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Effect of Sowing Date on the Incidence, Apparent Infection Rate and Severity of Scab on Cowpea

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Abstract: The main aim of this study was to investigate the effect of sowing dates on the incidences, apparent infection rates and severities of cowpea scab, caused by *Sphaceloma* sp. on three varieties of cowpea (*Vigna unguilata* L. Walp). The varieties were: TVx 3236, SAMPEA-6 and IT93K452-1. The investigations were undertaken during the 2004, 2005 and 2006 cropping seasons at Samaru and Shika in Zaria, Nigeria. Four sowings were done at 7-day interval starting from late July and ending in mid August of each year. Scab disease incidence and severity ratings were taken every seven days starting from the first visible symptoms of infection on the plant parts. The design used was a factorial concept in a Randomized Complete Block Design (RCBD) with three replications consisting of single row plots, each 75 cm wide, 6 m long, and 75 cm apart. For all the 3 seasons, the early sown cowpeas had higher scab incidences, apparent infection rates and severities than the late sown crops, even though not significantly higher in all cases or parameters. No scab symptoms were observed on the leaves of the more resistant cultivar, TVx 3236, in all 3 years of the investigation. Under northern Nigerian conditions, early cowpea plantings would result in higher infections from scab, unless more resistant cultivars are used in such early plantings.

Key words: Apparent infection rate, cowpea, incidence, scab severity, sowing date, *Sphaceloma*

INTRODUCTION

Cowpea (*Vigna unguiculata* L. Walp (Fabaceae) is the most widely cultivated food legume in the northern savanna states of Nigeria where rainfall is generally scanty and soils are sandy and relatively infertile. It is a cheaper source of protein than meat for the rural and urban poor in most developing countries (Henriet *et al*., 1997; Ogbuinya, 1997; Fawole *et al*., 2006). The crop is highly valued for both its grain and forage and therefore often has a dual use (Henriet *et al*., 1997; Ogbuinya, 1997).

The major constraints to cowpea production in Nigeria are pests and diseases. Scab, caused by the fungus *Sphaceloma* sp. is one of the most destructive diseases of cowpea in Nigeria and could account for more than 30% of the country's total cowpea crop production losses (Mungo, 1996). Scab is a seed-borne disease, and affects all the above ground parts of the plant- leaves, petioles, stems, peduncles and pods (Emechebe, 1980; Iceduna, 1993). Lesions on stems often coalesce and cover the entire stem while those on leaves often give rise to shot holes which may be confused with insect damage (Iceduna, 1993). Under severe infection conditions, these coalescing lesions, cause leaf distortion, and in some cases flower bud abortions thereby reducing podding and causing malformation of pods with almost no seed set. Yield losses of up to 80% and even total crop destruction under disease epiphytotic conditions have been reported in Nigeria (Emechebe, 1980; Mungo *et al*., 1995).

Subsistence farmers in developing countries, including those in Nigeria have very few options for the control of cowpea diseases on their crops. The use of fungicides is very limited because of the associated costs of these chemicals as well as handling issues and safety concerns to the users and to the environment. They therefore rely mainly on cultural practices as an important aspect for their disease control. The practices used include crop rotations, intercropping and crop spacing (Adebitan and Ikotun, 1996). Sowing dates have been reported to reduce the effects of diseases such as anthracnose (*Colletotrichum lindernuthianum)*, brown blotch (*Collectrichum capsici)*, and web blight (*Thanatephorus cucumeris*) on cowpeas (Yayock *et al*., 1988). Limited

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information is however, available on the effect of sowing dates on the incidence of scab on cowpea. The main objective of this study was therefore to investigate how the manipulation of different sowing dates could identify suitable production periods in which the crop could be sown with less favourable conditions for disease development during the production cycle.

