Response of okra (*Abelmoschus esculentus* (L.) Moench) to weed control by mulching

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ABSTRACT

The effects of mulching material on okra performance during the rainy seasons of 1999 and 2000 were evaluated at the Teaching and Research Farm of the Ladoke Akintola University of Technology, Ogbomoso, Nigeria. Three mulch types–plastic mulch, grass mulch (*Panicum maximum*) and wood shavings (of *Tectonia grandis*)–were compared with hand weeding and no weeding control in a randomized complete block experiment with three replications. Growth and yield characteristics of okra were assessed together with weed control efficiency under the five treatments. Okra growth and yield were significantly ($P < 0.05$) influenced by the treatments. Plants under plastic and grass mulches had wider leaves and bigger stems, as well as higher number of branches compared to those of wood shaving mulch and weedy control. The plants were also significantly ($P < 0.05$) taller. They were, however, similar to plants under the hand weeding control in these characteristics. Plants under the weedy control were the poorest in these growth attributes. The highest yield of 12,135 kg ha^{-1} was recorded under plastic mulch, which was significantly higher ($P < 0.05$) than all the other treatments. Yields from grass mulch (607 kg ha^{-1}) were similar to those for hand weeding control (6,976 kg ha^{-1}). However, these were significantly higher than those of wood shavings mulch (5,301 kg ha^{-1}). Yield from the weedy control was the lowest (946 kg ha^{-1}; 14 g plant^{-1}). The weed control efficiency of the control methods followed the trend: plastic mulch > hoe weeding > wood shavings > grass mulch.

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RÉSUMÉ

OLABODE, O. S., OGUNYEMI, S. & AWODOYIN, R. O.: *Réaction de gombo* (Abelmoschus esculentus *(L.) Moench) au contrôle de mauvaise herbe par le paillis.* Les expériences se sont déroulées au champ d'enseignement et de recherche de l'Université de Technology de Ladoke Akintola à Ogbomoso pour évaluer les effets de matériel de paillis sur le rendement de gombo pendant les saisons des pluies de 1999 et 2000. Trois types de paillis-paillis en plastique, paillis en herbe *(Panicum maximum*) et paillis en copeaux de bois *(*de *Tectonia grandis)* étaient comparés avec le désherbage à la main et le contrôle de non désherbage dans une expérience de bloc complet choisi au hasard avec trois reproductions. Les paramètres de croissance et de rendement de gombo étaient évalués ensemble avec l'efficacité du contrôle de mauvaise herbe sous les cinq traitements. La croissance et le rendement de gombo étaient considérablement ($P < 0.05$) influencés par les traitements. Les plantes sous les paillis en plastique et en herbe avaient des feuilles plus larges et des tiges plus grandes ainsi que de nombre des branches plus élevées comparées à celles de paillis en copeaux de bois et à celles du contrôle de non désherbage. Les plantes étaient aussi considérablement ($P < 0.05$) plus hautes. Elles étaient cependant semblables aux plantes sous le contrôle de désherbage à la main selon ces paramètres. Les plantes sous le contrôle de non désherbage étaient les plus pauvres dans ces attributs de croissance. Le rendement le plus élevé de 12, 135 kg ha^{-1} était obtenu sous le paillis en plastique qui étaient considérablement plus élevé ($P < 0.05$) que tous les autres traitements. Les rendements du paillis en herbe (607 kg ha^{-1}) étaient semblables à ceux du contrôle de désherbage à la main (6,976 kg ha^{-1}). Toutefois, ces étaient considérablement plus élevés que ceux du paillis de copeaux de bois (5,301 kg ha^{-1}). Le rendement du contrôle de non désherbage étaient le plus faible (946 kg ha^{-1}; 14 g plant^{-1}). L'efficacité du contrôle de mauvaise herbe des méthodes du contrôle suivait la tendance: paillis en plastique > sarclage > copeaux de bois > paillis en herbe.

