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Development of groundnut rosette disease and vector resistant varieties

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Abstract

Varietal resistance to groundnut rosette disease is the most practical and effective way to manage the disease and to reduce yield loss. Collaboration between the Oilseeds Programme at SAARI and ICRISAT Plant breeders was fostered utilising sources of resistance identified and developed at ICRISAT Lilongwe. The overall objective was to incorporate rosette resistance and several other key traits in order to meet the requirements of farmers in Uganda. The most important traits were identified as being high yield potential, short duration and drought resistance as well as quality characteristics that would meet the requirements of consumers in the market place. As a result of these efforts , two rosette resistant varieties were released in 1999; Serenut 1R and Serenut 2. Serenut 2, in particular, has been widely adopted by farmers. However, one limitation is that Serenut 2 is a medium duration variety (110 days) and hence it is vulnerable to end of season droughts. Short duration genotypes with resistance to rosette have been developed by ICRISAT and a major aim was to evaluate these genotypes to determine their suitability for release in Uganda. In 2002, two varieties were released by SAARI under the names Serenut 3R and Serenut 4T. These are early maturing (90 – 100 days), rosette resistant and high yielding (up to 3,000 kg/ha).

Key words: *Aphis croccivora, Arachis hypogaea,* host-plant resistance, rosette disease

Introduction

Groundnut *(Arachis hypogaea)* is the second most important food legume in Uganda. It is also an important cash crop and a good source of protein and oil in the diet of both urban and rural populations.

The crop suffers from a number of serious pests and diseases. Groundnut rosette virus is the most destructive disease of groundnut in Africa including Uganda [Subrahmanyam, et al]. It is transmitted by the aphid (*Aphis craccivora*) as the principal vector of the virus. It can cause up to 100% yield loss in severe attacks. Globally, rosette is estimated to cause annual yield losses worth US$ 156 million and potential yield gains in alleviating this constraint through crop improvement are estimated at US $ 121 million.[Subrahmanyam, et al].

Management of groundnut rosette by insecticidal control of the vector has been known since the 1960s. Cultural practices such as early planting and optimal plant densities are known to reduce the disease incidence. But smallholder farmers in Uganda for a number of reasons, seldom use these practices. For example, rainfall patterns usually dictate when crops are to be sown, so early planting may not be possible if rainfall is not constant at the beginning of the season. The aphids are known to disperse soon after the rains start and the main migratory flights are 5-6 weeks after the emergency of the earliest groundnut crop [Kimmins]. If these aphids carry and transmit the groundnut rosette virus (GRV) the crop will be infected at its most vulnerable stage of growth. The Oilcrops Project at SAARI places major emphasis on the development of rosette resistant lines especially short duration varieties which are frequently preferred by farmers but which have not hither to been available. Therefore host-plant resistance to the disease and its vector is considered as the most viable and suitable solution.

Sources of resistance to rosette were first discovered in Senegal in 1952 [Subrahmanyam and van der Merwe, 2003). Many breeding programmes for rosette resistance in Africa were based on these sources and have contributed to the development of several high-yielding rosette resistant groundnut varieties such as Igola-1 (RMP-12). However, most of the rosette-resistant varieties have late maturing types (130 –135 days) and not suitable for some production systems in Uganda where the rainy season is short. But in recent years a number of early maturing varieties (90-100) have been identified by ICRISAT and some of them have

been released in Uganda by SAARI as Serenut 3R and Serenut 4T. The overall objective of the study was to improve the productivity and sustainability of smallholders groundnut production in Uganda through the development of rosette-resistant varieties with desirable market attributes. The specific objective was to breed naturally occurring resistance to groundnut rosette disease (GRD) into ergonomically important early maturing and /or drought resistant varieties.

Materials and methods

Breeding lines from ICRISAT were bulked up in field plots at SAARI and the most promising lines selected for further evaluation. Nine medium duration lines were evaluated for rosette resistance, adaptability, yield and other attributes at SAARI and 5 other locations. The test lines were: ICGV-SM 93530, 93535, 93524, 94581, 99540, ICG 12991, Red Beauty, ICGV-SM 94584, 93557 and Serenut II. Groundnuts rosette-susceptible variety Serenut 1R was used as control in the field trials. The ten lines were tested in a completely randomized block design, with four replications. Each plot consisted of six rows, 5 metres in length with a spacing of 45 x 10 cm.

As the level of disease inoculum at all the test locations was considered to be sufficiently high, the original plan to use infector rows to increase disease pressure was not followed. Plants were scored for rosette disease symptoms at 4 weekly intervals until harvest and dry pods weights recorded for each plot. In addition to the on-station trials at the six locations, participatory on-farm trials were conducted in which 8 farmers took part. Multiplication of breeder and basic seed was carried out at SAARI involving the newly released varieties plus some other promising lines which are currently under test, covering 5 acres.

