

Incidence and Severity of Virus Diseases of Okra (*Abelmoschus esculentus* L. Moench) under Different Mulching Types

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ABSTRACT

An experiment was carried out to assess the effect of mulching material on the incidence and severity of some common virus diseases on Okra NH 47-4 (*Abelmoschus esculentus* L. Moench). The treatments were (3X4) factorial designed and fitted into randomized complete block design on field. A block was divided into three plots each measuring 15m X 5m. Mulching types was at three levels i.e. no mulching, dry grasses mulch and polythene mulch. These were factorial combined to give twelve treatment combinations. The results showed that all the okra plants under the varying treatments were susceptible to virus diseases on the field. However, virus disease incidence and severity was lowest in okra plants that received a treatment combination of polythene mulching type and highest in those that received a treatment combination of no mulch application.

At 7 week after planting, a treatment combination of polythene mulching produced significantly the lowest viral incidence of 18.75% and the treatment combination of no mulch application produced significantly highest viral incidence of 89.63%. In the same vein, a treatment combination of polythene mulch produced the significantly lowest disease severity of 7.41% whereas treatment combination of no mulching application produced significantly highest disease severity of 99.98%. The yields of okra plants taken at harvest also indicated that those plants treatments combination of polythene mulching application produced highest yield parameters compared to okra plants that received other treatment combinations.

Introduction

Okra (*Abelmoschus esculentus* L Moench) is of the family Malvaceae. There are four known domesticated species of *Abelmoschus*. Among these, *A. esculentus* (common okra) is most widely cultivated in South and East Asia, Africa, and the southern USA. In the humid zone of West Africa Countries, *A. caillei* (West African okra) with a longer production cycle, is also cultivated [1]. Plants of *A. manihot* sometimes fail to flower and this species is extensively cultivated for leaves in Papua New Guinea (Farooq 2010), Solomon Islands and other South Pacific Islands [2]. As a plant originated in Africa, okra is now cultivated in tropical, subtropical and warm temperate regions around the world [1]. The economic importance of okra cannot be overemphasized. However,

it is widely cultivated fruit vegetable and fruit crop by subsistence farmers of guinea and Sudan savannah of West Africa (Kumar 2010).

Moreover, okra is a highly nutritious and delicious vegetable which is rich vitamins (A, B & C) and minerals [3]. Okra contains proteins, carbohydrate and vitamin C [4]. Okra plays a vital role in human diet due to the fact that it is packed with high fibre of 1.5g of Protein, 5.8g of carbohydrate, 37 mg of folic acid, 13mg of vitamin C, 46 mg of magnesium, 50mg of calcium, 0.4mg of iron, 4.6mg of vitamin A and 257mg of potassium (Kahlon 2009). In Nigeria Okra does well in all forms of reliefs and develop optimally on different forms of soil due to its adaptability to wide range of soil pH of 5.0-9.8 according to the varieties adopted. However, all soils need to

be pulverized, moistened and enriched with organic matter before sowing. Also, it is ideally recommended to plant okra on plains of sandy loam soil of pH of 6.0 to 6.8 for an excellent production especially when incorporated with organic mulch well treated [5].

Okra cultivation and production has been widely practiced because of its importance to the economy development and can be found in almost every market in Africa (AVRDC, 2004). Okra is the most important fruit vegetable crop and a source of calorie (4550Kcal/kg) for human consumption. It ranks first before other vegetable crops [6]. Okra contains carbohydrate, protein and vitamin C in large quantities [7]. The essential and non-essential amino acids that okra contains are comparable to that of Soybean. It was also reported by Eke et al. [8] that fresh okra fruit is a good source of vitamins, minerals and plant proteins. As a result it plays a vital role in human diet; it can be consumed boiled, fried or cooked for the young immature fruits. The word mulch has been probably derived from the German word "molsch" means soft to decay, which apparently referred to the use of straw and leaves by gardeners as a spread over the ground as mulch [9].

