

INCIDENCE OF *CERCOSPORA* LEAF SPOT DISEASE OF
GROUNDNUT (*ARACHIS HYPOGAEA* L.) AS INFLUENCED BY
SOWING DATE IN MAKURDI, BENUE STATE OF NIGERIA.

INCIDENCIA DE LA ENFERMEDAD DE *CERCOSPORA* EN LA HOJA
DE LA MANZANA (*ARACHIS HYPOGAEA* L.) INFLUENCIADA POR
LA FECHA DE SEMILLA EN MAKURDI, ESTADO BENIGEO DE
NIGERIA.

Richard Isa Bwala^{1,*}, Chigoziri Ekhuemelo², and Dauda Zacharia¹

¹Department of Crop Protection, Faculty of Agriculture, P. M. B.1069 University of Maiduguri, Nigeria.

²Department of Crop and Environment Protection, Federal University of Agriculture, P.M.B. 2373 Makurdi, Benue State, Nigeria.

* Author for correspondence, email: richybwala@gmail.com

ABSTRACT

Leaf spots of groundnut caused by *Cercospora* spp is one of the major economic production constraint militating against groundnut production in Nigeria. Field experiments were conducted during the 2011 and 2012 seasons at the Teaching and Research Farm of the Federal University of Agriculture, Makurdi Nigeria to assess the effect of sowing dates on the incidence of *Cercospora* leaf spot of groundnut. The 2 x 4 x 3 factorial (2 groundnut varieties/ 4 sowing dates/ 3 replications) experiment was laid out in a Randomized Complete Block Design (RCBD) and replicated three times. Results indicated no significant effect of *Cercospora* leaf spot on the two varieties in 2011 but in Ex-Dakar recorded a significantly ($P < 0.05$) higher leaf spot incidence compared Borno-Red variety. Sowing

groundnut seeds in 14th June to 29th June recorded significantly higher ($P < 0.0$) leaf spot disease incidence compared with sowing groundnut seeds in May. Ex-Dakar variety recorded higher leaf defoliation compared with Borno-Red variety in 2011 and 2012 seasons. Results indicated that Borno-Red had a significantly ($P < 0.05$) higher 100 seed weight in 2011, while Ex-Dakar recorded higher 100 seed weight in 2012. The results has proved that early sowing of groundnut in May can be employed as alternative strategy for the management of leaf spot disease of groundnut in Makurdi, Nigeria

Key word: Groundnut, disease incidence, sowing date, leaf defoliation, leaf spot.

RESUMEN

Las manchas foliares del maní causadas por *Cercospora* spp son una de las principales limitaciones de la producción económica contra la producción de maní en Nigeria. Los experimentos de campo se realizaron durante las temporadas 2011 y 2012 en la Granja de Enseñanza e Investigación de la Universidad Federal de Agricultura de Makurdi, Nigeria, para evaluar el efecto de las fechas de siembra en la incidencia de la mancha de la hoja de *Cercospora* en el maní. El factorial $2 \times 4 \times 3$ (2 El experimento de variedades de cacahuete / 4 fechas de siembra / 3 repeticiones) se presentó en un diseño de bloques completos al azar (RCBD) y se repitió tres veces. Los resultados indicaron que no hubo un efecto significativo de la mancha foliar de *Cercospora* en las dos variedades en 2011, pero en Ex-Dakar registró una incidencia de mancha foliar significativamente mayor ($P < 0.05$) en comparación con la variedad Borno-Red. La siembra de semillas de maní en el 14 de junio al 29 de junio registró una incidencia significativamente mayor ($P < 0.0$) de la enfermedad de la mancha foliar en comparación con la siembra de semillas de maní en mayo. La variedad ex-Dakar registró una mayor defoliación foliar en comparación con la variedad Borno-Red en las temporadas 2011 y 2012. Los resultados indicaron que Borno-Red tuvo un peso significativamente mayor ($P < 0.05$) de 100 semillas en 2011, mientras que Ex-Dakar registró un mayor peso de 100 semillas en 2012. Los resultados han demostrado que la siembra temprana de maní en mayo se puede emplear como estrategia alternativa para el manejo de la enfermedad de mancha foliar del maní en Makurdi, Nigeria

Palabra clave: maní, incidencia de enfermedades, fecha de siembra, defoliación de la hoja, mancha foliar.

