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INFLUENCE OF VARIETY AND INTRA-ROW SPACING ON *CERCOSPORA* LEAFSPOT DISEASE OF GROUNDNUT IN BAUCHI, NIGERIA.

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ABSTRACT

Cercospora leafspot infection was analyzed for ten diverse groundnut varieties sown at two intra-row spacings during 1998 and 1999 rainy seasons at Bauchi, Nigeria. Significantly ($P<0.01$) lower incidence and severity of *Cercospora* leafspot were obtained at 50x30cm intra-row spacing. Spacing of 50x20cm however encouraged development of the disease. Late maturing and spreading types were resistant to Cercospora leafspot,compared to erect and early maturing types which are susceptible. Progress of *Cercospora* leafspot on groundnut was influenced by higher rainfall, relative humidity and low temperatures.

INTRODUCTION

Groundnut (*Arachis hypogaea* L.), also called pinder, peanut or earthnut, is cultivated mainly in northern Nigeria (ICRISAT, 1993). The crop is cultivated in over 19million hectares annually in the arid and semi arid lands of Africa and Asia. In Nigeria, its production is concentrated within the semi arid zone of the country (Lat. 8°-13° N) where the mean annual rainfall varies between 800mm in the far north to 1200mm in the southern end of the zone

From the late 1970s, farmers in northern Nigeria began to abandon the crop due to the effect of diseases, drought and poor management practices such as late sowing and unavailability of improved varieties (Yayock, 1979). Among the major factors militating against the normal growth and development of groundnut plants are diseases. Diseases notably afflicting groundnut production include; Rust, Aflatoxin, Rossette disease, Bud necrosis, Peanut mottle disease and *Cercospora* leafspots. The *Cercospora* or *Tikka*; leafspots are generally regarded as the most important fungal disease of groundnut occurring wherever the crop is cultivated. The disease is referred to as *Cercospora leafspot* since it is their conidial stages that are normally found in the field. Two principal species are involved; *Cercospora arachidicola*, the cause of 'early' leafspot and *Cercosporadium personatum* which causes 'late' leafspot (Mc Donald, 1978). Symptoms of the two leafspots are effectively indistinguishable in the early stages of their development. Late lesions caused by *Cercospora arachidicola* tend to be lighter than those caused by *Cercospora personatum*. Lesions induced by *Cercospora arachidicola* normally first appear 3-4 weeks after sowing, while *Cercospora personatum* occurs about 2-3 weeks later. Despite its late development, *Cercospora personatum* is potentially the more destructive specie because of its much higher rate of spread, leading to more rapid defoliation.

The principal effect of both leafspots is to cause premature defoliation (Elston *et al.* 1976) and it has been estimated that groundnut leaf defoliation by leafspots may begin when 6% of the leaf area is diseased. Severe infection may cause complete defoliation. Under farmers fields in northern Nigeria, losses of about 23% for pods and about 56% for haulms may occur regularly, suggesting that some 200,000 tones of groundnut may be lost annually in Nigeria (Fauler, 1970; 1971). *Cercospora* leafspot have been known to effectively be controlled by various fungicides like copper and sulphur dusts (Clark *et al.* 1974; Little, 1974). However, in northern Nigeria, fungicide spraying is only practiced on high volume breeding material and on seed multiplication schemes but rarely at farmers level. This is so because small-scale farmers in Africa generally can ill afford the high cost of the product and the spraying equipment. Cultural control measures such as crop rotation, clean weeding and destruction of volunteer groundnut on which the pathogen often survive the dry season on, may also assist in delaying the onset of infection and reducing its severity (Fauler, 1970b). There may also be scope of adjusting time of sowing and spacing to reduce incidence (Ferrel, *et al.* 1967). It was recently appreciated that groundnut cultivars differ in susceptibility to the *Cercospora* leafspot (Garba *et al.*, 2003). Early maturing cultivars, usually erect are generally highly susceptible. Late maturing types, usually runner types were observed to have varying degrees of resistance. A field study was therefore undertaken to evaluate the reaction of different groundnut varieties sown at two intra-row spacings to on incidence and severity of *Cercospora* leafspot. In addition, this paper also highlighted the influence of some environmental factors on progress of *Cercospora* leafspot on groundnut in Bauchi.

MATERIAL AND METHODS

The study was carried out for two years during the rainy seasons of 1998 and 1999 at the Abubakar Tafawa Balewa University, Research Farm, Bauchi. Bauchi is located in the northern Guinea savanna of Nigeria situated at 602 meters above sea level with mean annual rainfall of 1095mm. The rainfall period is mostly between the months of June and October and the mean temperature during the growing season is 30°C (Kowal and Knabe, 1972.).

