Effect of Propiconazole (Tilt) and pruning on severity of Black Sigatoka disease and yield of plantain

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SUMMARY

The use of Propiconazole (Tilt) and pruning to control Black Sigatoka disease in plantain was tested from March 1995 to April 1997 at Kade, Ghana. There were four treatments: Tilt application alone, Pruning alone, Tilt + Pruning, and Control in a randomized complete block design. Expressed as percentage total leaf area attacked, disease severity was 16 (13.1-19) for the control treatment while it was 4.6 (2.9-6.2), 5.1 (3.7-6.4), and 3.8 (2.5-5.0) for Tilt, Pruning, and Tilt plus Pruning, respectively. The control was significantly different from the other three treatments which were, however, not different from each other at $P = 0.05$. At the 44th week after transplanting, the youngest leaf with symptom (YLWS) was on the average the 6th leaf for Tilt while it was 4th, 5th, and 3rd for Pruning, Tilt + Pruning, and Control, respectively. It meant that the plants treated with Tilt appeared healthier than the control. The total number of bunches harvested after 66 weeks were 47, 54, 50, and 52 with bunch weights of 249.1, 453.0, 392.2, and 405.0 kg for Control, Tilt, Pruning, and Tilt + Pruning, respectively. The Control was significantly different from the other treatments which were, however, not different from each other at $P = 0.05$. Correlation analysis indicated a negative but significant association ($r = -0.96$) between severity of disease and yield. The results show that pruning and burning of diseased leaves can be used as an alternative to fungicide application to control Black Sigatoka on plantain.

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RESUMÉ

BODAKPUI, C. K., ODURO, K. A. & AFREH-NUAMAH, K.: *L'influence de propiconazole (Tilt) et la taille sur la sévérité de la maladie Sigatoka Noire et le rendement du plantain.*

L'application de Propiconazole (Tilt) et la taille pour le contrôle de Sigatoka Noire sur le plantain était mise à l'essai de Mars 1995 à Avril 1997 à Kade au Ghana. Il y avaient quatre traitements: L'application de Tilt seule, la taille seule, Tilt plus la taille, et le contrôle dans un dessin de bloc complet choisi au hasard. Exprimé en tant que pourcentage total de la superficie de feuille infectée, la sévérité de maladie pour le traitement du contrôle était 16.0 (13.1 – 19.0) alors qu'il était 4.6 (2.9 – 6.2), 5.1 (3.7 – 6.4) et 3.8 (2.5 – 5.0), respectivement pour propiconazole, la taille et propiconazole plus la taille. Le contrôle était considérablement différents de trois autres traitements qui, cependant, n'étaient pas différents l'un de l'autre à $P = 0.05$. A la 44 ième semaine aprés la transplantation. La plus jeune feuille avec symtôme (JFAS) était en moyenne la 6^e feuille pour propiconazole alors qu'il était 4^e, 5^e et 3^e respectivement, pour la taille, propiconazole plus la taille, et le contrôle. Cela signifiait que les plantes traitées avec propiconazole se montraient plus saines que le contrôle. La quantité totale de régimes moissonnés aprés 66 semaines étaient 47, 54, 50, 52 avec les poids de régime de 249. 1, 453.0, 392.2 et 405 kg, respectivement, pour le contrôle, propiconazole, la taille et propiconazole, plus la taille. Le contrôle était considérablement différent de trois autres traitements qui, cependant, n'étaient pas différents l'un de l'autre à $P = 0.05$. L'analyse de corrélation donnait une association considérable mais négative ($r = -0.96$) entre la sévérité de maladie et le rendement. Les résultats montraient que la taille et la brûlure des feuilles infectées pourraient être pratiquées comme une méthode alternative à l'application de fungicide pour le contrôle de Sigatoka Noire de plantain.

Introduction

Plantain (*Musa paradisica* L.) is a major source of carbohydrate for millions of people in the developing world (Stover & Simmonds, 1987). In Ghana, it is estimated that the national production between 1986 and 1990 was 5.2 million tonnes (PPMED, 1990).

