NIGERIAN AGRICULTURAL JOURNAL
ISSN: 0300-368X
Volume 53 Number 2, August 2022 Pg. 211-215
Available online at: http://www.ajol.info/index.php/naj
https://www.naj.asn.org.ng

Taro Leaf Blight Management using some Botanical Foliar Sprays for High Yield and Disease Inhibition in Umudike, South East Nigeria

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Abstract

The study was carried out in National root Crops Research Institute, Umudike in 2020 and 2021 to evaluate the effect of some botanical foliar sprays for the management of taro leaf blight incidence and severity, enhance disease inhibition in taro fields and, yield improvement in Umudike, South East Nigeria. Available literature showed that Taro Leaf Blight (TLB) has reduced taro production in Northern Nigeria and caused substantial damage to the crop, particularly in Adamawa State, in the past and in the 1990s, the disease became epidemic in Nigeria. The disease was first reported scientifically in Nigeria in 2009. Disease incidence and severity were used to evaluate the fungicide potentials of the botanicals, while yield was used to evaluate the TLB management potentials of the botanicals. The results showed the treatments; water extract of *azadiracta indica* (T1), water extract of garlic (T2) and mixture of the two extracts (T3) were effective in reducing the TLB incidence at the rate of 16.42%, 15.50% and 36.22% in cocoyam and were significantly different from control at P<0.05. The treatments were also effective in reduction of TLB severity, improved the plant leaf size which directly and indirectly improved the corm number and yield obtained from treated plots compared to the ones obtained from non treated plots (controls). The taro suckers and yields from the control experiments presented the least mean number of suckers and yields which differed significantly at P<0.05 with those of the three fungicide treatments. The average fresh weight of corms obtained from plants in the net plot under the various treatments was 17.40 kg/ha, 15.08 kg/ha and 13.27 kg/ha for water extract of *azadiracta indica* (T1), water extract of garlic (T2) and mixture of the two extracts (T3) respectively, while, only 5.98 kg/ha was obtained for control treatments. Therefore, these botanicals containing fungicides such as *A. indica* and *garlic* can be used by farmers and recommended that farmers should use the botanicals for the management of TLB in cocoyam production as protectant and curative botanical fungicides.

Key words: Botanicals, Protectants, Curatives, Fungicides, Taro leaf blight

Introduction

Taro [*Colocasia esculenta* (L.) Schott], a tropical aroid with nearly 1000 known cultivars, is an important subsistence crop for millions of people in Africa, Pacific islands, Caribbean islands and South East Asia (Misra *et al*., 2008; Mbi *et al*., 2021). In Nigeria, cocoyam is an important crop and regarded as food eaten at times of food scarcity. The plant is a herbaceous perennial, made up of a collection of long-petioled 30-150cm leaves emerged from the top of a swollen Taro (corm) with primary and secondary swollen taro (cormel) that develop from the sides. The heart-shaped leaves vary in size from 20-30 x 30-60 cm. The heart-shaped leaves vary in size from 20-30 x 30-60 cm. The inflorescence is a spadix of closely packed, small male and female flowers surrounded by a yellowish-green spathe (Fukushima, 2010). In Nigeria, all the major agro climatic zones are suitable for the crop. Taro leaf blight disease is an important disease of taro; the disease was first noticed during the rainy season of 1988 in Kogi State, Nigeria. It was found to be widespread and very destructive in the 1990s on many farms throughout Nigeria. The Taro leaf blight disease is caused by a pathogenic oomycete; *Phytophthora colocasiae*.

