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Reaction of selected cassava cultivars to cassava anthracnose disease (CAD) in Nigeria

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Key words
Anthracnose disease, cassava, resistance, severity, Nigeria

1 SUMMARY

The objective of this work was to determine reaction of selected cassava cultivars to anthracnose disease (CAD). Eighteen cultivars were evaluated over 3 years (2003-2006) and assessed for natural CAD infection between 2 - 6 months after planting. The assessment of CAD incidence was based on observations of symptoms on naturally infected plants fortnightly for 12 months. The height of the first canker from the ground level (mm) was measured and the number of cankers per plant counted. The length and the diameters of the cankers on each infected stem were measured and the area was calculated using the formula for area of a circle (πr^2) fortnightly for 6 months. Disease incidence in all trials was recorded as the percentage of infected plants in each host plant line. Cultivar TMS 30211, TMS 4(2)1425 and TMS 30001 had cankers high up on the stem (400 -1,530 mm) which showed that they were not attacked in the early stages of growth. Cultivars Akwakwuru, 91/02324, Nwageri, 97/3200, 96/1642, TMS 30572 and TMS 91934 had cankers closer to the ground (50.7 – 225 mm), indicating that they were infected in the early stages of growth. Cultivars TMS 30555, 96/1642, 91/02324, Nwaocha, Akwakwuru and Nwageri had high disease severity score ranging from 3.35 - 4.0 and large cankers of size 8.5 – 32.5 mm^2. These susceptible cultivars are not recommended to farmers or breeding programmes because their use would lead to build up and spread of CAD. Cultivars TMS 91934, TMS 4(2)1425, TMS 30211, TMS 30001 and 98/0510 had small cankers of size 1.8 -13.5 mm^2 in the first trial year (2003-04) and low severity score ranging from 1.0 – 2.26 in the third trial year (2005/06), and did not develop any cankers in the third trial (2005/06).With these desirable characteristics, these cultivars are regarded as resistant and can be recommended for cultivation by farmers and further use in research .

2 INTRODUCTION

Cassava produces abundant and affordable food all the year round and the crop tolerates extreme stress conditions well (DeVries *et al*, 1967). It plays a major role in the effort to alleviate food scarcity in Africa (Chinaka *et al*., 1995). Cassava is one of the least risky food crops to produce in Africa because of its ability to tolerate and recover from drought and disease and pest attacks when favourable conditions return (Hahn & Keyser, 1985). It is one of the most important root crops in the tropics, and a preferred crop for resource poor

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farmers in most of sub-Saharan Africa (IITA, 1990). In tropical Africa, cassava is cultivated mainly for its storage roots (Cock, 1982; Hahn, 1989) though leaves are also consumed in some areas.

Cassava anthracnose disease (CAD) is characterized by light to dark-brown oval lesions, depressions which develop into deep cankers on the soft green stems and at leaf axils. *C. gloeosporioides* (Penz)f.sp. *manihotis* Chev. is the causal agent of CAD and it attacks the tissues that are weakened by the puncture and the lytic action of the saliva of the insect *Pseudotheraptus devastans* Dist., thus inducing dark brown lesions. CAD can cause significant loss of planting materials; or result in a decrease of 20-45 % germination (IITA, 1990; Fokunang *et al*., 1999b), and even total crop failure (Makambila, 1987). The fungal spores are dispersed by rain and require high humidity for infection (Muimba-Kankolongo, 1982). The deeper cankers affect plant-conducting tissues, leading to poor plant vigour, severe wilting, and defoliation (Fokunang *et al*., 1999a; Van der Bruggen & Maraite, 1987). These cankers serve as entry points for other pathogens such as *Agrobacterium manihotis*, which causes crown gall disease in South America, as well as stem, root and tuber-rotting organisms such as *Sphaerostilbe repens* and *Armillaria mellea* (Lozano & Booth, 1974; Akinyele & Ikotun, 1989).