One important disease of plantain is the Black Sigatoka caused by *Mycosphaerella fijiensis*. Yield losses due to the disease at Onne, southern Nigeria, range from 20 (Pasberg - Gauhl, 1989) to 50 per cent (Mobambo, 1993).

Black Sigatoka was observed in some West African countries, including Ghana, in 1985 (Wilson, 1986) and it became epidemic in the 1990s (Hemeng, Banful & Twumasi, 1995). Oduro *et al.* (1992) reported that the national incidence was 62.5 per cent and recommended pruning and burning of diseased leaves as one of the control measures. In 1994, Ghana's Ministry of Food and Agriculture also recommended the use of Propiconazole to control Black Sigatoka (Boadu, 1994). Propiconazole is a foliar fungicide with systemic properties. Its chemical name is (2 - (2,4 - dichlorophenyl) - 4 propyl - 1, 3 - dizolan -2- yl - methyl) - 1H - 1, 2, 4 triazole. It is manufactured by CIBA - GEIGY under the trade name Tilt.

This study aimed at evaluating the effect of the two recommendations, namely the application of Propiconazole (Tilt) and pruning, on the severity of Black Sigatoka and yield of plantain.

Materials and methods

The project was carried out from March 1995 to April 1997, at the University of Ghana Agricultural Research Station, Kade, which has a mean annual rainfall of 1386.3 mm. The land was prepared by slashing without burning. There were four treatments: Tilt (0.125 g ai/1), Pruning, Tilt (0.125 g ai/1) + Pruning, and Control (neither chemical nor pruning). Each treatment was replicated four times in a randomized complete block design. Each plot of size 18 m × 12 m had 20 plants, but records were taken on 15 plants selected at random. Data were analyzed by analysis of variance (ANOVA) and significant values were subjected to the least significant difference (LSD) test at 0.05 significant level.

The plantain cultivar used was 'Brodeyuo' (Dark pseudostem) belonging to the False Horn (Apentu) AAB group. The split corm technique (Wilson, Vuylsteke & Swennen, 1985) was used to raise suckers at the nursery for 4 months. Before transplanting to the field, roots and necrotic lesions were trimmed and suckers were cut to an average height of 50 cm.

The number of expanded non-droping leaves were counted 8 weeks after planting and subsequently at 4-week intervals. The disease severity on the leaves was scored with a 6-grade scale of 0-5 (modified after Gauhl *et al.* (1993) as follows: grade 0 = no symptom; 1 = less than 1 per cent leaf area attacked; 2 = 1-5 per cent leaf area attacked; 3 = 6 - 15 per cent leaf area attacked; 4 =16 - 33 per cent leaf area attacked; and 5 = 34 - 100 per cent leaf area attacked. The percentage total leaf area per plant attacked by the fungus was estimated according to the formula by Gauhl *et al.* (1993) as follows:

Total leaf area attacked (%):

$$= \frac{LN_1 \times 1 + LN_2 \times 5 + LN_3 \times 15 + LN_4 \times 33 + LN_5 \times 100}{LN}$$

where LN_1 to LN_5 = number of leaves with respective grades, and
LN = total number of leaves.

The youngest leaf with symptoms (YLWS) which gives an idea of how healthy the plant appears (Stover & Dickson, 1970; Stover, 1971) was also determined by recording the number of youngest leaves of each test plant that have the symptoms, counting from the folded leaf downwards. The average of the numbers was calculated for each treatment.

The four treatments were also applied when plants were 8 weeks old after transplanting and subsequently at 4-week intervals until the plants were 44 weeks old, and had started flowering without producing new leaves. The treatments

were applied immediately after the severity determination to ascertain the initial natural infection, and also the effect of the previous treatments on disease severity. The details of the four treatments (T_1 - T_4) were as follows:

T_1 (*Pruning*). Plants were inspected 8 weeks after transplanting, and diseased leaves above Grade 2 removed with cutlass and gathered outside the test plants and burnt. It was repeated at 4-week intervals till plants started fruiting.

