www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2022; 11(5): 1123-1127

www.thepharmajournal.com
Received: 17-02-2022
Accepted: 26-03-2022

Omesh Kumar
Department of Genetics and Plant Breeding, College of Agriculture, Vijayapura, Karnataka, India

O Sridevi
Department of Genetics and Plant Breeding, College of Agriculture, Vijayapura, Karnataka, India

GK Naidu
Department of Genetics and Plant Breeding, College of Agriculture, Vijayapura, Karnataka, India

BC Patil
Department of Genetics and Plant Breeding, College of Agriculture, Vijayapura, Karnataka, India

Corresponding Author:
Omesh Kumar
Department of Genetics and Plant Breeding, College of Agriculture, Vijayapura, Karnataka, India

Association between productivity parameters and iron deficiency chlorosis in groundnut (*Arachis hypogaea* L.)

Omesh Kumar, O Sridevi, GK Naidu and BC Patil

Abstract
Iron deficiency chlorosis in groundnut is a common problem causes reduction in yield particularly in calcareous, alkaline and black soils. The association study in eleven groundnut genotypes and minicore was studied under iron deficient calcareous soil. The association study in mini core and eleven genotypes indicated significant negative correlation between VCR (Visual chlorophyll ratting) with all other iron absorption efficiency and productivity parameters (haulm weight and pod yield). The SCMR (Spade chlorophyll meter reading) has significant positive correlation with ferrous and chlorophyll ('a', 'b' and 'total') content and yield per plant.

Keywords: Groundnut, VCR, SCMR, IDC, Minicore

Introduction

Groundnut (*Arachis hypogaea* L.) is an important oilseed legume crop grown in arid and semi-arid regions of the world. Plants require many essential nutrient for competing their life cycle among them iron is an essential nutrient required for completing life-sustaining process i.e. respiration to photosynthesis. It plays an important role in the synthesis of chlorophyll, carbohydrate production and cell respiration, chemical reduction of nitrate and sulphate and nitrogen assimilation. To maintain optimum growth plants need to maintain 10-9 to 10-4 M Fe in the concentration but it is a challenging due to low solubility of Fe in soil solution. Any factor that interfere its absorption and translocation may cause the plant to develop chlorosis. Iron present in abundant in nature but in the presence of oxygen at neutral or basic pH it forms insoluble hydroxide complexes which is an unavailable form of iron for the plants (Guerinot and Yi, 1994). The deficiency of iron indicates by yellowish interveinal parts of leaves on younger leaves referred as 'iron chlorosis'. In severe deficiency leaves convert into 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) [34].

The soils with high calcium carbonate content show the chlorosis immediately after irrigation or high rainfall because in the presence of high bicarbonate plant cannot absorb the iron. The yield reduction up to 16-32% (Potdar and Anderes, 1995; Singh *et al*., 1995; Singh, 2001) [19, 30] due to iron deficiency chlorosis whereas in severe cases it may lead to complete crop failure. There IDC severity is quite high in crop grown in post-rainy/ summer under irrigation. The IDC problem can be overcome by the soil application of iron in the form of ferrous sulphate ($FeSO_4$) but this approach is not feasible to the farmer and crop as iron gets convert into ferric compound which are unavailable to plants. The most feasible approach to overcome the iron chlorosis is development of iron deficiency chlorosis resistant cultivars by exploiting the genetic variability (Reddy *et al*., 1993; Kulkarni *et al*., 1994; Samdur *et al.*, 1999, 2000) [8, 24, 23]. 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) [23, 20].

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. The iron deficiency chlorosis effect the many yield attributing character therefore the association study between iron deficiency chlorosis parameters and productivity parameters was conducted.

