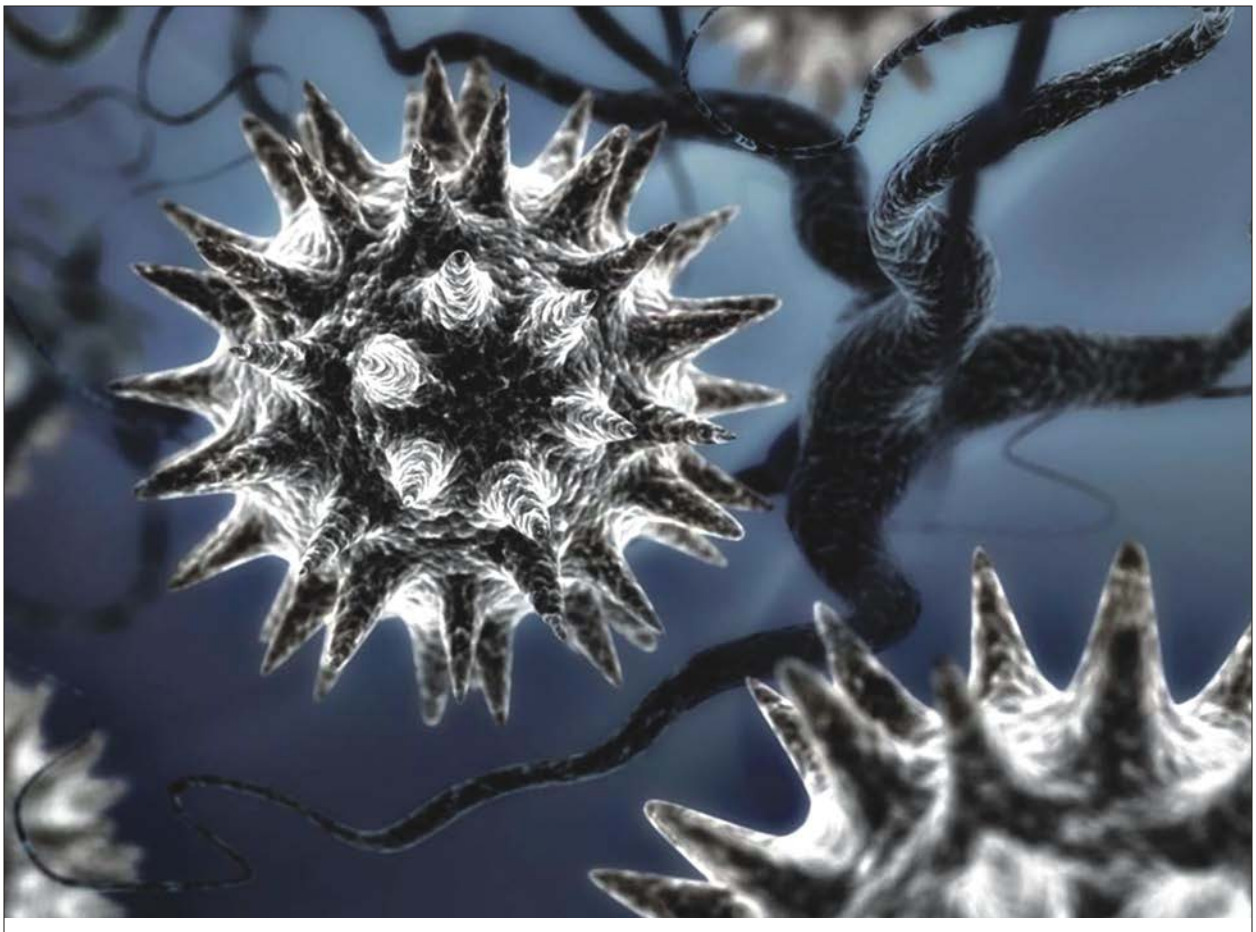

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Screening Cucumber Plant Introduction Accession Lines for Resistance against Cucumber Strain of *Papaya ringspot virus* (PRSV)

