Results of Three Years of Spraying with Fungicide-Insecticide Combinations Against Inflorescence Dieback Disease of Cashew

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ABSTRACT

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A 1976–1979 study in Nigeria of the efficacy of chemical protection against inflorescence dieback disease of cashew, caused by *Lasiodiplodia theobromae*, a parasite of insect-infested tissues, showed that 1.5 g a.i./L of captafol plus 1 g a.i./L of emulsifiable concentrate of gamma-BHC was most effective in preventing inflorescence infection and increasing nut yield per tree. Treatments were 0.5, 0.75, 1, or 1.5 g a.i./L of captafol alone, 0.5 or 1 g a.i./L of gamma-BHC alone, or each amount of each chemical combined with each amount of the other. Nut yield of untreated control trees declined in the first and second years of the study by 18 and 20%, respectively, whereas yield of treated trees increased by 86 and 137%. Yield in treated trees in the third year increased by only 27%, owing to invasion of developing nuts by a complex of fungi. During the 3 yr, trees sprayed with 1.5 g/L of captafol and 1 g/L of gamma-BHC had yields 374, 984, and 1,608% greater than those of control trees. Efficacy of captafol was reduced when 1 g/L of gamma-BHC was added to 1 g/L of the fungicide.

Cashew (*Anacardium occidentale* L.) is a tree crop of considerable economic importance in Africa, Asia, and Latin America. The tree produces a panicle inflorescence that bears male, female, and hermaphrodite flowers. Yield is primarily governed by the extent of hermaphrodite flowers produced.

Inflorescence dieback is a serious disease caused by *Lasiodiplodia theobromae*, a parasite of insect-infested tissues, that reduces fruit bearing of cashew in Nigeria (7). The floral symptoms result from progressive dieback of the small peduncles that usually starts from the tips and advances downward to the main floral shoot. The normally green shoots progressively turn brown and the flowers on the shoots are killed so that no fruit forms (Fig. 1). Damage caused by insects that frequently visit the fragrant flowers for nectary juice predisposes the inflorescence axes to infection by *L. theobromae*.

This paper is the first report of investigations of the potential of protective chemicals against inflorescence dieback infection in Nigeria.

MATERIALS AND METHODS

Field spraying trials were conducted in a cashew plantation at Iwo. The 0.5-ha experimental plot had 60 bearing trees, all 10 yr old. Yield of trees with severe inflorescence infection was recorded with the mean of the two crops during 1974–75 and 1975–76. Captafol and emulsifiable concentrate of gamma-benzene hexachloride (gamma-BHC) were evaluated alone or combined as protective treatments against infection of the inflorescence. Emulsifiable concentrate of gamma-BHC was included because it is active against numerous destructive insects that visit cashew flowers.

The experimental design was a randomized block with four single-tree replicates and 15 treatments. Captafol (Difolatan 80WP) was applied at 0.5, 0.75, 1, and 1.5 g a.i./L of water. Gamma-BHC (Gammalin 20) was applied at 0.5 and 1 g a.i./L. After flowers had opened, a knapsack sprayer with fine nozzles was used to direct the spray against the inflorescences at the periphery and above the tree at the rate of 5 L of solution per tree to completely cover the flowers.

The chemicals were applied twice a month from 2 October through 30 November in 1976, 1977, and 1978. Observation of the effectiveness of the treatments in protecting the flowers started a week after each spraying. The sprays were applied to protect developing nuts as well as the inflorescences. Harvesting of cashew nuts started in February every year, and the average nut production per tree for each treatment was recorded and weighed. Infected nuts were recorded separately.

RESULTS

Three years of chemical spraying trials showed that several treatments resulted in yields significantly greater than those from unsprayed plots. Statistical analysis indicated that treatment with 1.5 g/L of captafol plus 1 g/L of gamma-BHC was significantly superior to other treatments in protecting the inflorescence against dieback disease (Table 1). With this treatment, inflorescence infection was minimal and nut production per tree during the 1976–77, 1977–78, and 1978–79 crop seasons was 374, 984, and 1,608%, respectively, greater than that of control trees. Treatment with 1.5 g/L of captafol plus 1 g/L of gamma-BHC resulted in 84% greater nut production per tree than did 1.5 g of captafol alone. The efficacy of treatments involving only captafol did not differ significantly. Addition of 1 g/L of gamma-BHC to 1 g/L of captafol reduced the efficacy of captafol. Disease increased rapidly in control trees as more unprotected floral shoots developed.

While the nut yield per tree on the control plots declined during the first two crop seasons by 18 and 20%, respectively, yield per tree on the sprayed plots increased by 86 and 137%, respectively.

