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Genetic variability for resistance to iron Chlorosis, yield and yield related traits in segregating population of groundnut

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Abstract
Iron deficiency chlorosis (IDC) common in groundnut particularly in calcareous, alkaline and black soils causes reduction in yield. The present experiments including 612 F_4 populations were conducted for IDC. In F_4 populations (612) of four different crosses eight lines in cross G 2-52 × ICGV 86031, twenty seven lines in cross Dh 86 × ICGV 86031, twenty six lines in cross GPBD 5 × ICGV 86031 and twenty one lines in cross TAG 24 × ICGV 86031 were resistant to iron deficiency chlorosis at all the stages with high pod yield per plant. These progenies need to further evaluate over seasons and years to test their stability of resistance and productivity.

Keywords: Chlorosis, IDC, population, resistance, yield

Introduction
Groundnut, *Arachis hypogaea* L. is an important crop both in subsistence and commercial agriculture in arid and semi-arid regions of the world. Iron (Fe) is an essential nutrient for plants for growth and development. It is required for life-sustaining processes from respiration to photosynthesis, where it participates in electron transfer through reversible redox reactions, cycling between Fe^{2+} and Fe^{3+}. It plays an important role in the synthesis of chlorophyll, carbohydrate production and cell respiration, chemical reduction of nitrate and sulphate and nitrogen assimilation. Plants need to maintain Fe in the concentration of 10^{-9} to 10^{-4} M to achieve optimal growth; however Fe acquisition is challenging due to the low solubility of Fe in soil solution. Any factor that interfere its absorption and translocation may cause the plant to develop chlorosis. Although abundant in nature, iron often is unavailable because it forms insoluble ferric hydroxide complexes in the presence of oxygen at neutral or basic pH (Guerinot and Yi, 1994) [5]. Iron deficiency symptoms appear on younger leaves, indicating yellowish interveinal areas of leaves commonly referred as 'iron Chlorosis'. In case of severe deficiency, leaves become almost pale white due to loss of chlorophyll. In general, plants are prone to iron deficiency in soils which are alkaline, calcareous, coarse textured and eroded soils with low organic matter and cold-weathered except flooded rice (Tandon, 1998) [16]. The chlorosis is mainly observed in the soils with high calcium carbonate content immediately after irrigation or high rainfall. High bicarbonate levels especially in moist calcareous soils appear to affect the plants ability to absorb iron. Iron deficiency in groundnut (Tandon, 1998) [16], causes considerable reduction in pod yield (16-32%) (Potdar and Anderes, 1995; Singh *et al*., 1995; Singh, 2001) [9, 15] and in extreme cases may lead to complete crop failure. Severity of IDC is quite high for groundnut crop grown in post-rainy/ summer under irrigation.
The soil application of iron in the form of ferrous sulphate ($FeSO_4$) has often been recommended to alleviate the problem of iron chlorosis and concomitant loss in yield. But, this is often of little benefit to the crop as iron ionizes and gets converted into insoluble ferric compounds which are unavailable to plants. A major problem with foliar application is poor translocation of applied iron within the plant. Though, the use of iron chelates provide iron in available from, their use is not popular and not feasible from the economic point of view. The feasible approach to combat iron chlorosis is development of iron deficiency chlorosis resistant cultivars by exploiting the genetic variability observed for resistance to IDC (Reddy *et al*., 1993; Kulkarni *et al*., 1994; Samdur *et al*., 1999, 2000) [11, 7, 13, 12]. Growing IDC resistant groundnut cultivars under calcareous soils has shown significantly higher pod yield compared to susceptible cultivars (Samdur *et al*., 1999; Prasad *et al*., 2000) [13, 12].

Identification of iron deficiency chlorosis resistant groundnut genotypes to overcome/ minimize lime induced chlorosis with higher productivity is a better and long lasting option for sustainable agriculture.

