Control of Root (Wilt) Disease of Coconut (*Cocos nucifera*) with Micronutrients, Phenolic Compounds, and Ascorbic Acid

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ABSTRACT

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Certain phenolic compounds, micronutrients, and ascorbic acid markedly reduced root (wilt) disease symptoms on coconut. The improvement was most pronounced when all three treatments were applied in combination. Yield also increased significantly in all treatments except phenolic compounds.

The cause and control of root (wilt) disease of coconut are unknown. The disease is impairing growth and yield of 250,000 ha of coconut plantations in India (1). Diseased palms appear dehydrated, show rapid deterioration and aging, and have 10–50% senescent leaves compared with 0–8% in healthy palms. Affected palms have less zinc and molybdenum in their leaves (8) and lower levels of total phenols in their roots (5) than healthy palms. Intercropping with fodder and recycling animal waste in mixed farming reduced the yellowing of leaves and increased nut yield 28 percent (1). Spraying with 2% magnesium sulfate reduces foliar yellowing, and applying small doses of micronutrients to the soil improves yield of diseased palms to some extent (4). However, no treatment has been found to significantly reverse the diseased condition of palms.

Micronutrients, essential to plant growth, have also been reported to induce disease resistance mechanisms in plants (6,7). Phenolic compounds also act as protective agents against several pathogens (9). Ascorbic acid, which plays a vital role in plant growth, has been found to alter the redox potential and to improve plant growth under various types of stress (3). We attempted to examine the effect of these compounds on root (wilt) disease of coconut.

MATERIALS AND METHODS

Seven-year-old diseased coconut palm seedlings and 20-yr-old diseased trees growing in different plots at the Central Plantation Crops Research Institute, Kayangulam, India, were given the following five treatments in triplicate: T1) NPK (control), T2) micronutrients, T3) micronutrients plus ascorbic acid, T4) micronutrients plus phenolic compounds, and T5) micronutrients plus ascorbic acid plus phenolic compounds (combination). All palms received NPK.

The phenolic compounds, including gallic acid, coumarin, and caffeic acid, each at 200 ppm, and ascorbic acid at 400 ppm were sprayed on and injected into palms once every 2 mo. Chemicals were sprayed on the foliage on bright days with a fine sprayer to avoid runoff. On cloudy days during the rainy season, chemical solutions were applied through the cut end of roots or leaf axil or by stem injection. Foliar spray and injection of chemicals through the cut end of root, leaf axil, and stem were avoided on rainy days.

Micronutrient treatments in the experiment, apart from magnesium as a secondary element, included iron, zinc, copper, magnesium, boron, molybdenum, sodium, and chloride, supplied as 300 g each of cupric sulfate, manganese sulfate, zinc sulfate, and sodium borate; 200 g of ferrous sulfate; 1 kg of sodium chloride (common salt); 1 kg of lime; and 50 g of ammonium molybdate per palm per year. Half the doses were applied in the soil before the monsoon, one-fourth was applied during September–October, and the remainder was sprayed or injected. Each control palm received 1 kg of urea, 2.5 kg of muriate of potash, and 1 kg of superphosphate each year in two applications, one before the monsoon and the other during October–November.

Nutrients were applied to the soil after the soil around the palm was removed up to the root zone in a radius of 1.2 m. All externally visible rotten roots were cut and removed. The chemicals—150 g of cupric sulfate, 150 g of zinc sulfate, 1 kg of lime, and 1 kg of salt—were mixed together with water to form a paste. The paste was held overnight at 30 C and applied to the root zone. The remaining nutrients were then added and mixed thoroughly in the soil. The palms were irrigated in the absence of rain.

All treatments began in March 1976 and continued until December 1977. Pretreatment observations of the total number of leaves; number of leaves showing yellowing, interveinal yellowing, rotting at margins, flaccidity, and senescence; nature of spindle; stage of flowering; and nut yield were recorded. After treatment, observations were recorded every 3 mo. Data obtained at the end of March 1978 are given in Table 1.