MATERIALS AND METHODS

Field experiments were carried out during the wet seasons of 2003/2004, 2004/2005 and 2005/2006 at the Institute for Agricultural Research farms at Samaru and Shika (11º11′N, 07º38′E, 686m above the sea level) in Nigeria. These farms are located in a predominantly cowpea production district of northern Nigeria and supplies most of the cowpea grain to the southern markets. For all three seasons, three varieties of cowpea (TVx3236, SAMPEA-6, IT93K452-1) selected on the basis of their agronomic characteristics and reactions to scab were used in the study. The variety TVx 3236 is moderately resistant, IT93K452-1 is moderately susceptible and SAMPEA-6 is susceptible to scab.

Four sowing dates were staggered, 7-days apart starting from the last week of July in each year, when the typical first seasonal rains set in, and ending during the third week of August. The typical sowing period for cowpeas in these districts ranges from start of July to end of September. The dates selected therefore fell within this period.

The experiment was arranged in a Randomized Complete Block Design (RCBD), in three replications. Each plot consisted of five rows of 75 cm width and 6m long with 75 cm gap between ridges. The plots were separated by border rows consisting of one ridge along each of the plot length and 2 m along the width. Cowpea seeds were hand-sown at a depth of 3-5 cm and at the rate of two seeds per hole using a spacing of 25 cm between holes.

Plots were hand-weeded and with the help of a hoe, three times each season, and fertilizer (N.P.K., 15:15:15) was applied only once at 14-days after sowing (DAS). Plant stand establishment recordings were made 14 DAS and the plants were protected from insect damage by spraying biweekly with the insecticide uppercott (Cypermethrin+Dimethoate) at 1 litre/ha, starting at 21 DAS until 75% podding. No fungicide applications were made on the plots and the plots relied on natural rainfall for their irrigation and plant growth.

Scab disease incidence and severity data were recorded from the different infected plant parts at 7-days interval starting from the first appearance of scab infection symptoms. The data was collected from 5 plants in the three middle ridges in each plot. The following infection parameters were recorded:

- Disease incidence - calculated from percentage of plants exhibiting scab lesions.
- Apparent infection rate - calculated using the Van der Plank (1968) formula:

$$r = \frac{2.3}{(t_2 - t_1)}\left[\log 10\left(\frac{x_2(1-x_1)}{x_1(1-x_2)}\right)\right]$$

where x_1 and x_2 are the proportions of the disease on dates t_1 and t_2 respectively.

- Disease severity on the affected plant parts.

The following subjective rating scale, of 1-10, modified from Emechebe (1981), was used to assess disease severity on the leaves, stems, peduncles, flower cushions and pods: 1 = No symptoms; 2 = Few pin point lesions; 4 = Few lesions, 3-5 mm in diameter with well defined borders; 6 = Many lesions, some larger than 5 mm in diameter, with dark brown or white centres; 8 = Large coalescing lesions with shot hole spots and 10 = Severely damaged with marked distortion and stunting.

The rates of scab incidence, apparent infection rate and severity on the three cowpea varieties were recorded for each of the 4 sowing dates during 2004, 2005 and 2006 production seasons.

At crop maturity, pods were harvested from all plants in the three middle ridges of each plot of the three varieties evaluated. The harvested pods were sun-dried over 4 week period to about 14% dry matter. Pod weight was taken for each plot. Combined seed yields from the harvested ridges of each plot were recorded after hand-threshing and winnowing by weighing on a balance, to determine if the different sowing dates affected the plot yields because of the differential scab infections.

All the data collected for scab disease incidence and severity were subjected to an Analysis of Variance (ANOVA) as described by Snedecor and Cochran (1967), using the statistical soft ware, SAS (1998). Mean separations were performed with the Student Newman Keuls (SNK) Test to determine sowing dates effects.

RESULTS

In all three seasons of the study, scab lesions were first observed on plants during the vegetative growth stages for the first plantings and this determined the commencement of the ratings. These lesions generally increased in severity with growth throughout the season as shown by the mean rating values at different dates after sowing.

