African Journal of Agricultural Research Vol. 2 (4), pp. 182-186, April 2007
Available online at http://www.academicjournals.org/AJAR
ISSN 1991- 637X © 2007 Academic Journals

Full Length Research Paper

Levels of variability in groundnut (Arachis hypogaea L.) to cercospora leaf spot disease – implication for selection

A. U. Izge[1]*, Z. H. Mohammed[2] and A. Goni[2]

[1]Department of Crop Production, Faculty of Agriculture, University of Maiduguri, P.M.B. 1069, Maiduguri, Borno State, Nigeria.
[2]Department of Crop Protection, Faculty of Agriculture, University of Maiduguri, P.M.B. 1069, Maiduguri, Borno State, Nigeria.

Accepted 19 April, 2007

Groundnut (Arachis hypogaea L.) is an important crop both in subsistence and commercial agriculture in arid and semi-arid regions of the world. Leaf spot diseases caused by fungus have been a major destructive disease of groundnut and could cause a yield loss of up to 50 % or more. A two-year experiment was conducted during the cropping seasons of 2002 and 2003 at the Faculty of Agriculture Research Farm, University of Maiduguri, Nigeria. The objective of the study was to determine the reaction of different groundnut varieties to cercospora leaf spot disease to create basis for selection for cercospora leaf spot disease tolerance. The experiment consisted of twenty-four groundnut varieties, laid out in a randomized complete block design (RCBD) with three replications. The analysis of variance (ANOVA) indicated highly significant difference among the groundnut varieties in all the characters studied. The results indicated that ICGV-SM-93531, ICGV-IS-96802, ICGV-IS-96827 and ICGV-IS-96808 had the lowest cercospora leaf spot incidence. The variety ICGV-IS-96808 that produced the highest kernel yield also had the lowest days to 50% flowering and incidentally is among varieties that recorded the lowest leaf spot incidence. The study found tremendous level of variability existing among the groundnut varieties that is essential in crop improvement. This study recommends that development or selection of tolerant varieties to leaf spot should be based on their level of incidence. This will be the only effective measure in decreasing production costs and protect the environment from pollution. Potential therefore exist for selection among the groundnut varieties evaluated for cercospora leaf spot disease tolerance. There is however, a need to undertake further studies in order to determine the type and the number of genes controlling cercospora leaf spot disease tolerance in groundnuts for enhanced breeding strategies.

Key words: Groundnut, leaf spot, tolerance, incidence, selection, breeding strategy.

INTRODUCTION

Groundnut (*Arachis hypogaea* L.) is grown in many agro-environments. It is cultivated in some 90 countries around the world (Virmani and Singh 1985). In semi-arid tropical areas it is an important cash crop in subsistence and even in commercial farming systems, as well as an important food source. Its successful production has been drastically affected by a number of problems; some of which is leaf spot disease, which is economically important.

Early leaf spot disease caused by the fungus *Cercospora arachidis* S. Hori (teleomorph *Mycosphaerella arachidis* Deighton) and late leaf spot disease caused by fungus *Cercosporidium personatum* (Berk and M. A. Curtis) Deighton (teleomorph *Mycosphaerella berkeleyi* Jenk.) are the major destructive disease of groundnuts worldwide, (Backman and Crawford, 1984; Jackson and Bell, 1969; Smith et al., 1992). Problems related to leaf

*Corresponding author. E-mail: bamsyizge@yahoo.com
Tel: +234 (0) 8030636782

Table 1 Analysis of variance showing source of variation, degrees of freedom and mean squares for yield, yield components and cercospora disease incidence in groundnut .

Source of Variation	DF	Establishment Count (%)	Plant height (cm)	Branches /plant	Days to 50 % flowering	Disease incidence (%)	Haulm yield (kg/ha)	Kernel yield (kg/ha)
Replications	2	41.514	1.042	0.222	4.291	1.1.681	1106836	91164
Treatments	23	119.237**	182.763**	38.373**	90.463**	388.072**	1011934**	1112329**
Error	46	36.47	0.418	0.193	5.842	6.188	247818	121539

** Significant at 1 % level of probability

spot diseases cause nearly complete defoliation and yield losses of up to 50% or more. The leaf spot disease epidemics are affected by weather patterns such as hot and wet conditions (Shew et al., 1988). Control of leaf spot diseases in Nigeria has depended on some cultural practices and on multiple applications of fungicides. Effective and long-term control of leaf spot disease can be achieved by applying recommended fungicides at the recommended time intervals. However, repeated application of fungicides could cause a slow erosion of disease control due to a gradual loss of sensitivity in the target pathogen population and contribute to greater production costs and environmental pollution.

