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Research Article

Sanitary Diagnosis of Cotton Cultivation in the West Central Region of Cote D'ivoire

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Abstract

In order to contribute to cotton cultivation sustainability in west central Côte d'Ivoire, a phytosanitary diagnostic study was conducted in 11 plots. It consisted of monitoring the sanitary condition of 10 rural plots and an experiment plot set up at the Research Farm of University Jean Lorougnon Guédé of Daloa according to the regular and careful inspection of cotton seed germination, seedling health and cotton plants throughout the growing season. The results obtained indicated that the cotton varieties used by farmers had very low germination with maximum number of healthy seedlings of 43.75 % in an experiment condition. Highest number of infected seedlings (24-51%) showing characteristic symptoms of seedling blight leading to their death was observed. Under cultivation, a variety of pests was identified on cotton plants. The most important were *Bemisia tabaci, Jacobiella fasciali, Helicoverpa armigera, Dysdercus sp, Earias sp, Zonocerus Variegatus, Haritalodes derogata.* The Species *Zonocerus Variegatus and Haritalodes derogata* proved to be devastating on the experimental plot where 100% loss was recorded. The main disease observed at flowering stages in cotton plants was cotton virescence disease. Although lowly infection were observed (0.11 -0.35%) cotton cultivation monitoring and management must be set up so as to prevent its expansion in the west central. Theses finding gives useful information to farmers to reduce cotton yield losses in west central Côte d'Ivoire.

Keywords: cotton cultivation; healthy seedlings; seedling blight; virescence disease

Introduction

Cotton has been cultivated for millennia in many parts of the world for its fiber, but it was not until the 2000s that African countries became the world's second largest exporter (Fok, 2010). This place is remarkable especially as cotton cultivation on the continent is carried out in small family farms covering on average a surface area of 1.5 ha (Fok et al., 2004).

In Côte d'Ivoire, until the middle of the last decade, cotton played an important role in the agricultural economy. The

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sector accounted in 2001 for about 7% of the country's exports and generated a turnover in foreign currencies of around 53 billion CFA F. Moreover, it was the backbone of the rural economy of northern Côte d'Ivoire and directly supported 180 000 producers, that is, about 2.5 million inhabitants (Diarrassouba et al., 2014). Unfortunately, this cotton adventure has been shaken since 2003 by the current economic context marked by the underlying increase in the prices of chemical inputs and the instability of seed cotton purchase price on the national and world market (Donikpoho, 2012 ; Sigué, 2011). To this crisis are added the great inter- and intra-annual variability of rainfall observed in the Sudano-Sahelian zone, the depletion of soils, the recrudescence of parasitism, the poor implementation of crop management techniques for production and the use of bad quality seeds (Brou et al., 2005 ; Hema, 2004 ; Tonessia et al., 2018). These facts have led to a decline in cotton yield in the north to the detriment of food crops and have contributed to its development in other more rain-fed regions of the country including the west central (Sigué, 2011).

For example, rural farms are booming in the department of Daloa, Vavoua, Bédiala and Séguéla in west central Côte d'Ivoire. However, this zone which is conducive to the development of agriculture has been undergoing for some time, like the whole country, the impact of climate change expressed by a negative variability of rainfall and drier weather. If this fact has led to yield decline forecasts in the country in recent years, its impact on bio aggressor populations is more difficult to grasp (Mollard, 1988; Kouakou et al., 2011 Soko et al., 2015). Taking into account the important place occupied by the west central today in cotton cultivation in Côte d'Ivoire, it is therefore necessary to carry out a sanitary diagnosis of cotton cultivation for sustainable yield. The interest of such a study in the zone is to control the environment of the crop in order to limit yield losses (Renou, 2000; Toe et al., 2000; Traoré, 2008). This study aims at identifying the sanitary constraints of cotton cultivation in west central Côte d'Ivoire from the monitoring of 10 rural fields and one experimental plot set up at the Research Farm of University Jean Lorougnon Guédé of Daloa.

Material and Methods

Study site

During 2016, field surveys were carried out from May to June in the cotton growing-region of west central Cote d'Ivoire and made it possible to select easily accessible rural farms and to collect seed samples. Ten farmer's field support by the Cotton Exploitation Company (SECO-SA) were randomly selected for cotton crop monitoring (Table 1). In addition a plot experiment was carried out at the Research Farm of the University of Jean lorougnon Guedé in September (late sowing) on a one-year fallow land in the area.