Materials and Methods

The material consisted of F_4 population derived from the crosses *viz.,* G 2-52 x ICGV 86031, Dh 86 x ICGV 86031, GPBD 5 x ICGV 86031 and TAG 24 x ICGV 86031. Among the parents, released cultivars of groundnut *viz.,* G 2-52, Dh 86, GPBD 5 and TAG 24 have differential level of susceptibility to iron chlorosis while, ICGV 86031 is resistant to iron chlorosis. Field evaluation of F_4 population of the four crosses was carried in iron-deficient calcareous soil during *Kharif* 2016 at Regional Agricultural Research Station (RARS), Vijayapur located in the northern dry zone of Karnataka, India. Each F_3 derived F_4 plant to progeny was planted as one row of 1.5 m length with a spacing of 30 x 10 cm. The recommended cultivation practices were followed to raise good crop. However, iron containing fertilizers were not applied.

Observations

Iron absorption efficiency: The iron absorption efficiency was recorded based on severity of calcium induced interveinal chlorosis in the individual plant to progeny at different stages *viz.,* 30, 60 and 90 days after sowing (DAS) using VCR and SCMR.

Yield and yield components: The yield and yield components *viz.,* main stem height (cm), number of primary branches, number of pods per plant, pod yield per plant (g) were recorded on three randomly selected plants at harvest or after harvest in all the four F_4 population, on individual row basis.

Results and Discussions

All the four F_4 populations were evaluated for resistance to iron deficiency chlorosis (IDC) related traits like VCR and SCMR across three stages (30, 60, and 90 DAS). The severity of iron chlorosis was highest during 60 DAS in all four F_4 populations. Based on severity of VCR, the progenies in all the four crosses were grouped as ‘resistant’ (1 to 2), moderate resistant (>2 to 3) and ‘susceptible’ (>3 to 5).

1. **G 2-52 × ICGV 86031:** The F_4 population of cross G2-52 × ICGV 86031 comprised of 52 progenies. Out of which 45 were found ‘resistant’, while 7 were ‘moderate resistant’ to iron deficiency chlorosis based on VCR score. Across the progenies the highest mean for VCR and lowest mean for SCMR was recorded at 60 DAS. The high variance was recorded at 60 DAS (0.30) for VCR as compared to other stages *viz.,* 30 (0.17) and 90 DAS (0.12). The variance for SCMR was high at 30 DAS (51.70) but low at 60 (24.73) and 90 DAS (21.12) (Table 1). Among the productivity parameters high variance was recorded for plant height (30.36) and number of pods per plant (27.58) as compared to other traits. There was high range of variance recorded for VCR (1.00 to 3.67) and SCMR (20.67 to 47.87) at 30 DAS. Among the 45 resistant lines 8 lines were selected based on their high yielding performance (mean+ 1Sd for yield per plant). Among the eight lines, progeny B-6-56-1 was having resistance at all the stages with high pod yield per plant (12.38 g).
2. **Dh 86 × ICGV 86031:** The F_4 population of Dh 86 × ICGV 86031 comprised of 225 progenies, Among these progenies 217 were ‘resistant’, 6 were ‘moderately resistant’ and 2 were ‘susceptible’ to iron deficiency chlorosis based on VCR. The highest mean for VCR (1.54) and lowest mean for SCMR (33.15) were recorded at 60 DAS (Table 2). High variance was recorded at 60 (0.20) DAS for VCR as compared to other stages *viz.,* 30 (0.10) and 90 (0.05) DAS. Variance for SCMR hovered around 20 (20.97 to 22.58) across different stages *viz.,* 30, 60 and 90 DAS. Among the productivity parameters high variance was recorded for plant height (40.27) and yield per plant (13.08) as compared to the other traits. The range of variance for VCR was high at 60 (1.00 to 4.33) while it was high for SCMR at 30 (13.75 to 56.00) DAS. Among the 217 resistant lines 27 lines were selected based on their high yielding performance (mean+ 1Sd). Among the 27 lines, line number B-6-62-1 was having resistance at all the stages with high pod yield per plant (25.70 g) (Table 2).
3. **GPBD 5 × ICGV 86031:** The F_4 population of GPBD 5 × ICGV 86031 comprised of 183 progenies, out of which 171 were found ‘resistant’, 11 were ‘moderately resistant’ and one was ‘susceptible’ to iron deficiency chlorosis based on VCR. The highest mean for VCR (1.67) and lowest mean for SCMR (32.17) was recorded at 60 DAS (Table 3). The variance was high at 30 DAS (0.32) for VCR as compare to other stages. Variance of SCMR hovered around 20 (18.57 to 23.60) across the all stages *viz.,* 30, 60 and 90 DAS. Among the productivity parameters high variance was recorded for plant height (33.45) followed by the number of pods per plant (17.50) and yield per plant (10.34). The range of variance for VCR was high at 60 (1.00 to 3.67) DAS. The range of variance for SCMR was high at 30 (20.67 to 47.87) DAS. Among the 171 resistant lines 26 lines are selected based on their high yielding performance (mean+ 1Sd). Among the 26, progeny I-1-249-1 exhibited resistance at all the stages with high pod yield per plant (23.04 g) (Table 3)
4. **TAG 24 × ICGV 86031:** The F_4 population of TAG 24 × ICGV 86031comprised of 152 progenies, out of which 146 were found ‘resistant’, 4 were ‘moderately resistant’ and two were ‘susceptible’ to iron deficiency chlorosis based on VCR. The highest mean for VCR (1.64) and lowest mean for SCMR (32.72) was recorded at 60 DAS. There was high variance for VCR at 60 DAS (0.19). Variance for SCMR hovered around 15 (15.96 to 17.53) across the all stages *viz.,* 30, 60 and 90 DAS (Table 4). Among the productivity parameters high variance was recorded for plant height (28.40) followed by number of pods per plant (9.41) and yield per plant (8.22). The range of variance for VCR was high at 60(1.00 to 3.33) DAS. The range of variance for SCMR was high at 30 (25.17 to 50.80) DAS. Among the 146 resistant lines, 21 lines were selected based on their high yielding performance (mean+ 1Sd). Among the 21 lines, progeny I-1-141-2 recorded resistance at all the stages with high pod yield per plant (18.64 g) (Table 4).