Disease incidence data recorded in the three-year study showed that at 42 to 49 DAS, scab incidence increased with plant age in all the three cowpea varieties

Table 1: Incidence of scab on three cowpea varieties at different sowing dates in northern Nigeria, combined for the 2004, 2005, and 2006 production seasons

		Scab incidence at:	
Variety	Sowing dates	42 DAS	49 DAS*
TVx3236	July – 26	0.59a	2.09a**
	August – 02	0.06b	1.81a
	August – 09	0.00b	1.09a
	August – 16	0.00b	0.71a
SAMPEA-6	July – 26	4.95a	11.27a
	August – 02	1.91b	10.05a
	August – 09	0.65b	4.78b
	August – 16	0.13b	3.46b
1T93K452-1	July – 26	2.31a	6.42a
	August – 02	1.29b	4.95ab
	August – 09	0.25b	2.63bc
	August – 16	0.19b	1.79c

*: DAS = days after sowing

**: Values in the column followed by the same letter are not significantly different at $p \leq 0.05$ (SNK Test)

following increasing order: SAMPEA-6>IT93K452-1>TVx3236. Sowing dates significantly ($p \leq 0.05$) influenced the incidence of scab in the field, with the July 26 sowing showing a significantly higher scab incidence than the August 16 sowing which exhibited the lowest incidence for the first rating at 42 DAS. (Table 1), Generally, the effect of sowing date on scab incidence was significantly different ($p \leq 0.05$) on the three cowpea varieties with the July 26 and August 2 plantings having a higher scab incidence when compared to the August 9 and August 16 sowing dates.

There were no increases in the rates of scab per day on the leaves, flower cushions and pods for TVx3236 in all the four sowing dates (Tables 2, 3 and 4). The apparent infection rates of leaf and stem scab on SAMPEA-6 were lower on early sown crops than on the late sown ones, with a significant difference ($p \leq 0.05$) for the stem ratings (Table 2). Peduncle scab, however, showed the reverse with SAMPEA-6 exhibiting the highest incidence followed by IT93K452-1 and then TVx3236 which had the lowest scab incidence (Table 1). In general, scab incidence during the three years of the study confirmed the reactions of the varieties to the disease in the with early sown crops having a high apparent infection rate than the late sown crops (Table 3). The apparent infection rates on the leaves, stems, peduncles and flower cushions and pod scab of IT93K452-1 was generally higher on early sown crops than on the late sown ones,though not significantly so in some cases (Tables 2, 3 and 4). There was no increase in the rate of stem scab on the third and fourth sowing dates of TVx 3236 (Table 2), fourth sowing date on peduncle scab of IT93K452-1 (Table 3) and third and fourth on pod scab of the same variety (Table 3). Generally, the apparent infection rates of scab on the different plant parts of the three cowpea varieties sown at different dates were higher on early sown crops than on the late sown crops in all the years of evaluation combined.

Table 2: Effect of sowing date and apparent infection rate (r) of scab on leaves and stems of three cowpea varieties in northern Nigeria at 56, 63, 70 and 77 days after sowing combined for the 2004, 2005 and 2006 production seasons

			Proportion of plant parts with disease at:				
Plant part	Variety	Sowing date	56 DAS	63 DAS	70 DAS	77 DAS*	Apparent infection rate (r)
Leaf	TVx3236	July – 26	0.00a	0.00a	0.00a	0.00a	0.00a**
		August – 02	0.00a	0.00a	0.00a	0.00a	0.00a
		August – 09	0.00a	0.00a	0.00a	0.00a	0.00a
		August – 16	0.00a	0.00a	0.00a	0.00a	0.00a
	SAMPEA-6	July – 26	0.10a	0.20a	0.60a	0.82a	0.19a
		August – 02	0.07ab	0.17a	0.65a	0.77a	0.20a
		August – 09	0.01b	0.11a	0.49a	0.77a	0.25a
		August – 16	0.01b	0.11a	0.42a	0.69a	0.22a
	IT93K452-1	July – 26	0.06a	0.13a	0.35a	0.49a	0.12a
		August – 02	0.04a	0.07ab	0.35a	0.42a	0.12a
		August – 09	0.00a	0.03b	0.21a	0.35a	0.09a
		August – 16	0.00a	0.01b	0.13a	0.21a	0.06a
Stem	TVx3236	July – 26	0.01a	0.06a	0.16a	0.21	0.03a
		August – 02	0.00a	0.01b	0.11a	0.14ab	0.01a
		August – 09	0.00a	0.00b	0.07a	0.10ab	0.00a
		August – 16	0.00a	0.00b	0.06a	0.06b	0.00a
	SAMPEA-6	July – 26	0.10a	0.20a	0.65a	0.77a	0.16b
		August – 02	0.06b	0.14ab	0.57a	0.71a	0.17b
		August – 09	0.01c	0.09b	0.44a	0.69a	0.19b
		August – 16	0.00c	0.04b	0.38a	0.66a	0.29a
	IT93K452-1	July – 26	0.06a	0.09a	0.30a	0.55a	0.15a
		August – 02	0.03ab	0.07a	0.30a	0.45a	0.12ab
		August – 09	0.00a	0.03ab	0.23a	0.34ab	0.10ab
		August – 16	0.00a	0.00b	0.10a	0.17b	0.02a

