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Effect of different mulch materials on the incidence and severity of okra mosaic virus (OMV) in okra

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Abstract

The study was conducted from June to September, 2010 to assess the impact of different mulch materials on the incidence and severity of okra mosaic virus (OMV) in okra cv. 'LD 88-1' in Ibadan, Nigeria. The overall effects of the different mulches were assessed on the incidence and severity of OMV and the resultant effect on the number of pods and pod biomass. The mulches assessed in the field experiment were *Azadirachta indica* (neem) leaves, *Eugenia uniflora* (pitanga) leaves, *Terminalia catappa* (tropical almond) leaves, *Panicum* clippings and black plastic polythene. Positive and negative controls included hoe-weeded and unweeded plots, respectively. Results indicated that at 5 weeks after sowing (WAS), there was no significant difference in the OMV incidence on plants mulched with *A. indica*, *E. uniflora* and *T. catappa* with values ranging from 11.91 to 15.48% while a low virus incidence of 0.5% was recorded for the plastic mulched plants. The mean virus disease severity ranged from 0.7 to 4.0 on a scale of 1-4 scoring system with plastic mulched plants showing little or no symptom of OMV at 5 WAS. However, the plants on the unweeded plots were stunted with deformed fruits. Similar trend was observed at 7 WAS with plastic mulched plot having the least incidence and severity score while the unweeded plot has the highest OMV incidence and severity. Of all the mulch materials, plots mulched with *Panicum* produced the least yield values while plastic mulch induced the highest yield on the okra plants. Comparing the mean number of pods of weeded and unweeded control plots; the weeded plot produced average value of 23.0±0.1 pods/plant while the unweeded plot produced average of 12.0±0.15 pods/plant. The results obtained showed that mulches especially plastic are effective in controling okra mosaic virus.

Key words: Okra, okra mosaic virus, mulches, disease severity, *Azadirachta indica*, *Eugenia uniflora*, *Terminalia catappa*, *Panicum*, black plastic polythene, fruit yield

Introduction

Okra (*Abelmoschus esculentus* (L.) Moench) is a member of the family Malvaceae and is a popular vegetable of considerable value. It is widely grown in tropical and sub-tropical areas for its immature pods that are used in salads, soups and stews (Ndunguru and Rajabu, 2004). It is among the most commonly cultivated vegetables throughout Nigeria and other tropical regions because of its much liked mucilaginous or 'draw' property of the fruit and its ability to grow well under most tropical conditions (Vincent *et al.*, 2005). It is a good source of calcium derived from fruits (90 mg/100 g) and leaves (70 mg/100 g). Its secondary use is the production of oil which is 20% content of the seed. Amino acids found in *A. esculentus* seeds compare favourably with those in poultry eggs and soybean (Hamon and Charrier, 1997).

Okra is susceptible to at least 19 plant viruses with Okra mosaic virus (OMV) and okra leaf curl virus (OLCV) being the most common and well studied (Swanson and Harrison, 1993). OMV has been reported from Cˆote d' Ivoire, Kenya, Nigeria and Sierra Leone in Africa (Brunt *et al.*, 1996). OMV is transmitted in a non-persistent manner by the coleoptera *Podagrica decolorata* (Brunt *et al.*, 1990). The use of mulch materials in the reduction of mosaic virus diseases in plants have been reported in literature. Reflective plastic mulch delayed and reduced the severity of silverleaf whitefly infestations in zucchini squash, pumpkins and cucumber (Summers and Stapleton, 2002). The onset of virus disease symptoms was delayed by 3 to 6 weeks in plants grown with plastic mulch, which was critical for normal flowering and fruiting (Stapleton and Summers, 2002). In zucchini squash grown with straw mulch, yields were as high and the incidence of aphidborne virus diseases was no greater than in plants grown over reflective plastic mulch (Summers *et al.*, 2004).

Surface mulching either by synthetic plastic sheets or natural organic waste material offers protection for plants against root borne diseases, in addition to moisture conservation, temperature amelioration and weed control. Organic mulches including sawdust, dry grass (lawn clippings), maize cobs, rice and wheat straw, water hyacinth etc., have been very effective for vegetable growth and yield by improving moisture content of soil, heat energy and add some of the organic nitrogen and other mineral to improve nutrient status of the soil (Saeed and Ahmad, 2009). Mulching has been used to obtain good vegetable growth and yield in crops like sweet potato, potato, tomato and pepper (Awodoyin and Ogunyemi, 2005; Rahman *et al.*, 2006).