In F_4 populations of four different crosses *viz.,* G2-52 × ICGV 86031, Dh 86 × ICGV 86031, GPBD 5 × ICGV 86031 and TAG 24 × ICGV 86031 were used. Based on VCR at severe stage (60 d), two female parents Dh 86 (4.31) and TAG 24 (3.33) were found 'susceptible' while GPBD 5 (2.10) was found moderately resistant, G-2-52 (2.00) was resistant while male parent ICGV 86031 was 'resistant' (1.00). When the parents were compared for pod yield per plant, ICGV 86031 had low yield. F_3 derived F_4 populations from the all four crosses were evaluated for resistance to iron deficiency chlorosis (IDC) related traits like VCR and SCMR across three stages (30, 60, and 90 DAS). The severity of iron chlorosis was highest during 60 DAS in all the four F_4 populations which was coinciding with high soil moisture due to receipt of high rainfall during the period which made Fe unavailable to the plants. Based on severity of VCR at 60 DAS, all the F_4 progenies of four crosses were grouped as 'resistant' (1 to 2), moderate resistant (>2 to 3) and 'susceptible' (>3 to 5).

The F_4 populations of different crosses comprised large number of progeny rows selected from F_3 generation out of which many progenies showed resistance to iron deficiency chlorosis. High per cent of resistant lines could be because of non segregation in the selected progeny. Earlier Prakyat (2016) reported complementary gene action (15:1) governing resistance in the crosses involving G 2-52, GPBD 5, Dh 86 and TAG 24 as a female parent and ICGV 86031 as male parent. In all the crosses some showed segregation and showed susceptible for iron chlorosis based on high VCR score at 60 DAS. In the cross G2-52 X ICGV 86031 progeny B-6-56-1 (12.38 g) (Table 1), in cross Dh-86 × ICGV 86031 progeny B-6-62-1 (25.70 g) (Table 2), in crosss GPBD 5 × ICGV 86031 progeny I-1-249-1 (23.04 g) (Table 3) and in the cross TAG 24 × ICGV 86031 the progeny I-1-141-2 (18.64 g) (Table 4) exhibited resistance at all the stages with high pod yield per plant. Earlier eighteen promising advanced breeding lines of groundnut were screened for their tolerance of lime-induced iron chlorosis and reported that PBS11015, PBS11040 and PBS21018 had higher resistance to IDC by Samdur *et al.*, (1999) [13]. These progenies need to further evaluated over seasons and years to test their stability of resistance and productivity.