Introduction

Okra, *Abelmoschus esculentus* (L.) Moench, a member of the family malvaceae, is an important vegetable crop grown mostly by peasant farmers in Nigeria. The immature leaves and fruits are rich sources of vitamins and minerals, and are eaten in various forms. Okra is cultivated either sole or in crop mixtures over a total area of about 1.5 million hectares (Adejonwon *et al.*, 1989; Anon., 1980). A major constraint to increased okra production in Nigeria is weeds which have to be controlled timely and effectively in the first 6 to 9 weeks of planting (Adejonwon *et al*., 1989; William & Warren, 1975). Uncontrolled weeds had been reported to cause losses in okra yield ranging from 63 to 91 per cent (William & Warren, 1975; Adejonwon *et al*., 1989). The effectiveness of mulching in weed control, soil protection and fertility improvement had been reported by many workers (Asoegwu, 1991; Salau, Opara-Nadi & Swenrem, 1992; Nill & Nill, 1993).

Akobundu, Poku & Gowman (1982) and Akobundu (1987) recommended mulching for controlling weeds in the tropics. However, diverse materials can be used as mulch and Opara-Nadi (1993) has reported variation in potential of the materials in controlling weeds to conserve and improve soil.

The objective of this study was to evaluate the performance of a short-duration crop like okra under various mulch materials available for weed control.

Materials and methods

The site for the study was the Teaching and Research Farm of the Ladoke Akintola University of Technology, Ogbomoso, in southwestern Nigeria during the rainy seasons of 1999 and 2000. The mean annual rainfall was 1539 mm for 1999 and 990 mm for 2000, while the minimum and maximum temperatures were 21 and 32 °C for 1999, and 23.7 and 28 °C for 2000. Table 1 presents the properties of the soil of the experimental plot. The soil, a sandy loam low in organic carbon and nitrogen, was slightly acidic. The major weed on the plot was *Tithonia diversifolia* (Hemgl.) A. Gray with some stands of *Commelina benghalensis* and *Cyperus* spp.

TABLE 1

Pre-cropping Soil Analysis of Experimental Soil

Parameter	*1999*	*2000*
*p*H	6.4	6.3
Organic carbon (%)	2.0	1.6
Total N (%)	0.24	0.2
Available P (ppm)	6.32	5.98
Exchangeable K (meq/100 g)	0.38	0.38
Sand (%)	81	88
Silt (%)	13	10
Clay (%)	6	2

The site was cleared manually, tilled and leveled. The experimental design was a randomized complete block. The plot size was 3 m × 3 m. There were three replicates. The treatments were plastic mulch, grass mulch (using *Panicum maximum*) and wood shavings mulch. Hand hoeing and unweeded plots served as control. The plastic mulch in 0.25-μm thick black-grey polythene sheet was collected from the International Institute of Tropical Agriculture (IITA), Ibadan, Nigeria, while the grass mulch was sourced from slashing of *P. maximum* from adjacent plots. The wood shavings of *Tectona grandis* were collected from a local sawmill in Ogbomoso.

The mulches were applied to rain-wetted soils in the 2 years. The plastic was laid with the grey side up and plantings were done through holes drilled at marked points. The grass and wood shavings were laid to a thickness of 3 cm. The grass mulch was augmented at 4 weeks after first application owing to rapid decomposition. The hoe-weeding plots were weeded two times at 2 and 4 weeks after planting (WAP).

Okra seed variety V35, collected from the Nigeria Institute for Horticultural Research and Training (NIHORT), was used for the experiment. Plantings were done on 10th and 20th May, respectively, for the 1999 and 2000 trials. Three seeds were planted at a spacing of 0.5 m × 0.6 m

within and between rows, respectively, and were thinned to two plants per stand at 10 days after planting (DAP). Cypertex, an insecticide containing 100 mg ml^{-1} of cypermethrin, was applied to protect the crop from being attacked by *Podagrica* spp. Weekly spraying started from 2 WAP till fruiting.