It causes severe damage to the plant and can result in poor production during rainy periods when the infection is most common (Amusa *et al*., 2018). In a study by Ayogu *et al*. (2015) on the epidemiological description of taro leaf blight disease (TLB) in Nigeria, the study focused on the incidence, severity and distribution of this disease in Nigeria's major agro-ecological zones, using data from a national survey conducted by the Nigerian Agriculture Research Institute (NARI) between 1975-1977. The results of the work showed that TLB has reduced taro production in northern Nigeria and caused substantial damage to the crop, particularly in Adamawa State and in the 1990s, the disease became widespread in Nigeria. There is evidence showing that the pathogen causing TLB may be present in high numbers all year round due to suitable climatic conditions for survival rather than being restricted seasonally as has generally been accepted. TLB symptoms appear as small, water soaked spots, which increase in size to form dark brown lesions, often with a yellow margin and red droplets along the margin (Mishra *et al*., 2008). The normal lifespan of a healthy taro leaf is about 40 days, but once attacked, this can last only 15-25 days (Jackson *et al*., 1980). Its inoculum in the form of spores is spread by wind-driven rain and dew to adjacent Colocasia plants (Jackson, 1999). The use of planting material from infected corms increases TLB incidence in subsequent Colocasia crops (Ooka, 1990).

The *Colocasia* Leaf Blight (TLB), was first reported scientifically in Nigeria in 2009 (Adeleke and Odedeji, 2010), and has since become a major threat to taro cultivation cocoyam in the country, especially in the Southern and Northern regions. In addition to significant reductions in yields or complete crop failure, TLB appearance is also associated with widespread damage to human health and food security. It also affects household incomes due to food shortages caused by the disease (Mbong *et al*., 2013). The Taro Leaf Blight Disease (TLB) has been an epidemic among taro and cocoyam in many parts of West Africa. This disease causes significant yield loss. The general objective of this study therefore, was to determine effects of some botanical fungicides in reduction of TLB progression to a less economically injurious level, based on the hypothesis that foliar spray with *Azadiracter indica* interrupts disease cycle of *P. colocasiae*.

Materials and Methods

Study site

The study was carried out in the Western Farm of National Root Crops Research Institute (NRCRI) Research and experimental field, Umudike, Nigeria located at 05^{0}28′09N, 007^{0}33′29.6E. The area is made up of eight months rainy season beginning from mid-March to end of October and four months dry season, that is, beginning from November to March, with average day length of 12.25h and 11.75h in the rainy and dry seasons respectively. In Umudike, the mean annual temperature range is 25 -30°C, average humidity of 88%, and average number of days of rainfall/month of 20 days during the rainy and dry seasons. Mean rainfall is 315 - 345 mm during the rainy season (NRCRI, 2014). The plot area where the experiment was carried out had *Colocasia* grown on it for over years and has been known to be a hotspot for TLB reoccurrence, hence the soil was considered to be highly infested with *P. colocasiae* spores.

Land preparation and sowing

The plot was cleared, ploughed and made into ridges using a tractor. Each ridge was separated from the adjacent 1m x 1 m. The planting materials were collected from a stock in cocoyam barn where cocoyam is stored in NRCRI, Umudike. For the sake of homogeneity, corms of relatively the same size were selected and sown in rows at an intra-space of 50cm. The plot size is 3m x 4m giving an area of 12m^{2} with 24 plants per plot. Evaluations were on the net plot containing 6 plants.

Experimental design

The treatments in the experiment include; three botanicals (water extract of *azadiracta indica*, water extract of garlic and a mixture of the two extracts at a ratio of 1:1 in equivalent volume of water). The control experiment involves plant plots that did not receive any treatment. Eight plants situated in the inner (net) plot constitute the sample size for each treatment. The experiment was replicated five times. The composition of the spray solution was 5g/L of water. The spraying was done such that the laminar of all the leaves per plant stand were in contact with the spray solution; hence, no specific volume was used per plant because the plants were not homogenous in agronomic characteristics. The spraying was done at an interval of 14 days beginning from 1 MAP (month after planting) until after the third application. Close observations for the first symptoms as described by Mishra *et al*. (2008) were made on daily basis in the course of the treatments. The experiment was randomized complete block design with 3 treatments and five repetitions. Given that the leaves of Colocasia are slanting and highly waxy, adherence of spray solution was difficult and performance was estimated to be low. To resolve this problem, an adjuvant called Tween 20^{o} (manufactured by SDS Ramcides Crop Science Pvt. Ltd, India) with role to reduce the surface tension, enhance stickiness, increase coverage and penetration of active ingredients into the target sites was added to the spray solution at a dosage of 1 ml/L. Besides, spraying between 6-7 AM before sunrise optimized adherence of the spray solution on the waxy leaf surfaces.