Groundnut *Cercospora* leaf spot diseases occur mainly in the warm and humid areas, because of that this disease is prevalent in the Northern Guinea and Sudan Savanna zones of Nigeria during the rainy seasons. Farmers in these arid and semi-arid areas of Africa where groundnuts are grown extensively are naturally in economic resource and so affordability to chemical control measure of this disease is almost zero.

Development of cultivars tolerant to this could be effective in decreasing the production costs, improving production quality and reducing the detrimental effects of chemicals on our ecosystem. Because of the economic importance of leaf spot disease in groundnut and the environmental impact of chemical control method it is necessary to breed or select groundnut cultivars based on their level of tolerance to leaf spot disease. It is for these reasons therefore, this study was conducted to determine the level of variability in tolerance of different groundnut cultivars to leaf spot disease among which tolerant cultivars could be chosen for further breeding program.

MATERIALS AND METHODS

A two-year study was conducted during the cropping seasons of 2002 and 2003 at the Faculty of Agriculture Research Farm, University of Maiduguri, Nigeria. Maiduguri is located in the Sudan Savanna agricultural zone of Nigeria, which is characterized, by low rainfall, short rainfall duration and a very high temperature that is accompanied by a high relative humidity during the cropping season.

The groundnut materials used for the study were obtained from the International Crop Research Institute for the Semi-Arid Tropics (ICRISAT), Patencheru India, the Lake Chad Research Institute (LCRI), Maiduguri, Nigeria and the Institute for Agricultural Research (IAR), Samaru-Zaria, Nigeria. The twenty-four groundnut varieties used for the study included; ICGV-SM-89754, ICGV-SM-89767, ICGV-SM-93518, ICGV-SM-93523, ICGV-SM-93524, ICGV-SM-93525, ICGV-SM-93528, ICGV-SM-93530, ICGV-SM-93531, ICGV-SM-93533, ICGV-SM-93534, ICGV-SM-93535, ICGV-SM-94583, ICGV-SM-94587, ICGV-IS-96801, ICGV-IS-96802, ICGV-IS-96805, ICGV-IS-96808, ICGV-IS-96826, ICGV-IS-96827, ICGV-IS-96845, ICGV-IS-96855, 55-437 (SAMNUT-14), and UGA-2.

The experiments were laid out in a randomized complete block design (RCBD) replicated three times. Each plot measured 3 x 3 m with inter and intra row spacing of 50 x 30 cm respectively. Two seeds each were sown per hole at the depth of 5 cm. Before sowing, the seeds were treated with Apron Plus 50 DS (Metalaxyl) at the rate of 1 gram a.i. /kg of seed to prevent seedling disease and ensure good plant establishment.

The treatments that is, the groundnut varieties grown on the field were exposed to natural infection in the first year. In the second year artificial inoculation was done to increase the inoculum's potential by spraying the plants at three weeks after sowing with a spore suspension using a brush. Inoculation was done between the hours of 5:00 - 6:00 PM in the evenings.

Parameters for data collection included; establishment count, plant height, number of branches per plant, days to 50% flowering, leaf spot disease incidence, haulm yield and kernel yield. The data collected were subjected to analysis of variance (ANOVA) and the means were compared using DMRT at 5% level of probability according to Duncan (1955).

RESULTS

The analysis of variance indicating the source of variation and mean squares for the yield and yield component characters among the groundnut varieties studied are presented in Table 1. The analysis of variance indicated that highly significant difference existed among the groundnut varieties for all the characters investigated.

The mean performance values for the groundnut varieties in all the characters studied averaged over two years are presented in Table 2. The results indicated that the groundnut varieties; ICGV-IS-96809, ICGV-SM-93523, ICGV-IS-96801 and ICGV-SM-89767 recorded the highest establishment counts of 87.66, 87.00, 86.33, and 84.66 % respectively. However, ICGV-SM-93518, ICGV-SM-93524, ICGV-SM-93534 and UGA-2 recorded the lowest establishment counts of 63.33, 68.33, 69.33 and 71.33% respectively. Incidentally the groundnut variety ICGV-IS-96808 that had the highest establishment count also had the highest kernel yield and was among the earliest maturing varieties. The results indicated that,

Table 2. Mean performance of yield; yield components and leaf spot incidence among certain groundnut varieties.