Mulches are used for various reasons in agriculture but water conservation and erosion control are the most important objectives particularly in arid and semi-arid regions. Other reasons for use of mulching include soil temperature modification, weed control, soil conservation and after decomposition of organic mulch add plant nutrients, improvement in soil structure, increase crop quality and yield. Mulching reduces the deterioration of soil by way of preventing the runoff and soil loss, minimizes the weed infestation and reduces water evaporation [9]. Thus, it facilitates more retention of soil moisture and helps in control of temperature fluctuations, improves physical, chemical and biological properties of soil, as it adds nutrients to the soil and ultimately enhances the growth and yield of crops [10]. In addition mulch can effectively minimize water vapour loss, soil erosion, weed problems and nutrient loss [11]. Organic mulches are efficient in reduction of nitrates leaching, improve soil physical properties, prevent erosion, supply organic matter, regulate temperature and water retention, improve nitrogen balance, take part in nutrient cycle as well as increase the biological activity [12]. Natural materials cannot be easily spread on growing crops and require considerable human labour [13]. Chen and Katan [14] also reported high water content in the top 5 cm of soil (an increase of 4.7 per cent in clayey, 3.1 per cent in loamy and 0.8–1.8 per cent in sandy soil) with polythene mulch. Das, et al., 2000 observed that use of polyethylene mulch in the field, increased the soil temperature especially in early spring, reduced weed problems, increased moisture conservation, reduction in certain insect pest population, higher crop yield and more efficient use of soil nutrients.

Abu-Awwad (2009) showed that covering of soil surface reduced the amount of irrigation water required by the pepper and the onion crop by about 14 to 29 and 70 per cent respectively. Trials

conducted in the higher potential areas of Zimbabwe indicated that mulching significantly reduced surface runoff and infiltration [15]. Therefore, the main objectives of this paper are to investigate the use of mulching as a cultural practise in ameliorating viral diseases incidence and severity on Okra; to evaluate the effect of treatment combinations {mulching materials (dry grasses and polythene film)}.

Material and Methods

The experiment was conducted at the Teaching and Research Farm (Crops section) of the University of Ilorin, Kwara State, Nigeria between September and November 2016. The area lies between the savannah, between latitude 80.291N and 90301N and longitude 40301E and 60251E. The rain fall pattern of Ilorin is bimodal with a wet season of about four months occurring from June to October and with a brief dry spell, which in most cases occur in the second half of August. The peak rainfall period is June/July and September/October, while the short dry season last from November to December. Also, the daily temperature ranges from 26°C and 49°C [16]. The place of the field Experiment falls under AEZ- (Agro Ecological zone). The topography of the land was medium high with sandy loam soil. And this area has been proven to be suitable for okra cultivation [17].

The experiment was laid down in 3 X 4 Factorial Design fitted into Randomized Completely Block Design (RCBD) with three (3) replicates. Each block consists of 12 treatment combinations. Total land area planted measured 30m X 15m, Block sizes measured 5 X 15m with 1m alley ways between replicates. Experimental field was partitioned into three blocks with mulching types within the plots. Each experimental plot consisted of 24 ridges each 5m long. The Mulching types were at 3 levels namely: No mulching, plastic (polythene) mulching, organic mulching (dry grass). Each treatment was replicated 3 times and was randomly assigned to each plot.

All data were collected on a weekly basis on growths, yield and disease parameters as at when due in the morning and the record was maintained on the selected samples of the population in each that were already tagged. The diseased leaves obtained on the selected samples were counted and recorded start from 4 weeks after planting. The number of diseased fruits was obtained by counting the number of okra yields of selected sample plants of fresh harvest that showed almost 80% viral symptoms base on visual observation. Virus detection was carried out at International Institute of Tropical Agriculture (IITA) Ibadan. Samples of the 12 treatment combinations that showed viral symptoms were collected in each block and were subjected to Antigen Coated Plate - Enzymes Linked Immunosorbent Assay (ACP-ELISA).