INTRODUCTION

Leaf spots disease is one of the major biotic production constraint of groundnut in Nigeria and other parts of the World particularly where the crop is not grown under any protection umbrella. *Cercospora arachidicola* Hori (Early leaf spot) and *Phaeoisariopsis personata* (Berk & Curt) (Late leaf spot) are the two main pathogenic fungal microorganisms responsible for the disease. The destructive nature of the two diseases on groundnut crop has given it a significant recognition worldwide, including other parts of Africa (Subrahmanyam and Simth 1989 and Subrahmanyam *et al.* 1982). These major fungal diseases are prevalent almost in all groundnut growing areas of the world and become endemic frequently (Agrihunt, 2011; Meena, 2011; Ghewande and Mira, 1983). Farmers in the developing countries have reported huge yield losses as a result of the negative impact of the disease attack on their crops. Infected soil, debris and shells are the three potential sources of leaf spots inoculums (Richard *et al.*, 2017) The pathogens usually overwinter in the soil and can infect almost every parts of the crop causing lesions on leaves, petioles, pegs, main stems and lateral branches (Shokes and Culbreath 1997). The primary initial inoculums is responsible for the onset of the disease epidemic, while the rain-splash and wind-blown moist air helps in dispersing the secondary and tertiary spores to the adjacent susceptible plants. The environmental conditions and genetic make-up of the groundnut varieties plays a major role in the level of disease incidence and carry-over of the disease from seasons to season in different agro-ecological locations. In West Africa, about 50 to 70% yield loss have been reported (Waliyar 1990) and because of the destructive nature of the disease, international attention has been given to the disease causal pathogens (ICRISAT 1985).

The used of unilateral chemicals for the management of the disease have been practiced in the developing countries since 1970s. Incidentally, these chemicals were associated with unwanted and unintended human and environmental consequences such as pesticides persistence, resistance, residual, pest resurgence and environmental pollution apart from their exorbitant cost and not readily available sometimes (Richard *et al.* 2010). Many disease control management strategies have also been adopted to reduce crop diseases menace to economic minimum level in the development countries (Richard *et al.* 2014). The current global weather change makes it difficult to standardize the sowing date (Training Manual for Trainers 2011). Similarly, Yayok, (1981) reported that there is no definite universal recommended sowing date for groundnut for all agro-ecological locations.

Therefore, the objective of this study was to assess the influence of sowing date on incidence of *Cercopora* leaf spot disease of groundnut in Makurdi, Benue State of Nigeria.

MATERIALS AND METHODS

Study Area: The study was conducted at the Teaching and Research Farm of the Federal University of Agriculture Benue State, Nigeria in 2011 and 2012 cropping seasons. The location lies between the Latitude 7.41⁰N and Longitude 8.35⁰E; at an elevation of 95m above sea level located within the Guinea Savanna (Agboola 1979). The experimental field has been under intensive cultivation of groundnut crops for more than fifteen years which ensures readily available natural source of disease inoculums. The site received total annual rainfall of 955.74mm and 1492.80mm in 2011 and 2012 respectively, and relative humidity of 69.45 and 72.83 in the first and second year respectively. It had maximum and minimum temperatures of 32.98⁰C and 21.71⁰C; 32.8⁰C and 20.69⁰ C in 2011 and 2012 respectively (Department of Meteorological Services Makurdi, Benue State, 2011/2012).