Table 1: Iron deficiency resistant tolerant and productive progenies of the cross G 2-52 x ICGV 86031

S.N.	Progenies	VCR			SCMR			Eff.	Yield parameters			
		30 DAS	60 DAS	90 DAS	30 DAS	60 DAS	90 DAS		PH(cm)	NPB	NPP	YPP(g)
1	B-6-56-1	1.00	1.50	1.00	42.05	34.00	45.55	R	39.00	4.50	10.50	12.38
2	B-6-40-6	2.00	2.00	1.00	32.90	26.00	35.10	R	19.00	5.00	24.00	11.22
3	B-2-15-3	1.00	1.33	1.67	39.63	35.63	34.07	R	19.00	5.33	16.67	11.15
4	B-2-16-1	1.00	1.33	1.00	42.23	34.67	40.43	R	16.33	4.67	21.67	11.14
5	B-6-32-1	1.00	1.67	1.67	38.27	33.47	33.37	R	20.67	5.00	20.00	10.79
6	B-9-64-5	1.33	1.33	1.00	38.20	32.50	41.60	R	15.67	3.33	9.67	9.24
7	B-6-33-3	1.33	1.33	1.00	36.33	34.30	38.27	R	25.67	5.67	19.33	9.18
8	B-9-64-7	1.00	1.00	1.00	40.55	36.25	41.95	R	21.00	4.00	9.50	9.04
Parents	G 2-52	1.67	2.00	1.33	29.50	27.20	33.63	R	24.00	4.00	12.00	7.52
	ICGV 86031	1.00	1.33	1.00	43.57	35.37	45.73	R	15.67	4.00	5.33	4.98
Mean		1.22	1.57	1.21	36.47	32.51	37.38		19.55	3.99	11.50	6.29
Variance		0.17	0.30	0.12	51.70	24.73	21.12		30.36	0.69	27.58	7.28
Min.		1.00	1.00	1.00	24.27	14.10	24.85		7.00	2.00	3.00	0.45
Max.		2.33	3.00	2.00	44.27	39.90	45.90		39.00	5.67	24.00	12.38
SD		0.42	0.55	0.34	7.19	4.97	4.60		5.51	0.83	5.25	2.70
Mean+1Sd		1.63	2.12	1.55	43.66	37.48	41.98		25.06	4.82	16.75	8.99

VCR: Visual chlorotic rating; SCMR: SPAD chlorophyll meter reading; DAS: Days after sowing; PH: Plant height; NPB: Number of primary branches per plant; NPP: Numbers pods per plant; YPP: Pod Yield per plant; Eff.: Efficiency

Table 2: Iron deficiency Chlorosis resistant and productive progenies of the cross Dh 86 x ICGV 86031

S.N.	Progenies	VCR			SCMR			Eff.	Yield parameters			
		30 DAS	60 DAS	90 DAS	30 DAS	60 DAS	90 DAS		PH (cm)	NPB	NPP	YPP(g)
1	B-6-62-1	1.00	2.00	1.00	42.00	31.20	51.20	R	12.00	5.00	15.00	25.70
2	I-5-382-2	1.00	1.50	1.00	36.00	33.30	40.95	R	30.50	4.50	16.00	21.19
3	I-5-370-9	1.67	1.67	1.00	34.73	29.53	42.10	R	16.67	4.00	13.00	18.91
4	I-5-380-7	1.00	1.00	1.00	36.70	38.20	37.85	R	24.50	4.50	17.00	18.90
5	B-6-55-1	1.00	1.00	1.00	45.80	39.45	44.30	R	9.50	3.50	3.50	18.83
6	I-5-374-5	1.00	1.33	1.00	37.80	36.13	42.37	R	14.00	4.00	19.33	16.18
7	I-4-336-2	1.00	1.00	2.00	33.50	37.10	31.40	R	16.00	4.00	15.00	15.92
8	B-5-43-4	1.00	1.00	1.00	40.27	36.35	40.05	R	12.50	3.00	18.00	15.47
9	B-9-91-1	1.00	1.00	1.00	37.80	37.03	45.70	R	11.33	4.67	16.33	15.47
10	I-1-191-1	1.50	2.00	1.00	34.70	29.80	40.70	R	10.00	4.00	19.00	14.89
11	B-9-92-5	1.00	1.33	1.00	35.97	33.37	37.73	R	18.33	4.00	10.67	14.37
12	B-9-93-7	1.00	1.67	1.00	40.87	31.03	47.77	R	17.00	4.33	16.33	14.08
13	I-3-272-8	1.33	1.33	1.00	32.93	36.63	35.27	R	26.33	4.00	15.00	13.84
14	B-9-88-6	1.00	1.33	1.00	44.83	33.30	47.27	R	30.67	4.33	11.33	13.68
15	I-3-266-6	1.00	1.00	1.00	42.80	38.50	46.70	R	13.00	5.00	22.00	13.62
16	B-4-26-3	1.00	2.00	1.00	37.27	28.53	43.03	R	13.67	4.67	16.33	13.29
17	B-9-95-2	1.00	2.00	1.00	47.73	32.00	45.67	R	16.00	5.67	15.33	13.21
18	I-5-386-3	1.00	2.00	1.00	39.40	25.57	36.00	R	16.00	4.00	9.33	12.96
19	I-4-324-6	1.00	1.33	1.00	37.10	35.93	41.13	R	18.00	4.00	12.00	11.87

