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Review

The major economic field diseases of cowpea in the humid agro-ecologies of South-western Nigeria

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Cowpea, which has now become an important protein source for the teeming populace of Nigerians especially those living in the humid agro-ecological zones of South-western Nigeria, is severely attacked by diseases. The causal agents of these diseases find the environment more conducive for survival and hence induce disease conditions in the host plant causing significant yield reduction. This paper reviews the present situation of the cowpea diseases in the humid forest agro-ecologies of South-western Nigeria.

Key words: Cowpea, field diseases, humid forest agro-ecology, Southwestern Nigeria.

INTRODUCTION

Cowpea (*Vigna unguiculata* L. Walp) a dicotyledonous plant belonging to the order fabaceae, genus *Vigna* (Cronquist, 1988) is of major importance to the livelihood of millions of people in the tropics (Quin, 1997). This crop provides food, animal feed and cash for the rural populace in addition to benefits to farmlands via *in situ* decay of roots residues and ground cover from cowpea's spreading habits. Besides, cowpea grain provides a cheap and nutritious food for relatively poor urban communities (Quin, 1997). In the humid tropics of South-western Nigeria, cowpea is cultivated for its grain production, leaves, green pods, as an anti-erosion crop and stover. Cowpea grain is consumed directly after cooking, or as a component of meals made from cereals or root crops (Latunde-Dada, 1993). Cowpea cakes (made from mashed and fried seed) are also sold as a fast food along roadsides in humid forest of South-western Nigeria.

It was been estimated that about 3.3 million tonnes of cowpea dry grains were produced worldwide in year 2000. Nigeria produced 2.1 million tonnes of this, making it the world's largest producer, followed by Niger (650,000 tonnes) and Mali (110,000 tonnes) (IITA, 2004). Total area grown to cowpea is 9.8 million hectares and about 9.3 million hectares of these is in West Africa. World average yield is 337 kg/ha and average yield in Nigeria is 417 kg/ha

Cowpea is widely cultivated in the humid tropics of South-western Nigeria, however, its cultivation is faced with several set backs such as pests and diseases (Ajibade and Amusa, 2001). The mean annual rainfall ranges between 1,150 – 1,500 and falls mainly between April and October with the major peak in June and September. Relative humidity values (80 – 95%) are recorded during the rainy season and the dry season (20–50%). The maximum and minimum temperatures are 19 and 35°C, respectively. Most diseases thrive best under high relative humidity, which correlates with high rainfall pattern and atmospheric temperature that are found in humid forest of Southern Nigeria. The effect of field diseases on cowpea has led to significant reduction in yield of cowpea in the humid forest of Nigeria. The major economic diseases of cowpea in the humid agro-ecologies of South-western Nigeria include brown blotch, anthracnose, cercospora leaf spot, choaniphora pod rot, false smut, web blight and sclerotium stem blight (Table 1).

This paper reviews the present situation of these diseases and efforts being made in managing the diseases in the humid forest agro-ecologies of Nigeria.

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Table 1. Percentage cowpea lines (71) infected with fungal diseases in the humid tropics (Ibadan, SW Nigeria).

Disease	% Infected cowpea lines	
	1999	2000
Cercospora leaf spot	47.89	33.80
Choaniphora pod rot	84.51	23.48
Sclerotium rolfsii	2.28	5.68
Web blight	39.44	8.45
Brown blotch	100.00	64.10
False smut	64.79	6.23

Source: Ajibade and Amusa (2001).

Table 2. Response of 14 cowpea cultivars to in-vitro inoculation with Phyto-toxic metabolites of *Colletotrichum truncatum* and *C. lindemuthianum*[a].

Line	Mean size of the necrotic lesion							
	C. truncatum				*C. lindermutianum*			
	Leaves	Stems	Pods	X[B]	Leaves	Stems	Pods	X[B]
IT282E-16	20.2	15.8	14.70	18.2a	20.7	16.3	14.6	17.2a
TVU3236	21.7	16.0	13.40	17.6	21.6	15.2	14.1	16.9ab
TW300	20.4	15.4	14.60	17.2ab	17.5	15.9	14.9	16.1g
IT82E-32	19.2	15.4	14.40	16.9bc	15.5	14.2	12.9	14.2c-e
TVU-1994	18.3	16.2	14.90	16.6bc	18.3	15.2	13.9	15.8d-f
IT81D-1137	16.2	15.7	13.80	16.0cd	16.9	16.9	14.1	15.3d-f
IFE BROWN	16.5	16.4	14.70	15.9d	18.6	15.4	13.6	15.9d
IT82D-60	16.4	15.9	14.70	15.8d	18.5	16.3	13.9	16.3bc
848-2245-4	17.6	15.7	13.70	15.7d	16.5	14.4	14.1	14.9fg
TVU-3232	15.4	14.5	13.00	14.6e	15.2	14.2	13.3	14.3g
IT82D-699	13.9	13.7	11.11	13.0f	17.2	15.9	14.4	15.8c-e
IT81D-773	13.5	13.0	11.50	12.8f	15.5	14.8	13.7	14.7fg
IT82d	11.6	11.2	11.20	11.6g	15.7	14.2	13.3	14.4g