The 2 x 4 factorial experiment was laid out in a Randomized Complete Block Design (RCBD) and replicated three times (Two groundnut varieties and four sowing dates). The experimental area was 49m x 8m = 392m² (0.0392ha). The experimental site was cleared and cultivated manually. The two groundnut varieties (Borno Red and Ex-Dakar) and four different sowing dates (D1 = 15th May, D2 = 30th May, D3 = 14th June and D4 29th June) formed the 24 treatment combinations. The groundnut varieties were assigned in the main plots each measuring 15m x 2m (30m²) while the four different sowing dates were assigned in the sub-plots each measuring 3 x 2m (6m²) with four ridges and replicated 3 times leaving 1m walking alley between the main plots and sub plots. Groundnut seeds were sown at a spacing of 20cm within rows and 75cm between rows at the rate of 2 seeds per hole. The experimental plots were kept weed-free throughout the study period and no chemical was used.

Data collection-Leaf spot incidence (%): Disease incidence was assessed at 47, 54 and 61 DAS. The disease incidence was taken by counting the number of plants infected in the net plot and divided by the total number of plants per net plot and multiply by 100 using the disease incidence formula according to Turaki *et al* (2014).

$$Z = \frac{K}{Y} \times 100$$

Where:

Z = Disease incidence (%)

K = Number of plant stands infected by the disease in the net – plot

Y = Number of plant stands infected and uninfected by the disease in the net – plot

Data collection-Leaf defoliation (%): The leaf defoliation was assessed at 70, 80, 90 and 100 DAS. Eight plants were selected at random, tagged in the net plot of each plot and scored for leaf defoliation using the leaf defoliation scale according to Schiller and Sampoapal (1973).

1 = No leaf fall

2 = less than 10% leaf fall

3 = 10 – 25% leaf fall

4 = 25 – 50% leaf fall

5 = >More than 50% leaf fall

The leaf defoliation was computed in percentage using the formula:

$$\frac{\sum n \times 100}{N \times 5}$$

Where: $\sum n$ = summation of individual assessments

N = Total number of plants assessed

5 = Highest score of the defoliation scale.

Data collection-One hundred seeds weight (g/plot): At 130 DAS of physiological maturity stage, all the groundnut stands in the net plot of each plot were carefully lifted up, the pods were picked, sun dry and shelled separately One hundred seeds were randomly hand-picked from the net plot of each plot and weighed in gram using a sensitive electronic weighing scale model (Sartorius 6MBH Gottingen-Type Fabr-Nr.) in the Plant Pathology

laboratory of the Department of Crop and Environmental Protection Department, University of Agriculture, Makurdi Benue State.

Data Analysis Data collected were subjected to analysis of variance {ANOVA} using SAS 9.1 version. Means were separated using the Duncan's Multiple New Range {DMNRT} at 5% probability level {Obj, 2002}.

RESULTS

Results on incidence of leaf spots of groundnut as influenced by varieties, sowing date and their interaction at 47, 54 and 61 DAS in 2011 and 2012 cropping seasons are presented in Table 1. In 2011, the effect varieties on incidence of leaf spot disease were not significantly different ($P > 0.05$) from 47 to 61 DAS. However, in 2012, the effect of varieties on disease incidence were significantly higher ($P < 0.05$) at 54 and 61 DAS but was not significant at 47 DAS. In 2011 and 2012, sowing date significantly influenced disease incidence at 47, 54 and 61 DAS. The interaction between varieties and sowing date on disease incidence were not significantly different at 47 DAS and 61 DAS in 2011 and from 47 to 61 DAS in 2012, but was significant at 54 DAS in 2011.

In 2011, results show that groundnut sown between Early and 29th June had higher leaf spot incidence while the lowest leaf spot incidence of 14.51% was recorded from those groundnut plants sown in 15th May followed by those sown on 30th May which had disease incidence of 22.18% at 47 DAS. Similarly at 54 DAS, higher disease incidence of 44.45 and 50.29% was recorded from those groundnut plants sown in 14th June and 29th June respectively. Those groundnut sown in 15th May and 30th May had lower leaf spot disease incidence of 38.76 and 36.79% respectively at 54 DAS. Groundnut sown in 30th May, Early and 29th June had significantly higher leaf spot disease incidence of 64.69%, 68.43% and 67.80% respectively at 61 DAS.

