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Influence of planting date on incidence and severity of viral disease on cucurbits under field condition

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ABSTRACT

Three field experiments were conducted to assess the effect of planting date on the incidence of viral diseases and the severity and the susceptibility of the cultivars. Two cultivars of cucumber (Hybrid Tokyo F1 and Poinsett) and one local variety of zucchini (Bolle) were used for the evaluation in May-July 2014, September-November 2014, and February-April 2015. A randomized complete block design with three replications was used for the experiments. Data were collected on disease incidence, severity, and time until first symptoms occurred. Area under severity index progress curve (AUSIPC) and area under disease progress curve (AUDPC) were calculated respectively for disease severity as well as the incidence on each cultivar. The results demonstrate the susceptibility of all cultivars to the tested viral diseases. The effect of planting dates on cultivars was significantly different ($P < 0.05$) at the different growing stages whereas there was no significant difference ($P > 0.05$) in planting date-variety interaction.

Introduction

Viral diseases are the major problem of cucurbits production in Ivory Coast. *Cucumber mosaic virus* (CMV) and *Zucchini yellow mosaic virus* (ZYMV) have been reported as the most prevalent viruses in these crops (Fauquet and Thouvenel, 1987; Koné et al., 2016; Agneroh et al., 2012; Kone, 2016). They are transmitted by aphids in a non-persistent manner. These viruses cause mosaic, mottling, enation, and puckering of foliage; mosaic and distortion of fruits; and plant stunting (MacNab et al., 1983). Significant yields losses due to ZYMV infections have been reported, ranging from 50 to 94% (Blua and Perring 1989; Müller et al., 2006).

Hence, management of these viral diseases is of utmost importance in order to safeguard yields of cucurbit crops in Ivory Coast. Various strategies have been employed in the management of cucurbit viral diseases, including removal of weeds and volunteer cucurbit crop plants (Sharma et al., 2016), use of super reflective plastic mulch (Stapleton and Summers, 2002; Barbercheck, 2014); the use of beneficial insects to control aphids (Kos et al., 2008), and the application of insecticides (Sharma et al., 2016). However, all these methods have not been very effective in the management of viral diseases. One reason is that the aphid populations developed resistance against the frequently applied insecticides. In addition, non-persistently transmitted viruses can already be transmitted before the aphid vector is killed by the insecticide (Jayasena and Randles, 1985; Maelzer, 1986; Simons, 1957; Webb and Linda, 1993). A limitation for the successful us of reflective films in cucurbits has been that plant growth rapidly covers the mulch and thereby lessens reflectivity (Damicone et al., 2007).

The most effective and simplest strategy of controlling viral diseases is growing resistant varieties. Breeding for host resistance is difficult due to the incompatibility among different cucurbit species (Zitter and Murphy, 2009). Therefore, evaluation of other cultural methods to control viral diseases such as the planting date could help to develop alternative strategies (Hull, 2013). It is

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known that the planting date is important in tropical climates (Hull, 2013). Planting date based strategies have been successfully used in the avoidance or management of tungro virus disease in rice (Manwan, 1987) and to control of groundnut affecting viruses in African countries by sowing groundnut at the start of the main rainy season (Hull, 2009). However, adequate information on the use of specific planting dates in managing viral diseases in cucurbits in Ivory Coast is lacking. Therefore, in this study we attempted to evaluate the effectiveness of different planting dates for the management of virus diseases in cucumber and zucchini.

Materials and methods

Study site

The field study was conducted in Dabou-Agneby, situated 45 km west of Abidjan. This location (04°16 W; 05°16 N) experiences two rainy seasons interrupted by two dry seasons. The long rainy season spans from February to June while the short rainy season is from September to November. The annual mean rainfall is between 1500 and 1600 mm distributed through the year. The area has sub-equatorial climate characterized by hot and humid weather, with temperatures varying around 28° C and a relative humidity of 85% (Table 1). The vegetation is of coastal type dominated by small mangroves (Avenard et al., 1971; Comoé et al., 2009).

Plant material

Two cucumber varieties (Tokyo hybrid F1 and Poinsett) obtained from a seed- shop and a farmers' preferred variety of zucchini ("Bolle", local variety) obtained from a local market were used for this study.

