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Effects of Plant Extracts on Different Manifestations of Bacterial Blight of Cotton in Yola and Mubi, Adamawa State, Nigeria

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ABSTRACT

This study was carried out in Yola and Mubi both of which are located in Northeastern Nigeria to evaluate the efficacy of some plant extracts on the different manifestations of bacterial blight caused by Xam on different cotton varieties. The study was also intended to examine the reaction of these treated varieties to the disease with a view to identify the most effective plant extract. Results revealed that SAMCOT-8 and SAMCOT-12 varieties have moderate resistance to Xam haven recorded least mean incidences of vein blight, black arm, boll blight and lowest percentage boll rot and higher yield of seed cotton in both locations. Results further revealed the most effective plant extract to be A. sativum (50%) which consistently recorded the lowest mean value of 6.00% and 9.33% seedling blight, 4.67% and 30.00% vein blight, 10.66% and 10.00% black arm, 20.66 and 12.66 boll blight and yield of 403.89 kg ha^{-1} and 921.25 kg ha^{-1} in Yola and Mubi respectively. From these findings, it can be inferred that the various cotton varieties and plant extracts at 50% concentration tested on Xam showed promising prospect for management of bacterial blight of cotton. It is hereby suggested that SAMCOT-8 and SAMCOT-12 with A. sativum (50%) and A. cepa (50%) should be put to further field trial in these locations to determine their effectiveness in the management of Xam.

Keywords: *Bacterial blight, Cotton, Manifestation, Plant Extracts.*

1. INTRODUCTION

Cotton (Gossypium spp.) belongs to the family malvaceae and is one of the most important fibre crops commercially grown worldwide that is used to produce textile materials, oil cake and edible oil [4]. In Nigeria, cotton is adapted to most ecological zones and is been cultivated in the northern, eastern and southern cotton growing zones with a total production of 1.48 million bales in 2010 [20].

However, the production potential of this crop has been constrained by the prevalence of abiotic and biotic factors which affects the yield and fibre quality [10, 15]. Amongst the various diseases of cotton in Nigeria, bacterial blight disease caused by Xanthomonas axonopodis pv malvacearum (Xam) has been reported to be the most important and devastating disease reducing yield of up to 30% [11, 8]. At present, quick and effective management of the disease and other microbial contamination in agricultural commodities is generally allowed by the use of synthetic pesticides [3]. However, the incessant and indiscriminate usage of these pesticides has caused health hazards in animals and humans due to their residual toxicity [4] and development of resistance by the pests and microorganisms [21] which seriously hinders the management of diseases of crops and agricultural products [7]. Considering the deleterious effects of synthetic pesticides on life supporting systems therefore, there is an urgent need for alternative agents which will equally be effective and eco-friendly for the management of pathogenic microorganisms including Xam. Reports are available on the use of several plants by-products which possesses antimicrobial properties on several pathogenic fungi and bacteria [17, 5].

It is for this reason therefore, that this study was conducted to assess the efficacies of some selected plant materials on the different manifestation of bacterial blight of cotton and to identify the most effective plant extract for the management of bacterial blight of cotton.

2. MATERIALS AND METHODS

This study was conducted in Yola and Mubi all in northeastern Nigeria during the 2011 cropping season. One of the field trial was conducted at the Teaching and Research Farm of the Department of Crop Protection, Modibbo Adama University of Technology, Yola. Yola is located between latitude 9^{o} 11′ N and 9^{o} 19′ N and longitude 12^{o} 20′ and 12^{o} 31′ E [1]. The second field trial was conducted at the Teaching and Research Farm of Agricultural Technology Department, Federal Polytechnic Mubi. Mubi is located between latitude 10^{o} 11′ N and 9^{o} 26′ N and longitude 13^{o} 1′ and 13^{o} 44′ E [1].

The design used for conducting the experiment in both locations was split-plot design replicated three (3) times with cotton varieties allocated to the main plots while the plant extracts were allocated to the sub-plots. The experimental fields measured 29 m x 59 m (1711 m^2) with plots measuring 5 m x 3 m, and alleys of 1m pathway between plots and replicates.