Parameters measured

The parameters investigated in this study were disease incidence (DI), disease severity (DS), number of suckers, leaf area and evaluation of corm yields.

Disease incidence (I)

For this parameter, eight plants established in the net-plot at 3-5 leaves stage, in a treatment were carefully monitored thrice a week within a period of 12 weeks. A plant was considered infected if a water soaked lesion with associated characteristics described by Mishra *et al*. (2008) appeared on any of its leaves. The total number of plants infected per treatment was noted and cumulatively assessed at the end of the study period. Disease incidence (DI) was computed using the formula thus:

$$DI = \frac{\text{No.of infected plants in given treatment}}{\text{Total number of plants in the treatment}} X100$$

Disease severity (DS)

The eight plants in the net-plot used for incidence served as the sample size. DS is defined as percentage of the leaf surface affected by blight; either lesion or lesions plus lesion related chlorosis (James 1971). Three leaves were tagged per plant and examined every 3 days for symptom initiation and subsequent progression of symptoms, using the Disease severity scale developed by Horsfall and Cowling (1978) adapted from Bechem and Mbella (2019) and Rifaath *et al*. (2021) amended and used within a period of 27 days as shown in Table 1.. Besides, the impact of disease factors (DI and DS), other growth parameters like leaf area, number of suckers and corm yields were also evaluated.

Leaf surface area

Leaf area (LA) surface of plants infected by the disease was assessed using the maximum length and breadth of a specific leaf on plants under the various treatments. Data for LA assessment was collected from each of the 8 plants in the net-plot per treatment. A single leaf (3rd leaf) was evaluated in each of the eight plant stands and LA was calculated using the equation thus:

LA = 7.9012 + 0.8437(L x W), derived by linear measurement of leaf blade (Carolina *et al*., 2011).

Number of suckers

Mean number of suckers growing from the mother plant was counted at 10WAP.

Evaluation of corm yields

Ten randomly selected samples per treatment were uprooted after 6 months and the remaining leaves and all the adventitious roots cut off. The corms were washed to get rid of soil particles. The fresh weight of corms from each treatment was measured using a balance. Data for all parameters examined, was analyzed using SPSS version 22. To determine the level of significance, mean values for the treatments were compared using the studentized t-test.

Results and Discussion

Results

Potency of botanical treatments on disease incidence (DI) and severity (DS)

Disease incidence was slightly higher in controlled plants (100%) compared to plants under the different treatments where scores of 16.42% was obtained in water extract of *azadiracta indica* (T1) and 15.50% in water extract of garlic (T2) and 36.22 obtained in mixture of the two extracts (T3) (Figure 1). This is a clear indication that the botanicals each do have some levels of antifungal potentials to have caused reduction of TLB in plants where they have been applied, compared to areas where they have not been applied in which case there was a 100% incidence of TLB. The severity of TLB disease was more in control taro fields where there was no treatment compared to where plants were subjected to water extract of *azadiracta indica*, water extract of garlic and the mixture of the two extracts. The water-soaked lesions were observed both on the lamina and the petioles of controlled experiment, while in plants treated with botanicals; the few necroses observed were limited only on the lamina. Even though disease symptoms occurred in leaves of plants treated with water extract of *azadiracta indica,* water extract of garlic and mixture of the two extracts, only a few further progressions of water-soaked lesions was observed once the treatment was administered on the infected area. However, the soggy lesions became dry and within 5 days, the dead tissues fall off leaving a hole on the lamina (Figure 2). The TLB disease severity was very rapid on leaf lamina on cocoyam plants in control fields with over 50% of the lamina surface infected with rust-like look within 10 days of incubation. This high severity caused the lamina to wither (Figure 2) between 16-22 days after attack.