The objective of this work was to assess the reaction of selected cassava cultivars to CAD, and identify cultivars that are adapted to the environment thus can be adopted by the local farmers.

3 MATERIALS AND METHODS

The study site was located at the Teaching and Research Farm of the Federal University of Technology, Ihiagwa, Owerri. The University is located between latitudes 5° 23'N and 5°24'N and longitudes 6°59'E and, 6°58'E .The site is situated in the rain forest zone of south-eastern, Nigeria, in Owerri West Local Government Area, Imo state. Thirteen improved cassava cultivars were obtained from the International Institute of Tropical Agriculture (IITA), Ibadan. The cultivars were Tropical *Manihot esculenta* (TME) 117 (Isunikankiyan), 92/0326, 92/0067, 91/02324, 97/3200, 96/1642, 98/0510, Tropical *Manihot* Selection: (TMS) 91934, 4(2)1425, 30001, 30211, 30572 and 30555. Two improved cassava cultivars were obtained from the National Root Crop Research Institute, Umudike, Umuahia, Abia State. The two cultivars were National Root (NR) 8212 and NR 8082. Cultivars Nwaocha, Nwageri and Akwakwuru are the local varieties and were obtained from local farmers at Ihiagwa village, Owerri West Local Government Area.

Eighteen cultivars were used for the study and these comprised the treatments. An experimental site of an area of 1820 m^2 (0.182 ha) was cleared, ploughed and harrowed. The experiment was laid out in a randomized complete block design, with each of the eighteen treatments replicated thrice. Each plot size was 10 m by 2 m with a border of 1 m between plots; and block size was 65 m by 8 m with a border of 2 m between blocks. The ridges, spaced at 1 m apart, were 30 cm high and 10 m long. Stem cuttings about 25 – 30 cm long were planted 1 m apart on the ridge crests. The total plant population density was 10,000 plants per hectare. The eighteen cultivars were planted over 3 years (2003-2006) and harvested 12 months later. No fertilizers or herbicides were applied during the course of the study. Hand weeding was done fortnightly. The height of the plants was measured vertically from the base to the terminal bud with a graduated ruler fortnightly for 6 months. Between 2 and 6 months after planting (MAP), plants were observed for the natural development of CAD symptoms. The incidence of CAD development was observed on green cassava stems of naturally infected plants. These were assessed using the parameters outlined below: Disease severity was scored on a scale of 1-5 by the method of Ikotun and Hahn (1991) where: 1 = No symptom (resistant); 2 = Development of shallow cankers lower on the stem; 3 = Development of successive cankers higher up the plant with older cankers becoming larger and deeper; 4 = Development of dark brown lesions on green shoots, petioles and leaves. Young shoots collapse and are distorted; and 5 = Wilting and drying up of shoots and young leaves and death of part of or whole plant.

The height of the first canker from the ground level (mm) was measured with a graduated

meter ruler and the number of cankers per plant was also counted. The length and the diameters of all the cankers on each infected stem was measured with a ruler and the infected area was calculated using the formula for area of a circle (πr^2) fortnightly for 6 months. Cankers on the following parts of the stem were measured: shoots, young stems, maturing stems, and matured stems. The final height of all the stems of each stand was also measured at 6 months after planting.

Disease incidence in all trials was recorded as the percentage of infected plants in each host plant line (Fokunang *et al*., 2001). At the end of 6 MAP, when plants were too high and the canopies had closed up thus making disease severity scoring impracticable. The assessment of the incidence of CAD was based on observations of disease symptoms on naturally infected plants fortnightly for 12 months.

The data from the three years were pooled together and subjected to Analysis of variance (ANOVA) using the generalized linear model (GLM) of SAS analytical package. Treatment means were separated using the Duncan's Multiple Range Test (DMRT). Analysis of correlation was done to establish the relationship between the incidence and yield among the different cultivars.