Source: Amusa et al. (1994).
[a]Each value is a mean of 5 replicates (5 measurements per replicate) and is a transformation from the loge of the original value.
[B]Values followed by the same letters are not significantly different (p = 0.05) by the least significant difference test.

COLLETOTHRICHUM DISEASE OF COWPEA

Colletothrichum sp. induces two major diseases in cowpea (anthracnose and brown blotch) in the humid forest of South-western Nigeria. These diseases are induced by two different species of the genus *Colletotrichum*. Emechebe and Florini (1997) had suggested that the cowpea anthracnose pathogen be regarded as a species that is distinct from *Colletotrichum lindemuthianum*, the *Phaseolus* bean anthracnose pathogen. Latunde-Dada et al. (1999) have provided strong evidence in favour of considering the cowpea anthracnose pathogen as a form of *Colletotrichum destructivum* O'Gara and this has been accepted and adopted (Allen and Lenne, 1998). In Savannah agro-ecologies of Nigeria, cowpea brown blotch disease is induced by *Colletotrichum capsici* (Allen and Lenne, 1998; Emechebe and Shoyinka, 1985). However, *Colletotrichum truncatum* (Schew) Andrus and More is regarded as the causal agent of brown blotch of cowpea in humid forest of South-western Nigeria (Adebitan, 1984). Symptoms of the disease includes purplish brown discolouration on pods, which may also extend to petioles, leaf veins and peduncles. Pod infection often leads to maldevelopment and distortion of pods (Allen et al., 1998). The diseases have been found to be seed borne (Emechebe and McDonald, 1979). The role of toxic metabolites of the pathogens inducing both the anthracnose and brown blotch disease development and symptoms manifestation in cowpea in the humid forest of southern Nigeria has been demonstrated (Amusa, 1991). Ajibade and Amusa (2001) reported that 64% of 74 cowpea lines evaluated in 1999 were found susceptible to brown blotch disease of cowpea (Table 2). Yield loss has been estimated as ranging between 46

Table 3. Yield and reaction of some cowpea lines (18^B) to six fungal diseases in the humid environment of South-western Nigeria during 1999 cropping season.