Results and Discussion

The results are presented in tables 1 – 4. Serenut 3R and Serenut 4T were tested against check cultivars Red Beauty, and Serenut 2 in multi-locational trials from 1999 to 2001. In these tests, Serenut 3R gave a seed yield of 2505 kg/ha as an average of three seasons, compared to 2352 kg/ha for Serenut 2, a yield advantage of 106.6%. Serenut 4T gave a seed yield of 2494 kg/ha as an average of three seasons, compared to 2352 kg/ha for Serenut 2, a yield advantage of 106.1%. Red Beauty gave an average yield of 1613 kg/ha, conceding a yield advantage of 155.3% for Serenut 3R. and 154.6% for Serenut 4 T. Serenut 3R therefore out yielded the control cultivars by an average pod yield advantage of 6.6% over Serenut 2 and 55.3% over B1 in pure stands, while Serenut 4T out-yielded Serenut 2 by 6.1% and by 55.54.6 over B1.

Table 1: Yield performance (kg/ha dry pods) rosette count for 1st season, 1999, at 6 locations

Variety	SAARI		Kumi		Kuju		Nakabango		Ngetta		Aduku		Mean	Mean
	Yield (kg/ha)	Rosette Count	Yield (kg/ha)	Rosette Count	Yield (kg/ha)	Rosette Count	Yield (kg/ha)	Rosette Count	Yield (kg/ha)	Rosette Count	Yield (kg/ha)	Rosette Count	Yield (kg/ha)	Rosette Count
93530	2710	0.0	2568	0.0	3000	0.0	2280	0.0	3250	0.2	2380	0.0	2698	0
93535	2800	0.0	2453	0.0	2980	0.0	2100	0.0	2550	0.5	2500	0.0	2564	0
93524	2515	1.0	2410	1.0	2910	1.0	2000	1.0	2750	3.2	2250	0.0	2473	1.2
94581	1997	2.0	2050	1.0	2670	1.0	2215	1.0	1.750	0.6	2130	0.0	2135	1
93540	1860	10.7	1735	11.0	1950	9.0	1847	8.0	3400	0.0	2500	0.0	2215	6.45
12991	2885	0.0	2570	0.0	2740	0.0	2335	1.0	3000	0.0	2130	0.0	2610	0.1
R.B	1790	30	1700	52	1953	57	1630	67.0	1750	53.0	1850	43.0	1779	50.3
94584	2857	1.0	2737	1.0	2875	2.0	2110	3.1	2100	0.0	2000	0.0	2447	1.2
93557	2334	2.0	2230	2.0	2346	2.0	2160	4.2	2000	1.0	2380	1.0	2242	2
Sere.II	2900	0.0	2800	0.0	3015	0.0	2310	0.0	2780	0.0	2380	0.0	2698	0
s.e.d	0.590	11.23	0.314	0.201	0.166	4.356	0.191	1.120	0.160	5.32	0.450	6.21		

Table 2: Yield performance (kg/ha dry pods) for 1st season, 2000, at 6 locations

Variety	SAARI Yield (kg/ha)	Rosette Count	Kumi Yield (kg/ha)	Rosette Count	Kuju Yield (kg/ha)	Rosette Count	Nakabango Yield (kg/ha)	Rosette Count	Ngetta Yield (kg/ha)	Rosette Count	Aduku Yield (kg/ha)	Rosette Count	Mean Yield (kg/ha)	Mean Rosette Count
93530	2800	0.5	2525	0.0	2500	0.8	-	-	2375	0.0	3375	1.3	2262.5	0.43
93535	2600	0.2	1900	1.0	2475	3.2	-	-	2500	0.0	1250	1.5	1787.5	0.98
93524	2510	0.0	2125	0.75	2800	1.0	-	-	2250	0.0	2125	2.0	2018.3	0.758
94581	2010	0.2	2000	0.0	2400	0.8	-	-	2125	0.8	2200	1.8	1789.2	0.6
93540	1890	3.2	2475	6.7	2725	1.8	-	-	2500	2.0	2500	7.2	2015	3.483
12991	2803	0.2	2300	5.25	2825	3.7	-	-	2125	0.0	2530	0.8	2097.2	1.658
R.B	1690	25.0	1100	105.25	1325	71.0	-	-	1850	20.0	1350	166.8	1219.2	64.675
94584	2769	12.8	1800	0.0	2550	1.8	-	-	2000	0.0	1550	1.8	1778.2	2.73
93557	2400	0.5	1925	4.5	1950	1.8	-	-	2375	1.3	1250	2.2	1650	1.716
Sere.II	2880	0.0	2300	0.0	3200	1.0	-	-	2375	0.0	1750	1.0	1652	0.3
s.e.d	0.313	8.74	0.157	1.930	0.175	9.16	-	-	0.322	10.37	0.272	5.11		