Data collected at flowering were plant height, number of branches, stem diameter and leaf area, using the method of Olasantan (1999). Number of days for first flower appearance and 50 per cent flowering were recorded. Number of fruits per plant was determined from cumulative number of fruits harvested at 5 days' interval; weight of fruits per plant was taken as cumulative weight and used to estimate the fruit yield per hectare. The efficiency of the mulch materials in weed control was assessed using the dry matter yield of weeds harvested from three randomly placed 0.25-m^2 quadrats. Harvested weeds were oven-dried at 80 ^oC for 48 h and weighed. The data were analyzed using the relevant Analysis of Variance, and means compared at 0.05 level of probability using the Duncan's Multiple Range Test (DMRT) as outlined by Steel & Torie (1980).

Results

The study showed that mulch type significantly affected the growth and yield of okra in the 2 years. Okra growth measured as plant height, stem diameter, number of branches per plant, and leaf area were all significantly affected by mulch type (Table 2). Okra plants under plastic and grass mulches as well as under hoe weeding were not significantly different in these growth attributes (P = 0.05). Wood shaving-mulched plants had lower plant height, stem diameter as well as reduced number of branches and leaf area than the plastic, grass-mulched and hoe-weeded plots. They were, however, better than the weedy plot plants in these attributes.

Okra flowering was not significantly affected (P = 0.05) by mulch type in 1999, but was so in 2000 (Table 3). Plastic-mulched, grass-mulched and hoe-weeded plants flowered earlier than the wood shaving-mulched plants. Flowering was slow in

TABLE 2

Effects of Mulch Types on Growth Characteristics of Okra at Flowering

Mulch type	*Leaf area/plant (cm^2)*	*Stem diameter (cm)*	*Plant height (cm)*	*Number of branches /plant*
		1999		
Plastic mulch	3396.25a	1.36a	98.00a	5.66a
Grass mulch	3221.92a	1.27a	97.62a	5.66a
Wood shaving mulch	1515.57b	0.91b	76.51b	2.66b
Hoe weeding control	3165.93a	1.25a	90.58a	6.00a
Weedy control	362.97c	0.42c	39.00c	0.00c
		2000		
Plastic mulch	1841.82a	1.58a	65.00a	4.00a
Grass mulch	1483.95ab	1.57a	59.93a	4.00a
Wood shaving mulch	1083.10b	1.09b	33.78b	1.00b
Hoe weeding control	1718.90a	1.38a	57.00a	3.00a
Weedy control	286.79c	0.99b	45.11b	0.00b

Values with the same letter for each parameter along the same column for the same year are not significantly different at 5 % probability level by DMRT.

TABLE 3

Effects of Mulch Types on Okra at Flowering

Mulch type	*Number of days to flowering*	*Number of days to 50 % flowering*
1999		
Plastic mulch	52b	58b
Grass mulch	53b	58b
Wood shaving mulch	57b	64b
Hoe weeding control	53b	57b
Weedy control	70a	78a
2000		
Plastic mulch	63c	59c
Grass mulch	53c	58c
Wood shaving mulch	60b	67b
Hoe weeding control	52c	58c
Weedy control	74a	79a

Values with the same letter for each parameter along the same column for the same year are not significantly different at 5 % probability level by DMRT.

the unweeded plants. Uniformity of flowering, as measured by 50 per cent flowering, followed the same patterns.

The yield of okra varied much with mulched type (Table 4). Plastic-mulched plants had significantly higher number and weight of fruit per plant (12.11 and173.41 g plant^{-1} (P = 0.05) than the grass-mulched (8.67 and 99.7 g plant^{-1}) and hoe-weeded control (7.85 and 104.0 g plant^{-1}). Wood shaving-mulched plants had significantly lower yield (77.2 g plant^{-1}) than the above-mentioned mulch types, but was 77.0 per cent better than the weedy control which bore no fruit at all. Okra fruit yield (kg ha^{-1}) followed the trend: Plastic mulch > hoe weeding > grass mulch > wood shaving mulch > weedy plots during the 2 years.