Materials and Methods

The study was conducted in the field with calcareous soil at RARS, Vijayapur. Vijayapur comes under Northern dry zone (Zone 3) of Karnataka and situated at 16°49" N latitude, 75°43" E longitude with an altitude of 593 m above mean sea level. The soil collected for the experimentation is clay in texture. The soil samples were collected from a depth of 0 to 15 cm, powdered and mixed thoroughly to obtain a homogeneous mixture and chemical properties were analyzed by following standard procedures (Table 1). The recommended dose of nitrogen (25 kg ha^{-1}), phosphorus (75 kg ha^{-1}) and potassium (25 kg ha^{-1}) were added to the field at the time of sowing. Iron containing fertilizers were avoided. There are two set of experiment were conducted for association study. In first set one hundred ninety six groundnut genotypes which include 184 groundnut genotypes from ICRISAT mini core collection, 4 ICRISAT control genotypes and 8 local checks sown under unbalanced alpha lattice design with two replications. Each genotype was planted as one row of 2 m length with a spacing of 30 x 10 cm for bunch types and 60 x 10 cm for spreading types. The recommended cultivation practices were followed to maintain healthy plant population. The iron absorption efficiency was recorded based on severity of calcium induced interveinal chlorosis at different stages *viz.,* 15, 30, 45, 60, 75 and 90 days after sowing (DAS) using VCR (Visual chlorophyll ratting) and SCMR (Spade chlorophyll meter reading). The yield and yield components *viz.,* main stem height (cm), number of primary branches, number of pods per plant, pod yield per plant (g), shelling per cent and hundred seed weight (g) were recorded at harvest or after harvest for all the genotypes.

In second set eleven selected groundnut genotypes *viz.,* ICGV 86031, TAG 24, RIL 52, RIL 146, RIL 307 (Recombinant Inbred Lines from TAG 24 x ICGV 86031), A30b, ICGV 06146, GPBD 5, Dh 86, TMV 2 and G2-52, were sown in 2 sets, in iron-deficient calcareous soil in Factorial randomized block design (Factorial RBD). One set was sown under calcareous soil without any iron supplementation and second set in calcareous soil but with iron supplementation (foliar application 0.5% Fe EDDHA at two stages *i.e.* 30 and 45 DAS). Each genotype was planted in five rows of 3 m length with a spacing of 30 X 10 cm in 3 replications in each set. The recommended cultivation practices were followed to maintain healthy plant population. The iron absorption efficiency parameter *viz.,* VCR, SCMR, Leaf chlorophyll content and iron was recorded at different stages *viz.,* 30, 45, 60, 75 and 90 days after sowing (DAS). The yield and yield components *viz.,* main stem height (cm), number of primary branches, number of pods per plant, pod yield per plant (g), shelling per cent and hundred seed weight (g) were recorded at harvest or after harvest for all the genotypes. The association between productivity parameters and iron chlorosis deficiency trait in mini core and eleven genotypes was calculated by the using of WINDOSTAT statistical package.

Results and Discussion

Association studies in groundnut genotypes under iron sprayed and unsprayed condition: Association studies in genotypes are clearer under unsprayed condition as compared to sprayed condition. The study revealed that under iron unsprayed condition VCR had significant negative correlation with SCMR, ferrous and chlorophyll (‘a’, ‘b’ and ‘total’) content. VCR has non - significant negative correlation with number of primary branches per plant per plant, haulm weight per plant and yield per plant (Table 2). The VCR under sprayed condition had non- significant negative correlation with SCMR, chlorophyll a, chlorophyll b, total chlorophyll and hundred seed weight. It’s has non-significant positive correlation with active iron content (Fe^{2+}), number of primary branches per plant, number of pod per plant, shelling per cent, haulm weight per plant and yield per plant. This is because in iron sprayed condition iron deficiency has been recovered by plant whereas in unsprayed condition plant show the iron deficiency chlorosis which cause significant the yield reduction. Thus VCR could be used as a suitable selection trait to identify resistant genotypes.

A significant positive correlation was observed between ferrous and chlorophyll (‘a’, ‘b’ and ‘total’) content which is because iron is a major constituent element of chlorophyll (Table 2). Similar positive correlation has been noted earlier in groundnut (Nagarathnamma, 2006; Boodi, 2014; Singh, 2015) [15, 32] and in French bean (Zhang *et al.,* 1995). Significant positive correlation was found between SCMR and chlorophyll content (‘a’, ‘b’, and ‘total’) in the leaf. Similar results were observed earlier in groundnut (Samdur *et al.,* 2000; Boodi, 2014; Singh, 2015; Motagi *et al.,* 2000) [32, 24] and moong bean (Srinives *et al.,* 2010). Highly significant positive correlation was found between SCMR and ferrous content. Similar positive correlation was reported earlier in groundnut (Nagaratnamma, 2006; Lee *et al.,* 2009; Boodi, 2014; Singh, 2015; prakyat, 2016) [32]. SPAD values are related to the chlorophyll content of plants and there exists correlation between SPAD values and chlorophyll concentration (Samdur *et al.,* 2000) [24]. Higher values of SPAD were found to be positively correlated with chlorophyll content in the genotypes, confirming earlier findings that SPAD values measures the greenness and indirectly the chlorophyll content in plants. Painawadee *et al.* (2009) and Arunyanark *et al.* (2008, 2009) reported that SCMR is positively related to chlorophyll density and it is an indicator of the photo synthetically active light-transmittance characteristics of the leaf (Richardson *et al.,* 2002). These association studies suggest that SCMR can be used as supporting trait for VCR, chlorophyll content and ferrous content for identification of iron chlorosis resistant genotypes in groundnut.