In 2012, among the varieties, Ex-Dakar recorded significantly ($P < 0.05$) higher leaf spot incidence of 59.41 and 69.51% at 54 and 61 DAS respectively compared to Borno Red. In 2012, results indicated that those groundnut plants sown in 29th June recorded significantly higher disease incidence of 31.94%, followed by those sown in Early June which had 25.44% disease incidence, while those groundnut plants sown in 15th May and 30th May recorded lower disease incidence of 15.06 and 18.45% respectively at 47 DAS.

Results at 54 DAS revealed that higher disease incidence of 57.92 and 58.63% were recorded on those groundnut plants sown in 29th June and 14th June respectively, while those sown on 15th May and 30th May recorded lower leaf spot incidence of 43.98 and 46.37% which was not significantly ($P > 0.05$) different. Similarly at 61 DAS higher disease incidence of 70.39%, 69.02% and 67.77% were recorded on those groundnut plants sown in 29th June, 14th June and 30th May respectively, while those sown in 15th May had the lowest leaf spot incidence of 51.77%. The results of interaction between varieties and sowing date on disease incidence at 54 DAS revealed that disease incidence of 52.40% was recorded from Ex-Dakar sown in 29th June which was not significantly different from disease incidence of same variety sown in 14th June, Borno Red sown in 14th June and 29th June respectively. The interaction between varieties and sowing dates resulted in lower disease incidence in both Borno Red and Ex-Dakar varieties sown in 15th May and 30th May at 54 DAS. The interaction of variety and sowing dates was not significant at 47 DAS and 61 DAS in 2011 and throughout the period of 2012 season.

Results on leaf defoliation of groundnut as influenced by varieties, sowing date and their interaction at 70, 80, 90 and 100 DAS in 2011 cropping season are presented in Table 2.

The effect of varieties on leaf defoliation was significantly different ($P < 0.05$) at 70, 80, 90 and 100 DAS. The effect of sowing date on leaf defoliation were significantly different from 80 to 100 DAS. The effect of interaction between varieties and sowing date on leaf defoliation was not significantly different ($P > 0.05$) at 70 DAS but were significant at 80, 90 and 100 DAS. Ex-Dakar recorded significantly higher leaf defoliation 19.10%, 39.94%, 64.07% and 80.38% compared with Borno Red had lower leaf defoliation of 14.94%, 33.14%, 54.34% and 75.56% at 70, 80, 90 and 100 DAS respectively. Result revealed that at 80 DAS, higher leaf defoliation of 39.45%, 37.87% and 34.89% were recorded on those groundnut plants sown on 29th June, 14th June and 15th May accordingly compared to those groundnut plants sown in 30th May. At 90 DAS, the leaf defoliation trend was similar to those of 80 DAS. Those groundnut plants sown in 14th June and 29th June recorded higher leaf defoliation of 80.79% and 82.82% respectively compared to those groundnut plants sown in Mid and 30th May at 100 DAS. Sowing groundnut in June resulted in significantly higher leaf defoliation compared with sowing groundnut in May.

Table 1: Effect of Varieties, Sowing Date and their Interaction on Incidence of Leaf Spot of Groundnut at 47, 54 and 61 DAS in 2011 and 2012 Cropping Seasons.