Line	Disease incidence/severity						
	Yield (g)	CL	CH	SC	WB	BB	FS
IT82E-18	10.1	0.0(1.0)	1.3(2.0)	0.0(1.0)	0.0(1.0)	12.2(2.2)	5.1(2.0)
IT96D-610	7.9	0.0(1.0)	15.9(2.0)	0.0(1.0)	0.0(1.0)	15.7(2.5)	0.0(1.0)
IT96D-666	7.8	0.0(1.0)	0.0(1.0)	0.0(1.0)	20.0(2.0)	77.3(2.0)	60.0(3.0)
IT95K-105-2	4.6	4.6(2.0)	3.0(2.0)	0.0(1.0)	4.6(2.0)	12.3(2.0)	15.2(2.0)
IT95K-1491	8.6	0.0(1.0)	75.1(3.0)	0.0(1.0)	0.0(1.0)	72.2(3.0)	0.0(1.0)
IT95K-222-14	1.6	6.5(3.0)	4.4(2.0)	0.0(1.0)	0.0(1.0)	42.8(2.5)	34.8(1.0)
IT95K-362-2	4.2	0.0(1.0)	0.0(1.0)	0.0(1.0)	0.0(1.0)	27.7(2.5)	10.8(2.0)
Ife-98-12	3.5	4.7(2.0)	0.0(1.0)	0.0(1.0)	0.0(1.0)	4.4(2.0)	18.8(2.0)
IT84S-2246	3.5	0.0(1.0)	8.8(2.0)	0.0(1.0)	0.0(1.0)	20.1(2.5)	0.0(1.0)
Ife-BPC	2.5	7.5(2.0)	2.8(2.0)	0.0(1.0)	0.0(1.0)	6.3(2.0)	20.0(2.5)
IT96D-618	3.3	18.8(2.0)	0.0(1.0)	0.0(1.0)	0.0(1.0)	92.9(3.0)	0.0(1.0)
Ife-98-11	4.6	0.0(1.0)	31.3(2.5)	0.0(1.0)	0.0(1.0)	50.0(3.0)	50.3(3.0)
IT95K-282-13	6.3	8.3(2.0)	5.6(2.0)	0.0(1.0)	16.7(2.5)	37.3(2.5)	0.0(1.0)
Ife-98-1	5.8	4.6(2.0)	6.9(2.0)	1.9(2.0)	7.9(2.0)	18.9(2.5)	9.1(2.0)
Ife-brown	7.3	4.9(2.0)	7.3(2.0)	0.0(1.0)	4.9(2.5)	18.9(2.5)	14.7(2.0)
IT95M-303	6.8	0.0(1.0)	25.0(2.5)	0.0(1.0)	0.0(1.0)	41.6(3.0)	50.1(3.0)
IT95K-1384	4.1	0.0(1.0)	2.3(2.0)	0.0(1.0)	0.0(1.0)	9.1(2.0)	0.0(1.0)
IT95K-193-12	0	0.0(1.0)	0.0(1.0)	0.0(1.0)	0.0(1.0)	10.3(2.0)	0.0(1.0)
Mean	5.1	3.3(1.4)	10.5(1.8)	0.1(1.1)	3.0(1.4)	31.7(2.5)	16.0(1.0)
S E M	0.29	0.54(0.1)	1.0(0.1)	0.1(0.1)	0.6(0.8)	0.8(0.1)	0.9(1.0)

Source: Ajibade and Amusa (2001).
CL= Cercospora leaf spot, CH = Choaniphora pod rot, Sc =Sclerotium stem rot, Wb = Web blight, BB = Brown; Brown blotch, FS = False smut.
^B The 18 lines are representative samples of the 71-cowpea lines evaluated showing high, moderate and low reactions of the cowpea lines to the fungal pathogens.

and 74% depending on the susceptibility of the cowpea used for the evaluation (Alabi, 1994). Currently, due to susceptibility of cowpea germplasm *Colletotrichum* diseases stand as one of the most destructive diseases of cowpea in the humid forest of South-western Nigeria.

Adebitan et al. (1996) has reported greater reduction of brown blotch in monocropped cowpea as against intercrop. Moreover, it was shown that wide spacing of cowpea resulted in lower incidence and severity of brown blotch compared to the closer planted crop, both monocrop and intercrop in Ibadan the humid forest of Southern Nigeria.

Anthracnose incidence and severity were lower in the intercrop relative to the sole crop while reductions in both inter and intra-row spacing resulted in an increase in the incidence and severity of anthracnose (Adebitan and Ikotun, 1996). In the humid forest besides the cultural control practices, biological control as means of managing *Colletotrichum* diseases of cowpea has been investigated. Thus, Bankole and Adebanjo (1996) working in the humid forest of South-western Nigeria, reported that seed treatment or soil drenching with dense conidial suspension (1 x 10^8 condia/mL) of *Trichoderma viride* effectively reduced brown blotch infection. In addition, foliar application of spore suspension of *T. viride* once or twice weekly, beginning three days after inoculation of seedlings with the pathogen reduced brown blotch in the field. Another research conducted on the biological control of anthracnose in the humid forest of Eastern Nigeria has shown that water or alcohol extract of *Piper betle*, *Ocimum sanctivum* and *Citrus limon* significantly reduced the incidence and spread of anthracnose in the field. Extracts of *P. betle* were the most effective in both the laboratory and the field (Amadioha, 1999). The use of phytotoxic metabolites of *Colletotrichum* species or culture filtrates of the pathogen in screening for resistance (Table 3) to both brown blotch and anthracnose has been reported (Amusa, 1991; Amusa et al., 1994).

CERCOSPORA AND PSEUDOCERCOSPORA LEAF SPOTS

Cercospora leaf spot is induced by *Cercospora canescens* Ellis and Martin, while Pseu-docercospora leaf spot is induced by *Mycosphaerella cruenta* Latham in the form of its anamorph, *Pseudocercospora cruenta* (Sacc.) Deighton (formerly *C. cruenta)* (Allen and Lenne, 1998). Pseudocercospora leaf spot is characterized by chlorotic or necrotic spots on the upper leaf surface and profuse masses of conidiophores and conidia, appearing as downy gray to black mats, on the lower leaf surface. Cercospora leaf spot is characterized mostly by circular to irregular cherry red to reddish-brown lesions on both leaf surfaces.

