Indian Journal of Agricultural Sciences 69 (10) : 722–5, October 1999

Screening of some advanced breeding lines of groundnut (*Arachis hypogaea*) for tolerance of lime-induced iron-deficiency chlorosis*

M Y SAMDUR[1], R K MATHUR[2], P MANIVEL[3], A L SINGH[4], A BANDYOPADHYAY[5] and B M CHIKANI[6]

National Research Centre for Groundnut, Junagadh, Gujarat 362 001

Received : 23 November 1998

Key words : screening, iron-deficiency chlorosis, groundnut

In calcareous and alkaline soil-lime induced iron, deficiency chlorosis is of common occurrence in crop plants (Chen and Barak 1982). In groundnut, such chlorosis is very common in the Saurashtra region of Gujarat, Marathwada of Maharashtra and parts of Tamil Nadu and Karnataka (Kannan 1984). Soil and foliar application of iron containing fertilizers help the plants recover from such chlorosis but this effect does not persist for long and hence are required to be done frequently (Singh and Dayal 1992). The selection of Fe-efficient genotypes (tolerant) which can tolerate Fe-deficiency chlorosis is the alternative solution to this problem as iron is found in abundance in soil and groundnut genotypes differ in their response to Fe stress (Singh and Chaudhari 1991 and 1993).

Eighteen promising advanced breeding lines of groundnut were screened of their tolerance of lime-induced iron chlorosis by growing them in-situ in field during the winter-summer 1996 and 1997 at Junagadh in medium black calcareous soil. The soil had a pH of 7.9, contained, 29.6 % calcium carbonate, 0.8% organic carbon, 0.06 % total nitrogen, 6 ppm available P (Olsen's), and 1.35 ppm available Fe. The lines were grown in randomized block design with 3 replications. Plot size was 5m × 0.45m. For comparison four tolerant and four susceptible checks were included in the experiment based on the results of earlier studies (Singh and Chaudhari 1991 and 1993). The recommended package of practices was followed while growing the crop. The iron-deficiency as interveinal chlorosis of leaves appeared 20 days after emergence of seedling. The deficiency was measured by visual chlorotic rating on a 1–5 scale at 30, 50, 60, and 70 days after emergence. The third leaf of main axis of each plant of a line was collected, bulked and then chlorophyll (a and b) content was determined following Arnon (1949). The visual chlorotic rating and chlorophyll content observed at various stages were averaged. Based on chlorophyll content and visual chlorotic rating in the field the genotypes were put into 3 categories (i) tolerant: showing dark green leaves, rare appearance of Fe-deficiency of chlorotic plants with visual chlorotic rating of less than 1.50, (ii) moderately tolerant green leaves with visual chlorotic rating of 1.51 to 2.00 and (iii) susceptible: genotypes light green to yellow, visual chlorotic rating of more than 2.00, and plant showing some interveinal chlorosis (a typical symptom of Fe-deficiency), leading to complete chlorosis with appearance of white papery leaves at later stages. The crop was harvested at maturity, dried in the sun for 7 days and in the shade for 15 days. Pod and haulm yield was determined on dried plants from the whole lines of each genotype.

The occurrence of chlorosis symptoms were noticed from 15–20 days after emergence and continued till maturity. The genotypes 'PBS 11040' did not show any sign of iron chlorosis and fell under visual chlorotic rating category 1 (Table 1). The genotypes 'PBS 11015', 'PBS 11040', and 'PBS 21018' were tolerant of iron chlorosis and had their visual chlorotic rating on a par with the tolerant check I_1, 'PBS 21018' was high yielder (14.38 and 17.20 g/plant in 1996 and 1997 respectively) also. The moderately tolerant genotypes with high yield were 'PBS 11014', 'PBS 11050', 'PBS 14017', and 'PBS 14019'. The genotypes 'PBS 21015' and '12120' were highly sensitive to chlorosis and poor yielder too. These genotypes had their visual chlorotic rating at par with 'VRI 3', a highly sensitive check for iron chlorosis as identified earlier (Singh and Chaudhari 1991).