T_2 (*Fungicide (Tilt) application*). Five ml of Propiconazole (250EC) was mixed with 10 l of water for a concentration of 0.125 g ai/1. This was sprayed on both surfaces of the leaves. The knapsack sprayer was used for the first spraying, and the motorized sprayer for the subsequent ones so as to reach the leaves of the tall plants. The frequency of application was as mentioned in T_1.

T_3 (*Tilt plus Pruning*). Diseased leaves above Grade 2 were prunned and burnt as in T_1. Tilt 250EC was then sprayed as in T_2. The initial time and frequency of application was as mentioned in T_1.

T_4 (*Control*). Neither Tilt application nor Pruning was done.

Harvesting was done at 2-week intervals 54 weeks after transplanting. A bunch was considered mature when a finger had cracked or was beginning to ripen. The experiment was terminated after the 7th successive harvest when the plants were 66 weeks old. At harvest, the number of bunches per treatment and bunch weight (taken by cutting the peduncle above the first hand at the scar of the last bract and below the last hand) were recorded. However, other components of yield: number of hands per bunch, number of fruits (fingers) per bunch, and the circumference, length and weight of the middle finger (most representative of each hand), were also recorded.

Results

Effect of Tilt, pruning and amount of rainfall on severity of Black Sigatoka

The results are presented in Fig. 1. From the 8th to 44th week, the control plants were the most diseased. Throughout the experimental period, the total leaf area attacked in the control plants was higher than 13 per cent, but it was between 2 and 66.4 per cent for the other three treatments.

In all the treatments, the highest disease severity was observed when the plants were 32 weeks old; this coincided with the peak of rainfall (295 mm) in the Kade area where the experiment was conducted (Fig. 2). The lowest severity was recorded at week 28 for Tilt and Tilt + Pruning. However, disease severity fluctuated in all the treatments.

The YLWS also fluctuated throughout the period (Fig. 3). Eight weeks after transplanting, the Tilt and Pruning treatments had the same value of 2.6 while Tilt + Pruning recorded 2.2 and Control 2.3. The highest YLWS values of 6.8, 5.0, 5.9 and 3.4 for Tilt, Pruning, Tilt + Pruning and Control, respectively, were recorded in the 36th week.

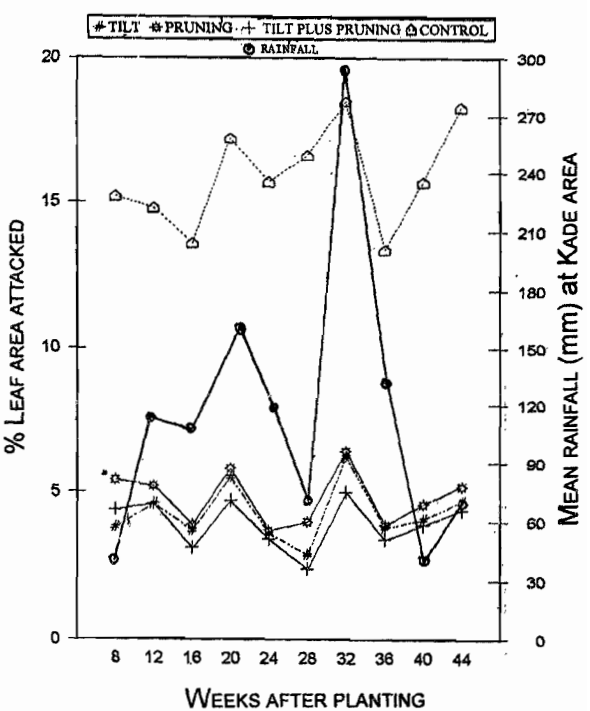

Fig. 1. Effect of Tilt and pruning and amount of rainfall on Black Sigatoka.

