

Research Application Summary

Evaluation of oleic acid rich groundnut lines for adaptation and resistance to foliar diseases in Malawi

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Abstract

Groundnut is an important oilseed crop for both food and nutrition security. The development of nutrient dense varieties including oleic acid to meet dietary needs in Africa is important. The study was undertaken to evaluate oleic acid rich lines for agronomic adaptation and reaction to foliar diseases. The experimental design was an alpha lattice in a randomized complete block design replicated thrice. Analysis of variance was done using Gnestat software. There were significant differences in yield traits and resistance to foliar diseases among the accessions. The most superior genotypes in relation to grain yield were, ICGV 16017, ICGV 171003, ICGV 171014, ICGV 171025 and ICGV 171050. Most of the genotypes were moderately resistant to early leafspot and resistant to late leaf spot. Genotypes, ICGV 15080, ICGV 15003, ICGV 16019 and ICGV 16669 had a score of <4 in relation to early leafspot. Genotypes ICGV 171025, ICGV 171003, ICGV 171024 and ICGV 171012 were highly resistant to rosette disease (GRD) while ICGV 15080 and ICGV 16669 were moderately resistant. The genetic variation observed for key traits among the groundnut genotypes can be exploited to select parental lines for improving oleic acid, yield, resistance and/or tolerance to diseases. The superior geneotypes identified can be advanced further towards release of oleic acid rich varieties in the region.

Key words: Groundnut, biotic stress, nutrition, rosette disease, breeding

Résumé

Groundnut is an important oilseed crop for both food and nutrition security. The development of nutrient dense varieties including oleic acid to meet dietary needs in Africa is important. The study was undertaken to evaluate oleic acid rich lines for agronomic adaptation and reaction to foliar diseases. The experimental design was an alpha lattice in a randomized complete block design replicated thrice. Analysis of variance was done using Gnestat software. There were significant differences in yield traits and resistance to foliar diseases among the accessions. The most superior genotypes in relation to grain yield were, ICGV 16017, ICGV 171003, ICGV 171014, ICGV 171025 and ICGV 171050. Most of the genotypes were moderately resistant to early leafspot and resistant to late leaf spot. Genotypes, ICGV 15080, ICGV 15003, ICGV 16019 and ICGV 16669 had a score of <4 in relation to early leafspot. Genotypes ICGV 171025, ICGV 171003, ICGV 171024 and ICGV 171012 were highly resistant to rosette disease (GRD) while ICGV 15080 and ICGV 16669 were moderately resistant. The genetic variation observed for key traits among the groundnut genotypes can be exploited to select parental lines for improving oleic acid, yield, resistance and/or tolerance to diseases. The superior geneotypes identified can be advanced further towards release of oleic acid rich varieties in the region.

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Introduction

Groundnut is among the widely cultivated legumes in Malawi and accounts for 25% of the income of smallholder farmers. The crop plays a big role for food security and a valuable source of protein and vitamins (Derlagen and Phiri, 2012), making it a viable option for improving the nutrition status of the malnourished (Geulein, 2010). The groundnut kernel is rich in energy and protein (Engels, 2012). Most of the groundnut is used for oil extraction (60%) and the rest (40%) is consumed in various food uses (Birth *et al.*, 2010). The groundnut kernel is a rich source of macro and micro-nutrients (Satish Ingale and Shrivastava, 2011). The nutritional and storage qualities of groundnut depend on the relative proportion of saturated and unsaturated fatty acids in the oil. Among them, oleic acid, linoleic acid and palmitic acid account for 85 to 90% of the total fatty acids (Ahmed and Young, 1982). Groundnut rich in oleic acid is less prone to oxidation that leads to rancidity compared to those low in oleic acid that have proportionately higher polyunsaturated fatty acids (Coates, 2015).

Groundnut production at farmers' fields is constrained by several factors. Among the major constraints are biotic stresses that include foliar diseases classified into fungal and viral diseases. Similar to most of other crops, a large yield gap exists between genetic potential and actual yield in the field. The yield losses are caused by pests and diseases and use of cultivars that are not adapted to local conditions such as edaphic and climatic factors. Leaf spot and rust fungal diseases are the most prevalent fungal diseases globally. The leaf spots cause yield losses of 60% on average in non-resistant varieties (Khedikar *et al.*, 2010; Meena *et al.*, 2014). The major devastating viral disease is the groundnut rosette disease occurring as result of a virus complex that includes two viruses and a virus-like nucleic acid molecule-the satellite RNA. ICRISAT breeding programs have developed advanced lines rich in oleic acid. The objective of the study was to evaluate these lines for adaptability including reaction to foliar diseases and their yield potential.

Materials and methods

Germplasm. Twenty five (25) groundnut genotypes, i.e., 20 from the ICRISAT-India breeding program, two accessions from ICRISAT's gene bank and three improved from the Malawi breeding program were evaluated in 2018/2019 cropping season. The test materials were derived from crosses between a oleic acid rich male parent and an popular improved line. Local checks used in the study were JL 24 and CG7, that are high-yielding commercial varieties grown widely in East and Southern Africa.