Experimental design and field layout

A randomized complete block design with three replications was used. The treatment comprised three planting dates (May 2014, September 2014 and February 2015) and two cucurbits (cucumber and zucchini). The field was divided into three blocks with three plots of 20 plants of each cultivar. Plots were 1 m x 10 m and each contained two 5-m long rows of cucumber or zucchini spaced by 60 cm. Sowing was done with 2 seeds per hill at intra-row spacing of 40 cm and inter-row spacing of 60 cm. The number of plants per hill was later reduced to one plant when seedlings reached the two leaves stage. Manure was incorporated into the soil prior to sow cucumber and zucchini.

Table 1
Microclimate of the site during the three trials.

Trial	Month	Temperature (°C)	RH (%)	Rainfall (mm)
Trial 1: 2014	May	26.4	86.6	102.3
	June	25.4	88.8	174.1
	July	27.1	87.2	260.6
Mean		26.3	87.5	179
Trial 2: 2014	September	26.3	83.7	20.57
	October	27.7	80.57	39.83
	November	26.13	81	93.33
Mean		26.71	81.75	51.24
Trial 3: 2015	February	27.1	84	16
	March	28	78	0
	April	25.6	90.6	3.2
Mean		26.9	84.2	6.4

Cultural practices

Granular fertilizer (12-22-22 kg/ha N-P-K) was incorporated two weeks after sowing (WAS). Compost was applied 28 days after germination at a rate of 10 L per 10 m^2 plot. The plots were watered when necessary. Fungicide Mancozan Ivory 80 WP (content: 800 g/kg), Callicuivre (content: 50%) (fungicide available in Ivory Coast) and the nematicide Diafuran 5G (Carbofuran: 5%) were applied with the doses recommended by the manufacturer on the plants to prevent fungial and nematode infections. The insecticides K-optimal 35 EC (Content: Lambda-cyhalothrine: 15 g/l, Acétamipride : 20 g/l), and Decis 12 EC (active molecule: Deltaméthrine: 12.5 g/l) were applied twice per week, starting one week after sowing when the first insects (aphids and whiteflies) were observed on the plants.

Data collection in the field

Data were collected on disease incidence and severity, the occurrence of the first symptoms and yield.

Disease incidence was determined based on the symptoms on diseased plants.

The proportion of diseased plants was estimated by: **IC** $= \frac{n}{N} \times 100$ (IC = incidence; n = number of diseased plants; N = total number of plant assessed).

The severity index of the disease described the damage caused by the diseases on plants leaves. A modified 0–5 visual scale of Nelson et al. (1999) and Steel and Torrie (1980) based on disease symptoms, was used to score the diseased plants as follows: 0: No disease symptoms; 1. Mild mottling on 10% of leaf area; 2. Mottling on 50% of leaf area/light downward cupping; 3. Pronounced downward or up cupping of leaf/chlorosis/75–100% leaf mottling; 4. Severe mosaic/severe distortion of leaf/crinkled leaf/stunting of entire plant/leaf bunching; 5. Severe leaf distortion/necrosis/narrowed or shoes-string leaf.

Disease severity index was then determined for each treatment using the formula according to Nelson et al. (1999) and Steel and Torrie (1980) as shown below:

$$\text{Disease Severity Index (DSI)} = \frac{0 * P0 + 1 * P1 + 2 * P2 + 3 * P3 + 4 * P4 + 5 * P5}{N(G-1)} \times 100$$

Where P_0 to P_5 = Total number of observed plants in each disease symptom grading per farm site in each state within the agro ecological zone surveyed.

G = Number of grading = 6 and N = Total number of observations.

Areas under disease progress curve

The areas of disease progress on the cultivars or varieties were calculated using the incidence and disease severity index.

Thus, the Area under severity index progress curve (AUSIPC) for disease severity was calculated using the modified formula described by Shaner and Finney (1977) as below:

AUSIPC = $\sum_{n=1}^{n-1}(DS1 + DS2/2)x(t2 - t1)$ where, DS1 is disease severity recorded in time 1 and DS2 the disease severity recorded in time 2.

Area under disease progress curve (AUDPC) for disease incidence was calculated using the formula described by Muengula-Manyi et al. (2013):

AUDPC $\sum_{i=1}^{n}[(Xi + X(i+1)/2)]x(t)$ where, Xi is the incidence of disease at time i, Xi + 1 is disease incidence recorded at the time i + 1, n, the number of registration on the incidence, and t, days between the registration of Xi and Xi + 1.

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