Experimental Design and Treatments

The experiment was laid out in a randomized complete block design with three replications. Each repetition consisted of 3 elementary plots made up of varieties Y301AR3, Y764AR3 and Y331BR4 (Tonessia et al., 2018**).** The size of the elementary plots were 0.80 m x 0.24 m, 1m apart and the space between the blocks was 2 m. Each plot had 4 rows of seedlings and 25 stand per row, that is, a density of 200 seedlings per plot. The seeds used were not treated before sowing. However, the replacement of empty stand was done by disinfecting the seeds with a mixture of Thirame (fungicide) and Imidacloprid (insecticide). Subsequently, the plot did not undergo any phytosanitary treatment.

Table 1: Plots Monitored in West Central Côte d'Ivoire

Localities	Plot numbers	Sowing dates
Worofla	P1	June7th
Somana1	P2	June8th
Sifié1	P3	June13th
Somana2	P4	June15th
Séguéla1	P5	June18th
Vavoua	P6	june14th
Séguéla2	P7	June22th
Séguéla3	P8	June26th
Sifié2	P9	July8th
Mankono	P10	July18th
Daloa (UJLOG)	P11	September 6th

Inventory of Pests and Diseases in the Cotton Plots

The observations of cotton pests and diseases were made according to the regular and careful inspection of crop plants throughout the growing season. Cotton seed germination was recorded at 14 days after sowing. Normal seedlings, abnormal seedling and empty stand were counted separately and expressed in percentage. Crop monitoring for detection of insect pests and disease was stated 30 days after sowing until the maturity of the cotton plant and Data were collected once (1) a week. The net catches were carried out on 100 m² randomize surfaces. Insects were captured with a sweep net and the threshing techniques. For that purpose, the cotton plants were shaken early in the morning between 6 am and 8 am in order to make the Coleoptera fall in petri dishes and to block Lepidoptera, some Orthoptera and other flying insects in the sweep net. After their capture, the insects collected were stored in ethanol diluted to 70%. The samples were labeled with an indelible marker. On the labels, the number of the rural plot and the date of collection were mentioned. At the same time, all parts of the cotton plant were carefully observed to detect possible diseases or anomalies in the plots. The anomalies noticed during the observations were described in an observation sheet and the diseased plants were counted. The pests were counted and identified in the laboratory.

Data Analysis Methods

All the data collected were subjected to analysis of variance (ANOVA) and treatment means were compared according to the Student Newman and Keuls test and the one-way ANOVA at 5% probability level.

Result

Germination Rate and Cotton Plant Diseases

In the rural plots, seeds germination were in rage of 98 % (data not shown). However, on the experimental plot, emergence gaps of about 27 to 40% due to empty stand were found for the 3 varieties reducing the germination rate to 59%, 72% and 68%, respectively, for varieties Y301AR3, Y331BR4 and Y764AR3 (Table 2). Among these germination rates some seedlings showed seedling blight disease. It was characterized by the appearance of a brown spot, at the junction of the seedling stem and root, which extended upwards; at that level, the altered and softened tissues lost their rigidity, the seedling bent, then collapsed on the ground, wilted and dried up. The losses due to this disease were in the range of 51%, 46% and 24%, respectively, for varieties Y331BR4, Y301AR3 and Y764AR3. The statistical analysis of the data revealed that the 3 varieties showed the same behavior except for normal seedling where variety Y301AR3 gave a very low value (12.75%). Subsequently, the disease was reduced in the plot after disinfection of the seeds with the insecticide + fungicide mixture (result not shown).

Under cultivation, at the flowering stage of the cotton plant, a disease attracted our attention in 5 rural plots. The symptoms of the disease were transformation of flowers into leafy structure indicative of cotton plant flower virescence (Fig. 1). This has been observed in the plots located in Worofla (P1) in Somana (P2, P4) in Sifie (P3) and in Seguela (P7). The incidence of this disease in plots was low, ranging between 0.11% and 0.35, thus being limited to a few isolated plants.

Fig. 1: Cotton plant with symptoms of virescence: Transformation of flowers into leafy organs (A)

Table 2: Germination analysis of cotton seed grown in West Central

Varieties	Rate (%) Germination		
	Empty stands	**Normal seedlings**	**Abnormal seedlings**
Y301AR3	40.5b	12.75a	46,75b
Y331BR4	27.75b	21b	51.25b
Y764AR3	2b	43.75b	24.5b
P-valeur	0.725	2.2810^{-05}	0.182

Treatment means followed by common letter(s) within column are not significantly different among each other at 0.05 level of significance .