Leaf area

Fungicide-treated plants (T1, T2 and T3) presented a larger leaf surface area compared to the controlled. The differences in leaf area were not significant between samples under the three treatments but all treatments were significantly different from those of the plants in control experiment. It was noticed that the higher the disease severity, the smaller the leaf area of subsequent leaves (Figure 2).

Effects of fungicide treatment on number of suckers and corm yield

The taro suckers and yields from the control experiments presented the least mean number of suckers and yields which differed significantly at $P<0.05$, with those of the three fungicide treatments. Even though T1 presented a higher number of suckers than T2 and T3, the difference was not significant from the other two treatments. The average fresh weight of corms obtained from plants in the net plot under the various treatments was 17.40 kg/ha, 15.08 kg/ha and 13.27 kg/ha for water extract of *azadiracta indica* (T1), water extract of garlic (T2) and mixture of the two extracts (T3) respectively, while only 5.98 kg/ha was obtained for control samples (Figure 2). Significant differences were noticed in corm yields between the treatments and the control. However, no significant differences were found between T1, T2 and T3 in terms of corm yield apart from the control

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Discussion

The plant's efficiency in converting solar energy into dry matter is dependent on the photosynthetic area and activity of the individual leaves. The physiological and economic implications of leaves on vegetative growth and corm yield of cocoyam had been demonstrated by Asumandu *et al*. (2011). It is therefore well-known that pre-mature death of leaves due to foliar disease will affect yields directly as observed in this study. Higher corm yields obtained in T1, T2 and T3 compared to the ones from the control treatment can be attributed to the fact that treated plants were healthier than the control experimental plants during the vegetative growth phase, hence they efficiently carried out their vital photosynthetic functions and the assimilates were stored in the corms which constitute the main sink in *Colocasia*. This corroborates the work of Mbi *et al*.

(2021) who noted that the efficiency of yield in *Colocasia* is dependent on the amount of foliage maintained by the plant. In this study, all the treatments that encouraged or sustained leaves on the plants were observed to be the ones that gave good yields

Conclusion

In order to limit the risks associated with outbreak of TLB, there is need to use a number of different approaches in an integrated manner. This study showed that TLB epidemic can be managed by the botanicals containing fungicides such as *A. indica* and *garlic*. Foliage spraying of these botanical fungicides at 5g/l fortnightly beginning from 8WAP for three months could significantly reduce the progression of the epidemic to a level that is not injurious to the environment and economically. It is therefore, recommended that farmers should use the botanicals for the management of TLB in cocoyam production as protectant and curatives botanical fungicide.

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Table 1: Disease severity scale and ratings

Score/Scale	Range	Rating
	Categories of Taro leaf blight severity	
1	Visually infection-free	Highly resistant
2	Small leaf area infected -25%	Resistant
3	>25-50% leaf area infected	Moderately resistant
4	>50-75% leaf area infected	Susceptible
5	>75% leaf area infected	Highly susceptible

