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VARIABILITY IN COMPONENTS OF SEED YIELDS FROM GROUNDNUT PLANTS INFECTED WITH COWPEA APHID-BORNE MOSAIC VIRUS

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ABSTRACT

Groundnut is a major oilseedcrop of global importance. It is consumed in various forms by humans and forms an integral component of livestock feed. However, *Cowpea aphid-borne mosaic virus*(CABMV) causes significant yield losses in susceptible cultivars. To date, adoption of resistant cultivars is the best management option against the pathogen. Therefore, this study was conducted to determine the effect of *Cowpea aphid-borne mosaic virus* on the seed weightsof some groundnut cultivars. The experiment was arranged as completely randomized design with five replications. Five groundnut cultivars were infected with CABMV at 10 days after sowing through mechanical inoculation. Uninfected plants of each cultivar served as control. Disease severity, number of pods per plant, pod weight per plant andseed weights were recorded. Of the five cultivars, SAMNUT 26 maintained a severity score of 2.6 while SAMNUT 21 and SAMNUT 23 elicited a symptom score of 3.0. In SAMNUT 23, SAMNUT 25 and SAMNUT 26, the seed weights of healthy plants were statistically similar to those infected with CABMV. However, SAMNUT 26 infected with CABMV gave the highest seed weight (20.4 g). These observations indicated that SAMNUT 26 was highly tolerant to CABMV infection. Further work is recommended in order to ascertain possible potential of SAMNUT 26 against severe yield losses induced by CABMV infection.

Keywords: CABMV; Correlation; Groundnut; Principal components; Seed weight

INTRODUCTION

Groundnut (*Arachis hypogaea* L.) is an important oilseedcrop with multipurpose uses. Its seeds can be consumed raw, cooked or roasted (Hampannavar*et al.*, 2018). Groundnut seed is rich in edible oil, carbohydrates, vitamins, protein, minerals, fibers, and its haulms are a good source of livestock feed. In developing countries, groundnut haulms attract additional income to farmers particularly during the dry season. Groundnut plant is capable of improving soil fertility through symbiotic nitrogen fixation into the soil (Jibrin*et al.*, 2016). Between 1956 and 1967, Nigeria with conspicuous Kano pyramids was globally recognized as a major exporter of groundnut (Ajeigbe*et al.*, 2014). The then groundnut pyramids eventually disappeared in the 1970s partly owing to groundnut rosettedisease (GRD) induced by *Groundnut rosette virus* (GRV). The Institute for Agricultural Research (IAR) at Ahmadu Bello University, Samaru-Zaria and the International Crops Research Institute for the Semi-AridTropics (ICRISAT), Kano, Nigeriahave the mandate to develop and disseminate high-yielding and pest resistant groundnut varieties in the country.

Groundnut is suitable for cultivation in all agro-ecologies of the country but a lot of productioncomes from the savanna zone. These areSahel Savanna, Sudan Savanna, Northern and Southern Guinea Savanna (Ajeigbe*et al.*, 2014). Groundnut yield is generally low in developing

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countries with about 500-800 kg ha^{-1} as opposed to yields >2.5 t ha^{-1}. Low productivity has been attributed to several factors including incidence of pests. In addition to GRV, *Cucumber mosaic virus* (CMV), *Groundnut bud necrosis virus* (GBNV), *Indian peanut clump virus* (IPCV), *Peanut clump virus* (PCV), *Peanut mottle virus* (PeMoV),*Peanut stripe virus* (PStV), *Tobacco streak virus* (TSV) and *Tomato spotted wilt virus* (TSWV) cause significant groundnut yield losses globally or regionally (Sreenivasulu*et al.*, 2008).Other viruses infecting groundnut include *Cowpea aphid-borne mosaic virus* (CABMV) and *Cowpea mild mottlevirus* (CPMMV).

The best management strategy against virus diseases is the use of resistant cultivars. However, farmers are much more interested in cultivars that combine disease resistance with desirable growth and yield performance. Yield is a complex trait influenced by growth variables commonly referred to as yield components (Reddy*et al.*, 2017). The interrelationships among yield components can be determined using Pearson correlation analysis. Principal component analysis (PCA) is a multivariate analysis that allows for identification of the dominant variables (components) responsible for the observed variability. Although GRD was a major virus disease that wiped out most of the groundnut cropped areas in Nigeria in 1975, CABMV also can also induce significant yield loses in susceptible cultivars (Sreenivasulu*et al.*, 2008). While there are several reports on the association among quantitative characters of groundnut under varying treatments (Babariyaand Dobariya, 2012; Reddy*et al.*, 2017; Hampannavar*et al.*, 2018), there is scanty information with respect to CABMV-infected groundnut plants. This knowledge would be useful to plant breeders for breeding high-yielding CABMV-resistant groundnut. The ultimate goal of this is to strengthen food and nutrition security.