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ABSTRACT

Cucumber is a popular fruit vegetable widely cultivated in Odukpani and Akamkpa local government areas of Cross River State, Nigeria, supplying the consumption needs of the nearby metropolitan Calabar City dwellers. However, its cultivation is threatened by infection by *Papaya ringspot virus* watermelon strain (PRSV-W). This study provides the result of screen house evaluation of USDA Plant Introduction (PI) accessions lines of cucumber for resistance to a Nigerian cucumber strain of PRSV-W. The response of the lines showed a spectrum of reactions to the virus strain from the extremely susceptible ones, that could not withstand the virus infection to the immune that were uninfected by the virus. Out of the 187 accession lines screened, 22 immune lines (PI 391570, PI 419010, PI 419017, PI 432873, PI 432877, PI 432878, PI 432895, PI 489752, PI 137845, PI 211979, PI 211984, PI 605924, PI 606010, PI 227207, PI 390253, PI 223437, PI 118279, PI 422200, PI 525152, PI 406473, PI 390952 and PI 357867) were identified. Besides, 17 others (PI 118807, PI 163217, PI 165509, PI 175121, PI 177364, PI 179263, PI 212985, PI 215589, PI 217644, PI 220791, PI 234517, PI 249562, PI 267746, PI 271326, PI 344384, PI 358813 and PI 358814) showed high tolerant and eight others were moderately tolerant to the virus. The remaining 140 PI lines were very susceptible to the virus. The identification of completely immune and highly tolerant PI accession cucumber lines in this study points the availability at the USDA germ plasm collections of potential materials that could be included in breeding programs to develop high resistant varieties of cucumber to PRSV-W.

Key words: Cucumber accession lines, *Papaya ringspot virus* (PRSV-W), susceptible, tolerant, immune

INTRODUCTION

Cucumis sativus L. (*Cucurbitaceae*), commonly known as cucumber, is believed to have originated in India (Renner *et al*., 2007), where a great many varieties have been observed and has now been introduced to other parts of the world. It is cultivated for its fruits which are eaten fresh or used in the preparation of sandwiches and salads. It is also reported to be a rich source of phytonutrients such as vitamins B1, C, K and essential minerals (Abiodun and Adeleke, 2010). Cucumber varieties have also been reported to provide valuable antioxidant, anti-inflammatory and anti-cancer substances in the diet (Lee *et al*., 2010; Kumar *et al*., 2010; Nema *et al*., 2011).

Papaya ringspot virus (PRSV), previously described as *Watermelon mosaic virus*-1 (WMV-1), (Purcifull *et al*., 1984) is a potyvirus transmitted by a number of aphid species in a style-borne

manner (Gonsalves and Ishii, 1980) and considered a major production constraint to papaya and cucurbit production worldwide (Gonsalves *et al*., 2010; Mohammed *et al*., 2012). Two biotypes are recognized, the papaya infecting biotype (PRSV-P) which infects papaya and cucurbits and the PRSV-W that infects only cucurbits (Tripathi *et al*., 2008). PRSV-W which has been reported to as a major limiting factor for watermelon production worldwide (Guner *et al*., 2002; Strange *et al*., 2002), has been found to be transmitted in a stylet-borne manner by 24 aphid species in 15 genera with *Myzus persicae*, *Aulacorthum solani*, *Aphis craccivora* and *Macrosiphum euphorbiae* as natural vectors (Purcifull *et al*., 1984). Reports of the occurrence of PRSV in cucurbits from Africa abound. The PRSV-P has been reported on *Cucurbita pepo* in Egypt (Omar *et al*., 2011), on *C. maxima* in Sudan (Mohammed *et al*., 2012), in *Carica papaya* in Nigeria (Taylor, 2001) and Cote d'Ivoire Diallo *et al*. (2007) while the PRSV-W biotype has been reported in cucumber in Nigeria (Owolabi *et al*., 2008).

From the review of literature, resistant accessions have been identified in several crop germ plasm against viruses of economic significance. These include cowpea (Bashir *et al*., 2002), okra (Rashid *et al*., 2002), soybean (Arif and Hassan, 2002), watermelon (Strange *et al*., 2002; Guner, 2004), bottlegourd (Ling and Levi, 2007), urbean (Ashafaq *et al*., 2007), cotton (Ahmad *et al*., 2010) and potato (Ahmad *et al*., 2011; Batool *et al*., 2011). Others include mungbean (Iqbal *et al*., 2011; Mondol *et al*., 2013), tomato (Imran *et al*., 2012; Osei *et al*., 2012) and chilli pepper (Ashafaq *et al*., 2014).

The cultivation of *C. sativus* has become a thriving business in Odukpani and Akamkpa local government areas of Cross River State, Nigeria, providing jobs for the local folks and meeting the consumption needs of the nearby metropolitan Calabar city dwellers. However, all the local varieties available for cultivation are susceptible to a PRSV-W strain isolated from cucumber in which it elicited mosaic, leaf malformation, rugosity, conspicuous green vein-banding and stunting (Owolabi *et al*., 2008).