20	B-5-41-8	1.00	1.50	1.00	42.90	34.20	44.85	R	7.00	4.50	14.00	11.86
21	B-9-84-3	1.33	1.00	1.00	36.60	37.20	38.33	R	15.33	4.33	11.33	11.78
22	B-6-63-4	1.00	1.67	1.00	41.13	31.80	45.20	R	10.67	4.33	11.67	11.63
23	I-5-403-1	1.00	2.00	1.00	43.60	26.03	48.10	R	9.67	4.00	10.33	11.63
24	I-5-387-1	1.00	1.33	1.00	37.40	32.87	44.07	R	18.33	4.00	17.67	11.43
25	I-5-381-17	1.33	1.33	1.00	35.93	34.77	45.43	R	19.33	4.67	12.33	11.40
26	I-5-397-10	1.00	1.33	1.00	36.63	35.40	40.10	R	9.67	5.33	13.67	11.24
27	I-4-316-3	1.00	1.33	1.00	40.57	33.63	42.03	R	20.00	4.33	11.33	10.91
Parents	Dh 86	2.10	4.31	2.70	29.10	13.40	23.77	S	6.67	4.00	11.67	5.87
	ICGV 86031	1.00	1.33	1.00	43.57	35.37	45.73	R	15.67	4.00	5.33	4.98
Mean		1.12	1.54	1.06	38.86	33.15	41.81		13.48	3.81	9.57	7.24
Variance		0.10	0.20	0.05	22.30	20.97	22.58		40.27	0.85	9.97	13.08
Min.		1.00	1.00	1.00	13.75	5.20	22.43		4.00	2.00	3.50	0.61
Max.		3.50	4.33	3.00	56.00	43.97	55.67		30.67	5.67	22.00	25.70
SD		0.31	0.45	0.23	4.72	4.58	4.75		6.35	0.92	3.16	3.59
Mean+1 Sd.		1.43	1.99	1.29	43.58	37.73	46.57		19.83	4.73	12.73	10.83

VCR: Visual Chlorotic rating; SCMR: SPAD chlorophyll meter reading; DAS: Days after sowing; PH: Plant height; NPB: Number of primary branches per plant; NPP: Numbers pods per plant; YPP: Pod Yield per plant; Eff.: Efficiency

Table 3: Iron deficiency Chlorosis resistant and productive progenies of the cross GPBD 5 x ICGV 86031