MATERIALS AND METHODS

Description of Study Location and Groundnut Cultivars

The experiment was conducted under screenhouse conditions at the School of Agriculture and Agricultural Technology, Federal University of Technology (FUT), Minna. Groundnut (SAMNUT 21, SAMNUT 23, SAMNUT 24, SAMNUT 25 and SAMNUT 26) cultivars commonly grown in Savanna agro-ecology of Nigeria were evaluated. The seeds were obtained from IAR, Samaru-Zaria, Kaduna State, Nigeria. These cultivars were developed by IAR, Samaru-Zaria and ICRISAT, Kano (NACGRAB, 2014). SAMNUT 21 is a medium-maturing cultivar with dual purpose (kernel and haulm). It has high pod yield potential with good oil content. The remaining cultivars are early maturing, GRV-tolerant and high-yielding (Ajeigbe *et al.*, 2014).

Experimental Layout, Sowing and Inoculations

The five groundnut cultivars listed above constituted the treatments. Plastic pots (30-cm diameter and 30-cm deep) were filled with heat-sterilized loamy soil. The experiment was arranged as completely randomised design with five replications, in which each replication consisted of 5 pots. Groundnut seeds were sown in their respective pots on 5th August, 2018. An isolate of CABMV obtained from the stock in the Department of Crop Production, FUT, Minna was used as inoculum source. Virus extract was prepared by homogenizing CABMV-infected leaves in inoculation buffer ((0.1M sodium phosphate dibasic, 0.1M potassium phosphate monobasic, 0.01M ethylene diamine tetra acetic acid and 0.001M L-cysteine per litre of distilled water, adjusted to pH 7.2) using cold sterilized mortar and pestle. One microlitre of β-mercapto ethanol

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was then added to the extract. At 10 days after sowing (DAS), the upper leaf surface of groundnut plants was rubbed with carborundum powder (600-mesh). A piece of cheesecloth was dipped into the virus extract and thereafter rubbed on the dusted leaf surface. Cold distilled water was then sprinkled on the inoculated plants and they were monitored for symptom expression. Uninoculated plantsof each cultivar were evaluated in a separate screenhouse to serve as controls.

Data Collection and Analysis

Both CABMV-inoculated and uninoculated plants were assessed for disease severity, number of pods per plant, pod weight per plant and dry seed weight. Disease severity was rated using a visual scoring scale of 1 – 5: 1 = no symptoms on the leaf surface; 2 = slight mosaic on 10 – 30 % of the leaf surface; 3 = mosaic on 31– 50 % of the leaf surface and leaf distortion; 4 = severe mosaic on 51 – 70 % of the leaf surface, leaf distortion and stunting; 5 = severe mosaic on >70 % of the leaf surface, stunting and death of plants.All the parameters were subjected to analysis of variance ($p \leq 0.05$).

RESULTS

Disease severity

Development of leaf chlorosis and mosaic on the secondary leaves was observed on the infected plants at two weeks after inoculation. Conversely, the leaves of uninoculated (healthy control) plants were consistently symptomless (score = 1) (Fig. 1). At 2 WAI, the differences in disease severity among infected plants were not significant ($p > 0.05$), but varied between 2.4 (SAMNUT 21 and SAMNUT 23) and 3.0 (SAMNUT 24 and SAMNUT 25). At 4 WAI, the intensity of mosaic symptoms was much more evident on most of the infected plants. Severity of CABMV infection varied significantly ($p < 0.05$) between 2.6 and 3.6. Of the five cultivars, SAMNUT 26 maintained a severity score of 2.6 while SAMNUT 21 and SAMNUT 23 elicited a symptom score of 3.0. The highest disease severity rating was observed on SAMNUT 24 (score=3.6), whereas the infected plants of SAMNUT 25 had a mean score of 3.2. At 6 WAI, the severities of disease in SAMNUT 21 (score=3.0), SAMNUT 24 (score=3.6), SAMNUT 25 (score=3.2) and SAMNUT 26 (score=2.6) were consistent with those observed at 4 WAI, but increased to 3.4 in SAMNUT 23.