The plant materials used in conducting this study were obtained from Jimeta Main Market (Allium sativum and A. cepa), while Vermonia amagdalina and Nicotania tabaccum were collected from surrounding gardens in Mubi. The five cotton varieties (SAMCOT-8,SAMCOT-9,SAMCOT-10,SAMCOT-11 and SAMCOT-12) were obtained from the Institute of Agricultural Research (IAR) Samaru Zaria. The plant materials collected were rinsed with 10 % sodium hypochlorite (NaOCl) and thereafter 200g of the respective plant material was pounded into paste using mortar and pestle. 500 ml of distilled water was later added to the paste each making a suspension

which was kept for 24 hours and later filtered using a muslin cloth and kept in clean glass bottles for later use in the experiments. The 50% concentration of the various plant extracts was prepared by taking 50 ml of the stock solution and dissolving it in 100 ml of distilled water, while 100 ml of distilled water was used for the control in the experiment.

Twenty Nine (29 g) of MacConkey Agar was dissolved in 500 ml of distilled water by heating the content and later autoclaved at 115^{o}C. These was later poured into sterilized petri dishes and allowed to solidify. A small piece from the advancing margin of a lesion from diseased leaves was cut with a sterile pair of scissors [18], washed thoroughly in several changes of sterilize distilled water and placed aseptically in sterile petri dishes containing the medium which was later incubated at 60 ^{o}C for 48 hours to observe the growth of the bacterial colonies from which sub-culturing to obtain pure culture was done. The pure culture was identified using the method of Hayward and Waterson [9] and later preserved on Agar slant and kept in refrigerator to use in inoculating plants in the field.

The fields used for conducting the experiment in each location were cleared of all plant debris, gathered and burnt after which the land was ploughed and harrowed using a tractor. After these operations, the experimental plots were marked and demarcated using measuring tape, line and wooden pegs. The cotton seeds, before land sowing were contaminated with infected fresh crushed cotton plant (leaves) which served as initial inoculum. The cotton seeds were sown as soon as the rain established and this was done in Mubi experimental plot on the 24/6/2011 and 28/6/2011 for Yola plot. The spacing adopted in both locations was 90 cm x 45 cm with five plants per stand which was later thinned to two plants per stand at 3 weeks after sowing (WAS) [11], giving a total of 4,800 plants in each location (1,600 per replicate).

Diuron was applied immediately after sowing at the rate of 1 kg (150mls in 20 litre sprayer) per hectare in both locations as a pre-emergence herbicide, while regular hand weeding was done to loosen the soil to improve water penetration and maintain good aeration of soil [6]. Cypermethrin (Cymbush) and Imidacloprid (Courage®) application was carried out at the ratio of 20 ml: 40 ml of Smash and Courage respectively per 20 litre knapsack sprayer. The spraying was done at beginning of flower formation and subsequently at two weeks interval till picking [11]. This was aimed at eliminating most of the insect pests such as boll worm, cotton leaf roller and the cotton stainer found to be associated with cotton.

Fertilizer were applied twice in both locations, first at 3 WAS and 8 WAS. Fertilizer containing nitrogen was applied at the rate of 60 kg ha^{-1}, phosphorus in the form of P_2O_5 at the rate of 30 kg ha^{-1}, and potassium in the form of K_2O at the rate of 30 kg ha^{-1}. Fertilizer were applied in furrows 10 cm away from the plants and covered with soil immediately [11, 6].

The isolated bacterial pathogen (10^8 cfu/ml) was suspended in distilled water and later sprayed under the leaves surfaces of the plants in the evening using a pressurized hand sprayer to increase the chance of infection by the pathogen. The plants were examined regularly for infection at weekly intervals beginning from 4 WAS and two weeks after inoculation up to 13 WAS.