Several approaches have been adopted for the management or control of virus diseases of plants. These include cross protection (Gonsalves, 2004; Zhou and Zhou, 2012), interference with vector activities (Murphy *et al*., 2009), obtaining virus-free plant materials through meristem culture (Shiragi *et al*., 2008; El Far and Ashoub, 2009), thermotherapy (Arif *et al*., 2005; Panattoni *et al*., 2013), coat protein mediated resistance (Bendahmane *et al*., 2007; Srivastava and Raj, 2008; Mehta *et al*., 2013) and the use of transgenic lines (Yu *et al*., 2011).

Although, some of these approaches may make valuable contributions to virus disease management in specific favourable situations, they sometimes are of little practical benefits. Planting resistant varieties, in many cases, appears to offer a more practical option in controlling plant virus diseases. The aim of the present study was to evaluate 187 accession lines of *C. sativus* with a view to identifying resistant lines that could provide genetic material for breeding resistance against PRSV-W in Nigeria.

MATERIALS AND METHODS

Source of accession lines: A total of 187 accession lines of *C. sativus* var. *sativus*, [except *C. sativus* var. *hardwickii* (PI 215589)], were sourced from the United States Department of Agriculture, Agriculture Research Station (USDA-ARS), Iowa State University Regional Plant Introduction Station and certified virus-free by Plant Germ plasm Quarantine Centre, Beltville,

Maryland (USA). The accessions lines had their origin from Africa, Asia, Europe and the Americas (33 countries in all). Countries with most accessions included India with 40, China 25, Turkey 17, Japan 16 and Iran 13. Other had less than 10 or fewer.

PRSV virus isolate: The PRSV-W strain used in the study was that described by Owolabi *et al.* (2008) and maintained on *Cucumeropsis manni* (Naudin) in the screen house.

Planting and inoculation procedure: Five seeds of each of the accession lines were sown in 20×16 cm polyethylene bags containing heat-sterilized garden soil. The cotyledonary leaves (8-day old seedlings), pre-dusted with 600-mesh carborundum were mechanically inoculated with the PRSV strain in 0.03 mM Na_2HSO_4, pH 8.00 inoculation buffer. Leaf to buffer ratio was 1:5 (1 g infected leaf to 5 mL of buffer). Three buffer-inoculated seedlings of each accession line served as controls.

The inoculated seedlings were promptly rinsed with water, kept in an insect-proof screen house at 27±°C in the University's Botanical Garden and left for symptom development for over a period of 21 days. Plants that did not show symptoms of infection were back-indexed on *C. manni* that had been reported to be readily susceptible to the virus (Owolabi *et al*., 2008) to check for latent infection.

Disease rating/determination of degree of susceptibility to PRSV: The germ plasm accession lines were evaluated against their response to the virus on a scale of 0-4 according to Bashir *et al*. (2002) with some modifications on the basis of viral symptoms where, 0 = immune (inoculated plants did not show symptoms and no virus recovered after back-indexing, 1 = highly tolerant (inoculated plant showed mild mottle and no apparent reduction in plant growth), 2 = moderately tolerant (inoculated plant showed mosaic, green vein-banding, leaves not malformed and no apparent reduction in leaf size), 3 = susceptible (stunting of inoculated plants, leaf malformed and accompanied by reduction in leaf size) and 4 = highly susceptible (apical necrosis leading growth cessation).

RESULTS

Reaction of accession lines to PRSV: The reaction of the cucumber accession lines to PRSV inoculation showed a spectrum of responses from complete lack of symptom induction to severe disease reactions (Fig. 1a-i and Table 1) and in some cases, growth cessation occasioned by shoot tip necrosis and eventual death of inoculated seedlings. Some of the symptoms observed included severe leaf malformation and reduction in leaf size (Fig. 1a-e), rugosity (blistering), (Fig. 1f) mosaic and green-vein banding and (Fig. 1h) no symptom at all (Fig. 1i).

Disease rating: Five categories of accessions lines were identified based on the criteria earlier defined. These were the immune lines, the highly tolerant, the moderately tolerant, the susceptible and the highly susceptible lines. The results showed that a significant number of the accession lines, 128 out of the 187, belonged to the susceptible category, representing about 68.45% of the total accession lines screened (Table 2) while, 22 (about 11.76%) were adjudged immune.