*: DAS = days after sowing

**: Values in the column followed by the same letter are not significantly different at $p \leq 0.05$ (SNK Test)

Table 3: Effect of sowing date and apparent infection rate (r) of scab on peduncles and flower cushions in three cowpea varieties in northern Nigeria at 63, 70 and 77 days after sowing combined for the 2004, 2005 and 2006 production seasons

			Proportion of plant parts with disease at:			
Plant part	Variety	Sowing date	63 DAS	70 DAS	77 DAS*	Apparent infection rate (r)
Peduncle	TVx3236	July – 26	0.03a	0.07a	0.16a	0.04a**
		August – 02	0.00a	0.01b	0.10ab	0.00a
		August – 09	0.00a	0.00b	0.03bc	0.00a
		August – 16	0.00a	0.00b	0.02c	0.00a
	SAMPEA-6	July – 26	0.21a	0.59a	0.69a	0.17a
		August – 02	0.11a	0.41a	0.66a	0.21a
		August – 09	0.10a	0.37a	0.63a	0.17a
		August – 16	0.09a	0.32a	0.53a	0.14a
	IT93K452-1	July – 26	0.16a	0.35a	0.57a	0.18a
		August – 02	0.13ab	0.32a	0.49a	0.14a
		August – 09	0.04bc	0.24a	0.41a	0.13a
		August – 16	0.01c	0.17a	0.29a	0.09a
Flower cushion	TVx3236	July – 26	0.00a	0.01a	0.03a	0.00a
		August – 02	0.00a	0.00a	0.01a	0.00a
		August – 09	0.00a	0.00a	0.00a	0.00a
		August – 16	0.00a	0.00a	0.00a	0.00a
	SAMPEA-6	July – 26	0.13a	0.13a	0.34a	0.11a
		August – 02	0.04a	0.06a	0.18a	0.08a
		August – 09	0.06a	0.04a	0.20a	0.08a
		August – 16	0.04a	0.04a	0.28a	0.11a
	IT93K452-1	July – 26	0.09a	0.09a	0.18a	0.07a
		August – 02	0.04a	0.04a	0.11ab	0.02a
		August – 09	0.03a	0.03a	0.9ab	0.02a
		August – 16	0.01a	0.01a	0.14b	0.00a

*: DAS = days after sowing

**: Values in the column followed by the same letter are not significantly different at $p \leq 0.05$ (SNK Test)

Table 4: Effect of sowing date and apparent infection rate (r) of scab on pods in three cowpea varieties in northern Nigeria at 77 and 84 days after sowing combined for the 2004, 2005 and 2006 production seasons

			Proportion of plant parts with disease at:		
Plant part	Variety	Sowing date	77 DAS	84 DAS*	Apparent infection rate(r)
Pod	TVx3236	July – 26	0.03a	0.07a	0.00a**
		August – 02	0.01a	0.06a	0.00a
		August – 09	0.00a	0.00b	0.00a
		August – 16	0.00a	0.00b	0.00a
	SAMPEA-6	July – 26	0.20a	0.41a	0.06a
		August – 02	0.13a	0.28a	0.07a
		August – 09	0.11a	0.25a	0.05a
		August – 16	0.10a	0.25a	0.05a
	IT93K452-1	July – 26	0.13a	0.27a	0.08a
		August – 02	0.11a	0.20ab	0.02ab
		August – 09	0.07a	0.10ab	0.00b
		August – 16	0.03a	0.04b	0.00b