The plant extracts prepared were applied unto the inoculated plants during boll formation in both locations at 4 WAS and at 8 WAS during morning hours. Harvesting of seed cotton by hand picking was carried out immediately after 50% of the matured bolls are fully open, and the weather was dry. This was done from early November up to the end of the month due to the indeterminate nature of the various varieties sown [11, 6].

Data were collected on incidences of seedling blight, vein blight, black arm, boll blight, boll rot and yield (kgha^{-1}). The data collected were analyzed using the Generalized Linear Model (GLM) procedure of Statistical Analysis System (SAS) [19] appropriate for a Split-Plot Design and means separation was carried out using the Duncan Multiple Range Test (DMRT).

3. RESULTS

The results obtained on the effects of varieties and plant extracts on incidences of seedling blight, vein blight, black arm and boll blight in Yola and Mubi are presented on Table 1. The results revealed there was no significant ($P \geq 0.05$) difference between the varieties on the incidence of seedling blight in both locations. However, it showed that SAMCOT-8 and 12 each recorded the least incidence of 9.33% of seedling blight in Yola. At Mubi, SAMCOT-8, 9, 10 and 11 all recorded the same mean value of 10.66% while the highest value of 11.33% was observed on SAMCOT-12. Results on the plant extracts revealed that A. sativum recorded the lowest mean value of 6.00%, followed by A. cepa 8.00% while the control recorded the highest mean value of 17.33% in Yola. However, in Mubi, the lowest mean value of 9.33% was recorded by A. sativum, followed by N. tabacum with 10.00% while the control had the highest value of 12.66%.

Results on the incidence of vein blight phase of bacterial blight revealed that there were significant difference among the varieties in Yola and Mubi. The results showed that the lowest incidence of vein blight in Yola was observed on SAMCOT-8 with a mean value of 10.66%, followed by SAMCOT-11 and 12 with mean values of 14.66 each while the highest incidence of vein blight was observed on SAMCOT-10 (18.66%). Equally for plant extracts, the result revealed a highly significant ($P \leq 0.01$) variations between the treatments on the incidence of vein blight, with A, sativum recording a much lower mean value of 4.67%, followed by A. cepa (6.00) while the highest value of 17.33% was observed on the control in Yola.

Though the vein blight value were generally higher in Mubi than those obtained in Yola, however SAMCOT-8 had the lowest mean value of 34.66%, followed by SAMCOT-12 (40.66%), while the highest incidence of this phase of the disease was observed on SAMCOT-9 (46.66%). When plant extracts were applied, it was observed that A. sativum recorded the lowest mean value of 30.00%, followed by A. cepa with 34.00%, while the highest mean value of 65.33% was observed on the control treatment.

Results on the incidence of black arm phase of bacterial blight in Yola revealed that SAMCOT-8 had the lowest incidence of 14.66%, followed by SAMCOT-12 (18.00%), while SAMCOT-10 had the highest mean value of 24.66%. The study equally revealed that there was highly significant ($P \leq 0.01$) difference on the efficacies of the plant extracts on the incidence of blackarm in Yola. Lowest mean value of 10.66% was observed on A. sativum, followed by A. cepa (12.66%) while the highest mean value of 38.66% was observed on the control.

In Mubi, the results revealed significant difference ($P \geq 0.05$) between the varieties on the incidence of blackarm. It was observed that SAMCOT-8 had the lowest mean value of 20.00%, followed by SAMCOT-9 and 12 with 23.33%, while SAMCOT-11 had the highest mean incidence of 28.66%. Mean values of plant extracts in Mubi revealed that there was highly significant ($P \leq 0.01$) difference among the extracts. The study further revealed that A. sativum had the lowest mean value of 10.00%, followed by A. cepa (13.33%) while the control had the highest mean value of 54.66%.