| Variety/Sowing Dates/Interactions | 2011 Cropping Season | | | 2012 Cropping Season | | |
|--------------------------------------|-------------------------|--------------------------|-------------------------|-------------------------|-------------------------|-------------------------|
| | 47 DAS | 54 DAS | 61 DAS | 47 DAS | 54 DAS | 61 DAS |
| Variety (V) | | | | | | |
| Borno Red | 25.16±2.30 | 41.56±2.73 | 61.14±1.91 | 20.57±2.45 | 44.04±2.50 ^b | 59.96±3.11 ^b |
| Ex-Dakar | 24.06±2.42 | 43.58±2.01 | 66.91±2.42 | 24.88±2.07 | 59.41±1.91 ^a | 69.51±1.99 ^a |
| <i>P-value</i> | <i>0.74NS</i> | <i>0.55NS</i> | <i>0.07NS</i> | <i>0.19NS</i> | <i>0.01</i> | <i>0.01</i> |
| <i>CV</i> | <i>33.20</i> | <i>19.50</i> | <i>11.90</i> | <i>34.60</i> | <i>14.90</i> | <i>14.00</i> |
| Sowing Dates (S) | | | | | | |
| 15th May | 14.51±1.48 ^c | 38.76±3.34 ^b | 55.18±1.98 ^b | 15.06±1.26 ^c | 43.98±4.39 ^b | 51.77±4.27 ^b |
| 30th May | 22.18±1.79 ^b | 36.79±1.40 ^b | 64.69±3.57 ^a | 18.45±2.01 ^c | 46.37±4.19 ^b | 67.77±2.15 ^a |
| 14th June | 29.16±1.78 ^a | 44.45±3.38 ^{ab} | 67.80±2.54 ^a | 25.44±2.75 ^b | 57.92±3.14 ^a | 69.02±2.17 ^a |
| 29th June | 32.58±1.53 ^a | 50.29±2.16 ^a | 68.43±1.70 ^a | 31.94±1.42 ^a | 58.63±3.04 ^a | 70.39±2.27 ^a |
| <i>P-value</i> | <i><0.01</i> | <i><0.01</i> | <i><0.01</i> | <i><0.01</i> | <i>0.01</i> | <i><0.01</i> |
| <i>CV</i> | <i>16.40</i> | <i>15.50</i> | <i>9.80</i> | <i>21.00</i> | <i>17.70</i> | <i>10.80</i> |
| Interactions (VX S) | | | | | | |
| Borno Red | | | | | | |
| 15th May | 17.63 | 32.20 ^b | 54.00 | 13.00 | 34.52 | 44.23 |
| 30th May | 20.71 | 36.10 ^b | 60.60 | 14.37 | 37.75 | 63.67 |
| 14th June | 27.56 | 49.70 ^{ab} | 65.00 | 24.31 | 51.30 | 65.50 |
| 29th June | 34.74 | 48.20 ^{ab} | 65.00 | 30.59 | 52.59 | 66.45 |
| Ex-Dakar | | | | | | |
| 15th May | 11.40 | 39.20 ^b | 56.40 | 17.11 | 53.45 | 59.31 |
| 30th May | 23.65 | 37.50 ^b | 68.80 | 22.52 | 54.99 | 71.86 |
| 14th June | 30.76 | 45.30 ^{ab} | 70.60 | 26.58 | 64.53 | 72.54 |
| 29th June | 30.42 | 52.40 ^a | 71.90 | 30.59 | 64.68 | 74.33 |
| <i>P-value</i> | <i>0.08NS</i> | <i><0.01</i> | <i>0.84NS</i> | <i>0.65NS</i> | <i>0.34NS</i> | <i>0.46NS</i> |
| <i>CV</i> | <i>14.80</i> | <i>12.00</i> | <i>9.20</i> | <i>19.40</i> | <i>7.10</i> | <i>7.40</i> |

Mean values within each column followed by the same letter (s) are not significantly different ($P > 0.05$) from each other according to Duncan's New Multiple Rang Test (DNMRT). CV = coefficient of variation, Ns = Not significant.

Table 2: Effect of Varieties, Sowing Dates and their Interaction on Leaf Defoliation of Groundnut at 70, 80, 90 and 100 DAS at 2011 Cropping Season.