A negative correlation of VCR with various yield and yield parameters like plant height, number of primary branches per plant, haulm weight per plant and yield per plant was observed whereas, SCMR had significant positive correlation with various yield and yield parameters like plant height, number of primary branches per plant, haulm weight per plant and yield per plant (Table 2). Similar results were reported by Singh *et al.* (2005), Savita and Koti (2004), Nagarathnamma (2006) [15], Boodi, (2014), Singh, (2015) [32] and prakyat, (2016). This is obvious due to the fact that there is a direct relation between source (leaves) to sink (pods) in any crop in general and groundnut in particular. SCMR, chlorophyll (‘a’, ‘b’ and ‘total’) and iron content recorded positive correlation with various yield and yield parameters like plant height, number of primaries per plant, haulm weight per plant and yield per plant due to the fact that there is direct relation between source (leaves) to sink (pods) in any crop in general and groundnut in particular.

Association studies in mini core

Association studies in mini core revealed that VCR had significantly negative correlation with SCMR (Table 3). This is obvious due to SPAD measures the greenness and indirectly the chlorophyll content in plants. Earlier studies on screening several released varieties and germplasm of groundnut for iron absorption efficiency, negative correlation was observed between VCR and SCMR (Samdur *et al.*, 2000, Savita and Koti, 2004, and Nagarathnamma 2006; Boodi, 2014; Singh, 2015; Prakyat, 2016) [24, 32, 15]. This shows that VCR could be suitable trait to identify iron deficiency chlorosis resistant genotypes.

VCR also exhibited negative correlation with various yield and yield parameters like plant height, number of primary branches per plant, number of pods per plant, shelling per cent haulm weight per plant and pod yield per plant whereas, SCMR had positive correlation with various yield and yield parameters like plant height, number of primary branches per plant, number of pods per plant, shelling per cent, haulm weight per plant and yield per plant (Table 3). Similar observations were reported by Singh *et al*. (2005), Savita and Koti (2004), Nagarathnamma (2006) [15], Singh, (2015) [32], Boodi, (2014) and Prakyat, (2016).

Table 1: Chemical characteristics of the soil in experimental site

Sl. No.	Parameter	Unit	Values
1	pH		8.02
2	EC	dsm^{-1}	0.53
3	Organic carbon	%	0.64
4	Available Nitrogen	kg/ha	294.00
5	Available P_2O_5	kg/ha	48.75
6	Available K_2O	kg/ha	468.00
7	Available Ca	Cmol (p^+)/kg	19.25
8	Available Mg	Cmol (p+)/kg	5.55
9	Available Sulphur	mg/kg	18.20
10	Free Lime	%	8.93
11	CEC	Cmol (p+)/kg	58.00
12	Base Saturation	%	42.75
13	Zinc	Ppm	3.12
14	Iron	Ppm	0.09
15	Copper	Ppm	2.24
16	Manganese	Ppm	0.23

EC: Electric conductivity; CEC: Cation exchange capacity

Table 2: Correlation between iron absorption efficiency traits at 60 days DAS and productivity traits under sprayed and unsprayed condition