This study was conducted to assess the effect of different mulch materials on the incidence and severity of okra mosaic virus and the overall effect on the yield and biomass of okra pods.

Materials and methods

Field experiment was conducted in June 2010 through September 2010 under rain fed condition, at one of the experimental fields of National Horticultural Research Institute, Idi-Ishin, Ibadan (Latitude 7^{o} 54'N, and Longitude 3^{o} 54'E, 213 meters above the sea level), Nigeria. Ibadan is in the rainforest-savanna transition ecosystem of south-west Nigeria. Okra seeds of 'LD 88-1' variety was obtained from NIHORT, Ibadan, which is a very popular and early maturing variety grown in Nigeria. There were five mulch treatments and two control treatments. The mulch treatments included *Terminalia catappa* (Tropical almond) leaves, *Azadirachta indica* (Neem) leaves, *Eugenia uniflora* (Pitanga) leaves, *Panicum* clippings (obtained from NIHORT fields) and black polythene sheet (0.25 µm thick) used as plastic mulch sourced from polythene distributor in Ibadan. Each mulch material was applied at 10 t/ha, which gave 9 kg mulch material per plot of 3 x 3 m. Positive and negative controls included plots that were weeded by hoeing twice and unweeded plots, respectively. Okra variety 'LD 88-1' was sown on 12th June, 2010. Two seeds were planted per hole and the emerged seedlings were later thinned to one at a spacing of 60 x 30 cm to give a plant population of 55, 556 plants/ha and each plot had 28 plants. Randomized complete block design (RCBD) was used with three replications.

Disease incidence: All the plots were randomly sampled in each treatment for distinct virus symptoms such as mosaic, leaf mottle, curling and malformation, plant stunting, and pod abnormalities. Disease incidence was estimated by counting the number of symptomatic plants and expressed as a percentage of the total plants sampled. Recording of disease incidence in the experimental plots was carried out 5 and 7 weeks after sowing (WAS) and the incidence of okra mosaic virus disease was recorded by visual diagnosis method. The visible symptoms of the disease were critically observed and the infected plants were identified according to Givord *et al.* (1972).

$$\text{Disease incidence (\%)} = \frac{\text{Number of symptomatic plant(s)}}{\text{Total number of sampled plants}} \text{x } 100$$

Disease severity: Disease severity was assessed using a 1-4 scoring system, (0: symptomless), 1: mild mosaic present, no leaf distortion; 2: slight distortion, chlorosis affecting <ca. 40% leaf area; 3: severe mosaic/leaf distortion, chlorosis affecting ca. 80% leaf area; 4: leaves severely distorted and stunted, 80-100% leaf area chlorotic (Ndunguru and Rajabu, 2004) and this was carried out at 5 and 7 WAS.

Measurement of pod biomass and fruit yield: Number of pods per plant was determined by counting the pods produced by the okra plants. The fresh weight of pods was obtained by weighing the fresh pods on a sensitive weighing balance while for the dry weight, pods were sun dried until constant weights were obtained; later the pods were weighed.

Weed species composition: Weeds were destructively sampled in each plot at 7 WAS using 0.5 m^2 quadrat and weed samples were separated into broad leaves and grasses. They were identified to species level and the names were confirmed using Akobundu and Agyakwa (1998).

Data analysis: The data were analysed using analysis of variance (ANOVA) by SPSS (version 16.0) statistical computer software. Duncan multiple range test (DMRT) was used to test for level of significance at 5% probability level.

Results

Disease incidence and severity of OMV: At 5 weeks after sowing (WAS), okra mosaic virus disease severity score ranged from 0.70 to 4.00 with plants in plastic mulched plot showing little or no symptoms of OMV while the plants on the unweeded plot had the highest score of 4.00 with plants having stunted stems, chlorotic leaves and deformed pods. Similar trend was observed at 7 WAS with the plastic mulched plot recording a disease severity score of 0.80 while the unweeded plot recorded a severity score of 4.0 (Table 1). The disease severity score of plants mulched with *A. indica*, *E. uniflora*, *T. catappa* and the hoe-weeded plot at 5 WAS gave mean values of 1.67, 1.90, 1.33 and 2.67 respectively. However, the average disease severity score at 7 WAS for *A. indica*, *E. uniflora*, *T. catappa* and the hoe-weeded plot were 1.70, 1.95, 1.38 and 2.70, respectively. The mean severity score of *Panicum* mulched plots at 5 and 7 WAS were 3.33 and 3.50 respectively.