Results on the incidence of boll blight in both locations revealed highly significant ($P \leq 0.01$) difference among the varieties. Cotton varieties sown in Yola recorded a higher incidence of boll blight as against those sown in Mubi. SAMCOT-8 recorded a lower mean value of 28.66%, followed by SAMCOT-12 with 34.00%, while SAMCOT-10 had the highest incidence of 43.33%. The effects of plant extracts on the incidence of boll blight, revealed a highly significant ($P \leq 0.01$) difference between treatments. A. sativum recorded a lower mean value of 20.66%, followed by A. cepa (25.33%) while the highest mean value of 63.33% was recorded for the control in Yola.

The results on the incidence of boll blight on varieties in Mubi, revealed that SAMCOT-8 had a lower mean value of 23.33%, followed by SAMCOT-12 (26.66%) while the highest mean value of boll blight was recorded on SAMCOT-9 (33.33%). Results on the performance of plant extracts on boll blight revealed that there was highly significant ($P \leq 0.01$) difference between the treatments with A. sativum recording the lowest mean of 12.66%, followed by A. cepa (16.66%), while the highest mean of 64.66% was recorded by the control (distilled water).

The results of the effects of varieties and plant extracts on percentage boll rot and yield of seed cotton (kg ha^{-1}) in Yola and Mubi are presented in Table 2. Results on percentage boll rot in Yola and Mubi revealed that there were significant ($P \leq 0.05$) differences between the varieties. SAMCOT-8 recorded the least mean value of 21.30% followed by SAMCOT-11 (22.05) with SAMCOT-10 having the highest percentage boll rot of 25.65% in Yola. Also, results indicated that there was highly significant ($P \leq 0.01$) difference between the extracts on percentage boll rot in Yola. A. sativum was observed to have the least mean value of 5.79%, followed by A. cepa with 8.16%, while the control had the highest mean value of 67.72% boll rot. In Mubi location, SAMCOT-12 was adjudged to have the least boll rot of 8.84%, followed by SAMCOT-8 (9.31%), with SAMCOT-11 (15.01%). Similarly, there existed a higher significant variation on the effects of plant extracts on percentage boll rot. Results revealed that A. sativum recorded the least mean value of 2.36%, followed by A. cepa 3.42% while the control had a much higher boll rot of 42.30%.

The results on yield of seed cotton indicated highly significant ($P \leq 0.01$) differences in both locations between the varieties. In Yola, it was observed that SAMCOT-8 had the highest mean value of 390.00 kg ha^{-1}, followed by SAMCOT-12 (341.66 kg ha^{-1}) while a lower value of 227.17 kg ha^{-1} was observed on SAMCOT-10. Also, there exists highly significant ($P \leq 0.01$) variation between the performances of the various extracts on the yield of seed cotton. It was observed that A. sativum recorded the highest mean value of 403.89 kg ha^{-1}, followed by A. cepa with 350.00 kg ha^{-1} while the lowest value of 163.89 kg ha^{-1} was recorded against the control.

In Mubi, similar trend was observed to that of Yola, though SAMCOT-8 recorded a much higher yield value of 868.09 kg ha^{-1}, followed by SAMCOT-12 (559.11 kg ha^{-1}) while SAMCOT-9 had the lowest weight of 461.61 kg ha^{-1}. Significantly higher ($P \leq 0.01$) differences were observed between the extracts in Mubi. Results reveals that A. sativum recorded a much higher value of 921.25 kg ha^{-1}, followed by A. cepa (781.92 kg ha^{-1}) while the control had the least mean weight of 189.45 kg ha^{-1}.

Table 1: Mean effects of varieties and plant extracts on incidence of seedling blight, vein blight, black arm and boll blight in Yola and Mubi.