Experimental site. The groundnut lines were evaluated at ICRISAT Malawi, located at Chitedze Agricultural Research Station (33038'E and 13085'S), from December 2018 to May 2019. The station is located 16 km west of Lilongwe (Malawi) with an altitude of 1146 meters above sea level (masl). The materials were evaluated under natural foliar disease infestation, since the station is a hotspot area with high leaf spots and GRD pressure during the growing season, especially with late-planted groundnuts. Based on the long-term climatic data, the station has an average minimum and maximum temperature of 16oC and 24oC, respectively, with a mean annual rainfall of 892 mm. The experiment was planted in sandy clay soils under rain fed conditions with supplementary irrigation when necessary.

Experimental design and management. The experiment was carried out in an alpha lattice design (5 × 5) with two replications. The genotypes were planted in 2 rows, each of 6 metres long. The row and plant spacing was 60 cm x 10 cm respectively. Recommended agronomic practices for groundnut (planting, weeding and harvesting) were followed. Harvesting and all other post-harvest handling processes were done manually on a plot basis. Pods from each plot were sun-dried to 13% moisture, determined using a moisture meter (Min GAC-Plus moisture tester DICKEY-John Corporation, UK) and thereafter weighed using a weighing scale (LBK, ADAM equipment, USA).

Data collection and analysis. Data on yield and yield-related traits were collected at different stages in the cropping season, which included days to 50% flowering, 100-seed weight (g), shelling out-turn (%), pod and grain yield (kg/ha). Grain yield per plot was converted to kilograms per hectare using the following formula: grain yield (kg/ha) = (Plot yield (kg) x 10,000 square meters/plot size in square meters (ha), adapted from Rana and Kumar (2014). Foliar disease severity was done using a modified nine-point scale (Subrahmanyam *et al.*, 1995); where a score of 1 was rated as highly resistant, 2 to 3 as resistant, 4 and 5 as moderately resistant, 6 and 7 as susceptible, and 8 to 9 as highly susceptible. The early leaf spot disease scoring was done at 35, 45 and 55 days after planting (DAP), while late leaf spot was done at 65, 75 and 85 DAP. Groundnut rosette disease incidence was scored at 4, 8, and 12 weeks after planting and was expressed as percentage of plants infected with GRD over the total number of plants per plot, whereby percentage disease incidence of 0-10 (highly resistant), 11 – 30 PDI (resistant), 31 – 50 PDI = moderately resistant and more than 50 PDI = susceptible. Analysis of variance (ANOVA) was performed using Genstat 20th edition (VSN, 2017).

Results and discussion

Yield and yield related traits. There was a significant difference in grain yield, shelling percentage and plant height (Table 1). The most superior genotypes in relation to grain yield were, ICGV 16017, ICGV 171003, ICGV 171014, ICGV 171025 and ICGV 171050. The yield ranged between 1340kg/ha to 1938kg/ha, which was higher than the grand mean yield. Though high yielding, these top five didn't not out compete three of the standard checks released recently, but had higher yield than CG7, the fourth check that is popular in Malawi. The 100 seed weight ranged between 26-56 and this concurs with findings by Hussein, (2004) that lowest and highest seed weight was 29.6g and 61.9g respectively. The 100 seed weight was high for the high yielding genotypes i.e. more than 38. The shelling percentage ranged between 46 to 74, and it was comparable among the top five superior genotypes and the standard checks.

The days to 50% flowering ranged between 30 to 33, an indication that these are medium maturing varieties. Studies by Nath and Alam (2002) found that the longest number of days to flowering was 57.80, and the lowest was 53.3 days, particularly for long duration varieties. Singh, (2003) and Prasad, *et al.* (2011), reported that, flowering in groundnut commences 20-30 days after emergence depending upon genotypes and environment and most of the flowers appear between 35-70 days after planting, and this corroborates to the current study.

Response of the genotypes evaluated to foliar diseases. There was significant difference in response to early and late leafspot diseases among the genotypes evaluated (Table 2). Most of the genotypes were moderately resistant to early leafspot and resistant to late leaf spot. Genotypes ICGV 15080, ICGV 15003, ICGV 16019 and ICGV 16669 had a score of < 4 in relation to early leafspot compared to JL 24, a standard check susceptible to all foliar diseases. The reaction to late leaf spot that indicated the materials were resistant is interpreted cautiously since the disease is not as severe in Malawi, thus there is need for validation by evaluating the genotypes at Serere in Uganda, and the experiment is under way.

Among the four that were resistant to early leafspot, ICGV 15080 and ICGV 16669 were moderately resistant to GRD as compared to ICGV-SM 01514, ICGV-SM 08503 and ICGV-SM 90704 groundnut rosette resistant standard checks developed by the breeding program in Malawi. This implies that the 2 genotypes can be used for further improvement to generate more resistant genotypes that are rich in oleic acid and high yielding. Other highly resistant genotypes to GRD included ICGV 171025, ICGV 171003, ICGV 171024 and ICGV 171012 that had an incidence of less than 3.5%. Once the genetics of these GRD resistant genotypes is dissected, they can be used in breeding programs to address the disease that is rampant in Africa alongside oleic acid. The cross comparison in overall performance, indicate that the resistant varieties are not necessarily high yielding. This can be explained by the fact that there is always cost on yield associated with resistance as reported by Zavaleta *et al.*, (2010) and Khalid *et al.*, (2019).