The variation was marked in the weed control effectiveness of the mulch

TABLE 4

Effects of Mulch Types on Okra Yield and Yield Parameters

Mulch type	*Number of fruits/plant*	*Weight of fruits/ plant*	*Estimated fruit yield (kg ha^{-1})*
1999			
Plastic mulch	12.11a	173.41a	11560.55a
Grass mulch	8.67b	99.73b	6648.60b
Wood shaving mulch	4.54c	77.20c	5146.62c
Hoe weeding control	7.85c	104.00b	6933.26b
Weedy control	0.00d	0.00d	0.00d
2000			
Plastic mulch	10.21a	190.67a	12711.00a
Grass mulch	6.33b	101.38b	6759.00a
Wood shaving mulch	6.00b	81.85c	5456.00c
Hoe weeding control	5.78b	102.29b	6820.00b
Weedy control	1.56c	38.38d	1892.00d

Values with the same letter for each parameter along the same column for the same year are not significantly different at 5 % probability level by DMRT.

types as measured by the harvestable weed dry matter yield (Table 5). The order of weed control was plastic mulch > hoe weeding > wood shaving > grass mulch. The highest weed biomass was recorded in the uncontrolled plot.

TABLE 5

Effects of Mulch Types on Weed Dry Matter Yield in 1999 and 2000

Mulch type	*Weed dry matter yield (g m^{-2})*	
	1999	*2000*
Plastic mulch	28.4c	0.0d
Grass mulch	98.5b	104.0b
Wood shaving mulch	84.7c	90.5b
Hoe weeding control	62.5d	57.6c
Weedy control	263.0a	220.4a

Values with the same letter for each parameter along the same column for the same year are not significantly different at 5 % probability level by DMRT.

Discussion

The higher plant height, stem diameter, leaf area and number of branches observed in okra plants under plastic and grass mulches were similar to the hand-weeded control. This may be due to plants conserving water better under mulch than hand weeding (Salau *et al*., 1992; Opara-Nadi & Lal, 1987). The stunted growth observed under wood shaving mulch is due to immobilization of soil N by the soil microbes caused by high C: N ratio in the shaving (Owaiye, 1993). Higher moisture stress resulting from transpiration on the weedy plots and the above and underground competitions from weeds may be responsible for poor okra growth on the all time weedy plot. Furthermore, the higher yield of okra recorded in the mulches except shavings, is a direct effect of improved soil nutrients, structure and moisture content, and reduced weed pressure (Opara-Nadi, 1993).

The decomposition of the grass mulch and solar effect of plastic mulch make for higher nutrient availability. The grass mulch with lower C: N ratio decomposed faster than the wood shaving and increased the soil organic matter for the plants' use. The C: N measures the rate of biodegradability of organic materials. Wood shavings with slow rate of decomposition becomes beneficial only in later years after decomposition is completed. Hence, it is not beneficial for short-duration crops like okra.

The better okra yield under plastic mulch compared to all other treatments confirmed the findings of IITA (1985) and Compos De Araujo *et al.* (1992) that plastic mulch increased crop yield over other mulches. This can be traced to solarization effect which leads to enhanced availability of soil nutrients. Similar findings were reported for sesame (Stapleton & Garza-Lopez, 1988) and straw berries (Abdul Razik *et al*., 1988).

The best weed control observed under plastic mulch may have resulted from better soil coverage, which prevented weed growth through preventing photo induction needed for weed seeds to germinate and act as a mechanical hindrance. Wood shavings were better than grass mulches in weed control due to better soil coverage and slower rate of decomposition.

Conclusion

The study had shown that mulching can control broadleaved weeds like *Tithonia diversifolia*, and that mulch materials vary in their effectiveness in weed control and influence on the crop. Furthermore, to produce short-duration crops like okra, the use of *Panicum maximum* for weed control on plots infested by *T. diversifolia* and similar broadleaved weeds is adequate, considering the ease of application, availability and long-term effects on soil.

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