Table 1. Disease incidence and severity of Okra mosaic virus as affected by different mulch materials

Treatments	5 WAS		7 WAS	
	Incidence (%)	Severity	Incidence (%)	Severity
A. indica	11.91c	1.67d	13.52d	1.70de
E. uniflora	15.48c	1.90d	15.80d	1.95d
T. catappa	13.09c	1.33de	14.90d	1.38de
Panicum	50.09b	3.33b	56.60b	3.50b
Plastic	0.50d	0.70e	3.57e	0.80e
Hoe-weeded	19.05c	2.67c	20.00c	2.70c
Unweeded	64.64a	4.00a	70.70a	4.00a

Means followed by the same letter along the column are not significantly different according to Duncan multiple range test (DMRT) (P=0.05).

The result on the incidence of okra mosaic virus with respect to the different mulch materials indicated that all the plants in the plots showed varying degree of OMV symptoms. The negative control plot (unweeded) had the highest incidence of 64.64% followed by the plot mulched with *Panicum* (50.09%) at 5 WAS. At 7 WAS, 70.7% incidence was recorded for the unweeded plot while 56.6% virus incidence was obtained from the *Panicum* mulched plot (Table 1). At 5 WAS, the incidence of the positive control plot (hoe-weeded) was not significantly different from those plots mulched with *A. indica*, *E. uniflora* and *T. catappa* with percentage incidence values ranging between 11.91 and 19.05%. Similarly, there was no statistical difference in the percent incidence of plots mulched with *A. indica*, *E. uniflora* and *T. catappa* but the incidence of these three mulch materials differed significantly from those of the hoe-weeded plot. The virus incidence of the plastic mulched plot was 0.5% at 5 WAS and 3.57% at 7 WAS (Table 1).

Effect on pod biomass and fruit yield: The least number of pods was recorded on the unweeded plot while the highest was recorded on the plastic mulched plot. The average number of pods of the weeded plot (23.0±0.10) was higher than that of the plot mulched with *Panicum* (19.0±0.07). The mean number of pods recorded on plots mulched with *A. indica*, *E. uniflora*, *T. catappa* and plastic were 24.0±0.13, 25.0±0.02, 27.0±0.05 and 30.0±0.03, respectively (Table 2). Results of the pod biomass showed that the unweeded plot had the least values of 146.0±0.61 g and 45.0±0.15 g for both fresh and dry weights of pods per plant, respectively while the weeded plot produced 253.0±0.10

and 105.0±0.28 g, respectively (Table 2). The use of plastic mulch gave the highest pods fresh weight (378.0± 0.44 g/plant) while the use of *Panicum* mulch resulted in pods with lesser fresh weight value of 162±0.54 g/plant. *A. indica*, *E. uniflora* and *T. catappa* mulched plots produced pods with fresh weight values of 240±0.35 g, 288±0.12 g and 284±0.15 g, respectively (Table 2). The trend of the result obtained for dry weights of pods was similar to what was observed in the fresh weights. The plants on the *Panicum* mulched plot produced pods with the least dry weight (76±0.08 g) while plants on the plastic mulched plot had pods with the highest dry weight values (233.0±0.29 g). The performance of *E. uniflora*, was better than that of *T. catappa* while that of *T. catappa* was higher than that of *A. indica* (Table 2). Generally, of all the mulch materials, plastic mulched plot produced the highest yield components while *Panicum* mulched plot produced the least yield components. Nonetheless, the yield produced by plots mulched with *Panicum* was greater than that produced by the unweeded plots but not as much as that produced by the weeded plots.