	Locations							
	Yola				Mubi			
	Seedling blight	Vein blight	Black arm	Boll blight	Seedling blight	Vein blight	Black arm	Boll blight
Variety								
SAMCOT-8	9.33[a]	10.66[c]	14.66[c]	28.66[d]	10.66[a]	34.66[c]	20.00[c]	23.33[c]
SAMCOT-9	12.00[a]	15.33[a]	22.66[a]	35.33[bc]	10.66[a]	46.66[a]	23.33[bc]	33.33[a]
SAMCOT-10	12.66[a]	18.66[a]	24.66[a]	43.33[a]	10.66[a]	44.00[ab]	25.33[ab]	28.66[b]
SAMCOT-11	10.66[a]	14.66[b]	21.33[ab]	39.33[ab]	10.66[a]	45.33[a]	28.66[a]	28.66[b]
SAMCOT-12	9.33[a]	14.66[b]	18.00[bc]	34.00[c]	11.33[a]	40.66[b]	23.33[bc]	26.66[b]
Probability of F	0.1920	0.0034	< .0001	< .0001	0.9699	< .0001	0.0227	< .0001
Plant Extracts								
A. sativum -50%	6.00[c]	4.67[c]	10.66[d]	20.66[e]	9.33[b]	30.00[d]	10.00[c]	12.66[d]
V. amagdalina-50%	11.33[b]	13.33[b]	22.00[b]	40.00[b]	12.33[ab]	43.33[b]	23.33[b]	24.66[b]
A. cepa-50%	8.00[bc]	6.00[c]	12.66[d]	25.33[d]	10.66[ab]	34.00[d]	13.33[c]	16.66[c]
N. tabacum-50%	11.33[b]	10.66[b]	17.33[c]	31.33[c]	10.00[b]	38.66[c]	19.33[b]	22.00[b]
Control	17.33[a]	39.33[a]	38.66[a]	63.33[a]	12.66[a]	65.33[a]	54.66[a]	64.66[a]
Mean	10.80	14.80	20.26	36.13	10.80	42.26	24.13	28.13
S.E	4.61	4.97	5.22	5.39	3.18	6.06	6.77	4.25
Probability of F	< .0001	< .0001	< .0001	< .0001	0.0682	< .0001	< .0001	< .0001
Extr. x Var.	*	*	*	*	ns	*	*	*

Means with the same letter(s) are not significantly different at P = 0.05 or P = 0.01 according to DMRT.

Table 2: Mean effects of varieties and plant extracts on boll rot and yield of seed cotton (kg ha^{-1}) in Yola and Mubi.

	Yola			Mubi	
	% boll rot	Yield of seed cotton (kg ha^{-1})		% boll rot	Yield of seed cotton (kg ha^{-1})
Variety					
SAMCOT-8	21.30[c]	390.00[a]		9.31[b]	868.90[a]
SAMCOT-9	25.15[b]	291.00[c]		10.91[ab]	461.61[bc]
SAMCOT-10	25.65[a]	227.17[d]		13.75[ab]	470.08[d]
SAMCOT-11	22.05[bc]	255.55[d]		15.01[a]	523.44[d]
SAMCOT-12	23.68[bc]	341.66[b]		8.84[b]	559.11[b]
Probability of F	0.0606	< .0001		0.0662	< .0001
Plant Extracts					
A. sativum -50%	5.79[c]	403.89[a]		2.36[b]	921.25[a]
V. amagdalina-50%	19.42[b]	277.77[b]		4.93[b]	479.57[d]
A. cepa-50%	8.16[c]	350.00[a]		3.42[b]	781.92[b]
N. tabacum-50%	16.75[b]	311.11[ab]		4.80[b]	511.01[c]
Control	67.72[a]	163.89[c]		42.30[a]	189.45[e]
Mean	23.57	301		11.56	576.45
S.E	4.61	52.27		6.73	88.61
Probability of F	< .0001	< .0001		< .0001	< .0001
Extr. x Var.	*	*		*	**

Means with the same letter(s) are not significantly different at P = 0.05 or P = 0.01 according to DMRT.