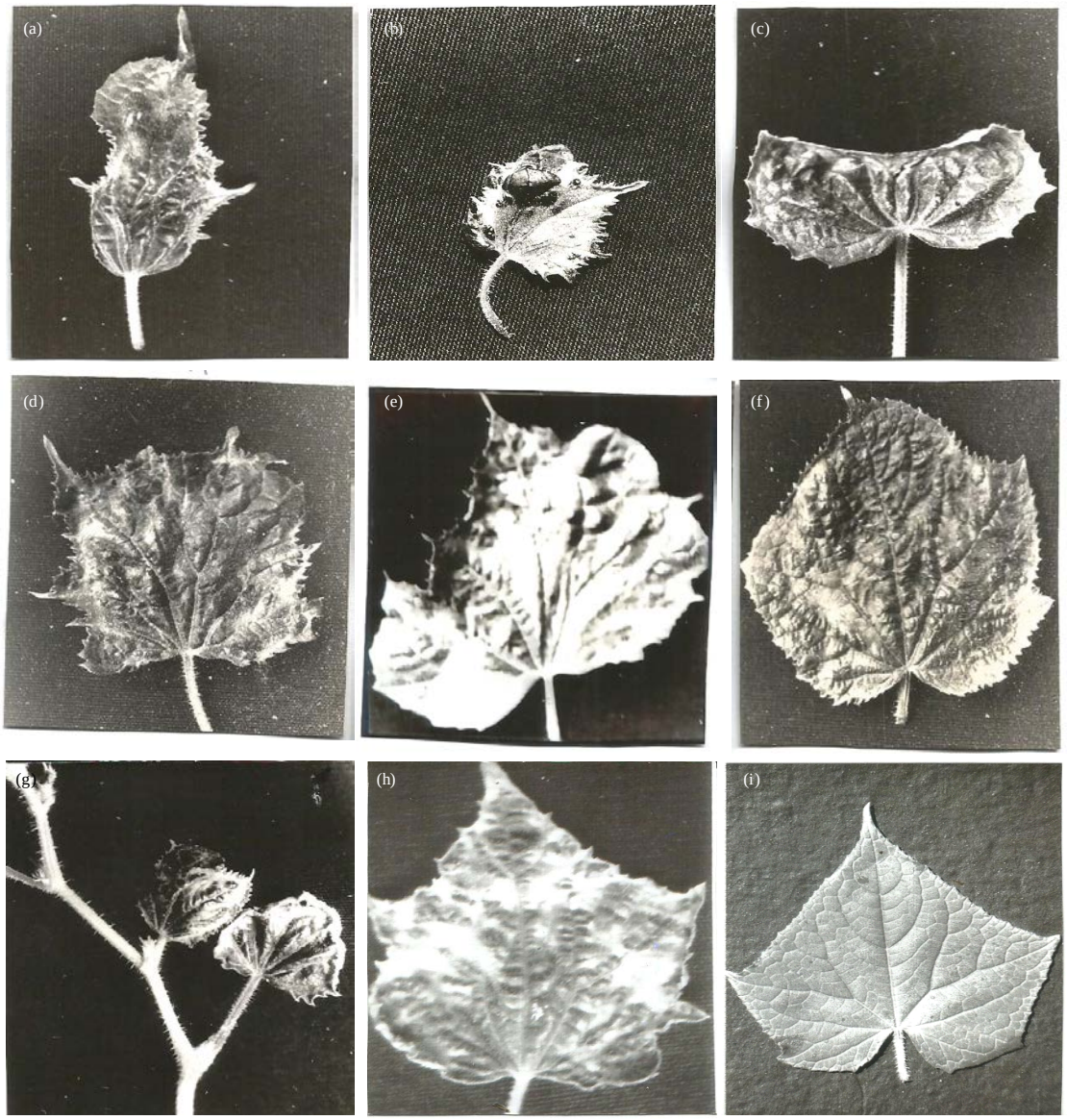

Fig. 1(a-i): Symptoms elicited in some accession lines of *Cucumis sativus* var. *sativus* to inoculation with Nigerian cucumber isolate of *Papaya ringspot virus*, (a) (PI 137856, Iran), (b) (PI 285607, Poland), (c) (PI 176523, Turkey), (d) (PI 169395, Turkey), (e) (PI 271327, India) showing various forms of leaf malformations, (f) (PI 483342, China) showing rugosity while, (g) (PI 220338, Afghanistan), (h) (PI 432891, China) exhibited mosaic and green-vein banding and (i) Shows healthy control

Out of the 22 immune lines eight (PI 391570, PI 419010, PI 419017, PI 432873, PI 432877, PI 432878, PI 432895 and PI 489752) were of Chinese origin, three (PI 137845, PI 211979 and PI 211984) from Iran, two each from India (PI 605924 and PI 606010) and Japan (PI 227207 and PI 390253) and one each from Afghanistan (PI 223437), Brazil (PI 118279), Czech Republic (PI 422200), Egypt (PI 525152), Netherlands (PI 406473), Russia Federation (PI 390952) and Yugoslavia (Slovania) (PI 357867).