Effect of mulch materials on weed species composition: A total of 20 weed species were recorded across the mulched plots, 14 were broad leaves while 6 were grasses (Table 3). All the mulched plots have varying degrees of weed flora composition. The plastic mulched plot had the least number of weeds. The broad leafed weed species found in the plastic mulched plot were *Calopogonium mucunoides* and *Oldenlanda herbacea* while the other plots had at least 3 species of broad leafed weeds. *Tridax procumbens* was the most abundant broad leafed weed species in all the plots but the plastic mulched plot was able to resist this weed. The plastic mulched plot could not resist the growth of the grasses as much as it did for the broad leaves. *T. catappa* mulched plot had the least number of grasses followed by *Panicum* mulched plot. *Cyperus rotundus* and *P. maximum* were found in all plots except the *T. catappa* mulched plot.

Table 2. Effect of the different mulch materials on yield and biomass components of okra plants

Mulch materials	No of Pods/plant	Fresh weight of Pods/plant (g)	Dry weight of Pods/plant (g)
A. indica	24.0 ± 0.13	240.0 ± 0.35	125.0 ± 0.18
E. uniflora	25.0 ± 0.02	288.0 ± 0.12	162.0 ± 0.21
T. catappa	27.0 ± 0.05	284.0 ± 0.15	145.0 ± 0.06
Panicum	19.0 ± 0.07	162.0 ± 0.54	76.0 ± 0.08
Plastic	30.0 ± 0.03	378.0 ± 0.44	233.0 ± 0.29
Hoe-weeded	23.0 ± 0.10	253.0 ± 0.10	105.0 ± 0.28
Unweeded	12.0 ± 0.15	146.0 ± 0.61	45.0 ± 0.15

Each value is a mean ± standard error

Discussion

The results obtained in this investigation showed that all the mulch materials except *Panicum* improved the performance of okra plants compared to the unmulched plants. Hudu *et al.* (2002) and Awodoyin and Ogunyemi (2005) also reported the superiority of mulched plants over unmulched plants. Very few of the plastic mulched okra plants were infected with OMV while the incidence was high in the unweeded plot. There have been several reports on plastic mulch reducing the incidence of mosaic diseases in vegetables. Vani *et al.* (1989) stated that yellow polythene mulch reduced the incidence of mosaic disease on muskmelons. Moreso, Lutzinsky *et al.* (1996) demonstrated that leaf curl incidence in tomato was low in rows mulched with yellow or brown plastic.

The highest severity of OMV in the unweeded plot may be explained by the fact that weeds serve as reservoirs of viruses, thus bringing about increased incidence and severity. Insects can transmit the viruses to the okra plants during non-persistent feeding, transmission can be through mechanical transmission or through other means. It has been reported that volunteer plants and weeds provide shelter and sources of nutrients for

Table 3. Weed species and their frequencies as influenced by the different mulch materials

Weed species	Mulch material						
	T. catappa	*A. indica*	*E. uniflora*	Plastic	*Panicum*	Hoe-weeded	Unweeded
A. Broad leave weeds							
Acalypha fimbriata Schum. & Thonn	1	0	0	0	0	0	0
Ageratum conyzoides L.	0	1	0	0	0	0	0
Amaranthus spinosus L.	0	0	0	0	2	1	0
Amaranthus viridis L.	0	3	0	0	0	0	2
Calopogonium mucunoides Desv.	4	0	1	2	0	0	4
Celosia leptostachya Benth.	3	2	2	0	3	1	0
Euphorbia heterophylla L.	0	0	1	0	4	2	5
Mitracarpus villosus (Sw.) DC.	0	0	1	0	0	0	0
Oldenlandia corymbosa L.	0	0	0	0	8	1	0
Oldenlandia herbacea (L.) Roxb.	0	0	3	1	0	4	0
Spigelia anthelmia L.	0	0	0	0	0	1	0
Stylosanthes gracillis L.	0	0	0	0	0	2	0
Tridax procumbens L.	6	12	3	0	10	12	10
Talinum fruticosum (L.) Juss.	0	0	0	0	1	0	0
B. Grasses							
Axonopus compressus (Sw.) P. Beauv.	1	6	0	1	0	0	0
Commelina benghalensis L.	1	0	4	1	0	1	3
Cyperus rotundus L.	0	2	4	1	2	2	2
Panicum maximum Jacq.	0	1	3	1	4	4	4
Paspalum conjugatum Berg.	0	0	4	1	0	0	0
Paspalum scrobiculatum L.	2	0	0	1	0	0	4