| Variety/Sowing Dates/Interactions | 70 DAS | 80 DAS | 90 DAS | 100 DAS |
|-----------------------------------|-------------------------|--------------------------|--------------------------|-------------------------|
| Variety(V) | | | | |
| Borno Red | 14.94±0.42 ^b | 33.14±0.82 ^b | 54.34±1.20 ^b | 75.56±1.36 ^b |
| Ex-Dakar | 19.10±0.16 ^a | 39.94±1.02 ^a | 64.00±1.52 ^a | 80.38±1.68 ^a |
| <i>P-value</i> | <0.01 | <0.01 | <0.01 | 0.03 |
| <i>CV</i> | 9.90 | 8.80 | 8.00 | 6.80 |
| Sowing Dates (S) | | | | |
| 15th May | 17.26±0.94 | 34.89±1.87 ^{ab} | 56.37±2.60 ^{ab} | 74.95±2.02 ^b |
| 30th May | 15.57±1.06 | 33.96±1.70 ^b | 55.13±2.13 ^b | 73.33±1.97 ^b |
| 14th June | 17.33±1.23 | 37.87±1.77 ^{ab} | 61.98±2.64 ^{ab} | 80.79±1.69 ^a |
| 29th June | 18.06±1.20 | 39.45±1.82 ^a | 63.19±2.70 ^a | 82.82±1.39 ^a |
| <i>P-value</i> | 0.46NS | 0.04 | 0.04 | <0.01 |
| <i>CV</i> | 16.00 | 12.00 | 10.50 | 5.60 |
| Interactions (V X S) | | | | |
| Borno Red | | | | |
| 15th May | 15.72 | 31.25 | 51.40 | 72.74 |
| 30th May | 13.66 | 30.98 | 51.47 | 71.44 |
| 14th June | 14.70 | 34.26 | 56.27 | 78.13 |
| 29th June | 15.71 | 36.10 | 58.20 | 79.93 |
| Ex-Dakar | | | | |
| 15th May | 18.80 | 38.53 | 61.35 | 77.16 |
| 30th May | 17.47 | 36.94 | 58.80 | 75.21 |
| 14th June | 19.96 | 41.47 | 67.69 | 83.44 |
| 29th June | 20.41 | 42.80 | 68.17 | 85.72 |
| <i>P-value</i> | 0.63NS | 0.96NS | 0.78NS | 0.96NS |
| <i>CV</i> | 9.10 | 7.10 | 5.90 | 5.00 |

Mean values within each column followed by the same letter (s) are not significantly different ($P > 0.05$) from each other according to Duncan's New Multiple Rang Test (DNMRT). CV = coefficient of variation, Ns = Not significant.

Results on effect of varieties, sowing date and their interaction on leaf defoliation at 70, 80, 90 and 100 DAS in 2012 cropping season are presented in Table 3. The effect of varieties on leaf defoliation was significantly different ($P > 0.05$) at 80 and 90 DAS but was not at 70 and 100 DAS. The effect of sowing dates on leaf defoliation was significantly different at 70, 90 and 100 DAS but was not at 80 DAS. The interactive effect of sowing dates and varieties on leaf defoliation was not significant ($P > 0.05$) different from 70 to 100 DAS.

Results indicated that variety Ex-Dakar recorded significantly higher leaf defoliation of 39.61 and 66.13% compared to Borno Red which had the lower leaf defoliation of 32.44 and 56.88% at 80 DAS and 90 DAS respectively. Those groundnut plants sown in 29th June, 14th June and 15th May recorded higher leaf defoliation of 19.07 18.31 and 17.54% respectively while those groundnut plants sown in 30th May recorded the lowest leaf defoliation of 16.35% at 70 DAS.. Results show that at 90 DAS those groundnut plants sown on 15th May, 14th June and 29th June recorded higher leaf defoliation of 59.75% 64.72% and 64.74% respectively compared with leaf defoliation of those groundnut plants sown on 30th May.. Similarly at 100 DAS, higher leaf defoliation of 86.37 and 83.58% which did not differ significantly from each other was recorded from those groundnut plants sown in 29th June and 14th June respectively. Result shows that those groundnut plants sown in 15th May and 30th May lower leaf defoliation of 77.41% and 78.72% respectively.

Results on effect of varieties, sowing date and their interaction on 100 seed weight (g) in 2011 and 2012 cropping seasons are presented in Table 4.

The effect of varieties on 100 seed weight (g) was significantly different in 2011 and 2012. The effect of sowing date, interaction between the varieties and sowing date on 100 seeds weight were not significantly different ($P > 0.05$) in 2011 and 2012. Results of 2011 shows that Borno Red recorded significantly the highest 100 seed weight of 40.95g compared with Ex-Dakar which had 39.59g, but on contrary, Ex-Dakar recorded significantly the highest 100 seed weight of 39.63g compared to Borno Red which recorded 35.64g in 2012.