4 RESULTS

In the first and third trials cv. 96/1642 had the lowest distance of the first canker from the ground level of 208.33 mm (first trial) and 63 mm (third trial), followed by TMS 91934 with 225 mm (first trial), 783.3 mm (second trial) and 50.7 mm (third trial). In the first trial, 2003/04, cv. TME 117 (Isuni), TMS 30555, NR 8082, TMS 4(2)1425, TMS 30211, and TMS 30001 had cankers high up on the stem (583.33mm, 543.33mm, 510mm, 433.33mm, 425mm and 363.33mm, respectively) (Table 1).

Cultivar TMS 4(2)1425 had the smallest size of cankers on the whole plant in both the first and second trials of 1.92 and 3.5 mm^2, respectively. Cv. Akwakwuru had the largest size of cankers in both the first and second trials of 8.53 and 39.6 mm^2, respectively on the whole plant (Table 2). Cv. TMS 4(2)1425 had the smallest size of cankers on maturing stem in both the first trial (1.80 mm^2) and second trial (3.8 mm^2), followed by TMS 30211 which had canker size of 12.9 mm^2 (second trial) and 6.3mm^2 (third trial). Cv. TMS 30555 had the largest size of cankers on maturing stem in both the first trial (6.80 mm^2) and second trial (31.6 mm^2) (Table 3).

Cultivar TMS 4(2)1425 had the lowest number of cankers in both the first trial (7.67) and second trials (1.3), followed by TMS 30211 which had 17.67 in the first trial , 9.7 in the second trial and 2.5 in the third trial. Cv96/1642 which had the highest number of cankers of 262.2 in the second trial, followed by Akwakwuru had 88, in the first trial, and TMS 30572 which had 11.5 in the third trial (Table 4).

Cultivars TMS 30555 and 96/1642 had the highest disease severity score of 4.0, followed by 91/02324 (3.67), while TMS 91934 and TMS 4(2)1425 had the lowest disease severity score of 1.0, followed by and TMS 30211 (1.67) in the first trial (2003/04). In the second trial (2004/05), cultivars Nwaocha, had the highest disease severity score of 3.58, followed by Akwakwuru and Nwageri (3.54 and 3.35 respectively), while TMS 4(2)1425, had the lowest disease severity score of 1.67, followed by 98/0510, TMS 30211 and TMS 30001 (2.0, 2.14 and 2.26, respectively). In the third trial (2005/06), TMS 30211 had the lowest disease severity score of 1.5, (Table 5).

There was consistency of reaction of the different trial years for TMS 4(2)1425 and TMS 30211 in the case of small sized canker, low number of cankers and severity whereas Akwakwuru, 96/1642 and TMS 30555 show consistency in large sized cankers, high number of cankers and high severity throughout the trial years.

5 DISCUSSION

Cultivars TMS 30211 and TMS 30001 had cankers high up on the stem in the first trial (2003/04). This observations suggests that the plants were infected later due to the presence of little or no inoculum during the early stage of growth. This is in line with the findings of Ikotun and Hahn (1991) who reported that cv. 30211 and TMS 30001 had cankers high up on the stem showing that they were infected later in life. Infection at latter stages of growth would lead to more disease–free stems being available for propagation in the next growing season. Thus, with these cultivars, the spread of CAD on the farms would be reduced and healthy cassava stands produced.

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Table 1: Distance of first canker (DFC) from the ground level at 6 Months After Planting