Table 3: Yield performance (kg/ha dry pods) for 1st season, 2001, at 6 locations

Variety	SAARI Yield (Kg/ha)	Rosette Count	Kumi Yield (kg/ha)	Rosette Count	Kuju Yield (Kg/ha)	Rosette Count	Nakabango Yield (Kg/ha)	Rosette Count	Ngetta Yield (Kg/ha)	Rosette Count	Aduku Yield (Kg/ha)	Rosette Count	Mean Yield (Kg/ha)	Mean Rosette Count
93530	3200	0	2130	0.0	2360	0.0	2850	0	2380	0	2400	0	2553	0
93535	2650	0	1630	0.0	2141	0.1	2380	2	2500	0	2520	0	2304	0.3
93524	2650	2	1881	1	2033	0.8	2310	2	2251	1	2271	0	2233	1
94581	1700	1	1635	0	2130	1.0	2700	3	2132	0	2150	0	2241	0.8
93540	1400	8	2803	11	3000	6.1	2830	15	2500	5	2522	3	2843	8
12991	3000	0	2790	0	2705	0.2	2910	1	2613	0	2630	0	2776	0.2
R.B	1800	32	1750	19	1630	17.2	2150	40	1850	30	1870	27	1842	28
94584	2110	0	1135	2	1990	1.4	2760	4	2000	0	2021	1	2003	1.3
93557	2005	2	2880	1	2532	0.0	2890	3	2380	1	2405	0	2515	0.7
Sere.II	2780	0	2750	0	2580	0.0	3310	0	2380	0	2440	0	2707	0
s.e.d	0.445	0.653	0.296	0.109	0.158	4.365	0.181	1.031	0.158	5.11	0.584	10.37		

Table 4. Yield performance (kg/ha dry pods) for 2^{nd} season, 2001, at 6 locations

Variety	SAARI Yield (Kg/ha)	SAARI Rosette Count	Kumi Yield (Kg/ha)	Kumi Rosette Count	Kuju Yield (Kg/ha)	Kuju Rosette Count	Nakabango Yield (Kg/ha)	Nakabango Rosette Count	Ngetta Yield (Kg/ha)	Ngetta Rosette Count	Aduku Yield (Kg/ha)	Aduku Rosette Count	Mean Yield (Kg/ha)	Mean Rosette Count
93530	2300	0.5	-	-	1900	0.9	2275	1.7	2735	1.5	-	-	1535	0.42
93535	1750	0.2	-	-	1450	3.0	2022	1.9	1255	1.7	-	-	1079.5	1.13
93524	2340	0.0	-	-	1800	1.9	1981	3.0	2130	2.1	-	-	1375	1.2
94581	2880	0.2	-	-	1400	0.9	2100	3.1	2205	1.9	-	-	1430.8	1.02
93540	3025	3.2	-	-	1730	3.0	14.1	6.9	2505	7.3	-	-	1610.2	3.4
12991	2995	1.1	-	-	2000	3.5	2490	1.5	2405	1.0	-	-	1648.8	1.18
R.B	1125	29.0	-	-	1300	70.0	1200	62	1350	168.9	-	-	1658	54.98
94584	2300	13.0	-	-	1560	1.9	1460	2.0	1557	1.9	-	-	1146.2	3.1
93557	1730	0.7	-	-	1400	1.9	1320	3.1	1256	2.2	-	-	951	1.32
Sere.II	2998	0.0	-	-	2200	1.0	2550	1.6	1755	1.3	-	-	1583.8	0.65
s.e.d	0.593	9.48	-	-	0.166	5.356	0.191	2.154	0.165	5.23	-	-		

In on-farm trials, Serenut 4T was out yielded by Serenut 2 overall, with an average yield of 11.2%. Serenut 3R is resistant to groundnut rosette virus disease while Serenut 4T is resistant to the vector, *Aphis craccivora*, which transmits the rosette virus. They both show good recovery for pod yield from mid-season drought.

Conclusion

The results above show significant yield increases by the new varieties over the control variety, Red Beauty. This is a good contribution towards poverty reduction because the improved productivity leads to greater production thus increasing farmers' income as well as ensuring the food security of the farm families. As a result of the use of short duration rosette/vector resistant varieties, groundnut production will be more cost-effective, environmentally friendly and will lead to improved control of rosette and other diseases. The partnership between research, extension, farmers and other collaborators during on-farm testing has brought closer linkage in the identification of the preferred varieties for desirable market attributes.

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