Table 3: Effect of Varieties, Sowing Dates and their Interaction on Leaf Defoliation of Groundnut at 70, 80, 90 and 100 DAS at 2012 Cropping Season.

| Variety/Sowing Dates/Interactions | 70 DAS | 80 DAS | 90 DAS | 100 DAS |
|-----------------------------------|--------------------------|-------------------------|--------------------------|-------------------------|
| Varieties (V) | | | | |
| Borno Red | 17.52±0.54 | 32.44±1.22 ^b | 56.88±0.90 ^b | 80.98±1.46 |
| Ex-Dakar | 18.11±0.64 | 39.61±0.55 ^a | 66.13±1.25 ^a | 82.06±1.19 |
| <i>P-value</i> | 0.49NS | <0.01 | <0.01 | 0.57NS |
| <i>CV</i> | 11.60 | 9.10 | 6.20 | 5.70 |
| Sowing Dates (S) | | | | |
| 15th May | 17.54±0.94 ^{ab} | 33.74±2.01 | 59.75±1.91 ^{ab} | 77.41±1.31 ^b |
| 30th May | 16.35±0.58 ^b | 34.17±2.43 | 56.82±1.82 ^b | 78.72±1.53 ^b |
| 14th June | 18.31±0.61 ^{ab} | 36.94±1.70 | 64.72±2.60 ^a | 83.58±0.92 ^a |
| 29th June | 19.07±0.89 ^a | 39.26±1.16 | 64.74±2.18 ^a | 86.37±0.57 ^a |
| <i>P-value</i> | 0.04 | 0.16NS | 0.04 | <0.01 |
| <i>CV</i> | 10.70 | 12.80 | 8.60 | 3.40 |
| Interactions (V X S) | | | | |
| Borno Red | | | | |
| 15th May | 17.51 | 29.62 | 55.58 | 74.80 |
| 30th May | 16.41 | 29.19 | 52.99 | 78.30 |
| 14th June | 18.37 | 33.78 | 58.96 | 84.93 |
| 29th June | 17.81 | 37.19 | 60.01 | 85.89 |
| Ex-Dakar | | | | |
| 15th May | 17.59 | 37.87 | 63.92 | 80.01 |
| 30th May | 16.29 | 39.15 | 60.65 | 79.13 |
| 14th June | 18.25 | 40.10 | 70.48 | 82.23 |
| 29th June | 20.33 | 41.33 | 69.48 | 86.86 |
| <i>P-value</i> | 0.60NS | 0.21NS | 0.10NS | 0.10NS |
| <i>CV</i> | 11.10 | 6.60 | 2.20 | 3.10 |

Mean values within each column followed by the same letter (s) are not significantly different ($P > 0.05$) from each other according to Duncan's New Multiple Rang Test (DNMRT). CV = coefficient of variation, Ns = Not significant.

Table 4: Effect of Varieties, Sowing Dates and their Interaction on 100 Seed Weight (g) in 2011 and 2012 Cropping Seasons.

| Variety/Sowing Dates/Interactions | 2011 Cropping Season | |
|--------------------------------------|-------------------------|-------------------------|
| | 100 Seed Wt (g) | |
| Variety (V) | | |
| Borno Red | 40.95±0.26 ^a | 35.64±1.23 ^b |
| Ex-Dakar | 39.59±0.45 ^b | 39.63±0.46 ^a |
| <i>P-value</i> | 0.01 | <0.01 |
| <i>CV</i> | 3.20 | 8.60 |
| Sowing Dates (S) | | |
| 15th May | 39.84±0.72 | 39.37±1.03 |
| 30th May | 40.60±0.64 | 37.40±1.70 |
| 14th June | 40.31±0.63 | 37.07±1.64 |
| 29th June | 40.33±0.45 | 36.70±1.83 |
| <i>P-value</i> | 0.85NS | 0.64NS |
| <i>CV</i> | 3.80 | 10.30 |
| Interactions (V X S) | | |
| Borno Red | | |
| 15th May | 40.67 ^s | 37.97 |
| 30th May | 41.55 | 34.77 |
| 14th June | 41.29 | 35.10 |
| 29th June | 40.31 | 34.71 |
| Ex-Dakar | | |
| 15th May | 39.02 | 40.77 |
| 30th May | 39.66 | 40.03 |
| 14th June | 39.33 | 39.05 |
| 29th June | 40.35 | 38.68 |
| <i>P-value</i> | 0.57NS | 0.94NS |
| <i>CV</i> | 3.40 | |