Variety	DFC (mm)		
	1st trial (2003/04)	2nd trial (2004/05)	3rd trial (2005/06)
TME 117 (Isuni)	583.33 ± 76.38a	2331.2 ± 3518.9h	0.0 ± 0.0a
TMS 30555	543.33 ± 110.15a	555.5 ± 1648a	0.0 ± 0.0a
NR 8082	510.00 ± 36.06ab	729.6 ± 1508.8ab	0.0 ± 0.0a
TMS 4(2)1425	433.33 ± 58.59bc	565.5 ± 1668a	0.0 ± 0.0a
TMS 30211	425.00 ± 113.03bc	1531.4 ± 3048.8fgh	97.95 ± 13.85c
TMS 30001	363.33 ± 40.41cd	1022.2 ± 2074.2cd	0.0 ± 0.0a
Nwaocha	333.33 ± 61.10cde	1846.3 ± 3081.8fgh	0.0 ± 0.0a
98/0510	300.00 ± 50.00def	1052.8 ± 2121.3cd	0.0 ± 0.0a
NR 8212	300.00 ± 50.00def	2160.4 ± 3135.7gh	0.0 ± 0.0a
TMS 30572	296.67 ± 47.26def	1355.5 ± 2038.5efg	12.3.0 ± 17.39bc
92/0326	246.67 ± 45.09efg	2293.7 ± 3448.5gh	0.0 ± 0.0a
92/0067	231.67 ± 42.52efg	1092.6 ± 1829.7cde	0.0 ± 0.0a
TMS 91934	225.00 ± 25.00efg	783.3 ± 1459.1ab	50.7 ± 8.78ab
96/1642	208.33 ± 56.20fg	977.8 ± 1956.3bc	63.0 ± 8.91abc
97/3200	190.00 ± 10.00fg	1381.5 ± 2258.5efg	0.0 ± 0.0a
Nwageri	183.33 ± 15.28g	933.5 ± 1906.9bc	0.0 ± 0.0a
91/02324	160.00 ± 52.92gh	1233.3 ± 1882.2def	0.0 ± 0.0a
Akwakwuru	70.00 ± 30.00h	1331 ± 2005.1efg	0.0 ± 0.0a

Means followed by the same alphabet in the same column are not significantly different (P>0.05) by Duncan's New Multiple Range Test (DMRT).

Table 2: Size anthracnose disease cankers (SC) on whole cassava plants at 9 Months After Planting at Owerri, Nigeria.

Variety	SC (mm^2)		
	1st trial (2003/04)	2nd trial (2004/05)	3rd trial (2005/06)
Akwakwuru	8.53 ± 2.82a	39.6 ± 17.1de	0.0 ± 0.0a
98/0510	7.00 ± 3.38ab	11.6 ± 13.8ab	0.0 ± 0.0a
TMS 30001	6.00 ± 1.57abc	33.4 ± 23.9cde	0.0 ± 0.0a
92/0067	5.90 ± 1.73abc	33.5 ± 12cde	0.0 ± 0.0a
91/02324	5.63 ± 2.42abcd	36.7 ± 8.7cde	0.0 ± 0.0a
Nwageri	5.40 ± 2.95abcd	37.9 ± 17.9cde	0.0 ± 0.0a
92/0326	4.60 ± 1.82bcde	30.8 ± 12.9cde	0.0 ± 0.0a
96/1642	4.30 ± 2.10bcdef	26.7 ± 16.9bcde	15.1 ± 2.14bc
97/3200	4.13 ± 1.15bcdef	29.7 ± 13.5cde	0.0 ± 0.0a
NR 8082	4.03 ± 0.55bcdef	20.7 ± 17bc	8.8 ± 1.52abc
TMS 91934	4.00 ± 0.56bcdef	28.9 ± 19.6cde	3.4 ± 0.59ab
TMS 30572	3.80 ± 0.26bcdef	33.6 ± 5.9cde	10.6 ± 1.49abc
TMS 30211	3.57 ± 0.81cdef	24.3 ± 22bcd	20.4 ± 2.88c
NR 8212	3.20 ± 2.07cdef	30.1 ± 13.9cde	0.0 ± 0.0a
Nwaocha	2.35 ± 0.45def	43.7 ± 22.6e	0.0 ± 0.0a
TMS 30555	2.27 ± 0.86def	35.5 ± 20.9cde	0.0 ± 0.0a
TMS 4(2)1425	1.92 ± 0.20ef	3.46 ± 9.8a	0.0 ± 0.0a
TME 117(Isuni)	1.03 ± 0.21f	34.6 ± 9.7cde	0.0 ± 0.0a

Means followed by the same alphabet in the same column are not significantly different (P>0.05) by Duncan's New Multiple Range Test (DMRT).