virus vectors (Akel *et al.*, 2010). Other vegetative structures or contaminated weed seeds may also harbor viruses. Apart from acting as alternative source of inoculum, these plants sustain the viability of the virus between crop seasons (Duffus, 1971). Furthermore, wild plants growing within the same fields as crops or in nearby areas can be inoculum sources and reservoirs of viruses for crops. The relationship between crops and disease organisms is generally a complex annual cycle involving crops, vectors and weeds. The disease severity of *Panicum* was equally high. This result is not surprising since *Panicum* itself is a weed and may serve as a reservoir of viruses. It has been reported that weeds are known to play important roles in the spread and epidemiology of virus diseases (Dufus, 1971; Sidek *et al.*, 1993). Many insect and nematode pests, which infect crops with viruses causing major diseases, have often been shown to acquire the viruses initially from weeds (Zimdahl, 1980). Moreso, Awodoyin *et al.* (2007) reported that grasses do not provide long cover over the soil because of rapid decomposition. Therefore, the rapid decomposition might enhance increase in the population of microorganisms including viruses and encourage rapid weed re-infestation and this may increase transmission of viral diseases.

The study revealed that mulching materials increased the yield of okra plant by increasing the number of pods, with plastic mulched plot having the highest yield followed by *A. indica, E. uniflora* and *T. catappa* mulched plots in decreasing order. This statement agrees with the previous studies which revealed that besides weed control, many advantages of using black polythene justify its use: better water use efficiency, higher yields and better quality, earlier plant development due to increased soil temperature, etc. (Scott 2005; Ghosh *et al.* 2006). The yields of *A. indica, E. uniflora* and *T. catappa* mulched plots were higher than that of the *Panicum* mulched plots. This may be due to the fact that the other three mulch materials are broad leaves and do not decompose rapidly as compared to *Panicum* which has narrow leaves and decomposes faster. Awodoyin *et al.* (2007) also stated that grass does not provide long cover over the soil because of rapid decomposition. Nonetheless, the yield of *Panicum* mulched plot was higher than that obtained from the unweeded plot. Ramalan and Nwokeocha (2000) reported that the effect of rice straw on crop yield was found to be variable but was normally higher than bare soil. However, in most of the publications the general trend is that straw mulch has positive effects on the crop, soil moisture, etc., but achieves only an intermediate yield improvement compared to black plastic mulch (Alca´ntara *et al.*, 2007; Cirujeda *et al.*, 2007). In addition, Summers *et al.* (2005) reported that plants grown over straw mulch produced higher overall yields, including large size melons, than those grown over bare soil.

All mulched plots had high fresh and dry pod weights with plastic mulched plot having the highest value. However, the unweeded plot had the least pod biomass value. Mulching is an effective method of manipulating crop growing environment to increase yield and improve product quality by controlling weed growth, ameliorating soil temperature, conserving soil moisture, reducing soil erosion, improving soil structure and enhancing organic matter content (Hochmuth *et al.*, 2001; Awodoyin and Ogunyemi, 2005). Moreso, weeds reduce crop productivity by interfering with crop growth. In Nigeria, uncontrolled weed reduced yield by about 40% in maize and 84% in upland rice (Akobundu, 1980), 31-70% in groundnut (Lagoke *et al.*, 1981) and 73-78% in cayenne pepper (Awodoyin and Ogunyemi, 2005).

The yields obtained from the mulched plots were higher than that of the hoe-weeded plot; the only exception was the *Panicum* mulched plot which had values below that of the hoe-weeded plot. Despite this fact, the use of *Panicum* as mulching material should be given consideration because weeding of agricultural land is expensive and Panicum mulched plot gave higher yield than un weeded plot. Chianu and Akintola (2003) stated that weed control requires more labours which limits the land area a farmer could cultivate. Usoroh (1983) reported that weeding alone takes 30-45% of total cost of labour required for fruit and vegetable production in Nigeria. In conclusion, mulching reduces incidence and severity of OMV and enhances the yield of okra plants by reducing weed infestation and improving the crop growing environment. This helps to reduce the cost incurred on weeding and increase agricultural productivity. Growers should be encouraged to adopt the use of mulches for growing okra in areas where okra mosaic virus is a problem.

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