During the study, ten groundnut varieties were used: RMP-12 ICGV-SM-89754, ICGV-SM-89767, ICGV-SM-96808 and 88-801 (spreading in growth habit and late maturing); UGA-3 and UGA-13 (spreading and intermediate maturing). These varieties were obtained from IAR, Zaria. Varieties Ex-Dakar, Ex-kafanchan and RRB that are erect and early

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maturing were obtained locally from farmer's fields. Two intra-row spacings (20 and 30cm) with a uniform inter-row spacing of 50cm were adopted. The varieties and the spacings were fitted into a randomized complete block design with three replications. Blocks and plots were separated by 1m-border row and a plot size of $9m^2$ (3x3m) with six rows was used.

Two weedings at 3 and 6 weeks after sowing (WAS) were carried out. Incidence of the disease was obtained by the observation of the disease symptoms on ten randomly selected plants per plot and the average taken as shown below: -

$$\text{Incidence (\%)} = \frac{\text{Number of infected plants}}{\text{Total number of plants sampled}} \times 100$$

Severity of the disease, which is the level or extent of the infection based on the leaf area per plant however, was obtained by individual assessment of the level of damage of the ten selected plants using a visual assessment scale shown below:

0- No disease
1- 1-12.5% of the plant leaves were affected
2- 13-25% of the plant leaves were affected
3- 26-50% of the plant leaves were affected
4- 51-75% of the plant leaves were affected
5- >75% of the plant leaves were affected

Observation of incidence and severity of the disease was taken from the first week after sowing to 14 (WAS). The plants were exposed to natural infection by *Cercospora* without supplementary artificial field inoculation since the farm was located in an endemic area.

Some environmental weather factors were also used to observe relationship if there is any with three of the most susceptible varieties to *Cercospora* leafspot; Ex-Dakar, Ex-Kafanchan and RRB as determined by Garba, (2002). The weather factors were; Amount of rainfall (mm), atmospheric temperature (C^0) and relative humidity (%). The weather factors were recorded from the meteorological station situated close to the research farm. The average of all the weather factors considered were taken at weekly interval. Combined analysis of variance (ANOVA) of two-year data was carried out to test for the significant effect of the treatments. Duncan Multiple Range Test (DMRT) was also used to compare means of varieties, spacing and their significant interaction (Duncan, 1955). The environmental weather conditions considered during the period under study were used to explain how disease progress changes with the environmental factors during this investigation.

RESULTS AND DISCUSSION

Incidence of *Cercospora* leafspot among the varieties and the intra-row spacing varied significantly (Table 1). All the erect varieties were observed to be attacked by *Cercospora* leafspot more than the spreading varieties toward harvest. In varieties like RMP-12, ICGV-SM-89754 and ICGV-SM-89767, very few spots were noticed on the lower older leaves very close to the ground. Camacho De Torres and Subero (1993)

Table 1: Effect of variety, spacing and year on the incidence (%) of Cercospora leafspot at different sampling dates at Bauchi.

	Weeks after sowing					
Treatment	4	6	8	10	12	At Harvest
Variety						
Ex-Dakar	6.3b	13.4b	27.3c	38.3a	44.6bc	60.3a
Ex-Kafanchan	3.8d	11.1c	22.3fg	30.3c	48.6a	60.2a
RRM	2.1h	4.9h	21.8gh	32.0b	45.4b	58.7b
UGA-13	5.3c	13.5a	24.1d	28.5d	43.7c	54.9cd
UGA-3	6.9a	7.7f	30.0b	28.1de	42.2c	54.8d
88-801	2.7f	7.7f	36.6a	27.3e	37.9e	49.3fg
ICGV-SM-96808	0.7i	7.4g	23.4ef	25.0f	37.8e	49.8fg
ICGV-SM-89767	5.3c	7.7f	23.5e	23.5g	39.4d	50.3ef
ICGV-SM-89754	3.1e	9.3d	21.8h	22.1h	36.8f	48.6g
RMP-12	2.5g	8.4e	23.5e	25.0f	32.3g	46.6h
SE±	0.03	0.03	0.28	0.25	0.43	0.56
Intra-row Spacing(cm)						
20	3.9a	9.4a	26.8a	30.7a	43.0a	55.8a
30	3.9a	8.8b	24.1b	25.3b	38.6b	50.8b
SE±	0.01	0.01	0.02	0.11	1.22	0.25
Years						
1998	3.9a	9.1a	25.5a	28.1a	41.0a	53.3a
1999	3.9a	9.1a	25.4a	28.8a	40.6a	53.4a
SE±	0.01	0.01	0.02	0.11	0.19	0.25

Means followed by common letter(s) are not significantly different at 5% probability level (DMRT).

reported that as long as rain splashes on the soil where *Cercospora* leaf fungi are known to be endemic, no groundnut plant would be spared from infection by the disease.