All the tolerant genotypes (based on visual chlorotic rating) had high chlorophyll content (more than 7 mg/g on dry weight basis) (Table 2). The chlorophyll content at 50 and 60 days after emergence was maximum in all the genotypes and differentiation between Fe-efficient and inefficient lines was quite clear. The carotene content was more in iron efficient genotypes but this was not true at all the growth stages. Pod yield (Table 1) varied from 5.39–22.10 g/plant. In general, the moderately tolerant genotypes had greater pod yield and

*Short note

[1,2,3]Scientists, Plant Breeding Section, [4]Scientist (SS), Plant Physiology Section, [5]Director and [6]Technical Assistant

Table 1 Visual chlorotic rating score at various stages, pod and fodder yield in various groundnut genotypes during winter-summer 1996 and 1997

Name of entry	Pedigree	Visual chlorotic rating										Overall mean	Pod yield (g/plant)		Fodder yield (g/plant)	
		1996 Days after emergence					1997 Days after emergence						1996	1997	1996	1997
		30	50	60	70	Mean	30	50	60	70	Mean					
PBS 11014	X-17-20 (S)	2.00	1.66	1.66	2.66	2.00	1.66	1.66	2.00	2.33	1.91	1.95	14.17	18.30	37.09	23.50
PBS 11015	X-17-20 (S)	1.66	1.66	1.33	1.00	1.41	2.00	1.00	1.00	1.33	1.33	1.37	12.71	13.60	32.79	42.26
PBS 11022	Dh-3-30 × NCAc 2214	2.66	2.66	2.66	3.00	2.74	2.33	2.00	2.33	1.66	2.08	2.41	12.17	12.60	40.94	43.48
PBS 11040	Sk 8/106	1.00	1.00	1.00	1.33	1.08	1.00	1.00	1.00	1.00	1.00	1.04	9.23	14.10	63.04	26.38
PBS 11050	Dh-3-30 × NCAc 2230	2.00	2.00	1.33	1.66	1.74	2.00	2.33	1.33	1.66	1.83	1.78	15.54	11.80	40.10	32.06
PBS 12120	VG (E) × B 227	2.33	2.66	3.00	3.33	2.83	2.66	2.66	3.00	3.33	2.91	2.87	8.91	10.30	69.70	41.42
PBS 14006	CGC 3 × TG (E)	2.33	1.66	2.33	2.33	2.15	2.33	2.33	2.33	2.33	2.33	2.24	20.13	13.70	51.63	36.07
PBS 14009	KRG-1 × JL 24	2.33	2.33	2.66	2.33	2.41	2.33	2.00	1.66	2.66	2.16	2.28	7.85	8.80	54.26	33.38
PBS 14014	S206 × ICGS (E) 2	2.33	2.33	2.66	2.66	2.41	2.33	2.66	2.66	2.66	2.57	2.53	12.21	11.10	54.54	49.11
PBS 14016	CGC3 × JL 24	2.33	2.66	2.66	2.00	2.41	2.33	1.66	2.00	2.33	2.08	2.24	11.00	17.08	45.70	41.79
PBS 14017	ICGS 11 × TG (E) 2	2.00	2.33	1.66	2.00	2.00	2.00	1.33	1.66	1.66	1.66	1.83	12.70	18.60	38.64	33.13
PBS 14019	CGC3 × Chico	2.33	1.66	1.66	1.66	1.82	2.33	2.00	2.00	2.00	2.08	1.95	11.76	22.10	46.45	30.06
PBS 14042	CGC 3 × (JL 24 × Chico)	2.33	2.33	2.33	3.00	2.49	2.33	2.66	2.66	3.33	2.74	2.61	12.66	17.30	30.49	21.01
PBS 19003	M 13 × PI 314817	2.33	2.66	2.66	3.00	2.66	2.33	2.33	2.66	3.00	2.58	2.62	10.26	8.30	52.26	37.25
PBS 20023	PBSM-1A	2.00	1.66	2.33	2.00	2.00	2.33	2.00	2.33	2.33	2.24	2.12	13.92	18.40	51.28	39.24
PBS 21015	TMV 10 × PI 405132	2.33	3.33	3.33	3.33	2.75	2.66	3.33	3.33	3.66	3.24	3.00	7.36	11.90	54.32	30.15
PBS 21018	Sel Kh 12/50	1.66	1.33	1.00	1.66	1.41	1.33	1.33	1.33	1.66	1.41	1.41	14.38	17.20	35.78	34.82
PBS 22009	VG (E) × B227	2.33	2.33	2.66	2.33	2.41	2.66	2.66	2.00	2.00	2.33	2.37	14.08	15.20	45.20	20.69
Sulamith (RC)		1.66	1.66	1.33	1.66	1.57	1.66	1.33	1.33	1.33	1.41	1.49	10.66	15.10	51.55	29.47
TG 26 (RC)		1.00	1.00	1.66	2.33	1.48	1.33	1.33	1.33	1.66	1.41	1.44	14.59	15.60	21.90	22.84
I_1 (RC)	ICGV 86031	1.33	1.33	1.00	1.66	1.33	1.33	1.66	1.66	1.00	1.41	1.37	12.25	7.90	78.88	37.74
GG 2 (RC)		2.00	2.00	2.33	1.66	2.00	1.66	1.33	2.00	2.00	2.00	2.00	11.75	16.30	35.63	28.15
VRI 3 (SC)		2.66	3.00	3.00	3.33	3.00	2.33	2.66	3.66	3.66	3.07	3.04	5.39	9.30	31.45	27.74
I_2 (SC)	ICGV 86030	2.66	2.66	2.33	3.33	2.74	2.66	2.33	2.33	2.66	2.49	2.61	7.85	9.10	58.86	33.09
JL 24 (SC)		2.00	2.00	2.66	2.00	2.18	2.00	2.00	2.00	2.33	2.08	2.13	12.62	13.20	43.90	48.98
Girnar 1 (SC)		2.00	2.33	2.33	3.00	2.41	2.33	2.00	2.66	2.66	2.41	2.37	10.79	16.60	32.56	24.09
CD (P = 0.05)		0.52	0.59	0.81	0.83		0.57	0.71	0.81	0.80			5.20	7.97	9.08	10.34

