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Effect of fungicide and N.P.K foliar fertilizer application for the management of fungal diseases of cucumber (*Cucumis sativus* L.)

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Abstract: Cucumber grown in Ebonyi state have low resistance to downy mildew and other fungal diseases, such that only few harvests are made before the foliages are completely destroyed. Farmers use fungicides for the management of cucumber fungal diseases. This study investigated the comparative advantage of using fungicides and N.P.K foliar fertilizer (to induce systemic resistance-SIR) application for the management of cucumber downy mildew and other fungal diseases. The experiment was conducted as 3x3 factorial laid out in randomized complete block design (RCBD) at Teaching and Research Farm of Ebonyi State University, Abakaliki during the 2013 cropping season. Fungicide (Hexaconazole 5% SC) was applied at the rate of 1.140 liters/ha, while the N.P.K foliar fertilizer was applied at the rate of 19.181kg/ha. Each treatment was applied three times at 15 days intervals starting from three weeks after plating till the commencement of fruiting. Diseases and yield data were collected and analysis. Results revealed significant differences (p= 0.05) between the fungicide and the N.P.K foliar fertilizer. Fungicide (Hexaconazole 5% SC) controlled downy mildew and other fungal diseases more than the N.P.K foliar fertilizer. However, that did not translate to yield increase. The N.P.K foliar fertilizer achieved more than average disease control and also gave higher yield and percent yield gain compared to the fungicide. All the cucumber varieties consistently gave higher percent yield gain with application of N.P.K foliar fertilizer. Application of N.P.K foliar fertilizer gave higher gross margin (Net revenue) and marginal revenue (benefit-cost ratio) compared to the fungicide (Hexaconazole 5% SC).
Keywords: Cucumber, downy mildew, fungal diseases management, fungicide, N.P.K foliar fertilizer

INTRODUCTION

Cucumber (*Cucumis sativus* L.) is an important member of the cucurbitaceae family which is grown mainly for its fruits. It is a rich source of minerals and vitamins [1]. The fruit is eaten fresh in salads in accompaniment with other vegetables. The crop is the fourth most important vegetable after tomato, cabbage and onion in Asia [2], the second most important vegetable crop after tomato in Western Europe [3]. In tropical Africa, its place has not been ranked because of limited use [4].

The worldwide production of cucumber is about 10,150, 000 tons per year [5]. Cucumber production is seriously affected by several diseases which result in poor growth and yield [6]. Diseases of cucumber are mostly caused by Fungi, some of which are Anthracnose (*Colletotrichum lagenarium*), Downy mildew (*Pseudoperonospora cubensis*), powdery mildew (*Erysiphe cichoracearum*), scab (*Cladosporium cucumerinum*), Target spot (*Corynespora cassicola),* Alternaria leaf spot (*Alternaria cucumerinum*). These fungal pathogens may cause injury to all- above-ground parts including the leaves, stems, petioles, peduncles and fruits [7].

Cucumber cultivars have been developed with resistance to many of these fungal foliar diseases [7], however resistance to diseases is a function of cultivar genetic make-up and environmental interaction. Resistances of many crops to diseases have always broken down in the presence of predisposing environmental conditions. The ubiquitous nature and the ability of fungi to cause epidemics in relatively short period of time make diseases management strategies imperative to secure agricultural production. Chemical measures are particularly common in the management of fungal diseases and most of these measures rely on the use of fungicides [8]. Fungicides control fungal diseases to a minimum, but as a result of its dangerous effects on the environment and the fear of harmful residues in crops (Hewitt, 1998), the search for possible environmental friendly alternatives becomes imperative. Foliar fertilizers have been used to induce systemic resistance and affect overall control of certain diseases in crops [9,10,11].

The present study was carried out to investigate the potency of N.P.K foliar fertilizer sprays as a possible alternative to fungicides for the management of cucumber fungal diseases.

MATERIALS AND METHODS

The experiment was conducted between May and August, 2013 at the Teaching and Research Farm of

Ebonyi State University, Abakaliki. The Abakaliki is located in a sub-humid agro-ecological zone (lat. 06 04'N, long. 08^0 65'E and at an elevation of 71.44mm above sea level) southeast of derived savanna belt of Nigeria. The soil type of the experiment site is sandy loam in nature with available nutrient status of medium nitrogen, phosphorus, and potassium. The rainfall pattern is bimodal (April- July) and (September-November). The mean annual rainfall ranges between 1700 to 2000 mm. The mean temperature range is between 24-28^{o}C, while the relative humidity is between 60-80%.