Higher percentage disease incidence of the *Cercospora* leafspot was observed on groundnut plant sown at 20cm intra-row than on plants sown at 30cm intra-row spacing. Kaur ad Sokhiss (1994) reported that infection of groundnut by the leafspot fungus could be contagious as it was noticed more on densely populated groundnut fields. There is an increase in plant-to-plant contact in the field, on plants spaced at 20cm apart, which increases the incidence and spread of the disease. Similarly, denser crop population generates higher relative humidity within the micro-surrounding environment built underneath the plant. This support earlier reports by Alderman and Nutter (1994) who observed that higher moisture content around groundnut plants under cooler environments help in spreading *Cercospora* leafspot on groundnut. There was no significant difference observed between the two growing seasons on groundnut infection by *Cercospora* leafspot.

Table 2 show the severity of Cercospora leafspot on different groundnut varieties sawn at two intra-row spacings. At harvest, varieties Ex-Dakar and Ex-Kafanchan and RRB that are erect in growth habit were more severely damaged by the disease. RMP-12 was however, the least to be affected. Varieties UGA-13 and ICGV-SM-89767 that had higher incidence of the disease were not severely affected by the disease. This difference between incidence and severity may be as a result of inherent capacity to restrict the growth of the fungi after infection by the varieties. Such restrictions have been ascribed to leaf epidermal thickness, including the cuticle, palisade tissue and the middle part of the larmina with the susceptible ones having more spongy parenchyma (Kaur and Sokhiss, 1994). However, no such investigations have been conducted in this study. Resistance to the disease in groundnut could also be a function of the growth habit, spreading varieties tend to "push out" their branches and cover the ground forming a compact leaf canopy thereby avoiding direct rain splash on the soil

Table 2: Effect of variety, spacing and year on the severity of *Cercospora* leafspot at different sampling dates at Bauchi.

	Weeks after sowing					
Treatment	4	6	8	10	12	At Harvest
Variety						
Ex-Dakar	1.0a	1.8bc	3.1a	4.0b	4.8a	1.3bc
Ex-Kafanchan	1.0a	2.2ab	3.2a	4.7a	4.8a	2.0a
RRM	1.0a	1.8bc	2.3bcd	3.3cd	4.7a	1.7a
UGA-13	1.0a	1.5cd	2.3bcd	2.9cd	2.5gh	1.2cd
UGA-3	1.0a	1.6cd	1.6e	3.4e	3.9b	1.2cd
88-801	1.0a	1.2d	2.3bcd	2.9cd	3.2cde	1.1cd
ICGV-SM-96808	1.0a	2.3a	1.8de	2.7d	3.1e	1.0d
ICGV-SM-89767	1.0a	1.8bc	2.2ef	2.2ef	2.1h	1.1cd
ICGV-SM-89754	1.0a	1.7bc	2.1cde	1.8f	2.6fg	1.2cd
RMP-12	1.0a	1.9	2.8abc	2.8d	3.2cde	1.0d
SE±	0.01	0.18	0.18	0.18	0.14	0.03
Intra-row Spacing (cm)						
20	1.0a	2.0a	2.7a	3.2a	3.5a	1.3a
30	1.0a	1.6b	2.2b	2.9b	3.4a	1.2b
SE±	0.01	0.10	0.11	0.10	0.08	0.05
Years						
1998	1.0a	1.6b	2.3a	3.0a	3.5a	1.2b
1999	1.0a	1.9a	2.4a	3.1a	3.4a	1.4a
SE±	0.01	0.10	0.11	0.10	0.08	0.05

Means followed by common letter(s) are not significantly different at 5% probability level (DMRT).

underneath the plant. Thus preventing plant propagules contact and subsequent infection.

From the first 5 WAS, the severity of the disease was zero (Table 2) meaning the infection types was minimal on the plant. The low severity of the disease exhibited by all the varieties during the first 5 WAS (Table 2) could be explained by the influence of environmental factors more especially relative humidity and temperature which are not conducive at the early stages for mycelia growth of the fungus. However, as the plant grows and ages, resistant qualities of the various varieties and the effect of spacing become more discernible. It was also observed in the present investigations that at harvest, about 80-90% of the leaves on the erect varieties have fallen off. This shows the susceptible nature of erect varieties to leafspot. Although leafspot was also noticed on the leaves of the spreading varieties, their leaves remained attached on the branches at harvest.

An association among various environmental traits with incidence and severity of Cercospora on groundnut is shown in Table 3 and 4. The significantly positive correlation ($P<0.05$) observed between amount of rainfall (mm) with incidence and severity is in agreement with an earlier report made by Robber and Nyvall (1979) who also showed the positive role of amount of rainfall on the attack of groundnut by leafspot disease. Amount of rainfall is likely to have the direct effect of providing moist leaf surface environment for infection to take place. It also has an indirect effect of increasing the percentage relative humidity coupled with high temperature. All these facilitate infection by the fungus leading to increase incidence and severity.

