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Effect of Mulching and Period of Weed Interference on the Growth, Flowering and Yield Parameters of Okra (Abelmoschus Esculentus L.)

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Abstract: *The experiment was conducted on a farmer's field in Agbarho ((5° 34'N and 5° 53'E), Delta State Nigeria in July- November 2012. The objective of the study was to evaluate the response of okra to different plant based mulching materials at different periods of weed interference. Four mulching treatments consisting of organic based materials; Pennisetum purpureum Schumach, Calopogonium mucunoides Desv., Synedrella nodiflora (L.) Gaertn and control (no mulching) while the five weeding regimes used were unweeded (control), weed infestation first 3WAP, weed infestation first 5WAP, weedfree till 5 WAP and weedfree till harvest. The treatments were combined in a 5 x 4 factorial in randomized complete block design with three replicates. Plant height, leaf number, leaf area per plant, leaf area index (LAI) per plant were highest in C. mucunoides mulch while the control (no mulching) had the least. Longer period of weed infestation increased flower abortion in okra, while mulching reduced flower abortion. When compared with the plot kept weedfree till harvest, percent pod yield reduction observed were 53.1% (unweeded control), 35.8% (weedfree till 5WAP), 27.0% (weed infestation first 3WAP) and 13.6% (weed infestation first 5WAP). Relative to the control, mulching increased okra pod yield by 62.8% (C. mucunoides), 25.2% (S. nodiflora), and 20.5% (P. purpureum).The study has shown that mulching with P. purpureum promotes microenvironment that reduces flower abortion due to reduced weed infestation, while use of C. mucunoides favour okra growth and yield and reduced weed infestation especially when weeding is done at 3 WAP.*
Keywords: *mulching, weed interference, okra, Pennisetum purpureum, Calopogonium mucunoides*

I. Introduction

Weeds are major source of concern for economic and food crops, since they compete with the crop for environmental and growth resources such as moisture, nutrients, light and space, hence interfering with the growth and developmental stages of the crop, consequently diminishing the final economic yield. In most vegetable crops such as okra, tomato, onion pepper, carrot and lettuce, weeding frequency has been observed to be high because these crops do not develop enough canopy that would shade the ground effectively at the early stage of their life cycle (Joshua and Deji, 2004). Beside crop loss weed interference also contributes to insect pest and disease attack, in addition to contaminating seeds during storage. Yield losses of 88% to 90% due to unchecked weed growth have been observed in okra in Nigeria (Adejonwo et al., 1989) while Singh et al. (1981) recorded 76.5% in India.

Determinants of critical period of weed interference in okra and other vegetables include the cultivar, competing weed species, environmental factors and plant density (Poku and Akobundu, 1985; Iyagba et al. 2012). As earlier observed by Yayoack et al., (1988) and Tanko et al (2015), farmers devote more than 50% of the cultural practices associated with crop production to only weed control. Oudejans (1991) and Larbi et al. (2013) also noted that in comparison with damage from insect pests, disease and rodents, the damage from weeds is much higher. It is therefore essential to adopt weed control measures that will reduce the impact of weeds on the crop during the period of growth, using methods that increases the competitive ability of the crop and reduces the period of weed interference.

Cultural methods of weed control are commonly practiced in the sub-tropics, Nigeria inclusive. Mulching is the practice of covering the soil with organic material such as dead leaves and compost or synthetic materials in order to create conditions favourable for the growth and development of the crop. Mulching is one of the old traditional cultural farming practices used by farmers (based on principles of protected cultivation) for different purposes such as conserving soil moisture, reducing soil temperature, reduction in soil temperature and weed control. These roles played by mulching contribute to the growth and development of the cultivated crop.
Significantly reduction in crop development and final economic yield has been observed when first weeding is delayed (Chivinge, 1990). Olabode et al. (2007) observed higher number of branches, increased leaves and stem size when okra was grown under plastic and grass mulches relative to weedy plots and wood shavings mulch. Increase in temperature resulted in delayed days to flower initiation and flowering in okra (Dalorima et al.

2014). Ibe et al (2008) also reported significant increase in weed control efficiency, reproductive parameters and fruit yield of okra when Siam weed mulch was used. This study was therefore aimed at evaluating the response of okra to different plant based mulching materials at different periods of weed interference.