S, Selection; RC, resistant check; SC, susceptible check

Table 2 Chlorophyll a, b, and carotene contents (mg/g) in different genotypes of groundnut during winter- summer 1997

Name of entry	Chlorophyll (Chl) and carotene content of leaves at various stages																			
	30 days after emergence				50 days after emergence				60 days after emergence				70 days after emergence				Overall mean			
	Chl a	Chl b	Total chl	Carotene	Chl a	Chl b	Total chl	Carotene	Chl a	Chl b	Total Chl	Carotene	Chl a	Chl b	Total chl	Carotene	Chl a	Chl b	Total chl	Carotene
PBS 11014	5.17	1.79	6.96	1.00	5.86	1.77	7.63	1.35	6.58	2.45	9.03	1.29	5.64	1.78	7.42	1.21	5.81	1.94	7.75	1.21
PBS 11015	5.65	1.99	7.64	1.11	5.73	1.77	7.50	1.26	7.05	2.70	9.75	1.27	5.52	1.70	7.22	1.16	5.98	2.04	8.02	1.20
PBS 11022	5.08	1.65	6.73	1.14	5.74	1.77	7.51	1.25	5.83	2.19	8.02	1.25	5.16	1.61	6.72	1.15	5.45	1.80	7.25	1.19
PBS 11040	5.73	2.07	7.80	1.10	5.18	1.58	6.76	1.18	6.39	2.36	8.75	1.28	5.40	1.69	7.09	1.17	5.67	1.92	7.59	1.17
PBS 11050	5.97	2.04	8.01	1.19	5.21	1.57	6.78	1.18	6.09	2.18	8.27	1.33	5.13	1.53	6.66	1.11	5.60	1.83	7.43	1.20
PBS 12120	5.33	1.87	7.20	1.12	5.93	0.81	6.74	1.50	5.67	2.04	7.71	1.27	4.50	1.42	5.92	0.97	5.35	1.63	6.98	1.21
PBS 14006	5.40	1.98	7.38	1.18	6.04	1.79	7.83	1.30	5.08	1.83	6.91	1.26	4.55	1.28	5.83	1.08	5.26	1.72	6.98	1.20
PBS 14009	5.85	2.03	7.88	1.15	6.00	1.82	7.82	1.26	6.90	2.73	9.63	0.93	5.78	1.77	7.55	1.17	6.13	2.08	8.21	1.21
PBS 14014	5.79	2.07	7.86	1.03	5.45	1.67	7.12	1.23	5.84	2.10	7.94	1.43	5.47	1.68	7.15	1.20	5.63	1.88	7.51	1.22
PBS 14016	5.71	2.04	7.75	1.16	6.31	1.94	8.25	1.32	6.87	2.52	9.39	1.33	6.02	1.75	7.77	1.24	6.22	2.06	8.28	1.26
PBS 14017	5.21	1.87	7.08	1.07	6.55	2.03	8.58	1.27	6.95	2.76	9.71	1.29	5.91	1.85	7.76	1.17	6.15	2.12	8.28	1.20