The ACP-ELISA mean values were collected after the analysis had been carried out based on Absorbent Value (OD*405nm) for 1 hour and overnight analysis of the samples collected using

ACP-ELISA. Antibodies that were used are as follows: Cucumber Mosaic Virus (CMV), Okra Leaf Curl Virus (OkLCV), Okra Mosaic Virus (OkMV) and Black eye Cowpea Mosaic Virus (BiCMV). Data collected were subjected to analysis of variance (ANOVA). The means were separated using Duncan's Multiple Range Test (DMRT) using SPSS (statistics packages for social sciences).

Results

Analysis of the results on mulching types showed that at 3rd and 4th week after planting, highest incidence were recorded on mulching level of no mulch (13.21% and 23.7%) respectively while mulching types of polythene had the lowest % incidence (3.29% and 5.66%) respectively. However, it implied that the mulching type level of no mulch and grasses are not significantly different when compare with each other. However, they are significantly different to polythene mulching type. At week 5, there was significant difference

between regimes where dry grasses mulching was applied and that polythene mulching types while there was no significant difference between the regime where no mulching was applied and the dry grasses mulching type's regimes.

The values from week 6 and 7 follow the same trend where at week 6 and 7, there was significant difference between the regimes without mulching types and the polythene mulching types regimes while there was no significant difference between regimes where mulching was not applied and dry grasses mulching type (Table 1). The main effect of the mulching types in Table 2 showed that at 3rd week after planting no mulch had the highest percentage severity of 17.72% followed by dry grasses (16.57%) and polythene (5.36%) had the lowest severity. However, it implied that there was no significant difference between mulching type level of no mulch and dry grasses while polythene mulch is significant different from no mulch and dry grasses.

Table 1: Main effects of Mulching types on percentage incidence of viral diseases on okra at different times after planting.

Incidence (%)					
MULCHING TYPE	3WAP	4WAP	5WAP	6WAP	7WAP
NO MULCH	13.21a	23.7a	35.67a	42.06a	69.40a
DRY GRASSES	13.99a	25.18a	37.76a	44.51a	73.51a
POLYTHENE	3.29b	5.66b	7.99b	14.28b	32.61b
S.E	0.93**	1.66**	2.47**	2.49**	2.44**

Table 2: Main effects of Mulching types on percentage severity of viral diseases on okra at different times after planting.

Severity (%)					
Mulching types	3wap	4wap	5wap	6wap	7wap
NO MULCH	17.72a	28.13a	47.75a	61.72a	76.53a
DRY GRASSES	16.57a	26.41a	44.75a	65.73a	84.24a
POLYTHENE	5.36b	8.44b	13.57b	24.37b	41.04b
S.E	1.45	2.31	3.9	2.49	3.34

Note: Values with same letter(s) in a given segment of a column are not significantly different at probability level using New Duncan's Multiple Range Test (NDMRT).

Key: S.E= Standard Error of Mean, WAP= Week After Planting

At fourth week after planting, mulching type level of no mulch had the highest percentage severity of 28.13% followed by dry grasses 26.41% and polythene mulch had the lowest percentage severity 8.44%. The assessment of this result implied that there was no significant difference between no mulch and dry grasses while polythene mulch was significantly different from the no mulch and dry grasses mulch. Analysis of the results on mulching types regimes showed that at week 5, the regime without mulching types had the highest severity of 47.76%, followed by the regime with dry grasses mulching type (44.75%) while that mulch of polythene had lowest severity of 13.57%. A significant difference occurred between the regimes of mulching of dry grasses when compared with polythene mulch. However, there is no significant difference between control and dry grasses mulch. At week 6, the regime treated with dry grasses had the highest percentage severity of 65.73 followed by

no mulch (61.72%) while polythene had the lowest percentage severity of 24.37%. there was no significant difference between dry grasses mulch and no mulch was applied while there was significant difference when comparing no mulch and dry grasses with polythene. Values with same letter(s) in a given segment of a column are not significantly different at probability level using New Duncan's Multiple Range Test (NDMRT).