Table 3: incidence of cotton tree flower virescence disease on 5 plots

Plots numbers	Plants virescents (%)
P1 (Worofla)	0.32
P2 (Somana1)	0.22
P3(Sifié1)	0.27
P4 (Somana)	0.35
P7 (Seguela2)	0.11

Inventories of Insects Trapped in Cotton Plant Plots

Several insects and pests were observed during crop year 2016 in the different plots. The insects found in the farms belonged to 7 genera, 4 orders and 6 families (Table 4). The Lepidoptera orders were the most dominant with 3 species, followed by the Hemiptera with 2 species. The Homoptera and Orthoptera were each represented by one species. Considering the lifestyle and the buccal system of the species encountered, they can be categorized into 3 groups:

- biting and sucking insects, living under the leaves and young shoots of plants, by continuously sucking the sap of these organs (*Jacobiella fasciali, Bemisia tabaci, Dysdercus sp*);
- Carpophagous caterpillars that feed on flower buds, flowers and capsules and perforate them (*Helicoverpa armigera, Earias sp*).
- phyllophagous pests or defoliating insects that devour the leaves and flowers of the cotton plant (*Haritalodes derogata, Zonocerus variegatus*);

Bemisia tabaci and *Jacobiella fasciali* were observed on all the plots with a relatively large number ranging from 67 to 32 and 45 to 13, respectively, during the measurement period (Fig. 2). As for Earias sp., although found in low numbers in the farms (between 1 and 13), the caterpillar was collected in all the plots except P9. *Helicoverpa armigera* was counted on 2 plots namely P4 (5) and P1 (1) with a low presence. This was also the case of Dysdercus sp on plots P1 (5) and P2 (8). In addition to the insects mentioned above, the experimental plot was invaded by the species *Zonocerus Variegatus* and *Haritalodes derogata*. Failing phytosanitary treatments, those pests have destroyed all the crop of the experimental plot.

Discussion

Quality seeds are one of the most important inputs in the cotton production chain (TRAORE, 2008). However, the ones used by farmers in plots showed low quality failing any chemical treatment. In fact, on the experimental plot, the seed germination rate was low (< 50%). High numbers of cotton seed from the collected samples deteriorated in the soil after sowing, thus affecting germination and resulting in empty stand of up to 40%. This low germination rate might mainly be due to the presence of fungi carried by those seeds which deteriorate their germination.

Table 4: Main Pest associated to Cotton plants in the west central

Orders	Families	Genera and especies	Specificity
Homoptera	Aleurodidae	*Bemisia tabaci* (Gennadius, 1889)	Biting and sucking insects
Hémiptera	Cicadellidae	*Jacobiella fasciali* (Jacobi, 1912)	Biting and sucking insects
	Pyrrhocoridae	Dysdercus sp	
Lepidoptera	Noctuidae	*Helicoverpa armigera* (Hübner, 1808)	Carpophagous caterpillars
		Earias sp	
	Crambidae	*Haritalodes derogata* (Fabricius, 1775)	Phyllophagous pests
Orthoptera	Acrididae	*Zonocerus variegatus* (Linnaeus, 1758)	Phyllophagous pests