RESULTS AND DISCUSSION

No improvements in the condition of diseased palms were noted with NPK treatments. On the other hand, significant reduction in the yellowing and flaccidity of leaves and increase in nut yield were noted in palms that received micronutrients, ascorbic acid, phenolic compounds, and combination treatments (Table 1). Based on the improvement in the condition of the palms and the disappearance of the disease syndrome, the treatments in descending order of curative effect were T5 (combination), T4 (micronutrients plus phenols), T3 (micronutrients plus ascorbic acid), and T2 (micronutrients). Based on the increase in nut yield alone, treatments in descending order of effectiveness were T3, T2, T5, and T4. The superiority of organic compounds, especially ascorbic acid, over micronutrients was also noted.

The beneficial effects of micronutrients in reducing yellowing and flaccidity and increasing yield may be because of the role of micronutrients in chlorophyll synthesis, flower primordia initiation, and synthesis of organic compounds essential for giving strength to leaves (7). The increase in nut yield and reduction in flaccidity and yellowing attributable to the application of ascorbic acid compared to micronutrient treatments may result from ascorbic acid's effect on reducing fast oxidation processes, inducing drought tolerance, and increasing flower primordia and fruit set (3). The phenolic compounds did not increase nut yield over that obtained with micronutrients but reduced yellowing

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Table 1. Effect of treatments on disease syndrome and nut yield of root (wilt) affected coconut palms

Time of observation	Total no. of leaves per palm	Spindle condition	No. of flaccid leaves per palm	No. of yellow leaves per palm	No. of margin rotten leaves per palm	No. of senescent leaves per palm	No. of unopened flower bunches per palm	No. of opened flower bunches per palm	Nut yield (nuts/palm)
Treatment 1: NPK (Control)									
Before treatment	18	Whitish, soft, rotten	8	5	2	5	1	0	1
After treatment	17	Unchanged	8	6	3	6	1	0	0
Difference (%)	− 5	None	0	+20	+50	+20	0	0	−100
Treatment 2: Micronutrients									
Before treatment	20	Whitish, soft, rotten	10	8	5	5	0	1	3
After treatment	22	Normal	5	3	0	2	3	3	13
Difference (%)	+10	+100	−50	−63	−100	−60	+300	+200	+333
Treatment 3: Micronutrients + Ascorbic Acid									
Before treatment	12	Whitish, soft, rotten	12	7	5	6	0	0	3
After treatment	15	Normal	5	2	0	2	4	6	22
Difference (%)	+25	+100	−60	−72	−100	−67	+400	+600	+633
Treatment 4: Micronutrients + Phenolic Compounds									
Before treatment	10	Whitish, soft, rotten	10	6	7	5	0	2	1
After treatment	12	Normal	0	0	0	0	2	3	3
Difference (%)	+20	+100	−100	−100	−100	−100	+200	+50	+200
Treatment 5: Micronutrients + Ascorbic Acid + Phenolic Compounds (Combination)									
Before treatment	10	Whitish, soft, rotten	10	7	5	6	1	3	2
After treatment	15	Normal	0	0	0	0	3	6	6
Difference (%)	+50	+100	−100	−100	−100	−100	+200	+100	+200

and flaccidity significantly more than the latter treatment. The phenolic compounds may have allowed the synthesis of more mechanical tissues by checking imbalanced distribution of auxins in the leaves (2) and may also have accelerated some other process responsible for inducing resistance in the plant to pathogens (9).

Although nut yield in the combination treatment was not greater than that with ascorbic acid or micronutrient treatments, the percentage reduction in yellowing, flaccidity, margin rotting, and senescence of leaves was higher than in any other treatment. Diseased palms and seedlings in the combination treatment were found to be free from the syndrome of root (wilt) disease, possibly because of interactions between chemicals or the cumulative effect of all treatments.

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