The mulching type main effects of okra plant height are significantly different in the following trends across all difference stages of growth: At week fifth week, mulching type of polythene is highly significant compare to no mulch and dry grasses with height of 38.51. However, No mulch main effect has ranked second to polythene with height of 31.94 while there is no significant difference between no mulch and dry grasses mulching type

of height 30.56. At week 6, the polythene mulching type was significantly different with plant height of 40.79 while dry grasses and no mulch are not significant with plant height 32.7 and 33.36 respectively. However, no mulch main effect plant height is higher than dry grasses mulching type. Week 7 follow the same trend as aforementioned fifth and sixth week above. The mulching type main

effect of polythene is significantly difference with plant height 43.92 while dry grasses of plant height 38.97 that second to polythene mulching type is not significantly different to no mulch of height 37.89 (Table 3). Values with same letter(s) in a given segment of a column are not significantly different at probability level using New Duncan's Multiple Range Test (NDMRT).

Table 3: Main effects of Mulching types on plant height of okra plant at different times after planting.

Mulching type	Plant Height (cm)				
	3wap	4wap	5wap	6wap	7wap
NO MULCH	14.41b	21.13b	31.94b	33.36b	37.89b
DRY GRASSES	13.89b	20.37b	30.56b	32.75b	38.97b
POLYTHENE	17.55a	25.74a	38.51a	40.79a	43.92a
S.E	0.57	0.97	1.26	1.25	1.69

The main effect of mulching types on okra, at there was a significant difference in the polythene mulching type (14.31) while dry grasses mulch (11.33) no of leaves and no mulching (11.75) are not significantly different from each other but no mulch regime had higher number of leaves to dry grasses. At the 6th week after planting, the number of leaves had same main effect as it occurred in the fifth week whereby polythene mulching type had a glaring

significant difference with number of leaves (17.33) followed by no mulch regime that had (13.52) that was not significantly difference when compare to dry grasses mulching types (13.52). At the 7th week after planting, there was no significant difference in the number of leaves. However, polythene mulch has highest number of leaves (6.83) followed by dry grasses mean (5.97) and no mulch had the lowest number of leaves (4.89) (Table 4).

Table 4: Main effects of Mulching types on incidence of viral diseases on okra Number of leaves at different times after planting.

Mulching type	Number of leaves (cm)				
	3WAP	4WAP	5WAP	6WAP	7WAP
No mulch	5.34b	7.83b	11.75b	13.52b	4.89
Dry grasses	5.15b	7.51b	11.33b	13.47b	5.97
Polythene	6.50a	9.54a	14.31a	17.33a	6.83
S.E	0.25	0.37	0.55	0.64	0.73NS

Note: Values with same letter(s) in a given segment of a column are not significantly different at probability level using New Duncan's Multiple Range Test (NDMRT).

Key: **=Significance, S.E= Standard Error of Mean, WAP= Week After Planting

Analysis on the main effect of the mulching types showed that there was a significant difference among the three levels of mulching types of the number of flowers namely: No mulch, dry grasses and polythene. The mulching type using polythene had 7.97 number of flowers that was significantly difference from dry grasses mulching type of 5.61 flowers while no mulch had the lowest number of flowers 5.53 that was not significantly difference from number of flowers obtained from dry grasses mulching type.

Table 5 under mulching types main effect on edible fruits shows that there was a significant difference among the mulching types of the number of edible fruits. The analysis showed that mulching type using polythene had the highest number of edible fruits of 3.50 that is highly significant to the rest of the mulching types while no mulch that had 2.47 number of fruits is not significantly difference from dry grasses mulching type of 2.41 number of edible fruits.

Table 5: Main effects of Mulching types on incidence of viral diseases on okra number of flowers, edible fruits and diseased fruits.

Mulching type	No of flowers	No of edible fruits	No of diseased fruits
No mulch	5.53b	2.47b	2.19
Dry grasses	5.61b	2.41b	2.19
Polythene	7.97a	3.50a	2.18
S.E	0.38	0.16	0.16NS

Note: Values with same letter(s) in a given segment of a column are not significantly different at probability level using New Duncan's Multiple Range Test (NDMRT).