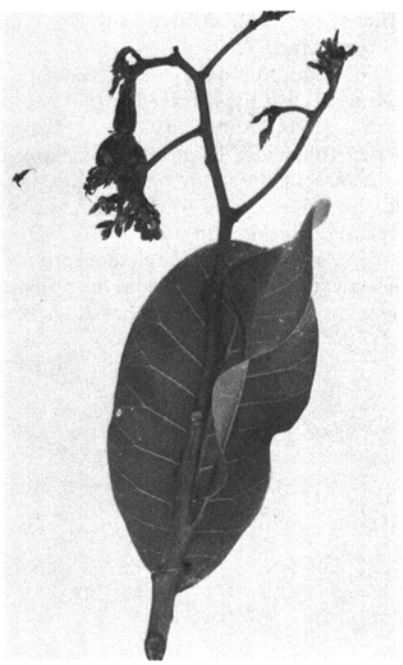

Fig. 1. Typical floral shoot of cashew with dieback disease caused by *Lasiodiplodia theobromae*.

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Table 1. Yield of cashew trees resulting from 3 yr of spraying with captafol and/or gamma-BHC (emulsifiable concentrate) against inflorescence dieback disease (*Lasiodiplodia theobromae*)

Treatment	Mean yield of healthy and diseased nuts per tree and mean weight of healthy nuts per tree								
	1976–77			1977–78			1978–79		
	Healthy	Diseased	Weight (g)	Healthy	Diseased	Weight (g)	Healthy	Diseased	Weight (g)
None (control)	136	207	700 a[z]	111	333	570 a	92	308	460 a
Captafol (g/L)									
0.5	267	213	1,400 bc	579	148	1,960 cd	601	160	3,070 c
0.75	555	111	2,840 e	735	72	3,750 ef	769	69	3,920 d
1	568	105	1,910 e	761	67	3,810 ef	812	55	4,070 d
1.5	601	100	3,080 e	773	70	3,870 ef	855	63	4,280 de
Gamma-BHC (g/L)									
0.5	232	183	1,200 b	270	130	1,380 b	316	94	1,610 b
1	243	196	1,250 b	285	142	1,530 b	342	110	1,820 b
Captafol + gamma-BHC									
0.5 + 0.5	310	164	1,710 cd	542	191	2,610 c	610	110	3,120 c
0.5 + 1	369	167	1,850 cd	591	107	2,960 cd	722	81	3,620 cd
0.75 + 0.5	411	222	2,060 cd	765	91	4,100 fg	887	86	4,710 ef
0.75 + 1	438	244	2,190 cd	765	79	2,100 fg	887	69	4,710 ef
1 + 0.5	245	176	1,280 b	778	59	4,270 fg	912	48	5,070 fg
1 + 1	280	138	1,430 bc	754	77	2,850 ef	861	64	4,390 de
1.5 + 0.5	597	99	3,050 e	902	85	4,600 g	1,127	68	5,950 g
1.5 + 1	621	86	3,320 e	1,133	26	6,180 h	1,409	12	7,860 h

[z] Means followed by the same letter are not significantly different ($P = 0.05$) according to Duncan's multiple range test.

The increase in yield between the second and third crops was only 27%.

DISCUSSION

Fungicide-insecticide combinations have been used to control insect and fungal diseases in the field (3,5). The present study showed that cashew inflorescence dieback can be effectively prevented by spraying with 1.5 g/L of captafol and 1 g/L of emulsifiable concentrate of gamma-BHC. Disease control and yield responses resulting from the use of this combination were significantly greater than with other treatments or no treatment. The benefits are derived from protection of the inflorescence prior to fruit formation. The fungicide alone showed some efficacy as a protective spray against dieback disease.

The reduced efficacy observed when 1 g/L of captafol was mixed with 1 g/L of gamma-BHC cannot be easily explained. When fungicides have been tank mixed with insecticides, however, fungitoxicity has been reduced (2,4). It has also been reported that certain insecticides had no adverse effects on the fungicidal activities of some fungicides (1). Similar phenomena were observed in the present investigation.

The drop in cashew nut yield per tree between the 1977–78 and 1978–79 crop seasons when 1.5 g/L of captafol was mixed with 1 g/L of gamma-BHC and applied as a protective spray was due to invasion of developing cashew nuts by a complex of fungi, including *L. theobromae, Aspergillus tamari*, and *Penicillium citrium*, causing dry rot that reduced nut production per inflorescence (6). Susceptibility of developing nuts to fungal infection has been ascribed to the release of a sugary exudate that serves as a food base for the microorganisms disseminated by *Atopomyrmex* insects feeding on it (6). *Atopomyrmex* is also an effective agent of inoculation (6).

The best time to apply a fungicide to protect the inflorescence of cashew should coincide with the time an insecticide would be applied. The extended period during which cashew inflorescence is susceptible to disease because of irregular flowering, however, is a particular concern because insect infestation of late flowering is often severe. In general, our spray trial suggested that cashew inflorescence needs to be protected and that adding an insecticide to a fungicide at correct concentrations protects the inflorescence against the insect infestation preceding the fungal attack on the panicles.

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