Both pathogens survive the no-crop period on infected crop residue and in infected seed (Williams, 1975; Scheneider et al., 1976). *P. cruenta* induces leaf spot on several legumes and *C. canescens* on an even wider range of legumes (Emechebe and McDonald, 1979). However Pseudocercospora leaf spot is economically more important than Cercospora leaf spot. Out of 75 cowpea lines evaluated in 1999 and 2000, about 40% of the germplasm was found susceptible to cercospora leaf spot diseases (Ajibade and Amusa, 2001). Ife brown, a widely adopted and cultivated cowpea cultivars in South-western Nigeria had 80% cercospora incidence on the field. Field observation revealed crop loss of over 40% in cercospora endemic field.

Evaluation of fungicides for the control of Pseudocercospora leaf spot conducted in Nigeria in 1995 revealed that weekly spraying of benomyl, beginning at three weeks after planting, gave the best control of the diseases and the highest grain yield (Amadi, 1995).

COWPEA LEAF SMUT DISEASE

Protomycopsis phaseoli (Ramak and Subram) is the causal agent of the cowpea leaf smut disease in Nigeria and not *Entyloma vignae* as claimed by some authors (Adejumo et al., 2000). It was first reported in Nigeria in 1975 (IITA, 1975) and later by Williams and Allen (1976). This pathogen formed dark ash-grey to sooty-black lesions of 3 – 10 mm in diameter, while young lesions had yellow haloes. False smut occurs mostly in humid and fertile soil causing yield losses of between 23 and 48% (Allen, 1979; Singh and Allen, 1979; Adejumo and Ikotun, 2003). In 1999 cropping season, about 65% of the 71-cowpea lines evaluated had leaf smut infection (Ajibade and Amusa, 2001) Table 2. Chlamydospores of *P. phaseoli* in infected cowpea leaves survived longer when buried in the soil for five months than when they were left on the soil surface for the same period at temperatures 26 – 27°C and humidity 70 – 82% prevailing in Ibadan. Some cowpea cultivars which includes IT85F-2805, IT88S-584-1 and TVu 4031, IAR 48, IT81D-1228-14, IT83D-422, IT86D-1056, TVu 4031 and TVu 11067 were found resistant to leaf smut pathogen (Adejumo et al., 2001). The potential of *Bacillus sp*., *Aspergillus fumigatus, Fasarium oxysporum, Trichoderma harzianum, Trichoderm koningii* and *Trichoderma* sp. and yeast as biological control agents of *P. phaseoli* as been reported (Adejumo et al., 1999). Destruction of leaf debris before crop emergence, long period of rotation and no tillage cropping are suggested to prevent the onset and spread of leaf smut disease of cowpea.

WEB BLIGHT AND RELATED DISEASES

Thanatephorus cucumeris (Frank) Donk and its anamorphic state, *Rhizoctonia solani* Kuhn, are soil-borne and ubiquitous in nature as causal agents (Emechebe and McDonald, 1979) for two distinctly different diseases in cowpea i.e. web blight and a root rot-seedling disease complex in South-western Nigeria. The root and seedling phase results in root rot and in damping-off/seedling blight, the latter being due to collar/foot rot. Web blight is induced by aerial types, usually belonging to AG-1, while the strains that induce root rots/seedling diseases are strongly soil-borne, in contrast to the aerial strain, which has only a transient association with the soil. The 2 phases of the disease complex have been reported to be seed-transmitted (Emechebe and McDonald, 1979). These diseases are often severe under localized, water-logged conditions in the humid forest of South-western Nigeria. Web blight pathogens infect leaves and many other young stem tissues. Initial symptoms are small circular brown spot which enlarge and often show concentric banding and become surrounded with irregular shaped water soaked areas. Under humid conditions the lesions develop rapidly and coalesces leading to extensive blighting and defoliation (Allen and Lenne, 1998). Information on the yield loss assessment has not been documented in Nigeria. However, out of 71 cowpea lines evaluated in 1999 and 2000, in Ibadan, 39% was found susceptible to web blight disease. The two diseases have been regarded as major important diseases in the forest belt of West Africa (Emechebe and McDonald, 1979). Similarly, web blight has been described as a destructive disease of cowpea in Latin America and in hot humid regions of India (Lin and Rios, 1985; Verma and Mishra, 1989).