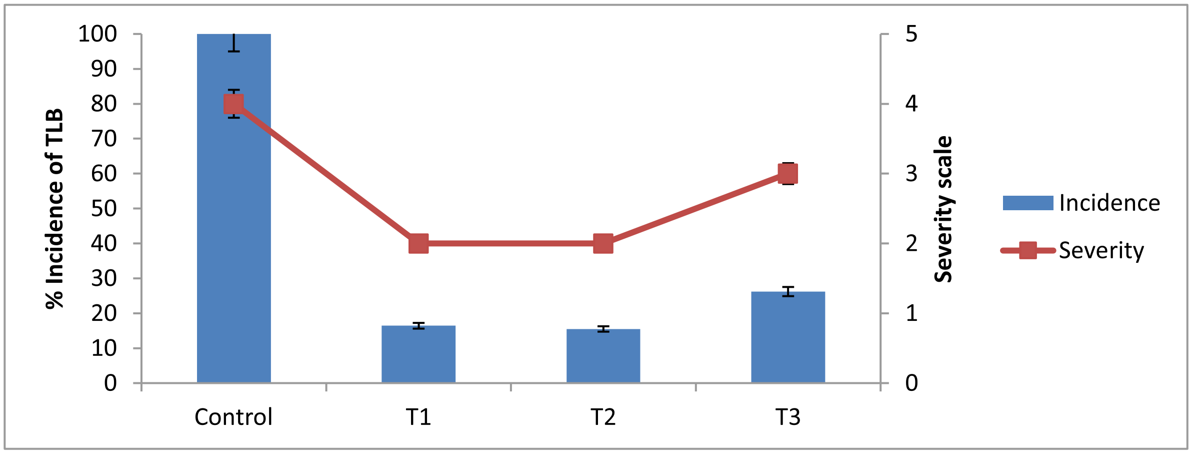

Figure 1: Potency of botanical treatments on disease incidence and severity of taro leaf blight of cocoyam

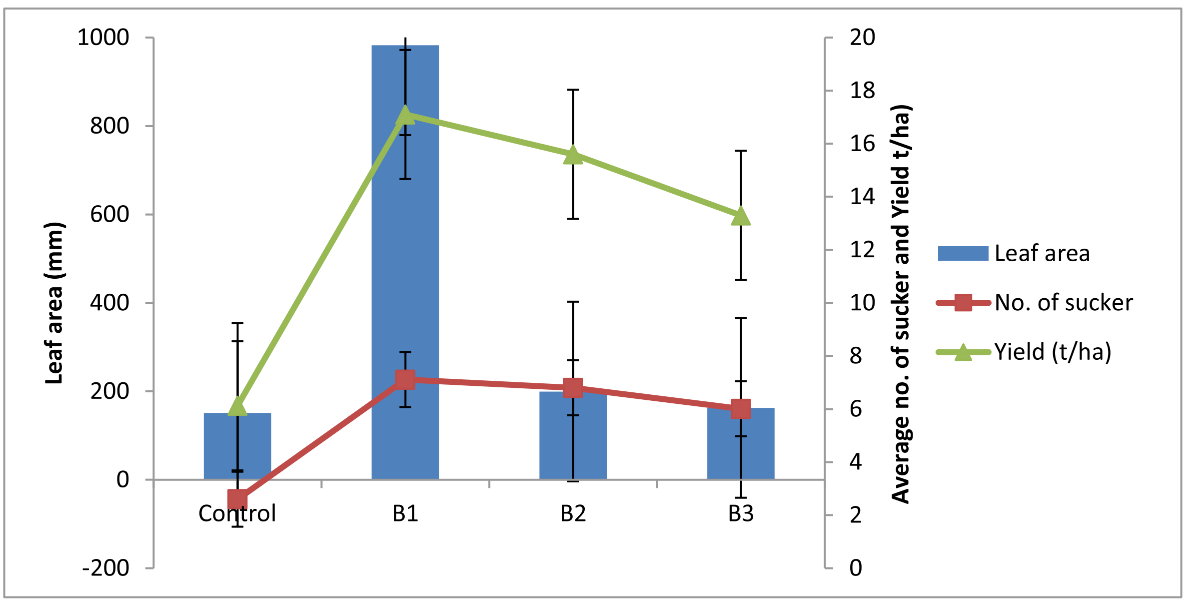

Figure 2: Effect of fungicide treatment on average leaf surface area, number of sucker and yield of cocoyam