Key: **=Significance, S.E= Standard Error of Mean, WAP= Week After Planting

Assessment of the data of the analysis of the main effect of the mulching types on number of diseased fruits showed that there was no significant difference between the mulching types shown on the last column of Table 3 second segment. However, it was recorded that polythene mulching had the lowest number of diseased fruits of 2.18 while dry grasses and no mulch had the highest number of diseased fruits of same mean 2.19. The assessment of the result based on mulching types showed that the main effect of polythene mulch of 41.76 is significantly different from dry grasses and control. However, control and dry grasses are not significantly difference with mean of 35.11 and 32.85 respectively (Table 6).

Table 6: Main effects of Mulching types on incidence of viral diseases on okra fresh yield.

Mulching types	Okra Fresh Yield (g)
No mulch	35.11b
Dry grasses	32.85b
Polythene	41.76a
S.E	2.18

Note: Values with same letter(s) in a given segment of a column are not significantly different at probability level using New Duncan's Multiple Range Test (NDMRT).

Key: **=Significance, S.E= Standard Error of Mean, WAP= Week After Planting

Discussion

Farmers are continually developing a stronger interest in okra production given its potential as an economic crop and its ability to grow optimally in the absence of fertilizers and also its ability to produce promising yield within short period of time. However, there are several factors such as pathogens, pests and very importantly diseases such as viruses hinder the realization of these intended objectives. Most plant viruses depend on vectors for their survival and spread, a most effective way of controlling viruses could therefore be by the use of herbicides, synthetic insecticide and cultural control of weed that would interfere with vector landing feeding.

Taking the result to consideration, all the okra plants in this experiment were susceptible to viral diseases, as all of them show symptoms of viral diseases but their susceptibility to viral diseases differ with different level of treatment combinations. However, okra plant that received a treatment combination polythene mulch appeared to be the least susceptible to viral diseases considering the yield and growth parameters of okra plant while those plants that received a treatment combination of no mulching appeared to be most susceptible to viral diseases considering the yield and growth parameters of okra plants. The most conspicuous viral symptoms are the yellow colouration of the leaves, vein banding, light green and dark green patches on the leaves, crinkling of leaves, curling of the leaves and severely stunting of the some young plants.

However, the effect of mulching treatment combinations tried in this study had effects on the incidence and severity of viral diseases. This study showed that the incidence of virus diseases was lowest at the treatment combination where polythene mulching was applied and the highest at the no mulch. Therefore, it implied that low virus incidence existed under the polythene mulch. This assertion is in agreement with Alegbejo [18] when they reported that viral incidence decreases progressively with weeding regime. This development must have been a result of polythene inhabiting the growth of weeds that usually serve as abode of potential vectors of the viruses [19]. Viral incidence was observed to be the highest at the regime that was not weeded and lowest at the regime that was weeded thrice. The reason for high incidence recorded was attributed to high weed interference. This declaration is in conformity with Hooks et al. (2012) who reported that weeds acts as reservoirs for insect, disease agent and nematodes.

This study also showed that interactive effective of mulching could effectively reduce incidence of virus diseases but it is better determined by polythene mulching type and this was in accordance with report of Holland, [20] who reported that polythene mulched rhizosphere had greatest potential that aid growth and development of herbaceous plant combating viral diseases. Also, yield reduction due to insect pest was estimated to be 89.7-91.6% in regime with dry grasses compared to no mulch and polythene mulch, this assertion is in agreement with Aiyelaagbe and Jolaoso [21] who reported that damage by insect pest on okra can be as high as 80-100% if not effectively controlled. In this study, it was showed that Okra mosaic virus was the most virulent virus that was positive irrespective of control measures applied this was so because OkMV had the widest host range [18].

According to Alegbejo, OkMV's epidemiology premised on early rains with intermittent dry and wet spell also other conditions that favour OkMV are warm weather condition and availability of abundant vectors and alternative host. More so, the study also showed that a treatment combination of polythene mulching and weeding thrice produced highest yield parameters. This suggests that weeding could be effective in viral disease control, it is better determined on polythene mulch. This could be explained by protection provided by polythene against insect that harboured in alternative host (weed) that surrounded the okra plant and this corroborates data obtained by Bhardwaj [13, 22-23].

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