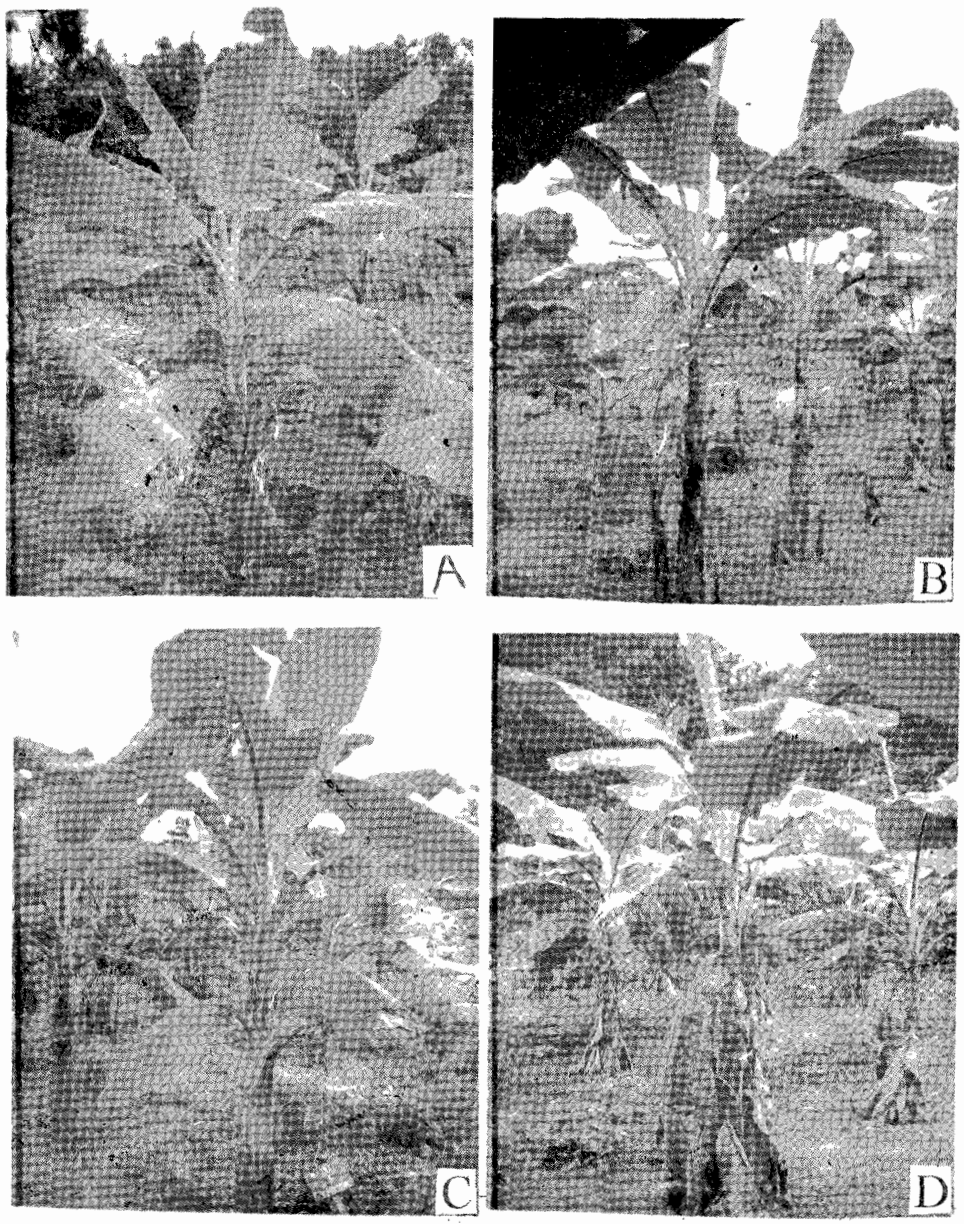

Fig. 2. Effect of Tilt and pruning on Black Sigakota disease severity of plantain 32 weeks after planting.
A = Plants sprayed with Tilt showing no visible symptoms of Black Sigatoka.
B = Plants pruned only, showing no visible symptoms.
C = Plants pruned and sprayed with Tilt showing no visible symptoms.
D = Control (neither Tilt nor pruning) plants showing the lower leaves with advanced stages of Black Sigatoka.