Number of pods, pod weight and seed weight

As for number of pods per plant, the healthy plants were more productive (43 – 62 pods per plant) than their infected counterparts (Table 1). However, in SAMNUT 21, SAMNUT 23 and SAMNUT 26, the difference in number pods between the healthy and infected plants was not significant ($p > 0.05$). With respect to pod weight, non-significant ($p > 0.05$) variation was found between the healthy (31.4 - 61 g) and infected plants was found only in SAMNUT 23 and SAMNUT 26 (Table 1). The seeds of healthy plants were large and weighed between 12.4 and 34.8 g per plant. In SAMNUT 23, SAMNUT 25 and SAMNUT 26, the seed weights of healthy plants were statistically similar to those infected with CABMV (Table 1).

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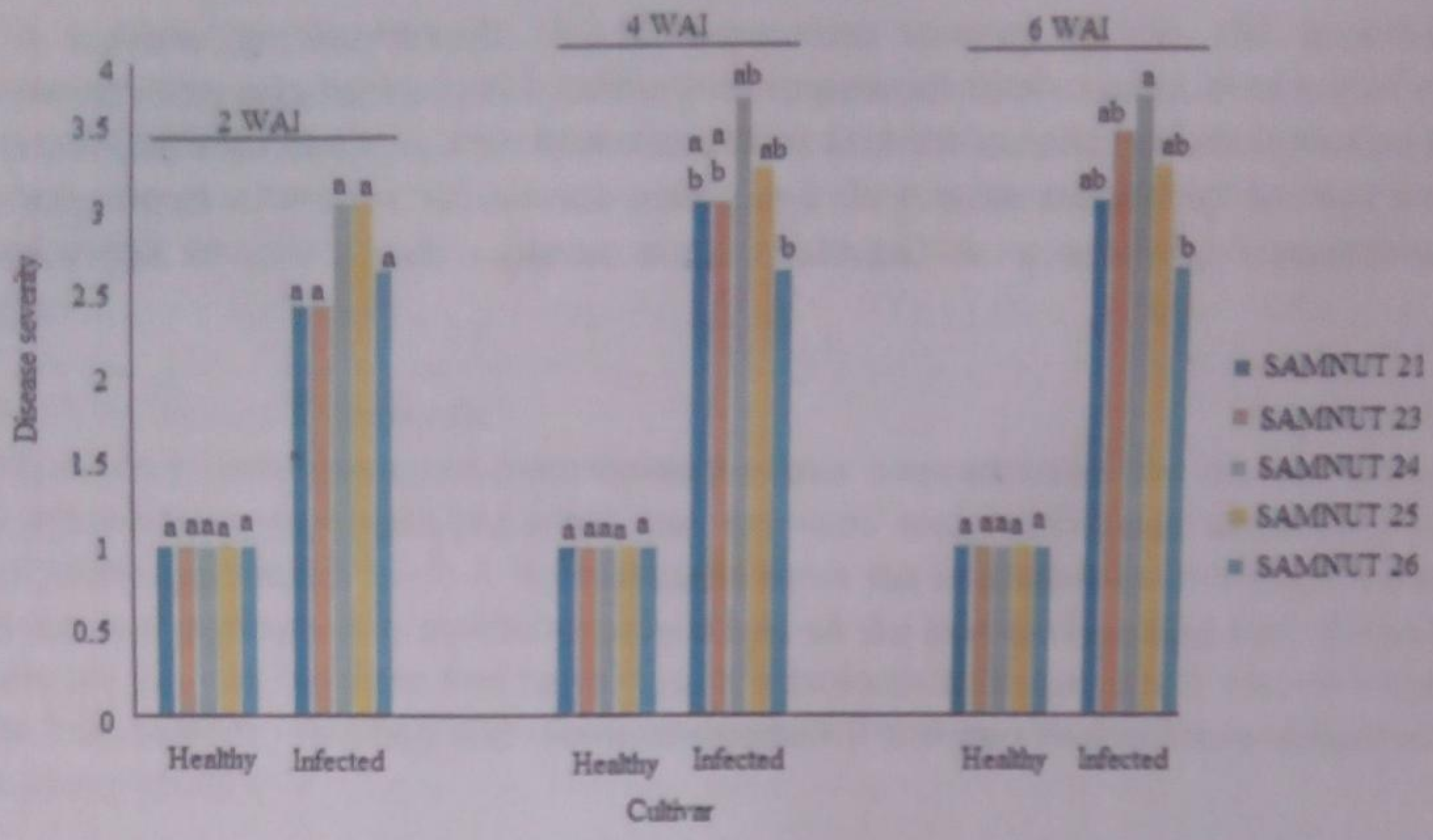