* DAS = days after sowing

**Values in the column followed by the same letter are not significantly different at $p \leq 0.05$ (SNK Test)

Table 5: Severity of scab on the different plant parts of three cowpea varieties in northern Nigeria at different sowing dates combined for the 2004, 2005 and 2006 seasons

		Disease severity scores on:									
		Leaf		Stem		Peduncle		Flower cushion		Pod	
Variety	Sowing date	70 DAS	77 DAS	70 DAS	77 DAS	70 DAS	77 DAS	70 DAS	77 DAS	77 DAS	84 DAS*
TVx3236	July-26	1.00a	1.00a	2.22a	2.67a	1.56a	2.22a	1.11a	1.22a	1.22a	1.56a**
	August-02	1.00a	1.00a	1.89a	2.11ab	1.11b	1.78ab	1.00a	1.11a	1.11a	1.44a
	August-09	1.00a	1.00a	1.56a	1.78ab	1.00b	1.22b	1.00a	1.00a	1.00a	1.00b
	August-16	1.00a	1.00a	1.44a	1.44b	1.00b	1.00b	1.00a	1.00a	1.00a	1.00b
SAMPEA-6	July-26 5.78a	7.56a	6.22a	7.33a	5.11a	6.89a	2.00a	3.67a	2.56a	4.22a	
	August-02	6.22a	7.11a	5.56ab	6.89a	4.22a	6.22a	1.33b	2.44a	2.00a	3.22b
	August-09	4.89a	7.11a	4.44ab	6.44a	3.89a	6.00a	1.44b	2.56a	1.89a	3.00b
	August-16	4.33a	6.44a	4.00b	6.22a	3.56a	5.22a	1.33b	3.22a	1.78a	3.00b
T93K452-1	July-26 3.78a	4.89a	3.33a	5.33a	3.56ab	5.56a	1.44a	2.44a	2.00a	3.11a	
	August-02	3.78a	4.33a	3.33a	4.56ab	4.00a	4.89ab	1.22a	1.89b	1.89a	2.56a
	August-09	2.67ab	3.78a	2.78ab	3.67b	2.89bc	4.22ab	1.22a	1.67b	1.56a	1.78b
	August-16	2.00b	2.67b	1.78b	2.33c	2.33c	3.56b	1.11a	1.11c	1.22a	1.33b

*: DAS = days after sowing

**: Values in the column followed by the same letter are not significantly different at $P \leq 0.05$ (SNK Test)

Table 6: Effect of sowing date on yield of three cowpea varieties infected with scab in 2004, 2005 and 2006

		2004		2005		2006	
Variety	Sowing date	Pod yield	Seed yield	Pod yield	Seed yield	Pod yield	Seed yield
TVx3236	July-26	533.30a	353.10a	1111.10a	888.90a	963.00a	728.40a
	August-02	972.90a	508.67ab	834.60a	963.00a	839.50a	642.00a
	August-09	864.20a	543.20ab	1592.60a	1259.20a	864.20a	691.40a
	August-16	1202.50a	703.67a	1739.50a	1222.20a	1098.80a	851.70a
SAMPE-6	July-26	1538.30a	943.20a	2209.90a	1543.20a	1901.20a	1432.10a
	August-02	1802.80a	1091.40a	2284.00a	1654.30a	2370.70a	1765.40a
	August-09	1493.80a	851.90a	2530.90a	1802.50a	1530.90a	1135.80a
	August-16	1459.30a	851.80a	2345.70a	1691.40a	1481.50a	1108.60a
T93K452-1	July-26	753.10a	523.50a	1555.57b	1185.17a	827.20a	592.60a
	August-02	975.30a	543.20a	1592.60b	1222.23a	1049.40a	790.10a
	August-09	1074.10a	637.30a	1679.00b	1283.93a	716.00a	555.60a
	August-16	1446.90a	1049.40a	1925.93a	1444.47a	1061.70a	876.50a

Values in a column followed by the same letters are not significantly different at $P \leq 0.05$ (SNK Test)

The severity of scab on the different plant parts of the three cowpea varieties was generally higher on early sown than on late sown crops with the fourth sowing date having the lowest severities (Table 5). There was no scab recorded on the leaves of the resistant variety, TVx 3236, and scab severity on flower cushions and pods of this variety were not significant in the three years of study (Table 5). Generally, the severity of scab on the three cowpea varieties in the three years of the study, was in the order: SAMPEA-6>IT93K452-1>TVx3236.