S.N.	Progenies	VCR			SCMR			Eff.	Yield parameters			
		30 DAS	60 DAS	90 DAS	30 DAS	60 DAS	90 DAS		PH (cm)	NPB	NPP	YPP(g)
1	I-1-249-1	1.00	2.00	1.00	39.00	29.95	36.10	R	13.50	6.00	17.50	23.04
2	I-1-279-6	1.00	2.00	2.00	42.30	22.10	31.70	R	16.00	4.00	14.00	15.67
3	I-1-261-1	2.00	2.00	1.00	32.50	27.60	38.20	R	19.00	5.00	24.00	15.19
4	I-1-272-4	1.00	2.00	1.00	43.50	33.50	44.80	R	16.00	5.00	24.00	15.06
5	I-1-217-5	1.00	1.50	1.00	39.80	34.40	42.80	R	20.50	5.50	21.50	14.05
6	I-1-223-3	1.00	1.33	1.67	47.10	33.47	33.50	R	10.00	4.67	15.67	13.36
7	I-1-220-10	1.00	1.33	1.00	41.57	34.87	39.60	R	20.00	6.00	21.67	13.30
8	I-1-224-5	1.00	2.00	1.00	44.90	29.93	39.07	R	14.67	4.33	16.67	12.17
9	I-1-219-9	2.00	2.00	1.00	31.70	33.90	41.60	R	24.00	5.00	16.00	11.68
10	I-1-278-9	1.00	1.33	1.00	45.03	34.63	41.67	R	18.33	4.00	12.33	11.63
11	I-1-278-7	1.00	1.00	1.00	44.90	43.00	47.80	R	24.00	3.67	15.33	11.36
12	I-1-280-2	1.33	1.67	1.33	36.63	32.33	33.73	R	14.00	3.67	12.33	11.18
13	I-1-273-4	1.00	2.00	1.00	44.90	28.45	48.50	R	19.00	4.00	18.50	10.97
14	I-1-273-10	1.00	1.67	1.00	45.80	32.67	43.23	R	10.00	4.00	10.67	10.87
15	I-1-223-4	1.00	2.00	1.33	45.10	26.60	34.33	R	10.33	3.33	14.00	10.84
16	I-1-219-2	1.00	2.00	1.00	41.27	29.17	44.70	R	27.00	4.67	9.33	10.82
17	I-1-273-11	1.00	1.33	1.00	38.00	32.17	42.55	R	14.50	4.50	16.00	10.81
18	I-1-223-5	1.00	1.33	1.33	41.43	33.63	35.67	R	12.33	4.33	15.00	10.80
19	I-1-278-4	1.00	1.00	1.00	42.40	41.83	40.47	R	14.00	4.00	18.33	10.77
20	I-1-278-3	1.00	2.00	1.00	44.33	32.50	36.50	R	20.00	4.00	14.00	10.42
21	I-1-255-3	1.00	1.67	1.00	39.80	32.30	41.50	R	16.67	5.00	15.00	10.35
22	I-1-215-4	2.00	2.00	1.00	29.70	30.70	37.40	R	8.00	3.00	12.00	10.30
23	I-1-227-3	1.00	1.33	2.00	37.50	35.67	32.30	R	14.00	3.67	10.33	10.19
24	I-1-223-7	1.00	1.33	1.67	46.43	33.30	33.50	R	13.00	3.33	8.67	10.18
25	I-1-223-9	1.00	2.00	1.00	40.90	28.77	37.27	R	11.67	4.00	12.33	10.13
26	I-1-213-1	1.67	2.00	1.33	31.63	28.67	34.23	R	13.67	3.67	11.33	10.03
Parents	GPBD 5	1.33	2.10	1.67	34.47	30.40	32.20	R	14.33	2.67	6.33	6.05
	ICGV 86031	1.00	1.33	1.00	44.90	34.20	40.77	R	6.33	4.00	8.33	4.98
Mean		1.19	1.67	1.12	39.02	32.17	39.12		15.41	3.98	10.49	6.78
Variance		0.32	0.21	0.06	23.60	18.57	18.36		33.45	1.00	17.50	10.34
Min.		1.00	1.00	1.00	20.67	17.17	25.60		6.00	1.50	2.00	0.55
Max.		2.67	3.67	2.00	47.87	43.47	49.17		39.33	9.00	24.00	23.04
SD		0.57	0.46	0.24	4.86	4.31	4.28		5.78	1.00	4.18	3.22
Mean+ 1Sd		1.75	2.13	1.37	43.88	36.48	43.41		21.20	4.98	14.67	10.00

VCR: Visual chlorotic rating; SCMR: SPAD chlorophyll meter reading; DAS: Days after sowing; PH: Plant height; NPB: Number of primary branches per plant; NPP: Numbers pods per plant; YPP: Pod Yield per plant; Eff.: Efficiency