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Table 3: Size of anthracnose disease cankers on maturing cassava stem (SCM) at 9 Months After Planting at Owerri, Nigeria.

Variety	SCM (mm^2)		
	1st trial (2003/04)	2nd trial (2004/05)	3rd trial (2005/06)
Akwakwuru	7.70 ± 1.41a	24.7 ± 19.6abcd	0.0 ± 0.0a
TMS 30555	6.80 ± 1.76ab	31.6 ± 17.8cd	0.0 ± 0.0a
98/0510	6.50 ± 1.04abc	7.2 ± 14.3ab	0.0 ± 0.0a
Nwageri	6.17 ± 3.17abcd	26.7 ± 24.2bcd	0.0 ± 0.0a
97/3200	5.90 ± 2.01abcde	21.9 ± 19.2abcd	0.0 ± 0.0a
92/0067	5.53 ± 1.03abcdef	17 ± 14.2abc	0.0 ± 0.0a
96/1642	4.90 ± 0.56bcdefg	17.4 ± 16.8abc	9.7 ± 1.37c
92/0326	4.53 ± 0.65cdefgh	23.9 ± 15.9abcd	0.0 ± 0.0a
91/02324	4.40 ± 0.95cdefghi	42.2 ± 26.9d	0.0 ± 0.0a
TMS 30572	4.23 ± 1.38defghij	24.1 ± 20abcd	5.1 ± 0.72ab
NR 8082	3.80 ± 0.89efghij	26.9 ± 27.7bcd	0.0 ± 0.0a
TMS 30211	3.73 ± 1.07efghij	12.9 ± 17.1abc	6.3 ± 0.89abc
NR 8212	3.67 ± 1.60efghij	13.2 ± 14.1abc	0.0 ± 0.0a
TMS 91934	3.40 ± 0.82fghij	16.5 ± 14.5abc	8.2 ± 1.42bc
Nwaocha	3.20 ± 0.20ghij	25.4 ± 16.6bcd	0.0 ± 0.0a
TMS 30001	2.37 ± 0.55hij	22.4 ± 14.5abcd	0.0 ± 0.0a
TME 117 (Isuni)	2.20 ± 0.26ij	26.2 ± 18.1bcd	0.0 ± 0.0a
TMS 4(2)1425	1.80 ± 1.80j	3.8 ± 10.6a	0.0 ± 0.0a

Means followed by the same alphabet in the same column are not significantly different (P>0.05) by Duncan's New Multiple Range Test (DMRT).

Table 4: Number of anthracnose disease cankers (NC) on whole cassava plants at 9 Months After Planting at owerri, Nigeria.