Table 1: Accession lines, countries of origin and reactions to Nigerian cucumber strain of *Payaya rinspot virus* countries of origin

Serial no.	Country of origin	State	Plant introduction number	Reaction to virus	Backindexing
1	Afghanistan	-	135345	LM, RLS, GC	
2		Badak	211728	ST, LM, Ru, RLS	
3		Nanga	212599	ST, LM, GVB, Ru	
4		Kabul	207476	ST, Mo, GVB	
5		Herat	220790	ST, GVB, RLS, GC	
6		Kondo	220338	ST, RLS, GVB	
7		Kabul	220791	Mot	
8		Pakti	221440	GVB, Chl,	
9		Pakti	222099	ST, RLS, Mot	
10		Badak	223437	NS	VNR
11	Brazil	San paulo	118279	NS	VNR
12		San paulo	267745	ST, GVB, Ru	
13	China	Beijing	103049	Mo, LM,	
14		-	257987	ST, Mo, GVB,	
15		Shaanxi	391570	NS	VNR
16		Shaanxi	391573	ST, LM	
17		-	419009	ST, LM, Mo	
18		-	419010	NS	VNR
19		-	419017	NS	VNR
20		-	432855	LM, GVB	
21		-	432858	ST, LM, Mo	
22		-	432860	LM, Mot	
23		-	432867	ST, LM,, Mo, RLS	
24		-	432868	LM, Mo	
25		-	432871	RLS, Ru, ST	
26		-	432873	NS	VNR
27		-	432877	NS	VNR
28		-	432878	NS	VNR
29		-	432886	Mo, ST	
30		-	432891	LM, Mo, GVB, Ru	
31		-	432892	Mo, ST, RLS, GVB	
32		-	432894	RLS, ST, GVB	
33		-	432895	NS	VNR
34		-	436648	RLS, GVB, ST	
35		-	483342	Mo, Ru, LM	
36		-	489752	NS	VNR
37		-	504816	RSL, Mot, ST	
38	Czech republic	-	422181	LM, Mot, ST	
39		-	422184	LM, Mot, ST	
40		-	422200	NS	VNR
41	Egypt	-	288238	LM, De, Ru	
42		-	525152	NS	VNR
43		-	525153	GVB, Mot, ST	
44	Ethiopia	Shewa	193497	LM, RLS, Mo, ST	
45	France	-	264227	LM, Ru, ST	
46	Hungary	-	288996	LM, RLS, De	
47	India	Tamil nadu	164284	Mo, LM, ST, GVB	
48		Karnataka	164734	LM, RLS, ST	
49		Uttar prad	165509	Mo	
50		Uttar prad	175111	LM, ST, RLS, Mot	
51		Uttar prad	175121	Mot	
52		Rajastan	179678	LM, RLS, ST, Mo	
53		Gujarat	183056	Mot	
54		Madhya prad	183445	Mot, LM	
55		Assam	197085	Mo, LM, ST	
56		Assam	197086	GVB, LM, Mo, Ru	
57		Assam	197087	Mo	
58		Assam	197088	Mot, GVB	
59		Maharashtra	212985	Mot	