4. DISCUSSION

Investigations in this study revealed the presence of seedling blight, vein blight, black arm and boll blight in both locations. Gwary et al. [8] had earlier reported similar manifestations of this disease in Yola. Results obtained from this study showed that SAMCOT-8 and SAMCOT-12 had a moderate resistance to tese various manifestations of bacterial blight goig by their performances in obtaining the least mean incidence value in both Yola and Mubi as against the performances of SAMCOT-9, 10 and 11 after foliar application with A. sativum. These lower incidences and higher yield by SAMCOT-8 and 12 may be attributed to their genetic makeup and the inhibitory effect of A. sativum in suppressing the spread of the pathogen. Though the

performance of these two varieties vary with those obtained by Poswal [16] and Nahunnaro et al. [15] who had earlier reported on their susceptibility to this manifestations and low yields. Seedling blight usually affects plant population and consequently yield. Results from this study showed a positive correlation between seedling blight and yield of seed cotton on all varieties used in this study. These findings are similar to the work of Adeoti and Popoola [2] who earlier reported a positive correlation between seedling emergence and yield of cotton.

The antibacterial activities of plant extracts on varieties showed a significant variation in their activity in suppressing the spread of the disease. A. sativum followed by A. cepa were observed to perform better in reducing the spread of the pathogen and consequently the manifestation of the disease on SAMCOT-8 and SAMCOT-12 owing to their antimicrobial properties. The vein blight phase of these disease has been found to distort and destroy leaves thus affecting photosynthesis which in ensures reduction of assimilates for the plant and subsequently yield. Similarly, the black arm phase affects the number of branches and bolls which results to low yields during harvest.

Yield of seed cotton is hinged on number of harvestable bolls, boll rot among other factors. These factors are reported to have some relationship with environmental conditions and the pathogen [14]. Results in the study conducted in both locations revealed that there was a highly significant relationship between seedling blight, vein blight, Black arm, Boll blight, and percentage boll rot on yield of seed cotton amongst the varieties and plant extracts. The higher number of branches recorded by SAMCOT-8 in both locations, coupled with the higher number of bolls per plant and lower percentage boll rot (21.30% and 9.30%) could be responsible for the higher yield of seed cotton recorded for this particular variety. The performance of SAMCOT-8 with those of other varieties on the aforementioned parameters may be as a result of its moderate resistance to Xam and its probable adaptability to these environment as was earlier reported by Idem [11], coupled with the influence of A. sativum in retarding the spread of the disease by recording least mean values on seedling blight, vein blight, Black arm, boll blight and higher yields in both locations. These findings agreed with Khan et al. [13] who reported on the bio-efficacy of Datura alba as foliar spray against Xam which increased the number of branches, number of bolls and yield of seed cotton, due to delay in the establishment of the pathogen on the plants, as evident by mild symptom of the disease. They further reported that differences in varietal response to infection and recovery by the plant extract may be due to the multiplication of the pathogen at a higher rate in a susceptible variety than in a resistant or immune variety which was more noticeable on SAMCOT-8 than SAMCOT-10.Low percentage boll rots and higher yield of seed cotton (921.25 kg ha^{-1} in Mubi and 403.89 kg ha^{-1} in Yola) recorded as a result of foliar application with A. sativum had achieved similar results as those obtained by Islam et al. [12] who recorded higher number of bolls per plant, low percentage boll rot and higher yield of seed cotton after applying streptomycine sulphate as seed treatment followed by cupravit (0.2%0 and streptomycine sulphate (100 ppm) as foliar spray against Xam. The yield obtained by SAMCOT-8 in Mubi (868.90 kg ha^{-1}) was higher than that obtained under ideal condition in this environment. Nahunnaro et al. [15] had earlier reported on the susceptibility of SAMCOT-8 to bacterial blight and consequently its low yield. This study, however, found SAMCOT-8 to be moderately resistant against Xam as evident by its performance in having the highest number of bolls, less percentage boll rot and higher yield of seed cotton in both locations due to the application of A. sativum (50%) and A. cepa (50%) which inhibited the activities of Xam in both locations. SAMCOT-10 was found to be more susceptible and SAMCOT-9 moderately susceptible to Xam in both location. However, all plant extracts had some level of positive effects on the disease relative to the control in both locations.

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