Variety	NC		
	1st trial (2003/04)	2nd trial (2004/05)	3rd trial (2005/06)
Akwakwuru	88.00 ± 16.3b	23.5 ± 10.5cde	0.0 ± 0.0a
91/02324	64.00 ± 16.3b	18.7 ± 7.6bcde	0.0 ± 0.0a
98/0510	58.67 ± 7.09bc	6.5 ± 10.3ab	0.0 ± 0.0a
92/0067	47.33 ± 8.02bcd	11.3 ± 3.1abc	0.0 ± 0.0a
96/1642	44.67 ± 6.81bcd	262.2± 736.2f	2.5 ± 0.35abc
TMS 91934	43.17 ± 0.67bcd	26.8 ± 24.9def	2.7 ± 0.46bc
92/0326	42.33 ± 18.93bcd	29.5 ± 25.5ef	0.0 ± 0.0a
Nwaocha	37.67 ± 11.24cde	25.5 ± 12.28cdef	0.0 ± 0.0a
Nwageri	36.67 ± 7.02cde	18.7 ± 12.2bcde	0.0 ± 0.0a
97/3200	32.00 ± 10.54def	15.9 ± 10.5abc	0.0 ± 0.0a
NR 8082	31.33 ± 5.86defg	17.9 ± 23.7bcd	1.7 ± 0.29ab
TMS 30001	29.67 ± 1.53defg	17.9 ± 26.5bcd	0.0 ± 0.0a
TMS 30572	28.00 ± 3.61defg	25.9 ± 12.9cdef	11.5 ± 1.63c
NR 8212	23.50 ± 11.30defg	13.5 ± 9.9abc	0.0 ± 0.0a
TMS 30211	17.67 ± 2.52efg	9.7 ± 10.8ab	2.5 ± 0.35abc
TMS 30555	16.00 ± 2.65efg	26.2 ± 17.5def	0.0 ± 0.0a
TME 117 (Isuni)	11.33 ± 3.51fg	16 ± 9.9abc	0.0 ± 0.0a
TMS 4(2)1425	7.67 ± 2.08g	1.3 ± 3.5a	0.0 ± 0.0a

Means followed by the same alphabet in the same column are not significantly different (P>0.05) by Duncan's New Multiple Range Test (DMRT).

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Table 5: Anthracnose disease severity scoring at 9 Months After Planting cassava at Owerri, Nigeria.

Variety	Severity score		
	1st trial (2003/04)	2nd trial (2004/05)	3rd trial (2005/06)
TMS 30555	4.00 ± 1.00a	2.8 ± 0.7b	1.0 ± 0.0a
96/1642	4.00 ± 1.00a	1.9 ± 1.6ab	1.5 ± 0.71ab
91/02324	3.67 ± 0.58ab	2.5 ± 1.4ab	1.0 ± 0.0a
98/0510	3.33 ± 0.58abc	1.8 ± 1.2ab	1.0 ± 0.0a
92/0326	3.00 ± 1.00abcd	3.1 ± 0.6b	1.0 ± 0.0a
92/0067	3.00 ± 0.00abcd	2.5 ± 0.9ab	1.0 ± 0.0a
Nwageri	3.00 ± 1.00abcd	3.4 ± 0.9b	1.0 ± 0.0a
97/3200	2.33 ± 0.58bcde	2.6 ± 1.4ab	1.0 ± 0.0a
NR 8212	2.33 ± 1.53bcde	2.8 ± 0.7b	1.0 ± 0.0a
NR 8082	2.33 ± 0.58bcde	2.5 ± 1.1ab	1.0 ± 0.0a
Nwaocha	2.33 ± 1.15bcde	3.8 ± 1.1b	1.0 ± 0.0a
Akwakwuru	2.33 ± 1.53bcde	3.4 ± 1.8b	1.0 ± 0.0a
TME 117 (Isuni)	2.00 ± 1.00cde	2.8 ± 1.1b	1.0 ± 0.0a
TMS 30572	2.00 ± 1.00cde	2.9 ± 0.2b	2.0 ± 1.41b
TMS 30001	2.00 ± 0.00cde	1.8 ± 1.9ab	1.0 ± 0.0a
TMS 30211	1.67 ± 0.58de	1.9 ± 1.2ab	1.5 ± 0.71ab
TMS 4(2)1425	1.00 ± 1.00e	0.8 ± 2a	1.0 ± 0.0a
TMS 91934	1.00 ± 1.00e	1.9 ± 1.6ab	1.33 ± 0.58ab

Means followed by the same alphabet in the same column are not significantly different (P>0.05) by Duncan's New Multiple Range Test (DMRT).