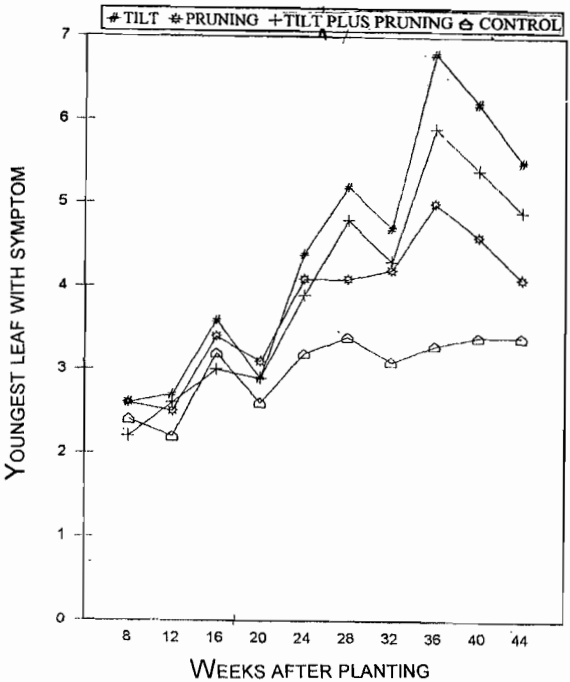

Fig. 3. Effects of Tilt and pruning on youngest leaf to show symptom (YLWS).

These decreased to 5.8, 4.2, and 5, for Tilt, Pruning, and Tilt + Pruning, respectively, by the 44th week while Control remained constant.

The results meant that at the 44th week after transplanting, on the average, the youngest leaf that had the symptom was the 6th leaf for Tilt while it was 4th, 5th, and 3rd for Pruning, Tilt + Pruning and Control, respectively. It meant that the plants treated with Tilt appeared healthier than the Control.

Effect of Tilt and pruning on yield

Fig. 4 and Table 1 present the results on the yield of plantain harvested between weeks 54 and 66.

Maturity delayed in the control plants. Thus, by the 54th week while four and two bunches were harvested for Tilt and Tilt + Pruning, respectively, nothing was harvested in either the Control or Pruning.

Also by the 56th week, only two and three bunches were harvested for Control and Pruning, respectively, while seven bunches each were harvested for Tilt and Tilt + Pruning.

By the 60th week, while 13, 11, and nine bunches were harvested in Tilt, Tilt + Pruning and Pruning, respectively, only six bunches were harvested in the Control.

By the 62nd week, when Pruning reached its peak of 14 bunches, Control had 12, Tilt 11, and Tilt + Pruning 8.

At the 64th week, the Control reached its peak of 15 bunches harvested, while 13, seven and five bunches were harvested in Pruning, Tilt+ Pruning and Tilt, respectively. At the 66th week, there was a fall in harvest in all the treatments. These were eight, six, five, and two bunches in Control, Pruning, Tilt + Pruning and Tilt, respectively. In all, the number of bunches harvested were 54,

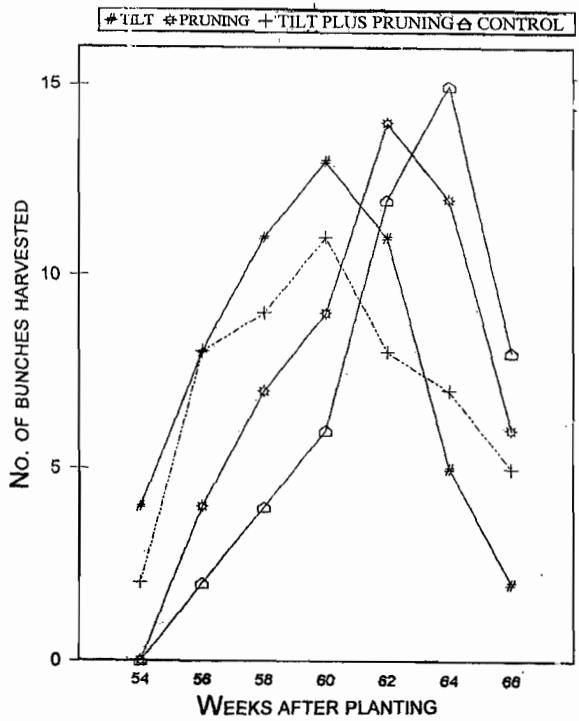

Fig. 4. Number of bunches harvested from weeks 54 to 66.