Groundnut Varieties	Establishment Count (%)	Days to 50% flowering	Plant height(cm)	Number of branches/plant	Disease Incidence (%)	Kernel yield (kg/ha)	Haulm yield(kg/ha)
ICGV-IS-96808	87.66* a	42.00 i**	22.00 h	9.00 d	27.66 k	3614 a	1931 c-g
ICGV-IS-96801	86.33 ab	47.66 d-f	27.00 e	21.00 a	53.00 a	2492 bc	2525 b-d
ICGV-IS-96802	84.00 a-d	52.66 bc	8.00 n	5.00 j	16.00 lm	1447 g-j	2670 bc
ICGV-IS-96827	82.00 a-e	58.66 a	10.66 m	5.66 ij	19.33 l	1176 h-k	3075 ab
ICGV-IS-96805	78.00 a-h	42.66 hj	30.00 d	8.00 ef	33.33 j	1558 e-j	2260 b-f
ICGV-IS-96845	75.33 c-h	50.00 c-e	36.66 a	12.00 b	33.66 j	2598 b	1348 g
ICGV-IS-96855	74.66 d-h	50.00 c-e	31.33 c	8.00 ef	28.33 k	1530 f-j	1772 d-g
ICGV-IS-96826	71.66 f-i	43.33 g-i	24.00 g	6.66 gh	40.66 f-h	2109 b-e	2272 b-f
ICGV-SM-93523	87.00 a	42.66 hj	14.00 k	7.33 fg	48.33 b-d	1150 i-k	1635 e-g
ICGV-SM-89767	84.66 a-c	40.66 ij	12.66 l	6.00 hi	39.33 g-i	1172 h-k	2334 b-e
ICGV-SM-93535	82.33 a-e	44.00 f-i	18.66 i	8.66 de	45.66 c-e	1285 h-k	2097 c-g
ICGV-SM-93530	79.33 a-f	41.33 ij	23.33 g	5.33 ij	44.33 df	2061 b-f	1642 e-g
ICGV-SM-94587	78.66 a-g	47.33 ef	25.33 f	5.66 ij	51.33 ab	1358 h-k	1573 e-g
ICGV-SM-94583	78.00 a-h	56.66 a	21.33 h	12.00 b	35.66 ij	1980 c-g	2220 c-f
ICGV-SM-93531	77.00 b-h	56.66 a	6.66 o	8.00 ef	12.00 m	857 k	3585 a
ICGV-SM-93525	77.00 b-h	46.00 f-h	25.33 f	4.00 k	42.00 e-g	1381 h-k	1346 g
ICGV-SM-93528	75.00 c-h	39.33 j	18.00 i	6.00 hi	48.30 b-d	1725 d-h	1574 e-g
ICGV-SM-93533	74.66 d-h	44.00 f-i	23.33 g	10.00 c	36.66 hj	1593 e-i	2191 c-f
ICGV-SM-89754	71.33 f-i	51.33 c-d	32.66 b	10.00 c	47.33 b-d	2269 b-d	1510 fg
ICGV-SM-93534	69.33 g-i	55.33 ab	15.33 j	5.00 j	43.00 e-g	1955 c-g	1573 e-g
ICGV-SM-93524	68.33 hi	44.33 f-i	21.33 h	8.00 ef	44.66 d-f	1547 e-j	1280 g
ICGV-SM-93518	63.33 i	46.00 f-h	15.33 j	5.00 j	49.66 a-c	1414 g-k	1603 e-g
UGA-2	71.33 f-i	46.66 e-g	14.66 jk	10.66 c	34.00 j	1659 e-i	2068 c-g
55-437	73.66 e-h	46.66 e-g	25.33 f	5.66 ij	51.33 ab	1010 jk	1372 g
SE	3.48	1.39	0.37	0.25	1.43	201.20	287.40

* Data are means of three replications.
** Means within a column followed by same letter(s) are not significantly different at 5 % according to DMRT (Duncan Multiple Range Test).

ICGV-IS-96845, ICGV-SM-89754, ICGV-IS-96855, and ICGV-IS-96805 had the tallest plant height with 36.66, 32.66, 31.33 and 30 cm respectively. While ICGV-IS-96827, ICGV-IS-96802 and ICGV-SM-93531 recorded the shortest plant height of 10.66, 8.00, and 6.66 cm respectively. The result also indicated that significant difference existed among the groundnut varieties in number of branches/plant. The groundnut variety ICGV-IS-96801 recorded the highest number of branches/plant, while ICGV-SM-93525 recorded the lowest number of branches/plant. Incidentally, this same variety performed so low in the other parameters. On the other hand ICGV-SM-93528, ICGV-SM-93530, ICGV-IS-96808, and ICGV-SM-89767 recorded the lowest days to 50% flowering.