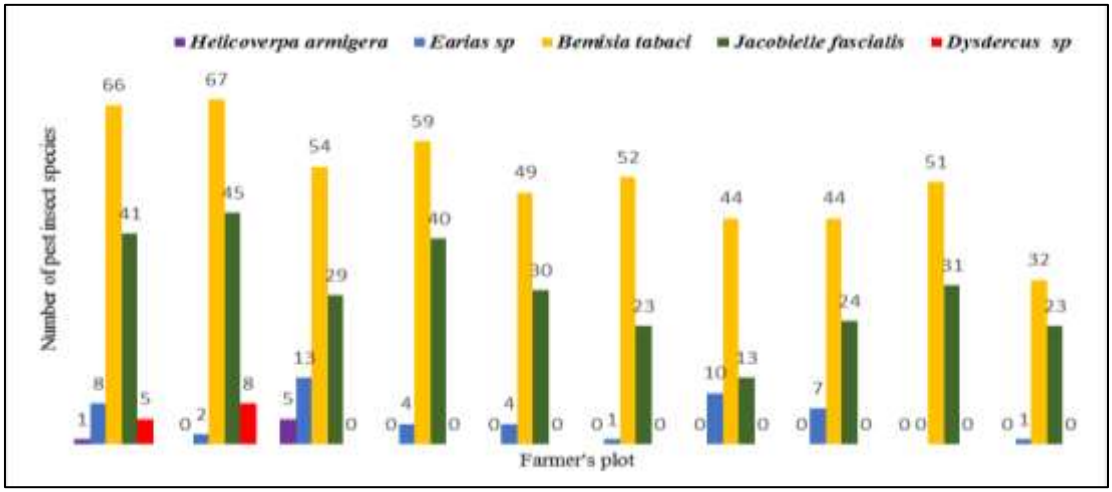

Fig. 2: The main pests of cotton observed in rural plots

Recently, fungi such as *Aspergillus*, *Fusarium. Curvularia*, *Rhizophus*, *Macrophomina* and *Paecilomyces* were found to be associated with cotton seed belonging to the varieties studied (Tonessia et al., 2018). Most of these fungi are heavily involved in seed rot and seedling blight (Djeugap et al., 2017). However, it should be noted that the disinfection of seeds using a mixture containing Thiram fungicide has helped increase their germination rate. This was observed in the 10 rural plots which were directly supplied with disinfected seeds. These results clearly show the general interest of cotton seed disinfection (Follin et Mangano, 1987). The sanitary quality of cotton seeds on which germination and sometimes crop health directly depend is necessary to ensure good crop year in the west central.Another problem which requires rigorous protection measures is the presence of floral virescence disease in the cotton fields of the region. The incidence of the disease in plots, although less than 1%, is a source of concern for cotton cultivation. Floral virescence is the most feared disease in the entire cotton belt of the sub-region. In Côte d'Ivoire, it is prevalent in the northern parts where it is subject to special surveillance (Traoré, 2008 ; Renou, 2000). With the dynamism of the current development of cotton cultivation in west central Côte d'Ivoire, this disease might extend especially as the supply of inoculum is favorable to such a context (Kalhid et al. 2009). The complexity of the disease lies in the fact that it attacks the reproductive organ, that is to say the flower, leading to total sterility of the plant. The disease is associated with the presence of mycoplasma-like organisms and might be transmitted by Orosius cellulosus (Laboucheix Jean, 1986). However host plants such as *Sida cordifolia* and *S. rhombifolia* (Malvaceae) but also *Mitracarpus scaber*, *Sesamum sp* may be possible sources of inoculum. Rigorous measures must be taken to prevent its spread in the west central zone because the management of phytoplasma diseases is difficult and is mainly limited to the uprooting of diseased plants (Memane et Joi, 1987 ; Mittempergher et al, 1990, FAO, 2014).

In addition to the identified diseases, this study has revealed several pests that attack cotton plant in the west central. They belong to 7 genera, 4 orders and 6 families. These are the main pests of cotton plant overall. All parts of the cotton plant were attacked by them (Miranda et al., 2013). However, the most severe attacks, mainly on the experimental plot, were the ones of defoliators. These included *Zonocerus Variegatus* and *Haritalodes derogata*. Their large presence in the experimental plot might probably be due to a lack of phytosanitary treatment (Renou, 2000). As for biting and sucking insects such as whitefly, *Bemisia tabaci* and jassid, *Jacobiella fasciali*, they have been observed abundantly in all the plots. This is primarily due to the fact that B. tabaci covers a significant geographical area from northern to southern Côte d'Ivoire (Fargette, 1985). It is especially in wetlands, such as the study area, that large numbers of such white flies can be found because of cassava cultivation (Nzi et al. 2010). Indeed, cassava is a host plant of *Bemisia tabaci*. It is also found on many other crops, especially market garden crops (Nume, 1983). Bemisia populations caused leaf yellowing, thus disrupting plant development. *Bemisia tabaci*, and *Jacobiella fasciali* are among the pests at the root of a real threat to cotton cultivation in West Africa and are responsible for losses that vary on average from 40 to 70% depending on the agro-ecological zones and the years.

In addition to the leaf pests, carpophaga such as *Helicoverpa armigera* and *Dysdercus sp.* were observed. The latter cause significant damage to flower buds, flowers and capsules. Of these two pests, the caterpillar, *Helicoverpa armigera* seems to be the most formidable. The larvae of that caterpillar penetrate the flowers or flower buds by emptying them of their contents and the attacked organs fall. This voracious pest was responsible for significant crop losses in the years 1991 and 1996 in the main cotton departments of western Burkina Faso (Toe et al., 2000).

Conclusion

This study presents an approach for the sanitary diagnosis of cotton cultivation in west central Côte d'Ivoire. The first observation is that cotton cultivation in that area is facing a problem of good quality seed that can help cotton farmers sow under the best conditions and obtain healthy and vigorous seedlings. Then in full growth, cotton is subject to attack from many pests which damage and modify the physiological functioning of the cotton plant. Those insects identified in this study are traditional pests of cotton. However, some of them could be vectors of emerging dreadful diseases such as floral virescence mainly transmitted by a jassid. Although this disease is observed in some rural plots with a relatively low incidence, it must be monitored carefully so as to prevent its spread and extension. The results obtained constitute a database in the knowledge of the enemies of cotton cultivation in the west central which can contribute to a quantitative and qualitative improvement of cotton yield.

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