II. Materials And Methods

The experiment was conducted on a farmer's field in Agbarho ((5° 34'N and 5° 53'E), Delta State Nigeria in July- November 2012. Agbarho is 34m above sea level. The experiment consists of two factors, namely; mulching and weeding regime (period of weed interference). Four mulching treatments consisting of organic based materials; *Pennisetum purpureum* Schumach, *Calopogonium mucunoides* Desv., *Synedrella nodiflora* (L.) Gaertn and control (no mulching) while the five weeding regimes used were unweeded (control), weed infestation first 3WAP, weed infestation first 5WAP, weedfree till 5 WAP and weedfree till harvest. The treatments were combined in a 5 x 4 factorial in randomized complete block design with three replicates.

Two seeds of okra (var. NHE47-4) were sown on all plots at 60cm between rows and 40cm within rows on 4.2m by 2.8m plots. Emerged seedlings were later thinned to one after two weeks. At three days after planting (3DAP) air dried organic mulching materials were applied at the rate of 5t/ha on the relevant plots. Data were collected on vegetative parameters which include plant height and leaf number per plant. The leaf area per plant and leaf area index (LAI) were derived from standard procedures as earlier described by Palanisamy and Gomez (1974). Flowering data obtained include days to 50% flowering, number of flowers, number of aborted flowers, and percentage of flowers aborted. Data on number of pods and pod yield was obtained from 8 weeks after planting (WAP) through repeated harvesting at 3 days interval. Shoot biomass was obtained from five randomly selected plants. The ratio of the economic yield to the biomass yield of the okra plants was used to obtain the harvest index (HI).

Data was collected on list of common weeds and their level of occurrence. Level of weed occurrence was measured on a 50cm x 50cm quadrat. Weeds found were counted, identified and classified based on growth cycle and habit. Level of weed occurrence was classified into three as follows: [+++] = high occurrence; [++] = moderate occurrence and [+] = minor occurrence.

Data were were subjected to statiticalnalysis of variance (ANOVA), while means found to be significant were separated using the least significant difference (LSD) at 5% level of probability.

III. Results And Discussion

Influence of mulching on vegetative growth, flowering and yield of okra

The results presented in Table 1 indicated significant (P<0.05) response of plant height and foliage parameters of okra to mulching and period of weed interference. *C. mucunoides* showed the tallest plants of 75.3cm followed by *S. nodiflora.* Similar trend was observed on the foliage parameters where *C. mucunoides* recorded highest leaf number (20.6), leaf area per plant (10371.0cm^2) and LAI (4.3). Among organic based mulching materials, okra plants mulched with *P. purpureum* showed the least vegetative growth attributes, while the control (without mulching) indicated the least among the treatments studied.

Relative to the mulched treatments, the control (without mulching) significantly delayed days to flowering of okra plants (Table 2). The unmulched okra took about 53 days to flower. Flowering was observed to be earlier in okra plants mulched with *P. purpureum* (47 days), compared with those mulched with *C. mucunoides* (49 days) and *S. nodiflora* (50 days). Mulched okra plants produced more flowers, with corresponding reduced number of aborted flowers. This effect of mulching on flowering was more pronounced in okra plants mulched with *P. purpureum* as indicated in the high number of flowers (12.9), reduced number of aborted flowers (2.3) and percentage aborted flowers (17.8). However the unmulched okra plants (control) showed low number of flowers (6.1), high number of aborted flowers (3.9) and high percentage of aborted flowers (63.9). The slow decomposing rate of *P. purpureum* would have contributed to its maintenance of lower soil temperatureand high soil moisture over a period of time resulting in lower number of aborted flowers compared to other mulching materials. Temperature has been shown to influence flowering in crops (Abel El Kader et al., (2010).

There was significant difference in the number of pods per plant, shoot biomass yield and pod yield of okra, which increased with application of organic based mulch materials. Okra plants mulched with *C. mucunoides* showed higher number of pods (21.6), shoot biomass yield (12030.2kg/ha) and pod yield (6515.3 kg/ha) compared to *S. nodiflora* and *P. purpureum.* Relative to the control, mulching increased okra pod yield by 62.8% (*C. mucunoides*), 25.2% (*S. nodiflora*), and 20.5% (*P. purpureum*). Harvest index (HI) of okra was higher with *C. mucunoides* (35.1%), while *S. nodiflora* (31.3%) indicated the least. Besides *C. mucunoides*, the other mulching materials were not statistically significant with the control (without mulch).

The effectiveness of organic mulch is dependent on the biochemical constituents of the material (Tian et al., 1994). In this study, the vegetative growth parameters, yield and components of yield of okra were more pronounced in leguminous *C. mucunoides* with low polyphenol, and C/N ratio and lignin contents allowing for easy decay and release of nutrients which enhanced the growth of the crop relative to *P. purpureum* with high values of same biochemical constituents.