The experiment was a 3x3 factorial laid out in randomized complete block design (RCBD) with three replications. The factors consisted of three treatments (fungicide, foliar fertilizer and control) and three varieties of cucumber (market more, Poinsett and marketer). The fungicide (Hexaconazole 5% SC) was applied at 1. 140 liters/ ha, while the foliar fertilizer spray (N.P K 20:20:20) was applied at 19.181kg/ha. Both treatments were applied at 15 days intervals starting from three weeks after planting (3 WAP) till the commencement of fruiting. All the treatments were applied three times (at 3 weeks, 5 weeks and at 7 weeks after planting).

Fertilizer (N.P K 15:15:15) was applied at the rate of 50kg/ ha as a blanket treatment. Protection against insect pests was achieved by use of Endocot emulsifiable concentrate (35% EC). All other standard cultural practices relating to cucumber production were applied as and when necessary.

Disease and yield data were collected. Data on diseases included Damping-off (%); fungal fruit rot (%) and Downy mildew. Downy mildew was assessed on a 0-9 scale [7]. Yield per plot (kg) were measured at harvest. Diseases and yield data were subjected to analysis of variance (ANOVA) using Genstat. The least significant difference test (LSD) at 5% probability was used to separate significant treatment means. Percent disease control (PDC) was calculated as:

$$\frac{\text{Diseases severity In control plot} - \text{diseases severity in treatment plot}}{\text{Disease severity in control plot}} \times \frac{100}{1}$$

While percent yield increase was calculated as:

$$\frac{\text{Yield in treatment plot - yield in control plot}}{\text{Yield in control plot}} \times \frac{100}{1}$$

To determine the economic benefit of fungicide and N.P.K foliar fertilizer usage, gross revenue was calculated (t/ha), using the local market price of ₦200 for 1Kg or marketable fruits. Variable costs included fungicide, N.K.P foliar fertilizer and labour. Marginal revenue (MR) was calculated as total revenue (TR) divided by total variable cost (TVC) [12].

RESULTS

Disease Control

Application of treatments had significant effect in the management of diseases of cucumber as compared to control. Application of the fungicide (Hexaconazole 5% SC) significantly (P =0.05) reduced downy mildew, damping off and fruits rot compared to foliar fertilizer and the control (Table 1). This was equally reflected in the percent disease controls (PDC) which were much higher for the fungicide than the foliar fertilizer (Table 1).

Application of treatment also significantly (P=0.05) brought about increase in yield, however, the application of the fungicide which displayed a higher disease control efficacy did not translate into better yield (625.0kg/ha) as against foliar fertilizer which yielded higher (1152.5 kg/ha) (Table -1). Percent yield gain for treatment was higher for foliar fertilizer (27.35%) compared to the fungicide (-30.94%) (Table-1). The yield of the three varieties of cucumber did not differ (P=0.05) from one another, however all the varieties consistently produced a higher percent yield gain over control on application of foliar fertilizer as against the fungicide. The percent yield gain were market more (fungicide,-21.49%; foliar fertilizer, 43.30%), Poinsett (fungicide, -25.72%, foliar fertilizer, 18.37%) and marketer (fungicide,- 44.27%, foliar fertilizer, 22.92%).

Table 1: Main effects of fungicide and foliar fertilizer sprays on damping off, downy mildew, and fruit rot and yield of cucumber.