Table 4: Iron deficiency Chlorosis resistant and productive progenies of the cross TAG 24 x ICGV 86031

S.N.	Progenies	VCR			SCMR			Eff.	Yield parameters			
		30 DAS	60 DAS	90 DAS	30 DAS	60 DAS	90 DAS		PH(cm)	NPB	NPP	YPP(g)
1	I-1-141-2	1.00	1.50	1.00	38.45	33.65	43.70	R	20.50	3.50	14.00	18.64
2	I-1-154-4	1.00	2.00	1.00	39.43	29.10	47.90	R	9.33	4.33	13.00	15.25
3	I-1-142-9	1.00	1.00	1.00	37.10	34.40	39.10	R	13.00	4.00	17.00	14.47
4	B-1-6-3	1.00	1.00	1.00	42.50	37.80	41.90	R	14.00	5.00	10.00	14.45

5	I-1-161-11	1.33	1.67	1.00	34.13	32.57	37.37	R	24.00	4.00	10.67	13.19
6	I-1-144-8	1.00	1.67	1.00	43.70	33.37	37.40	R	22.67	4.33	19.67	13.07
7	B-1-19-10	1.00	2.00	1.00	36.70	22.70	35.10	R	8.00	4.00	16.00	13.06
8	I-1-142-8	1.00	1.67	1.00	41.93	33.67	42.67	R	14.33	5.00	16.00	12.93
9	I-1-120-5	1.00	2.00	1.33	41.40	32.77	39.63	R	16.67	5.67	15.67	12.69
10	I-1-135-4	1.00	2.00	1.00	39.20	30.85	42.55	R	27.00	3.50	14.50	12.62
11	I-1-161-5	2.00	2.00	1.00	25.17	28.20	34.40	R	32.00	5.00	17.00	12.42
12	I-1-119-8	1.00	1.67	1.00	39.60	34.50	36.67	R	14.67	4.00	13.67	12.15
13	I-1-163-7	1.00	1.33	1.00	41.17	33.17	41.83	R	9.67	4.00	7.67	11.86
14	I-1-126-4	1.00	2.00	1.00	40.30	32.20	40.75	R	18.00	4.00	13.50	11.79
15	I-1-144-1	1.00	1.67	1.00	38.70	32.87	47.50	R	11.33	3.33	11.33	11.68
16	I-1-162-1	1.00	1.00	1.00	46.40	34.30	49.10	R	20.33	4.00	12.00	11.56
17	I-1-150-3	1.00	1.50	1.00	41.75	34.50	45.85	R	23.00	4.50	14.00	11.44
18	B-1-9-1	1.00	1.33	1.00	36.60	34.23	39.10	R	10.00	5.00	13.33	11.37
19	I-1-176-5	1.00	1.50	1.00	38.75	33.75	42.55	R	24.50	3.50	15.00	11.10
20	I-1-136-1	1.00	1.33	1.00	46.57	34.77	41.50	R	21.33	4.00	14.00	11.01
21	I-1-161-3	1.00	2.00	1.00	50.80	33.20	50.60	R	19.50	3.50	6.50	10.76
Parents	TAG 24	2.33	3.33	2.33	24.13	16.83	23.30	S	6.33	4.00	12.33	4.31
	ICGV 86031	1.00	1.33	1.00	44.23	34.83	45.23	R	18.33	3.67	10.33	4.38
Mean		1.08	1.64	1.07	39.90	32.72	41.30		13.71	4.02	10.14	7.81
Variance		0.05	0.19	0.03	15.96	16.37	17.53		28.40	0.68	9.41	8.22
Min.		1.00	1.00	1.00	25.17	17.57	25.23		5.67	2.67	3.50	1.02
Max.		2.33	3.33	2.00	50.80	41.60	50.60		32.00	7.00	19.67	18.64
SD		0.22	0.43	0.17	3.99	4.05	4.19		5.33	0.83	3.07	2.86
Mean + 1Sd		1.30	2.07	1.24	43.89	36.77	45.48		19.04	4.84	13.21	10.66

VCR: Visual chlorotic rating; SCMR: SPAD chlorophyll meter reading; DAS: Days after sowing; PH: Plant height; NPB: Number of primary branches per plant; NPP: Numbers pods per plant; YPP: Pod Yield per plant; Eff.: Efficiency

Conclusion

In breeding selection for resistance alone will not be useful but resistance with higher productivity is desired. In the present study, the progeny with resistance to iron deficiency chlorosis and having high productivity were selected (based on mean + 1SD) in F_4 populations of four different crosses. The iron deficiency severity was reported maximum at 60 DAS which is due to high rainfall during the period of time. These progenies need to be further evaluated over seasons and years to test their stability of resistance and productivity.