PBS 14019	5.81	2.05	7.86	1.13	5.44	1.61	7.05	1.31	5.44	1.94	7.38	1.35	5.32	1.60	6.92	1.17	5.50	1.80	7.30	1.24
PBS 14042	4.81	1.73	6.54	0.97	5.46	1.65	7.11	1.29	6.03	2.21	8.24	1.30	5.86	1.73	7.59	1.24	5.54	1.83	7.37	1.20
PBS 19003	5.22	1.79	7.01	1.07	4.96	1.49	6.45	1.14	5.85	2.04	7.89	1.29	4.83	1.40	6.23	1.08	5.21	1.68	6.89	1.14
PBS 20023	5.78	2.05	7.83	1.19	5.17	1.60	6.77	1.12	6.08	2.29	8.37	1.25	4.69	1.41	6.10	1.06	5.43	1.83	7.26	1.15
PBS 21015	4.89	2.10	6.99	0.96	6.29	1.93	8.22	1.36	5.80	2.10	7.90	1.36	5.22	2.15	7.37	1.07	5.55	2.07	7.62	1.18
PBS 21018	4.80	1.25	5.95	1.08	5.82	1.73	7.55	1.29	6.86	2.64	9.50	1.30	4.91	1.49	6.40	1.10	5.59	1.77	7.35	1.19
PBS 22009	4.95	1.93	6.88	0.92	4.87	1.44	6.31	1.18	4.66	1.60	6.26	1.19	4.32	1.33	5.65	0.93	4.70	1.57	6.27	1.05
Sulamith	5.90	2.19	8.09	1.07	5.82	1.80	7.62	1.34	6.10	2.17	8.27	1.37	5.74	1.68	7.42	1.25	5.89	1.96	7.85	1.25
TG 26	5.36	1.93	7.29	1.09	6.24	1.88	8.12	1.31	6.73	2.45	9.18	1.24	6.42	1.93	8.35	1.20	6.18	2.04	8.22	1.21
I_1	5.61	2.14	7.75	1.13	6.09	1.85	7.94	1.32	6.81	2.14	8.95	1.21	4.32	1.33	5.65	0.95	5.70	1.86	7.57	1.15
GG 2	5.70	1.94	7.64	1.17	5.62	1.66	7.28	1.28	5.92	2.06	7.98	1.36	4.17	1.27	5.44	0.98	5.35	1.73	7.08	1.19
VRI 3	4.92	1.41	6.33	0.90	5.59	1.67	7.26	1.27	5.25	1.81	7.06	1.28	4.68	1.42	6.10	1.05	5.11	1.57	6.68	1.12
I_2	6.03	2.15	8.18	1.18	5.27	1.50	6.77	1.25	5.71	2.03	7.74	1.35	4.07	1.21	5.28	0.92	5.27	1.72	6.99	1.17
JL 24	5.04	1.77	6.81	1.11	4.95	1.53	6.48	1.12	5.87	2.14	8.01	1.29	5.07	1.53	6.60	1.13	5.23	1.74	6.97	.16
Girnar 1	5.11	1.84	6.95	1.02	5.49	1.62	7.11	1.22	5.74	2.08	7.82	1.23	5.03	1.50	6.48	1.04	5.34	1.76	7.10	1.12
CD (P= 0.05)	1.25	0.55	1.78	0.23	1.05	0.72	1.70	0.19	1.43	0.92	2.35	0.21	1.12	0.40	2.40	0.22				