In the first trial, (2003/04) cv. Akwakwuru, 91/02324, Nwageri, 97/3200, 96/1642 and TMS 91934 had cankers close to the ground. In the third trial (2005/06), TMS 91934, 96/1642 and TMS 30572 had cankers close to the ground. The cultivars that had cankers close to the ground showed that they were infected at earlier growth stages. These cankers may serve as entry points for other pathogens. Lozano and Booth (1974) and Akinyele and Ikotun (1989) reported that cankers serve as entry points for pathogens which cause stem, root and tuber – rotting organisms such as *Fusarium* spp and *Botryodiplodia theobromae* (Bandyopadhyay *et al.*, 2006). It is known that cassava root rot fungi enter the plants through wounds caused by pests or farming tools or by piercing the roots themselves, (Msikita *et al*., 2000). Okechukwu et al., (2009) stated that *Nattrassia mangiferae* (Miskita *et al*. 2005), *Botrydiplodia theobromae* (Onyeka, 2002 and 2005), nematodes and bacteria acting singly or in combination have been reported to induce root rot disease. Bandyopadhyay *et al*., (2006) reported that *Fusarium* moves and establishes further up the stem than do other fungi causing rots and could be easily disseminated with the cuttings planted for the next season.

The presence of these pathogens would lead to secondary infections, which could lead to total loss of both yield and planting materials.

The implication of these findings is that cultivars TMS 4(2)1425, 98/0510 and TMS 30211 are likely to have higher resistance to anthracnose and thus can be recommended for further improvement through breeding and also for release to farmers for cultivation. This agrees with Ikotun and Hahn (1991) who also reported TMS 30211 as among the cultivars that develop small sized cankers, and further stated that plants producing small – size lesions survive much longer and would also mature and produce flowers that are needed for breeding for improving resistance to CAD and other diseases. The deeper cankers can block translocation of vital nutrients to active growing regions (IITA, 1990).

Cultivars TMS 4(2)1425, 98/0510, TMS 30211 and TMS 30001 which had low disease severity score of 1.0 – 2.26, showed tolerance to CAD. This supports the findings of CUL(1985), Ikotun and Hahn (1991), Fokunang *et al*., (2000b) and Dixon *et al*., (2002) who reported that TMS 30001 and TMS 4(2)1425 showed severity score as low as 2.0 and can be recommended for further improvement through breeding. Ahouandijinou (1983) also reported that cassava genotypes

producing small necrotic lesions tend to have low CAD incidence and severity, and can survive for longer periods, with higher production of functional leaves and reduced shoot die-back which affects yield. Based on these findings, TMS 4(2)1425, 98/0510, TMS 30211 and TMS 30001 are recommended for further improvement through breeding.

Cultivars TMS 30555, 96/1642, 91/02324, Nwaocha, Akwakwuru and Nwageri which had high severity score of 3.0 – 4.0 should not be used for any further work on CAD but can be explored for other good traits. Because their use would lead to build up and spread of anthracnose noted by Ikotun and Hahn (1991) and Makambila (1978). These cultivars are regarded as susceptible to CAD. Cultivars TMS 30211, TMS 30001, 98/0510 and TMS 4(2)1425 possessed more than three desirable characteristics such as the least size of cankers, absence of cankers in the first and second trials (2003/04 and 2004/05) respectively, and lowest severity score. With these desirable characteristics, they may be regarded as resistant. Based on the results of this study, it is concluded that considerable variation in susceptibility exists among the local and improved genotypes, thus suggesting a large range of genetic diversity is available within the germplasm and there is possibility of breeding cultivars that are resistant to CAD. Research institutes should supply the identified resistant cultivars to the farmers who do not have resistant planting materials for the next growing season at a reduced price. The selection and production of cassava cultivars that are resistant to pest and diseases is a major priority towards meeting international challenges in food security, poverty alleviation, agricultural productivity and environmental conservation. More cultivars, especially those resistant to other key diseases, example, cassava mosaic disease (CMD), cassava and bacterial blight (CBB), should be screened for resistance. Farmers should be educated on the advantages of using healthy stems and the risk involved in transportation of infected planting materials from one place to another.

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