Influence of period of weed interference on vegetative growth, flowering and yield of okra

From the data on Table 1, significant difference among periods of weed interference were observed for plant height, leaf number per plant, leaf area per plant and LAI (Table 1). Highest plant height (90.5cm) was observed with okra plants which were kept weedfree till harvest. This was followed by plants which were infested with weeds within the first 3WAP (78.3cm) and later kept weedfree. The unweeded control indicated the least plant height (40.2cm). The number of leaves per plant ranged from 12.4cm (unweeded) to 24.4 (weedfree till harvest). Though okra plants which were infested by weeds first 5WAP had higher leaf number than those weedfree till 5WAP, the results were not statistically significant. Leaf area per plant of okra plants relative to those kept weedfree till harvest was reduced by 52.9% (unweeded control), 26.9% (weedfree till 5 WAP), 16.3% (weed infestation first 5WAP) and 14.7% (weed infestation first 3WAP). The highest LAI (4.4) was observed in the weedfree plots and was significantly different from the control (2.1).

Infestation of weeds increased days to flowering, thus delaying the expect time of flowering of the okra plants. This could be seen in the significantly higher number of days to flowering in the weedy (control) plot (52.0 days) relative to the weedfree till harvest (47 days). Number of flowers per plant in all weeded okra plots were significantly higher than the unweeded control plots with values ranging from 13.1 (weedfree till harvest) to 6.3 (unweeded). The results also showed that weeds contributed to abortion of flowers of okra, in view of the significantly higher number and percentage of aborted flowers in the unweeded control (3.8; 60.3%) when compared to the weedfree till harvest (2.5; 19.1%) plot. These results are in consonance with the earlier findings of Iyagba et al. (2013) who observed more flower abortion in unweeded okra plots.

Weeding regime treatments showed significant effect on number of pods, shoot biomass yield, pod yield and harvest index. Delay in weeding or no weeding reduced the number of pods of okra and was more pronounced with the unweeded control (10.5) recording the least while the weedfree till harvest had the highest (22.8). Allowing weeds within the first 3WAP or 5WAP did not show any statistical difference in number of pods. Both shoot biomass and pod yield were significantly reduced by delay in weeding or lack of weeding and values were within the range of 8105.0kg/ha to 12566.8kg/ha (shoot biomass) and 3218.6kg/ha to 6863.7kg/ha (pod yield). Hence, when compared with the plot kept weedfree till harvest, percent pod yield reduction observed were 53.1% (unweeded control), 35.8% (weedfree till 5WAP), 27.0% (weed infestation first 3WAP) and 13.6% (weed infestation first 5WAP).These results are lower compared to other reports which observed yield reduction of 88-90% (Adejonwo et al., 1989;), 74-76% (Iyagba et al., 2013) due to weed interference.

HI obtained was within the range of 28.4% to 35.2%. Results indicated higher HI when okra plants were weeded during the growth period of the crop. The findings from this study show that leaving weeds in okra farm beyond 3 WAP resulted in poor okra performance. This in agreement with earlier reports from other studies (Orkwor et al., 1994; Dada and Fayinminnu, 2007; Adeyemi, et al., 2014) which notes that there is length of period within which most crops can tolerate weed competition, beyond which reduction in vegetative growth and yield of the crop will be observed.

Interactive effects between mulching and period of weed interference were significant. The longer the mulching material remains on the okra plot, the less the level of weed infestation consequently resulting in better crop yield.

The commonest weeds in the experimental site as shown in Table 4 were asteraceae, followed by poaceae, while cyperaceae, convolvolaceae and amarantheceae were less common. The weed species with high degree of occurrence were *Ageratum conyzoides Panicum maximum, Talinum triangulare and Syndrella nodiflora*. However *Amaranthus spinosus, Cyperus rotundus, Sida acuta and Ipomoea involucrate* showed the least occurrence.

IV. Conclusion

From the results obtained, it can be concluded that the use of organic mulch such as *Pennisetum purpureum* and *Calopogonium mucunoides* can be effective mulching materials in creating a microenvironment which suppresses weed growth, while at same time promoting okra growth and yield.