CHOANEPHORA POD ROT (LAMB’S TAIL POD ROT)

Lamb’s tail pod rot is induced by *Choanephora curcubitarum* (Beck and Rav.) Thaxt. Cowpea pods with this disease bear fungus with black-headed pin-like structures (Adejumo and Ikotun, 2003). Oladiran (1980) has reported that Choanephora pod rot is prevalent in the humid environment of Southern Nigeria. It had however been reported that this disease suffered neglect because it was thought to be of little economic importance (Oladiran, 1980). The impression has not changed even much now but the proportion of cowpea lines in a study conducted in 1999 and 2000 cropping seasons, showed that about 80% of the 71 cowpea lines evaluated were susceptible to the disease (Table 2). This is an indication that choaniphora pod rot needs more attention than is presently given.

SCLEROTIUM ROT

The fungus *Sclerotium rolfsii* infects the cowpea stems at the base of the plant, producing a fan of silking mycelium and large round sclerotia which are initially white and gradually darken. The infected plants usually wilt and die (Adejumo and Ikotun, 2003). Though sclerotium rot is often severe on infected crops, it is more localized in endemic areas and generally does not constitute major constraints to cowpea production.

CHARCOAL ROT (DAMPING OFF)

Damping off caused by *Macrophomna phaseolina* (Tassi) Goid. *Rhizotonia* (Taub) Butler is one of the most destructive diseases of cowpea in the tropics and subtropics (Chidamboram and Mathur, 1975; Dhingra and Sinclair, 1977; Reuveni et al., 1983). Besides charcoal rot, the pathogens also induce diseases such as dry root rot, wilt, leaf blight and ashy stem blight (Abdon et al., 1980; Singh et al., 1990). Seed, soil and plant residue are the sources of primary inoculum (Reuveni et al., 1983, Short et al., 1980).

The epidemic outbreak and yield losses due to charcoal rot of cowpea have been observed in many bean growing areas in Nigeria (Singh et al., 1990). Screening for resistance to *M. phaseolina* has been advocated and is being adopted in the humid forest of Southern Nigeria.

COWPEA PARASITIC NEMATODES

About 51 species in 23 genera of parasitic nematodes have been associated with cowpea plants (Caveness and Ogunfowora, 1985), while Florini (1997) reported about nine species of parasitic nematode on cowpea. The most important of the species of *Meloidogyne* pathogenic in cowpea is *Meloidogyne incognita* (Sarmah and Sinha, 1995; Khan et al., 1996; Adegbite et al., 2005). The root-knot nematodes, *M. incognita*, *Meloidogyne javanica* and *Meloidogyne areneria* were first reported in Nigeria on cowpea in 1958 and documented in 1960 (Anonymous, 1961). However, *M. incognita* and *M. javanica* have been found to be predominant in the southern forest zone of Nigeria (Olowe, 1976). It has been shown that those root knot nematodes are responsible for yield reduction in cowpea. Caveness (1979) and Ogunfowora (1976) reported yield losses of 20 and 59%, respectively due to infestation by *M. incognita*. Cowpea grain yield loss of 69% caused by root knot nematodes was reported by Babatola and Omotade (1991). Severe root knot nematode infestation has been observed to lead to crop failure in cowpea (Olowe, 1981; Adegbite et al., 2005). Out of the 15 varieties assessed for resistance to root-knot nematode (*M. incognita* race 2) under field conditions, IT84-2246-4 was the most resistant with a reproduction factor of 0.45, five varieties exhibited tolerance while nine varieties were susceptible to root-knot nematode (Adegbite et al., 2005) (Table 4).

Attempts have been made to evaluate several plant-derived materials for the control of *Meloidogyne* spp. In Nigeria, Onifade and Fawole (1996) demonstrated that extract from *Anacardium occidentale* was the most efficacious against *M. incognita*, the least effective being the extract from *Gmelina arborea*. Olabiyi *et a*l. (2007) demonstrated that addition of compost to soil infested with *M. incognita* in cowpea cropping systems resulted in significantly reduced soil nematode populations and root gall index. A pot culture study in India also showed that adding chopped green leaves of neem (*Azadirachta indica*) and Chromolaena *odorata* effectively controlled *M. incognita*.