Treatment	Damping Off sev.	PDC	Downy Mildew	PDC	Fruit Rot sev.	PDC	Yield Kg/ha	Yield Gain
Control	27.78	-	2.78	-	2.79	-	905.0	-
Fungicide	10.42	62.49	80.22	0.08	70.96	70.96	625.0	30.94
Fol. fert.	15.97	42.51	1.22	56.12	1.10	60.57	1152.5	27.35
LSD(0.05)	3.348	-	0.555	-	1.259	-	0.064	-

Economics of Disease Control

The assessment of the economic benefit of fungicide and foliar fertilizer application showed that the gross margin (net revenue) was higher in N.P. K foliar fertilizer (₦76,200) compared to the fungicide (₦46,400) (Table 2). This was because N.P. K foliar fertilizer gave higher yield (480 kg/ha) compared to the fungicide (320kg/ha), even though the total variable cost (TVC) was almost the same. The marginal revenue (Cost-benefit ratio) was equally higher in N.P.K foliar fertilizer (1:4.8) compared to the fungicide (1:3.4). This means that for every ₦ 1.00 invested in foliar fertilizer application, a return of ₦4.80k will be expected, compared to fungicide application where every ₦ 1.00 invested gave a return of ₦3.40k.

Table-2: Economics of fungicide and foliar fertilizer application on cucumber production per hectare.

	Unit	Rate (₦)	Fungicide Amount (₦)	Foliar fert. Amount (₦)
A. Variable cost 400g of seeds	gram	80	4000	4000
Fungicide (hexaconazole)5% S.C	liter	3.0	5400	_
Foliar fertilizer (NPK 20:20:20)	liter	3.0	_	6000
Labour				
Clearing	Manday	2000	2000	2000
Tilling	Manday	4000	4000	4000
Sowing	Manday	1800	1800	1800
Harvesting	Manday	2000	2000	2000
Total variable cost			19,200	19,800
B. Revenue				
328kg	Kg	800	65,600	-
480kg	Kg	800	-	96,000
Total revenue			65,600	96,000
Gross margin				
(net revenue = TR-TVC)			46,400	76,200
Marginal revenue				
(BCR) =TR/TVC			1:3.4	1:4.8

DISCUSSION

Disease Control

Plant diseases continue to play major role in agricultural production particularly in intensively managed crops, while host resistance to plant diseases where available is the most environment friendly method for diseases management. Valuable plants with resistance genes when developed always find their way into different environment for crop production. Unfortunately, it is a genetic fact that resistance to plant diseases is not permanent. Resistance could break down immediately on introduction to a different environment other than the location where it was developed or after few years of cultivation.

Chemical control of plant diseases in agricultural production is an old practice; however, concerns about food safety, environmental quality and pesticides resistance have dictated the need for alterative pest management techniques [13,14]. Breeding for resistance and plant immunization are among the possible alternatives and can be promoted as possible strategy for inclusion in an integrated pest management (IPM) program. It is also well established that resistance can be systemically induced in plants by inoculation with non-pathogens, restricted inoculation with pathogens or treatment with chemicals including phosphate salt [15]. Findings from this study show that the N.P.K foliar fertilizer affected high level of percent diseases control, though not better than the fungicide. However, the seemingly higher disease control efficacy of the fungicide could not translate to higher yield. The N.P.K foliar fertilizer affected disease control and consistently recorded higher yield and percent yield gain. This result is in agreement with report of other workers. Reuveni *et al.* [9] reported that a single phosphate foliar application can induce high levels of systemic protection against powdery mildew caused by *Sphaerotheca fuliginea* in Cucumber. A similar response was also found in maize, where foliar sprays with phosphates induced systemic protection against common maize rot (caused by *Puccinia sorghi* and northern leaf blight (NLB) (caused by *Exserohilum turcicum*). Protection was observed when the phosphate was sprayed ten days before the pathogen challenge and was persistent up to the seventh leaf [14]. Wiese *et al*., [16] introduced the term- chemically induced resistance (CIR), which is used to describe the systemic resistance after application of synthetic compounds. This resistance is proposed to be related to the formation of structural barriers such as lignification, induction of pathogenesis-related proteins and conditioning of the plants [17]. The ability of the N.P.K fertilizer to induce systemic resistance (SIR) could therefore be integrated with host resistance as an environment friendly alternative to reduce disease severity and also slow down the rate of development of pesticide resistant strain of pathogens.

Economics of Disease Control

The result equally showed that the cost-benefit ratio (CBR) was higher for application of N.P.K foliar fertilizer compared to the fungicide. Percent disease control (PDC) was more than fifty percent in most cases, and also percent yield gain was higher for N.P.K foliar fertilizer compared to the fungicide.

This means that where host resistance is available [18], few sprays of N.P.K foliar fertilizer would be needed to reduce diseases severity.

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