Table 1: Continue

Serial no.	Country of origin	State	Plant introduction number	Reaction to virus	Backindexing
60		Uttar prad	215589	Mot	
61		New delhi	217644	Mo	
62		Maharashtra	267746	Mo	
63		Maharashtra	271326	Mot	
64		Maharashtra	271327	LM, GVB, Mo	
65		Maharashtra	271328	Mo, GVB, ST	
66		Gujarat	288332	Mo, LM, ST	
67		Kerala	370019	LM, Mo, RSL,	
68		Madhya prad	504564	LM, GVB	
69		Rajasthan	605911	Mo, LM, RLS, GVB	
70		Rajasthan	605913	LM, Mot	
71		Rajasthan	605914	GVB, Mo, ST, LM	
72		Madhya prad	605915	Mo, LM,ST	
73		Rajasthan	605918	Mot, LM, ST	
74		Rajasthan	605919	Mot, LM, RLS	
75		Rajasthan	605922	Mo, LM, ST, GVB	
76	India	Rajasthan	605924	NS	VNR
77		Madhya prad	606010	NS	VNR
78		Madhya prad	606011	LM, Mot, GVB	
79		-	606016	LM, Mot	
80		-	606024	LM, Ru	
81		-	606032	Mot, GVB	
82		-	606033	LM, ST	
83		-	606046	ST, Ru	
84		Uttar prad	606050	ST, Ru	
85		-	606051	GVB, ST, RLS	
86	Iran	-	606067	GVB, LM, ST	
87		Fars	137839	Mo, LM, ST	
88		Mazandaran	137845	NS	VNR
89		Yazd	137846	Mo, GVB, LM, ST	
90		Fars	137856	Mo, GVB, LM, ST	
91		Zanjan	211962	GVB, LM, ST, RLS	
92		West azerbai	211979	NS	VNR
93		West azerbai	211984	NS	VNR
94		Mazandaran	211985	Mo, GVB, GC	
95		Kerman	226510	Mo, GVB, GC	
96		Khuzestan	227013	Mo, LM, GC	
97		-	296387	Mo, RLS, ST	
98		West azerbai	344438	Mo, RLS, GVB, ST	
99		Teheran	344442	LM, RLS, ST	
100	Iraq	-	177364	Mot	
101	Israel	-	292012	RLS, LM, ST, Ru	
102	Japan	-	227207	NS	VNR
103		-	279467	Mo, LM, ST	
104		-	390243	Mo, ST, Ru	
105		-	390248	Mot, LM	
106		-	390251	Mot, LM, ST	
107		-	390253	NS	VNR
108		-	390257	Mo, GBV, ST	
109		-	390264	Mot. LM	
110	Japan	-	400270	LM, GVB, LM, Ru	
111		-	432852	LM, GVB	
112		-	432865	Mo, LM, Ru	
113		-	451970	Mot, ST, Ru	
114		-	532521	Mot, LM	
115		-	532522	Mo, GVB, ST, Ru	
116		-	532523	Mot, LM	
117		-	532524	Mot, GVB, LM	
118	Kenya	-	385967	Mo, GVB, ST	

Table 1: Continue

Serial no.	Country of origin	State	Plant introduction number	Reaction to virus	Backindexing
119	Lebanon	-	181755	Mo, RLS, ST	
120	Malaysia	Kuala lumpur	358813	Mot	
121		Kuala lumpur	358814	Mot	
122	Netherlands	-	255937	GVB, RLS, LM, ST	
123		-	275410	Mo, LM, ST	
124		-	372893	GC	
125		-	406473	NS	VNR
126	Pakistan	Punjab	163217	Mot	
127		Punjab	258147	Mo, Ru, LM, ST	
128		North western	269480	Mo, LM, ST	
129		-	330628	Mo, Ru, LM, ST	
130	Philippines	Luzon	188807	Mot	
131		-	426169	Mot, LM	
132		-	426170	Mot, LM	
133	Poland	Warszawa	285607	Ru, LM, ST LM,	
134		Warszawa	369717	Ru, RSL, GC	
135	Russia fed	-	263079	Mo, Ru, ST	
136		-	390952	NS	VNR
137	South korea	Seou	484340	LM, RLS, GVB, ST	
138		Seou	483399	GVB, Ru, ST	
139		Inch	508452	Mot, LM, ST	
140		Inch	508455	Mot,GVB	
141		Inch	508456	Mo, LM, RLS, ST	
142		Inch	508457	Mo, Ru, LM	
143		Inch	508458	Mo, ST	
144		Inch	508459	Mot, ST	
145	Sweden	-	205995	Mot, ST	
146	Taiwan	-	321008	GVB, Ru, ST	
147		-	321009	Mot, Ru	
148		-	321011	Mo, LM, RLS	
149	Thailand	-	249561	Mot, GC	
150		-	249562	Mot	
151	Turkey	-	109484	LM, RLS, ST	
152		Icel	167223	LEY, ST, RLS	
153		Canakkale	169351	Mo, LM, ST	
154		Canakkale	169392	Mo, LM, ST	
155		Bursa	169395	GVB, LM, LEN	
156		Gumushane	171613	Mo, GVB, LM, ST	
157		Urfa	174166	Mo, LM, RLS, ST	
158		Nigde	175689	GC	
159		Kayseri	176519	Mo, LM, GVB, RLS	
160		Afyon	176523	GVB, LM, RLS, ST	
161		Bilecik	176525	Mo, LM, RLS, ST	
162		Samsun	176950	Mo, GVB, LM, ST	
163		Cankiri	178886	LEN, GVB, Ru	
164		Slirt	179263	Mot	
165		Balikesir	182192	Mo, LM, ST	
166		Kayseri	204568	CL, GC	
167		Trabzon	344384	Mot	
168	United kingdom	#VALUE!	274902	Ru, RLS, GC	
169	United states	Ohio	209064	Mot, Ru, GVB, LM,	
170		Ohio	209068	LEY, LM, GVB, ST	
171		Ohio	209069	LM, ST	
172		Sou	234517	Mot	
173		Hawaii	414158	Mo, GVB, LM	
174	†USSR (Former soviet union)	-	351140	LM, ST	
175	Uzbekistan	-	540415	GVB, Ru, ST	
176		-	540416	GVB, LM, RLS, Ru	
177	†Yugoslavia	-	357839	Mot, LM, ST	