Fig. 1: Progress of *Cowpea aphid-borne mosaic virus* disease in groundnut plants at various weeks after inoculation (WAI)

Note: Bars with dissimilar letter (s) differ significantly by Student-Newman-Keuls (SNK) test at $p \leq 0.05$

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Table 1: Components of seed yield from healthy and *Cowpea aphid-borne mosaic virus*-infected groundnut plants

Cultivar	Number of pods per plant			Pod weight per plant (g)			Dry seed weight per plant (g)		
	Healthy	Infected	SEM	Healthy	Infected	SEM	Healthy	Infected	SEM
SAMNUT 21	43^a	14^a	11.1	47.0^a	16.6^b	10	20.2^a	6.2^b	3.9
SAMNUT 23	51^a	37^a	15.4	37.6^a	18.2^a	15	34.8^a	17.2^a	9.1
SAMNUT 24	52^a	15^b	5.9	32.6^a	9.8^b	5.2	24.0^a	7.2^b	2.8
SAMNUT 25	44^a	26^b	4.9	31.4^a	16.6^b	3.3	12.4^a	11.2^a	1.4
SAMNUT 26	62^a	45^a	11.8	61.0^a	23.4^a	11	26.2^a	20.4^a	6.2

Means with dissimilar letter along the row differ significantly by the Least Significant Difference (LSD) at $p \leq 0.05$

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DISCUSSION

Cowpea aphid-borne mosaic virus induced lower growth and seed weights in infected plants, indicating the susceptibility of the evaluated cultivars to the pathogen. However, the observed variation implied that some cultivars were more tolerant to infection than others. The disease severity scores obtained at 6 WAI revealed that SAMNUT 26 was the most tolerant, whereas SAMNUT 24 was the most susceptible to CABMV infection. SAMNUT 21 which gave the lowest disease severity rating at the early stage of infection (2 WAI) was probably as a result of active responses of the plants' defense mechanism. Normally, the development of symptoms in virus-infected plants begins with replication of virus particles, followed by intra and inter cellular movement. As part of theirarsenal for infection of plants, viruses encode a movement protein (MP), a protein dedicated to enlarging the poresize of plasmodesmata (PD) and actively transporting the viral nucleic acid into the adjacent cell (Schoelz*et al.*, 2011). *Cowpea aphid-borne mosaic virus* is a member of the *Potyviruses* which encode two membrane-associated proteins,the 6-kDa protein (6K2) and the P3 protein (Eiamtanasate*et al.*, 2007). However, vesicles containing the 6Kprotein are the site for Potyvirus genome replication (Cotton*et al.*, 2009). Disease progression was relatively fastest in SAMNUT 24 due to low level of resistance to virus movement. Investigations have proved that CABMV exhibits systemic infection with characteristics leaf chlorosis and mosaic as observed in this study.

The differences in number of pods, pod weight and seed weights among the healthy plants could be attributed to variability in their genetic make-up. However, the lower performance of the infected plants was a consequence of the stresses imposed by the pathogen. Inspite of the disease condition, SAMNUT 26 which exhibited outstanding performance for most of the parameters could be regarded as the most tolerant to CABMV. However, SAMNUT 23 whose performance was next to SAMNUT 26 in terms of number of pods per plant, pod and seed weight per plant could be considered as another promising cultivar under CABMV infection. Cultivars with appreciable yield and yield components are desirable for breeding purposes. SAMNUT 26 which gave the best seed weight has been reported to be highly resistant to GRV and moderately resistant to early leaf and late leaf spot diseases (Ajeigbe*et al.*, 2014). In addition, SAMNUT 26 has been described as an early maturing cultivar with good oil content. All these desirable attributes are indices of possible wider acceptability of the cultivar by farmers. Cultivation of early maturing varieties is one of the avenues for managing plant viruses especially those that are transmitted by insects. The success of this strategy relies on the ability of the plants to complete their life cycle before the insect vectors attain peak population.

CONCLUSION AND RECOMMENDATION

This investigation has shown that SAMNUT 26 was highly tolerant to CABMV infection. Therefore, it is recommended as a guarantee against severe yield losses induced by CABMV in groundnut production.

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