Mean values within each column followed by the same letter (s) are not significantly different ($P > 0.05$) from each other according to Duncan's New Multiple Rang Test (DNMRT). CV = coefficient of variation, Ns = Not significant

DISCUSSION

Sowing date has a significant effect on plant growth and disease development in any agricultural production system. The results of this field trials has validated recommendation of sowing date at this agro-ecological location (Azamali *et al.* 1993)

The finding from this study indicates that early sowing significantly lowered leaf spot disease incidence compared with the late sown plants in the two cropping seasons. Ex-Dakar was more susceptible and exhibited significantly higher disease incidence compared to Borno Red at 54 and 61 DAS in 2012. 15th May sown plants had lower leaf spot incidence compared to 30th May sown crops which were moderate in their disease incidence, while the 29th June and 14th June sown crops recorded significant higher leaf spot incidence from 47 to 61 DAS in 2011 and 2012. Relatively groundnut sown in 15th May and 30th May had significantly lower leaf spot incidence in 2011 and 2012 compared with those sown in 14th June and 29th June of both years. Likewise, higher disease incidence was recorded on groundnut plants sown on 14th June and 29th June from 54 to 61 DAS in 2012 than in 2011 which could be attributed to higher annual rainfall (1,492.8mm) and favorable average relative humidity (72.85%) resulting to higher disease incidence in 2012 (Table 1). This result agrees with the finding of Cooperative Extension (2013) which reported that leaf spots is generally more severe on late sown groundnut plants than the early sown plants due to warm temperature later in the season that are more favorable for the growth and spread of the leaf spot pathogens. Similarly, significantly higher percentage leaf defoliation was observed on Ex-Dakar compared to local Borno-Red in the two cropping seasons. This may be due to the higher leaf spot disease incidence recorded in Ex-Dakar plants which could have resulted in subsequent higher leaf defoliation. This result agrees with the report of Bdiya and Muhammad. (2006) in which *Cercospora* leaf spots varied among the three groundnut varieties they studied. Bdiya and Muhammad. (2006) also reported a higher leaf spot disease incidence in Ex-Dakar compared with RMP 12 and Damboa local varieties. The significantly higher leaf defoliation could be attributed to delay sowing. The higher leaf defoliation observed in plants sown in June could be due to build up of inoculum leading to higher disease incidence and consequently higher leaf defoliation. According to Cooperative Extension (2013) groundnut plant sown late began leaf shading early because of early severe disease infection and attack on the tender leaves. Also, Adipala *et al.* (2000) reported that late sown groundnut showed high disease incidence and pest infestation resulting in lower yield. High leaf losses of up to 25 - 43% due to could result in the

disruption of the photosynthetic process, lesser pods and lower fruit quality Waliyar *et al.* 2000).

The differential seed weight recorded among the groundnut varieties in the two cropping seasons implies that seed weight is a genotypic trait and could be equally influenced by environmental factors (Kole and Gupta 1982; Mahesha *et al.* 2001 and Khatun *et al.* 2009). Gorbet *et al.* (1982) reported that number of spots per leaf and leaf defoliation both have a negative correlation with yield. Das and Roy (1995) also reported that *Cercospora* leaf spot disease reduced yield by every 1% increase in disease severity. The management of groundnut leaf spot through the manipulating of sowing date was very effective in reduction of disease incidence and leaf defoliation.

In conclusion, this study has shown that early sowing of groundnut in May could be another alternative viable option for the management of *Cercospora* leaf spot disease of groundnut in Makurdi.

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