The results also showed that the groundnut varieties differed significantly in their levels of susceptibility to cercospora leaf spot disease. The result indicated that ICGV-IS-96801, ICGV-SM-94587, 55-437 (SAM NUT-14) and ICGV-SM-93528 recorded the highest level of cercospora leaf spot disease incidence. However, ICGV-SM-93531, ICGV-IS-96802, ICGV-IS-96827 and ICGV-IS-96808 recorded the lowest cercospora disease incidence. The highest haulm yield was produced by varieties ICGV-SM-93531, ICGV-IS-96827, ICGV-IS-96802 and ICGV-IS-96801 with 3585, 3075, 2670, and 2525 kg/ha respectively. High kernel yield on the other hand was produced by ICGV-IS-96808, ICGV-IS-96845, ICGV-IS-96801 and ICGV-SM-89754 with 3614, 2598, 2492, and 2269 kg/ha of kernel respectively. The variety producing the highest kernel yield i.e. ICGV-IS-96808 also had the lowest days to 50% flowering and also among varieties that recorded the lowest cercospora leaf spot disease incidence.

DISCUSSION

The tremendous level of variability existing among the groundnut varieties or population studied indicated a positive step in their improvement. The presence of genetic variability in crop plants have been described as essential in plant breeding by Falconer (1989) and by Izge et al. (2005). Genetic variability encourages selec-tion, because selection on its own does not create variability.

The groundnut variety ICGV-IS-96808 was found to have recorded the highest establishment count. Interestingly, however the same variety had the highest kernel yield and was among that matured early. Izge et al. (1998) reported similar result in groundnut where establishment count/number of plants/plot was directly correlated with kernel yield/pod yield. A lot of review works in groundnut revealed that high pod yielding ability are positively and directly correlated with kernel yield. This study identified varieties ICGV-IS-96808, ICGV-IS-96845, ICGV-IS-96801, and ICGV-SM-89754 as the best kernel yielder among the population evaluated.

In Nigeria no form of disease control is practiced by local farmers, who most often link crop maturity to leaf defoliation as a result of diseases, thus overlooks the adverse effects on their crop. Disease severities are so high so much so that at harvest more than 80 % of the leaves on groundnut plants are defoliated due the combined attack of cercospora leaf spot diseases (Tsigbey et al., 2001). Variation and reactions of groundnuts to cercospora leaf spot disease were reported by Knauft and Gorbet (1990). The control of leaf spot disease in groundnut has also been reported to depend very much on multiple applications of fungicides. However, repeated application of fungicides could cause slow erosion of disease control due to a gradual loss of sensitivity in the target pathogen population and contribute to greater production costs and environmental pollution. The development or selection of tolerant varieties or cultivars could therefore be an effective method in decreasing production costs and improving product quality. This study found varieties, ICGV-SM-93531, ICGV-IS-96802, ICGV-IS-96827 and ICGV-IS-96808 as having the lowest levels of cercospora leaf spot incidence, indicating that they are relatively tolerant to cercospora leaf spot disease. However, the varieties, ICGV-IS-96801, ICGV-SM-94587, 55-437 (SAMNUT-14), and ICGV-SM-93528 were identified as relatively having the highest disease incidence, invariably indicating that they were susceptible to cercospora leaf spot disease.

The groundnut variety ICGV-IS 96808 which gave the highest kernel yield had the lowest number of days to 50% flowering and interestingly was among varieties that recorded the lowest disease incidence. This could imply that early maturity may be positively associated with cercospora leaf spot tolerance in groundnut. This study has identified ICGV-SM-93528, ICGV-SM-93530, ICGV-IS-96808 and ICGV-SM-89767 as having a good potential for early maturity among which selection could be made.

In conclusion, the study found a lot of variability existing among the groundnut varieties evaluated in all the characters. The varieties ICGV-SM-93531, ICGV-IS-96802, ICGV-IS-96827 and ICGV-IS-96808 have been found to be tolerant to cercospora leaf spot disease based on their level of incidence and their respective kernel yields. The study also affirms that varieties with higher kernel yield and low downy mildew incidences happened to mature early than the other varieties.

For the rain fed subsistence environment, stable performance is crucial and could be achieved by incorporating necessary resistance to biotic constrain such as leaf spots. Potentials therefore exist to select among the varieties that excelled for tolerance to cercospora leaf spot disease. There is however a need for further evaluation through a greater development and use of new non-conventional approaches to groundnut improvement, particularly against diseases, where limited useful variability occurs in the cultivated species. There is also a need for greater development and use of non-conventional approaches to groundnut improvement to complement the pre-

sent conventional methodologies.

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