Table 1: Continue

Serial no.	Country of origin	State	Plant introduction number	Reaction to virus	Backindexing
178	Slovania	-	357857	Ru, LM, ST	
179		-	357867	NS	VNR
180		-	368557	Ru, ST, GC	
181		-	368559	Mo, RLS, ST	
182		-	379283	Mo, GVB, LM, ST	
183		-	379279	Mot, Ru, RLS	
184	Zambia	-	500360	Mot, VC, LM, RLS	
185		-	500361	Mot, LM, ST	
186	Zimbabwe	-	482463	Mot, Ru, ST	
187		-	482464	Mot, Ru, ST	

GC: Growth cessation, LM: Leaf malformation, RLS: Reduced leaf size, Ru: Rugosity, GVB: Green vein-banding, Mo: Mosaic, Mot: Mottle, Chl: Chlorosis, NS: No symptoms, De: Defoliation, VC: Veinal chlorosis, LEY: Leaf edge yellowing, LEN: Leaf edge necrosis and VNR: Virus not recovered, †Some of the countries like USSR and Yugoslavia have ceased to exist as a result of political restructuring

Table 2: Grouping of cucumber germ plasm accession lines tested against Nigerian cucumber strain of *Papaya ringspot virus*

Disease[a] rating	Plant introduction accession lines falling under each category
0	PI 118279, PI 137845, PI 211979, PI 211984, PI 223437, PI 227207, PI 391570, PI 357867, PI 390252, PI 390952, PI 406473, PI 419010, PI 419017, PI 422200, PI 432873, PI 432877, PI 432878, PI 432895, PI 489752, PI 525152, PI 605924, PI 606010.
1	PI 118807, PI 163217, PI 165509, PI 175121, PI 177364, PI 179263, PI 212985, PI 215589, PI 217644, PI 220791, PI 234517, PI 249562, PI 267746, PI 271326, PI 344384, PI 358813, PI 358814.
2	PI 183056, PI 183445, PI 197087, PI 197088, PI 221440, PI 321009, PI 508455, PI 606032.
3	PI 103049, PI 109484, PI 137839, PI 137846, PI 137856, PI 164284, PI 164734, PI 167223, PI 169351, PI 169392, PI 169395, PI 171613, PI 174166, PI 175111, PI 176519, PI 176523, PI 176525, PI 176950, PI 178886, PI 179678, PI 181755, PI 182192, PI 193497, PI 197085, PI 197086, PI 205995, PI 207476, PI 209064, PI 209068, PI 209069, PI 211728, PI 211962, PI 212599, PI 222099, PI 220338, PI 255937, PI 257987, PI 258147, PI 263079, PI 264227, PI 267745, PI 269480, PI 271327, PI 271328, PI 275410, PI 279467, PI 285607, PI 288238, PI 288332, PI 288996, PI 292012, PI 296387, PI 321008, PI 321011, PI 330628, PI 344438, PI 344442, PI 351140, PI 357839, PI 357857, PI 368559, PI 370019, PI 379279, PI 379283, PI 385967, PI 390243, PI 390248, PI 390251, PI 390257, PI 390264, PI 391573, PI 400270, PI 414158, PI 419009, PI 422181, PI 422184, PI 426169, PI 426170, PI 432852, PI 432855, PI 432858, PI 432865, PI 432867, PI 432868, PI 432871, PI 432886, PI 432891, PI 432892, PI 432894, PI 432860, PI 436648, PI 451970, PI 482463, PI 482464, PI 483340, PI 483342, PI 483399, PI 500360, PI 500361, PI 504564, PI 504816, PI 508453, PI 508456, PI 508457, PI 508458, PI 508459, PI 525153, PI 532521, PI 532522, PI 532523, PI 532524, PI 540415, PI 540416, PI 605911, PI 605913, PI 605914, PI 605915, PI 605918, PI 605919, PI 605922, PI 606011, PI 606016, PI 606024, PI 606033, PI 606046, PI 606050, PI 606051, PI 606067.
4	PI 135345, PI 175689, PI 204568, PI 211985, PI 220790, PI 226510, PI 227013, PI 249561, PI 274902, PI 368557, PI 369717, PI 372893. (12)