In 2004, the effect of sowing dates on seed yield of the three varieties was not significantly different from each other. The significant (P£0.05) differences observed on seed yield of TVx 3236 were statistically similar but the August-16 plantings had a higher seed yield compared to the July-26 plantings. A general trend was observed for TVx3236 and IT93K452-1 with early sown crops having a lower pod and seed yields than late sown crops (Table 6).

In 2005, the differences on yield were not also significantly different from each other but a significant (P£0.05) difference was observed on pod yield of IT93K452-1 with the August-16 having a higher pod yield compared to the other sowing dates (Table 6).

In 2006, cowpea varieties TVx3236 and IT93K452-1 showed the same trend for yield as in 2004 with the August-16 plantings doing better than the other sowing dates (Table 6).

DISCUSSION

Higher incidences, apparent infection rates and severities of scab were recorded on the early sown cowpeas than the late sown crops. This is in agreement with earlier reports, which showed an increase in the infection of some diseases as a result of early sowing of the crop (Mungo, 1996; Alabi, 1994). Another report by Gurama *et al.* (1998), however, gave contrary results to what has been observed in this and other earlier studies; reporting that scab severity was lower on early sown cowpea than on late sown crops. The severity of scab, however, may be attributed to changes in the microclimate of the environment, more specifically rainfall and relative humidity within the plant community, which might have favoured disease development. This confirms previous reports (Emechebe, 1980; Edema *et al.*, 1997), that scab is more severe under wet conditions and consequent high relative humidity because the conidia are supposedly dispersed by rain splash and wind-driven moisture. These requirements probably partly explain the report from Uganda by Edema *et al.* (1997) that the severity of scab was higher during the second rains. They also confirm that scab is favoured by high plant populations, which are conducive for rain splash dispersal and high relative humidity.

Reaction of the three cowpea varieties to scab varied from moderately resistant to susceptible. The variety SAMPEA-6 was susceptible and IT93K452-1 was moderately susceptible to the disease, since both varieties had high scab incidences and severities. The variety TVx 3236 was moderately affected by the disease in all the years of study. This confirms that this variety is moderately resistant to scab as there was no increase in the rate of the disease on the leaves, flower cushions and pods. All the varieties exhibited symptoms of the disease in some form. All the above ground parts of susceptible plants were affected, as is typical of scab infection as also reported by Iceduna *et al.*, (1994), Nakawuka and Adipala, 1997. Similar observations have been made in earlier studies on these varieties under Nigerian conditions by Mungo, (1996) and Gurama *et al.*, (1998) and in Ugandan conditions by Iceduna *et al.*, (1994), Nakawuka and Adipala, (1997). The severity of scab on susceptible varieties showed that the disease can be very devastating when susceptible cowpea varieties are planted in the northern Guinea Savannas of Nigeria. This also confirms previous reports and the recommendations to use mainly resistant varieties, when available, in these environments (Iceduna *et al.*, 1994).

The effect of sowing date on the yields of the three cowpea varieties infected with scab indicated that early sown cowpea had a lower yield for TVx 3236 and

IT93K452-1 than late sown crops, for all three seasons of the study. The reverse was true for SAMPEA-6. This was in conformity with earlier reports for this variety (Gurama *et al*., 1998). In general, this study demonstrated that it is better to delay the sowing of moderately cowpea varieties such as TVx 3236 and IT93K452-1 to minimise scab infection which also could affect the pod and seed yields as demonstrated from the higher infections and lower corresponding yields from the early plantings.

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