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References

1. Briat JF, Lebrun M. Plant responses to metal toxicity. C. R. Acad. Sci. Paris 1999;322:43-54.
2. Briat JF, Fobis-Loisy I, Grignon N, Lebreaux S, Pascal N, Savino G *et al*. Cellular and molecular aspects of iron metabolism in plants. Biol. Cell. 1995;84:69-81.
3. Falconer DS. Introduction to quantitative genetics. Oliver and Boyd limited Edinburgh, U.K, 1967.
4. Fisher RA. Statistical methods for research workers, 14th edition, Hafner, 1963, 104-117.
5. Guerinot ML, Yi Y. Iron: Nutritious, noxious and not readily available. Plant physiology. 1994;104:815-820.
6. Habib AF, Joshi MS. Combating iron chlorosis in black soils of Malaprabha and Ghataprabha project area. Crop Sciences. 1982;11:51-54.
7. Kulkarni VN, Gowda MVC, Panchal YC, Nadaf HL. Evaluation of groundnut cultivars for iron absorption efficiency. Crop Research. 1994;7(1):84-92.
8. Parkyat K. Genetics of iron absorption efficiency and validating putative markers in groundnut (*Arachis hypogaea* L.), M.Sc. thesis, University Agricultural Sciences Dharwad Karnataka, 2016.
9. Potdar MV, Anders. On- farm performance of groundnut genotypes under different land configuration and foliar iron sprays for the correction of iron Chlorosis on calcareous soils in India. Iron nutrition in soils and plants, 1995, 111-118.
10. Prasad PVV, Satyanarayana V, Sotdar MV, Crufurd PQ. On farm diagnosis and management of iron chlorosis in groundnut. Journal plant nutrition. 2000;23(10):1471-1483.
11. Reddy KB, Ashalatha M, Venkaiah K. Differential response of groundnut genotypes to iron deficiency stress. Journal plant nutrition 1993, 16:523-531.
12. Samdur MY, Singh AL, Mathur RK, Manivel P, Chikani, BM, Gor, HK, Khan MA. Field evaluation of chlorophyll meter for screening groundnut (*Arachis hypogaea* L.) genotypes tolerant to iron deficiency chlorosis. Indian journal agricultural sciences. 2000;79(2):211-214.
13. Samdur MY, Mather RK, Manvir P, Singh AL, Bandyyopadhyay A, Chikani BM. Screening of some advanced breeding lines of groundnut (*Arachis hypogaea* L.) for tolerance of Liume induced iron chlorosis. Indian journal agricultural sciences. 1999;69:722-725.
14. Singh AL, Chaudhary V. Screening of groundnut (*Arachis hypogaea*) varieties tolerant to iron chlorosis. Indian journal agricultural sciences. 1991;61:925-927.
15. Singh AL, Choudhary V, Koradia VG, Zala PV. Effect of irrigation and iron sulphate fertilizers on the chlorosis, dry matter production, yield and nutrients uptake by groundnut in calcareous soils. Agro- Chem. 1995;39:187-198.
16. Tandon HLS. Methods of analysis of soils, plants, water and fertilizers. Fertilizer Development and Consultation Organization. 1998;31(9):9-16.
17. Thorne DW, Wann FB, Robinson W. Hypothesis

concerning lime induced chlorosis. Soil sciences society of American proceeding. 1950;15:254-258.
18. Upadhyaya HD, Bramel PJ, Ortiz R, Singh S. Developing a mini core of peanut for utilization of genetic resources. Crop Sciences. 2002;42:2150-2156.
19. Waldo GS, Wright E, Whang ZH, Brait JF, Theil EC, Sayers DE. Formation of the ferritin iron mineral occurs in plastids. Plant physiology. 1995;109:797-802.