TABLE 1

Yield and Components of Yield 66 Weeks after Transplanting

Treatment	*Total number of bunches*	*Total bunch weight (kg)*	*Bunch weight (kg plant^{-1})*	*No. of hands per bunch*	*No. of fruits per bunch*	*Middle finger*		
						Circumference (cm)	*Length (cm)*	*Weight (kg)*
Tilt	54	453.0	8.4	6.4	26.4	12.9	25.3	0.258
Pruning	52	392.2	7.5	6.1	25.6	12.5	24.2	0.245
Tilt + Pruning	50	405.0	8.1	6.3	26.1	12.6	24.8	0.253
Control	47	249.1	5.4	5.8	25.4	12.1	23.6	0.186
LSD		0.93						

52, 50 and 47 for Tilt, Pruning, Tilt + Pruning, and Control, respectively (Table 1). There was no significant difference in the number of bunches in the four treatments. However, the total bunch weight of 453.0, 392.2, 405.0 and 249.1 kg in Tilt, Pruning, Tilt + Pruning, and Control showed significant difference between Control and the other treatments. The difference was not due to the number of hands per bunch or the number of fruits per bunch or the circumference or length of the middle finger. It was due to the weight of the fingers.

Discussion

The percentage total leaf attacked in the control plants by Black Sigatoka was significantly different from the other treatments which were not significantly different from each other at 5 per cent significant level. This means that chemical treatment by Tilt or cultural practices like pruning could significantly reduce the severity of the disease. The highest severity was observed in the 32nd week when the rainfall was at its peak in the Kade area where the experiment was conducted. This confirms earlier report by Jacome, Schuh & Stevenson (1991) that severity of Black Sigatoka generally increases with increasing rainfall. The ascospores of *M. fijiensis* which cause considerable infection require free water or nearly saturated environment (RH of 98-100 per cent) for germination and germ tube growth (Jacome, Schuh & Stevenson, 1991).

One characteristic of the disease is that older leaves become more diseased than younger ones. Thus, if plantain has 10 leaves, and the youngest leaf to have the disease is the 6th, it means the first five younger leaves will be free from the disease while only the remaining five older leaves will have the disease with increasing severity from the 6th to the 10th. On the other hand, if the youngest leaf to have the disease is the 3rd, it means only two leaves will be clean while the remaining eight older leaves will be diseased and the plant will look more diseased than previously. In this experiment, the control plant had YLWS of three while Tilt had six, indicating that the Control will look more diseased.

When harvesting started 54 weeks after planting, no bunch was harvested from either Pruning or Control. By the 62nd week, 50 per cent of bunches had been harvested in the control plants while 65, 76, and 87 per cent bunches had been harvested in the Pruning, Tilt + Pruning, and Tilt plants, respectively. The results indicate that Black Sigatoka could cause delay in maturity of plantain.

When the harvesting was stopped at the 66th week after transplanting, there was no significant difference between the number of bunches in the Control and the other treatments. However, the bunch weight recorded for the control was significantly lower than the weights recorded for the other three treatments. The difference in bunch weight was due to significant differences in the weight per finger (i.e., individual fruit weight) which were 0.258, 0.245, 0.253, and 0.186 kg for

Tilt, Pruning, Tilt + Pruning, and Control, respectively.

Correlation analysis indicates a negative but significant association ($r = -0.96$) between severity of disease and yield. This means that as disease severity increased, yield is reduced.

The disease could reduce yield by 50 per cent of bunch weight in the first cropping cycle. Mobambo *et al.* (1993) made a similar observation.

The delay in maturity and reduction in yield weight of fingers caused by the disease may be due to its adverse effect on the photosynthetic efficiency of the plant.

Conclusion

The results showed that Black Sigatoka could delay maturity of plantain and reduce bunch weight. Pruning and burning of diseased leaves was effective in the control of Black Sigatoka disease, and farmers should be encouraged to use it as alternative to chemical control which is expensive and environmentally unfriendly, and therefore cannot be sustained by the peasant farmers in Ghana.

Acknowledgement

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