower grown on bare – ground. Sinclair [31], observed that early maturity in crops ensures water availability for the completion of reproductive growth before the onset of drought – induced senescence.

The shortened growth duration of sunflower can be adduced to an unfavorable soil hydrothermal regime under un-mulched conditions, particularly the dry season crop. Increased number of flower heads produced per plant grown on bare-ground and under black polythene sheet mulch at both early and late season trials were probably a moisture - stress induced condition. Increased number of flowers that could mature at different periods could be a survival strategy that can ensure preservation of life for the next generation. The high number of flower heads / plant observed under teak leaf mulch could be a result of factors other than soil temperature and soil moisture status. Purvis [27] suggested that the presence of toxic compounds, phenolic acids or allelopathic relationships could have implication for use of mulch materials in agriculture.

Sunflower grown under mulch produced larger heads. Esechie [12] and Agele *et al*. [4] attributed this to favourable growth conditions notably sunshine hours and temperature. Number of seeds/plant increased with decreasing percentage of medium and large seed and weight of 100 seeds. Improved vigour of root biomass development under grass mulch as a result of favourable soil condition could have resulted in the high value of harvest index (HI) in 1999. This suggested that sunflower partitioned more assimilate to seed development than to vegetative organs during this period. The high value of HI observed in 2000 on bare ground plot could be attributed to the significantly reduced root and shoot biomass and high partition of assimilate for reproductive development. Sunflower is sensitive to temperature regimes during its growth, high temperatures decreased maximum plant weight[]12,3,25].

Sunflower seed yield obtained in all the plots in both trials compared adequately with the results of Ogunremi[25], Esechie [12] and Fagbayide and Adeoye[2]. A noticeable difference of 15.10 %, 43.01 % and 5.34 % seed yield was observed in 1999 while a reduction in seed yield to 4.40 %, 15.5 % and 1.90 % in 2000 was obtained in black polythene sheet, dry grass and teak leaves mulched plots respectively over bare–ground plots. This result further buttresses the high values obtained for HI under grass mulch in 1999.

Conclusion

The result of this study showed that sunflower responded to mulching. It is obvious that improved soil hydrothermal regime in mulched plots was responsible for the enhanced vegetative growth and seed yields. The advantages derived from mulching were reflected in improved stem girth, leaf area/plant and days to obtain 50% flowering and enhanced percentage of large seeds, weight of 100 seeds and seed yield. Among the mulching materials tested, chromolaena and teak leaves were observed to decompose faster than dry grass in this study.

However, trends in soil hydrothermal characteristics of black polythene sheet did not favour growth and yield parameters of sunflower. In order to achieve good soil surface cover and improved hydrothermal and fertility status required for optimal sunflower growth and yield, mulching with chromolaena and teak leaves and mixture of dry grass applied at 6 t ha^{-1} is recommended to farmers in the study area. The results would be applicable to agricultural development of other sites with similar soils and climate.

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