Duration of rainfall during the day significantly and negatively corrected ($P<0.01$) with incidence ($r=0.69$) and with severity ($r=-0.77$) of the leafspot disease. This can be explained by the fact that the longer time it takes for rain to fall it tends to wash away the fungal propagules on the plant, thus reducing the chances of contact and infection.

The significant correlation ($P<0.01$) between morning temperature with incidence ($r=0.83$) and severity ($r=0.89$) of leafspot disease was not unexpected. During the morning hours there is gradual increase in temperature. The initial low temperature combined with high relative humidity allows for infection to take place by the fungal propagules. The subsequent gradual increase in temperature allows for rapid growth and development of the fungus resulting in higher levels of infection and disease. The result of the study corroborates the report of Alderman and Nutter (1994) that cooler environments coupled with higher humidity initiate disease on crops. Morning soil temperature also correlated positively ($P<0.01$) with incidence ($r=0.89$) and severity ($r=0.89$) of leafspot. This also show that low morning soil temperature allows infection to take place and as the temperature increases during the morning hours there was increased fungal growth which corresponds to increase in leafspot incidence and severity (the higher the temperature the higher the disease). It could also be that cooler morning soil temperature the pathogens for both early and the *Cercospora* leafspot as they attack the crop more at that time. More work is however, needed in this area to establish the relationship between morning soil temperature and pathogens in the soil in terms of proliferation of the disease on groundnut.

Higher relative humidity has been reported by several researchers to increase the prevalence and severity of diseases in field crops (Butler *et al.*, 1994; Alderman and Nutter, 1994; Pedro Junior *et al*, 1994). A significant correlation ($P<0.01$) between relative humidity with incidence ($r=0.75$) and severity ($r=0.75$) of leafspot indicated that the higher the relative humidity the more the disease. Although the late maturing and spreading varieties were shown to be more resistant to the disease, late leafspot was observed on the lower, leaves of the plants. This could be as a result of the compact and spreading nature of the genotypes, which tend to build high humid situation under the plant and so older leaves were affected even on varieties that appear resistant. This was manifest in percent incidence at harvest in RMP-12 ICGV-SM-89754 and ICGV-SM-96808 (Table 1). Susceptibility to the leafspot disease from the varieties studied clearly showed that growth habit could be the single most important factor affecting the incidence and severity of the disease. However, growth habit might not be enough to confer full protection of the crop against the dreaded leafspot disease since morphological, physiological and anatomical features could cause resistance and tolerance as well.

Table 3: Correlation coefficient between some environmental factors and the incidence of Cercospora leafspot disease of groundnut during the 1999 rainy season at Bauchi.

Character	Correlation Coefficient	Mean +
Leafspot	-	68.70%
Daily rainfall amount	0.59*	1.49mm
Rainfall duration during the day	-0.69	32.04min
Atmospheric morning temperature	0.83**	26.80°C
Atmospheric afternoon temperature	0.89**	32.49°C
Moring soil temperature	0.89	26.82°C
Afternoon soil temperature	-0.49	29.62°C
Relative humidity	0.75**	79.30%

\+ = Mean value for each ** = Sig. at 1% prob. Level.

* = Sig. at 5% prob. Level.

Table 4: Correlation coefficient between some environmental factors and severity of Cercospora leafspot disease of groundnut during the 1999 rainy season at Bauchi.

Character	Correlation Coefficient	Mean +
Leafspot		3.7
Daily rainfall amount	0.33*	11.49mm
Rainfall duration during the day	-0.77**	32.64min
Atmospheric morning temperature	0.89**	26.80°C
Atmospheric afternoon temperature	-0.30	30.49°C
Morning soil temperature	0.89**	26.82°C
Afternoon soil temperature	-0.56*	29.62°C
Relative humidity	0.76**	79.30°C

\+ = Mean value for each ** = Sig. at 1% prob. Level.

* = Sig. at 5% prob. Level

From the foregoing study, it is clear that the spreading varieties like RMP-12, ICGV-SM-89754 and ICGV-SM-89767 were more resistant to *Cercospora* leafspot, than the erect varieties like RRB, Ex-Dakar and Ex-Kafanchan. These varieties do not only produce higher haulm yield than the erect varieties, by resisting defoliation of their leaves but also check the spread of *Cercospora* leafspot. Intra-row spacing of 30cm was also found to reduce the level of infection irrespective of the plant growth habit. This reduction in infection is likely to have arisen from reduced contact among the plants that would have allowed for rapid spread of the disease. Although there will be more contact among the spreading types, the nature of their canopy reduced rain splash that would otherwise dispersed conidia for further infection to occur, which is not the case with the erect types. Groundnut infection by *Cercospora* pathogen is influenced by higher rainfall, relative humidity with low temperatures.

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