Table 1. Yield and yield related traits for the oleic acid rich genotypes evaluated for adaptability

Variety	Pod yield (kg/ha)	Number of pods/plant	Grain yield (kg/ha)	Shelling percentage	100 seed weight (g)	Days to 50%% flowering
CG 7	1005.29	18	410.35	63.12	49.08	32.02
ICGV 15003	931.82	24	422.84	68.42	36.70	31.24
ICGV 15074	987.80	24	663.39	67.40	43.67	32.01
ICGV 15080	601.54	19	1167.63	72.53	23.75	30.49
ICGV 16013	1101.13	21	708.92	71.31	34.06	31.46
ICGV 16017	1522.24	17	1037.66	68.49	38.41	30.48
ICGV 16019	1266.26	22	710.90	70.19	37.22	31.03
ICGV 16669	1178.90	24	556.97	54.13	38.51	30.51
ICGV 16673	948.63	23	381.21	46.89	47.79	30.77
ICGV 16676	709.74	19	886.46	60.83	19.53	30.98
ICGV 171001	1243.77	26	699.90	59.03	43.82	31.52
ICGV 171003	1504.90	22	1296.90	65.68	45.22	31.50
ICGV 171011	168.53	18	876.47	69.64	26.21	30.48
ICGV 171012	1232.94	21	947.99	67.30	56.28	30.01
ICGV 171013	996.81	21	488.74	73.63	56.92	31.25
ICGV 171014	1348.08	21	928.41	64.68	56.55	32.03
ICGV 171015	1250.86	19	911.91	65.67	48.94	31.25
ICGV 171024	885.16	18	614.43	57.44	48.23	30.71
ICGV 171025	1394.05	18	925.05	69.85	45.27	31.97
ICGV 171039	919.59	20	145.78	49.90	47.53	31.26
ICGV 171050	1938.78	19	1668.29	73.43	55.17	31.52
ICGV-SM 01514	2761.84	19	2156.56	67.39	42.54	30.23
ICGV-SM 08503	1620.85	25	932.52	62.14	50.29	31.52
ICGV-SM 90704	2244.33	20	1493.60	66.20	54.97	30.24
JL 24	1308.49	17	876.83	70.58	42.03	31.52
Grand mean	1243.00	21	876.00	65.04	43.55	30.56
P. Value	0.05	0.16	0.01	0.01	0.10	0.68
S.E	347.10	1.96	184.80	3.33	8.55	3.31

Table 2. Reaction of oleic acid rich lines to foliar diseases

Variety	Early leaf spot disease	Late leaf spot disease	Groundnut rosette disease (%)
CG 7*	3.64	2.71	17.21
ICGV 15003	3.35	2.67	20.13
ICGV 15074	4.68	3.00	17.14
ICGV 15080	3.50	3.05	7.70
ICGV 16013	4.18	3.00	13.78
ICGV 16017	4.12	1.95	11.15
ICGV 16019	3.82	2.50	11.46
ICGV 16669	3.44	3.00	4.85
ICGV 16673	4.91	2.99	9.81
ICGV 16676	4.12	2.84	7.84
ICGV 171001	4.62	2.95	4.17
ICGV 171003	3.76	2.71	12.08
ICGV 171011	4.84	2.01	7.17
ICGV 171012	3.94	2.39	1.51
ICGV 171013	5.03	2.35	4.31
ICGV 171014	4.32	2.39	5.60
ICGV 171015	4.03	1.95	10.74
ICGV 171024	4.21	2.94	3.22
ICGV 171025	3.94	3.16	2.50
ICGV 171039	4.71	2.94	19.66
ICGV 171050	4.88	3.05	10.68
ICGV-SM 01514**	4.59	2.01	1.04
ICGV-SM 08503**	5.62	1.84	1.04
ICGV-SM 90704**	3.53	2.49	2.86
JL 24***	4.94	3.16	16.62
Grand mean	4.269	2.643	8.571
P. Value	<0.001	0.049	0.379
S.E	0.5097	0.2836	5.531

*susceptible check for rosette disease and high yields when no disease; **-rosette disease resistant check and high yielding; ***-susceptible check for all the foliar diseases;

Conclusion

There was variation in the agronomic and yield traits among the groundnut genotypes which can further be exploited to select parental lines for improving oleic acid, yield and resistance and/or tolerance to diseases. The study forms a basis for further development of varieties that are rich in oleic acid suited for East and South African region. This is because breeding for nutrient dense, high-yielding and foliar disease resistant genotypes requires identification of resistant cultivars with superior breeding value. The rosette disease and foliar fungal disease resistant genotypes identified from the study would act as good sources for use in breeding programs subject to the validation of their combining abilities.

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