[a]Disease rating: 0: Immune, 1: Highly tolerant, 2: Moderately tolerant, 3: Susceptible and 4: Highly susceptible

The results also showed that 12 (PI 135345, PI 175689, PI 204568, PI 211985, PI 220790, PI 226510, PI 227013, PI 249561, PI 274902, PI 368557, PI 369717 and PI 372893) were highly susceptible to the virus as they suffered from growth cessation of the apical bud. The remaining 25 (about 13.37%) were found to be tolerant (both moderate and highly).

DISCUSSION

Cucumis sativus is an important fruit vegetative in Cross River, Nigeria. All available varieties under cultivation are readily susceptible to the PRSV-W strain, with concomitant poor growth. In this study, 187 USAD-ARS Plant Introductions of *C. sativus* var. *sativus* were screened against PRSV-W isolate from Nigeria for possible discovery of varieties that could provide materials for resistance breeding programme.

The results of this investigation showed a varying degree of reactions to the cucumber isolate of PRSV-W among *Cucumis sativus* var. *sativus* germ plasm collection from the USDA-ARS. A preponderance (about 67.02%) of the accession lines was susceptible to the virus. Similar observations have been made with respect to some cucurbits screened against viruses of economic

importance. Strange *et al.* (2002) found that a greater majority of 1248 accession lines of watermelon were susceptible to PRSV-W. The report of Ling and Levi (2007) also showed that 90 (47.37%) of the 190 screened were susceptible to the Florida strain of ZYMV and Kousik *et al.* (2009) did not detect resistance to *Squash yellowing vein virus* (SqVYV) among PIs 218 watermelon accession lines obtained from USDA germplasm collection as all were susceptible to the virus with varying degree of reactions.

Germ plasm collections have become veritable sources of genetic materials for possible breeding programmes against plant viruses. The result of this study demonstrated that no fewer than 22 were completely immune to the PRSV-W strain. These were PI 391570, PI 419010, PI 419017, PI 432873, PI 432877, PI 432878, PI 432895 and PI 489752 of Chinese origin, three (PI 137845, PI 211979 and PI 211984) from Iran, two each from India (PI 605924 and PI 606010), Japan (PI 227207 and PI 390253) and one each from Afghanistan (PI 223437), Brazil (PI 118279), Czech Republic (PI 422200), Egypt (PI 525152), Netherlands (PI 406473), Russia Federation (PI 390952) and Yugoslavia (Slovania) (PI 357867). Completely immune and moderately resistance PI accession lines have been detected among some cucurbit germ plasm sourced from USDA. Strange *et al.* (2002) reported the existence of PRSV-W resistance in eight PI accessions: three accessions from South Africa (PI 244017, PI 244018 and PI 244019), in three accessions from Zimbabwe (PI 482342, PI 482318 and PI 482379), one accession from Botswana (PI 485583) and one accession from Nigeria (PI 595203) in watermelon germ plasm collection from the USDA. Ling and Levi (2007) also found that of the 190 *Lagenaria siceraria* PIs screened, 30 were completely immune to the Florida strain of ZYMV while Kousik *et al.* (2009) reported the existence of moderate resistance in two C. colocynthis (PI 386015 and PI 386024), a Praecitrullus fistulosus (PI 381749) and two *C. lanatus* var. *lanatus* PIs (PI 482266 and PI 392291 to *Squash vein yellowing virus* (SqVYV). On the other hand, Habib *et al.* (2007) reported that none of 254 lines of mungbean was found to be resistant to MYMV while 247 lines were highly susceptible to the virus.

The USDA watermelon and other cucurbit germ plasm collections have been extensively screened for resistance to PRSV-W and ZYMV. This is the first report of screening cucumber accessions line for resistance against PRSV-W.

CONCLUSION

The result of the present study demonstrates that there is significant genetic resistance to PRSV-W among USDA *C. sativus* var. *sativus* germ plasm collections. The twenty two accessions so identified are potential sources of genetic materials for cucumber breeding against the virus.

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