Table 1. Effect of mulching and period of weed interference on plant height and foliage attributes of okra

	Plant height (cm)	Leaf number/plant	Leaf area/plant (cm2)	LAI
Mulching				
No mulching (control)	60.1d	17.3c	6688.7d	2.8b
Pennisetum purpureum	66.4c	18.0bc	7565.1c	3.2ab
Calopogonium mucunoides	75.3a	20.6a	10371.0a	4.3a
Synedrella nodiflora	70.1b	19.3ab	8624.9b	3.6ab
LSD (5%)	3.4	2.1	100.7	1.5
Weeding regime				

Unweeded (control)	40.2d	12.4c	5033.7e	2.1c
Weed infestation first 3WAP	78.3b	22.7a	8936.2c	3.7b
Weed infestation first 5WAP	59.2c	18.0b	9108.6b	3.8b
Weedfree till 5 WAP	71.4b	16.7b	7808.6d	3.2bc
Weedfree till harvest	90.5a	24.4a	10680.0a	4.4a
LSD (5%)	8.9	3.3	70.8	1.3
Mulching x weed regime	*	*	**	*

Values followed by the same letter(s) in a column are not significantly different at 5% level using LSD
*significant at 0.05 level of probability ** significant at 0.01 level of probability

Table 2. Effect of mulching and period of weed interference on flowering attributes of okra

	Days to 50% flowering	No. of flowers/plant	No. of aborted flowers/plant	% aborted flowers/plant
Mulching				
No mulching (control)	53.2a	6.1c	3.9a	63.9
Pennisetum purpureum	47.5c	12.9a	2.3c	17.8
Calopogonium mucunoides	48.8c	10.8ab	3.0bc	27.8
Synedrella nodiflora	50.3b	8.6bc	3.4ab	39.8
LSD (5%)	2.6	3.4	0.8	
Weeding regime				
Unweeded (control)	52.0a	6.3d	3.8a	60.3
Weed infestation first 3WAP	50.1ab	11.6b	2.9ab	25.0
Weed infestation first 5WAP	48.3bc	9.8c	3.1ab	31.6
Weedfree till 5 WAP	51.9a	7.2d	3.5a	48.6
Weedfree till harvest	46.7c	13.1a	2.5b	19.1
LSD (5%)	3.1	1.7	0.7	
Mulching x weed regime	*	*	*	

Values followed by the same letter(s) in a column are not significantly different at 5% level using LSD
*significant at 0.05 level of probability

Table 3. Effect of mulching and period of weed interference on pod yield, biomass yield and harvest index of okra

	No. of pods/plant	Shoot biomass yield (kg/ha)	Pod yield (kg/ha)	Harvest Index (%)
Mulching				
No mulching (control)	13.8c	8335.7d	4000.3d	32.4b
Pennisetum purpureum	15.0c	10004.4c	4818.7c	32.5b
Calopogonium mucunoides	21.6a	12030.2a	6515.3a	35.1a
Synedrella nodiflora	17.3b	10991.9b	5009.2b	31.3b
LSD (5%)	2.6	121.7	89.9	1.8
Weeding regime				
Unweeded (control)	10.5d	8105.0e	3218.6e	28.4c
Weed infestation first 3WAP	17.6b	10405.6c	5012.5c	32.5b
Weed infestation first 5WAP	18.8b	11339.3b	5930.2b	34.3a
Weedfree till 5 WAP	14.8c	9286.1d	4404.4d	32.2b
Weedfree till harvest	22.8a	12566.8a	6863.7a	35.3a
LSD (5%)	3.7	138.9	101.9	1.9
Mulching x weed regime	*	*	*	*

Values followed by the same letter(s) in a column are not significantly different at 5% level using LSD
*significant at 0.05 level of probability

Table 4. Weed flora found during growth period of okra on experimental site

Weed	Family	Growth cycle	Growth habit	Occurrence
Tridax procumbens L.	Asteraceae	A	BL	++
Ageratum conyzoides L.	Asteraceae	A	BL	+++
Amaranthus spinosus L.	Amarantheceae	A	BL	+
Panicum maximum Jacq.	Poaceae	P	G	+++
Aspilia africana (Pers) C.D. Adams	Asteraceae	A	BL	++
Talinum triangulare (Jacq.) Willd	Portulaceae	A	BL	+++
Cyperus rotundus L.	Cyperaceae	P	S	+
Eleusine indica (L.) Gaertn.	Poaceae	A	G	++
Sida acuta Burm.f.	Malvaceae	P	BL	+
Axonopus compressus Beauv.	Poaceae	P	G	++
Chromoleana odorata Kings & Robinson	Asteraceae	P	BL	++
Syndrella nodiflora Gaertn.	Asteraceae	A	BL	+++
Ipomoea involucrata Beauv.	Convolvolaceae	A	BL	+
Mucuna pruriens (L.) DC.	Fabaceae	A	BL	++
Mimosa pudica L.	Mimosaceae	A	BL	++

A = annual; P = Perennial; BL = broadleaf ; G = grass ; S = sedges
[+] = Low weed occurrence, [++] = Medium weed occurrence, [+++] = High weed occurrence

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