PARASITIC FLOWERING PLANTS

Cowpea plant has been reported to be susceptible to attack by two species in two genera of parasitic angiosperms, namely *Striga gesnerioides* (Willd.) Vatke and *Alectra vogelii* (L.) Benth (Emechebe et al., 1991). *S. gesnerioides* is however considered the more important of the two (Emechebe et al., 1991; Lagoke et al., 1994).

Field observation revealed that yield loss varied from 3.1 to 36.5% depending on the susceptibility of the cowpea genotypes to Striga pathogen. This observation is in agreement with the report of Muleba et al. (1997) that yield losses in Striga-infested plots varied from 3.1% at the experiment station to 44.2% in farmers' fields.

The methods of controlling Striga is the reduction of Striga seeds population in the soil which is often accomplished by inducing Striga seeds germination in the absence of the host leading to the subsequent death of the Striga seedling (crop rotation with non host cultivars) (Berner et al., 1999). Berner and Williams (1998) have reported that crop rotation with non host cultivars has potential for success only if these cultivars are selected with the Striga isolate(s) from the locality of intended deployment of the non host. Among the potential non host crops found in the humid forest includes genotypes of *Cajanus cajan, Lablab purpureus, Sphenostylis stenocarpa* and *Sorghum bicolor.*

Other diseases that occur in cowpea fields in the humid forest include cowpea aphid-borne mosaic virus, cowpea mosaic virus as well as pre and post-emergence damping-off of cowpea caused by *Pythium aphanidermatum* (Shoyinka et al., 2005; Shoyinka et al., 1978; Bankole and Adebanjo, 1998). These field diseases have on time or the other been found to affect cowpea production in the humid forest. Their effects often depend on prevailing rainfall pattern at the particular period of their epiphytotic activities. Efforts to control the viral activities have been the development of varieties with multiple virus resistance and bacterial diseases resistance. At present, series of varieties have resistance to five major cowpea viruses. Varieties 'IT96D-

Table 4. Reaction of cowpea cultivars and lines to infestation by *Meloidogyne incognita* in the field.

Cultivar or line	Plant ht (cm)[z]	Days to 50% flowering	Days to maturity	Seed wt (per 100)	Yield (kg/ha)	Gall index	Nodule no/plant	Reproduction factor ($R=P_f/P_i$)
Erusu local	48a	52	95a	16a	1025bc	1.5ab	55ab	1.5ab
Ife BPC	42bc	46ab	85bc	14a	895de	3.0a	30bc	1.5ab
Ife Brown	40bc	45ab	85bc	12ab	875de	3.5a	35bc	1.5ab
Ife 98-12	45ab	48ab	84bc	15a	825de	3.0a	28cd	1.5ab
IT84S-2246-4	45ab	40bc	85bc	14a	1066ab	1.5ab	60a	0.4d
IT86D-715	43bc	46ab	83bc	13a	1138a	1.5ab	50ab	1.5ab
IT90K-277-2	43bc	42bc	80cd	15a	956cd	3.0a	50ab	1.5ab
IT91K-180	45ab	42bc	85bc	15a	1078ab	1.5ab	50ab	1.5ab
IT93K-573-1	40bc	43bc	90ab	14a	1132a	1.2ab	55ab	1.6a
IT95K-1491	42bc	40bc	85bc	10bc	932cd	2.8a	30bc	1.2bc
IT96D-610	41bc	47ab	80cd	13ab	985cd	3.0a	35bc	1.5ab
Tade Brown-4	45ab	49ab	85bc	15a	952cd	3.0a	29cd	1.5ab
TV2 393	39bc	48ab	83bc	10bc	875de	3.0a	30bc	1.5ab
TVU 1190	35cd	40bc	85bc	12ab	958cd	2.0ab	35bc	1.8a
TVX 3236	35cd	40bc	80cd	12ab	1038bc	1.3ab	53ab	1.5ab
Year								
2002	41.9a	44a	84a	12.9a	980a	2.20a	41.8a	1.38a
2003	42.2a	45a	86a	13.7a	984a	2.44a	42.2a	1.50a
Mean	42	44.5	85	13.3	982	2.32	42	1.44

Source Adegbite et al. (2005).
[Z]Values are average of 10 plants. Means followed by the same letter in the same column are not different (P< 0.05), according to Duncan's multiple range test.

660' and 'IT96D794' are resistant to cowpea aphid-borne mosaic virus, blackeye cowpea mosaic virus and cowpea mosaic virus (Shoyinka et al., 2005). Sources of resistance are also available for other fungal disease pathogens, including anthracnose, Cercospora leaf spot and brown blotch.

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