susceptible genotypes were poor yielder. However, some of the susceptible genotypes 'PBS 14006' and 'PBS 14042' had high pod yield too. Yellowing reduce the growth of the plant resulted in less canopy development and lesser pod and fodder yield (Potdar and Anderes 1995, Singh and Dayal 1992). However, some of the sensitive genotypes 'PBS 12120', 'PBS 14014' and I_2 showed their inherited fast growth habit, grew profusely and shown higher fodder yield than tolerant genotypes.

Significant and negative correlation coefficients between overall mean of visual chlorotic rating score and overall means of chlorophyll a ($r = -0.34^*$) and total chlorophyll ($r = -0.43^*$) were observed. However, there were non-significant negative correlations between overall means of visual chlorotic rating and chlorophyll b ($r = -0.26$) and carotene contents ($r = -0.19$). Visual chlorotic rating could be a dependable and time saving approach for screening groundnut genotypes in a large scale. Out of eighteen advavced breeding lines studied 3 lines 'PBS 11015', 'PBS 11040' and 'PBS 21018' showed higher efficiency of iron utilization and these lines could be grown in calcareous soils where lime-induced iron-chlorosis is a major problem causing yield loss in groundnut as well as could be used as donor parents in hybridization programme.

REFERENCES

Arnon D I. 1949. Copper enzymes in isolated chloroplasts, polyphenol oxidase in *Beta vulgaris*. *Plant Physiology* **24** : 1–15.

Chen Y and Barak P. 1982. Iron nutrition of crop plants in calcareous soils. *Advances in Agronomy* **35** : 217–40.

Kannan S. 1984. Problems of iron deficiency in different crop plants in India: causative factors and control measures. *Journal of Plant Nutrition* **7** : 187–200.

Potdar M V and Anderes M M. 1995. On farm performance of groundnut genotypes under different configurations and foliar iron spray for the correction of iron chlorosis on calcareous soils in India. (*in*) *Iron Nutrition in Soils and Plants.* Proceedings of the Seventh International Symposium on Iron Nutrition and Interactions in Plants, held during 27 Jun–2 July 1993 at Zaragoza, Spain.

Singh A L and Chaudhari V. 1991. Screening of groundnut (*Arachis hypogaea*) varieties tolerant to iron chlorosis. *Indian Journal of Agricultural Sciences* **61**(12) : 925–7.

Singh A L and Chaudhari V. 1993. Screening of groundnut germplasm collection and selection of genotypes tolerant of lime-induced iron chlorosis. *Journal of Agricultural Sciences Cambridge*, **121** : 1–7.

Singh A L and Dayal D. 1992. Foliar application of iron for recovering groundnut plants from lime induced iron deficiency chlorosis and accompanying losses in yield. *Journal of Plant Nutrition* **15** (19) : 1421–33.