Traits	Cond.	VCR	SCMR	Chl. a	Chl. b	Total Chl.	Fe	PH	NPB	NPP	HSW	SP	HWP	YPP
VCR	S	1.000	-0.101	-0.297	-0.238	-0.326	0.110	0.000	0.099	0.215	-0.330	0.267	0.263	0.206
	US	1.000	-0.904**	-0.858**	-0.925**	-0.887**	-0.909**	-0.285**	-0.138	0.147	0.051	0.041	-0.305	-0.038
SCMR	S		1.000	0.365*	0.405*	0.407*	0.109	0.006	0.192	-0.211	0.451**	-0.402*	-0.075	-0.434**
	US		1.000	0.851**	0.913**	0.879**	0.871**	0.238	0.248	-0.121	-0.068	-0.058	0.354*	0.205
Chl. a	S			1.000	0.405*	0.977**	0.055	0.233	-0.045	-0.139	0.470**	-0.474**	-0.053	-0.498**
	US			1.000	0.838**	0.997**	0.822**	0.283	0.197	-0.111	-0.125	-0.056	0.366**	0.094
Chl. b	S				1.000	0.588**	-0.051	0.061	0.310	-0.274	0.284	-0.556**	-0.127	-0.522**
	US				1.000	0.879**	0.909**	0.268	0.259	-0.102	-0.145	-0.090	0.365*	0.043
Total Chl.	S					1.000	0.032	0.218	0.033	-0.192	0.480**	-0.544**	-0.078	-0.565**
	US					1.000	0.825**	0.289	0.209	-0.113	-0.125	-0.063	0.375*	0.088
Fe	S						1.000	-0.018	0.037	0.274	-0.063	-0.049	-0.034	0.046
	US						1.000	0.147	0.301	-0.212	-0.069	-0.077	0.233	0.124
PH	S							1.000	0.302	-0.083	-0.145	-0.003	0.698**	0.074
	US							1.000	0.049	0.029	-0.185	-0.196	0.778**	-0.053
NPB	S								1.000	-0.146	-0.110	-0.101	0.270	-0.277
	US								1.000	-0.146	-0.346*	0.095	0.285	0.197
NPP	S									1.000	-0.363*	0.078	-0.034	0.368*
	US									1.000	-0.219	0.146	-0.047	0.522**
HSW	S										1.000	-0.413*	-0.184	-0.455**
	US										1.000	-0.297	-0.294	-0.211
SP	S											1.000	0.196	0.601**
	US											1.000	-0.062	0.376*
HWP	S												1.000	0.437*
	US												1.000	0.216
YPP	S													1.000
	US													1.000

*, ** significant at 5% and at 1% level of significance; S: Under sprayed condition; US: Unsprayed condition; VCR: Visual chlorotic rating; SCMR: SPAD chlorophyll meter reading; Chl. a: Chlorophyll a; Chl. b: Chlorophyll b; total chl.: Total chlorophyll; Fe: Ferrous content; PH: Plant height; NP: Number of primary branches per plant; NPP: Numbers pods per plant; HSW: Hundred seed weight; SP: Shelling per cent; HWP: Haulm weight per plant; YP: Yield per plant

Table 3: Correlation between iron absorption efficiency traits at 60 DAS and productivity traits in mini core lines

Traits	VCR	SCMR	PH	NPB	NPP	HSW	SP	HWP	YPP
VCR	1.000	-0.934**	-0.219**	-0.154**	-0.215**	0.035	-0.009	-0.048	-0.107
SCMR		1.000	0.243**	0.181**	0.194**	-0.036	0.004	0.076	0.102
PH			1.000	0.262*	-0.041	0.015	-0.091	0.045	-0.003
NPB				1.000	0.052	0.057	-0.180**	0.077	0.046
NPP					1.000	-0.040	0.137**	0.014	0.610**
HSW						1.000	-0.120*	-0.032	0.238**
SP							1.000	-0.042	0.051
HWP								1.000	0.030
YPP									1.000

*, ** significant at 5% and at 1% level of significance; VCR: Visual chlorotic rating; SCMR: chlorophyll meter reading; PH: Plant height; NP: Number of primary branches per plant; NPP: Numbers pods per plant; HSW: Hundred seed weight; SP: Shelling per cent; HWP: Haulm weight per plant; YPP: Yield per plant

Conclusion

Groundnut being sensitive to iron deficiency, iron chlorosis is most commonly seen in areas of groundnut cultivation particularly in calcareous, alkaline and black soils. Association studies between traits related to IDC productivity parameters both in mini core and eleven genotypes indicated negative significant correlation between VCR with all other iron absorption efficiency parameters (SCMR, chlorophyll ‘a’, chlorophyll ‘b’, ‘total’ chlorophyll and ferrous content) and productivity parameter (haulm weight and pod yield). So the VCR along with the SCMR value can be used as selectable criteria for selection of iron deficiency chlorosis resistance genotypes in groundnut.

Acknowledgements

The authors would like to extend their sincere appreciation to the Dept. Of Genetics and Plant Breeding, College of Agriculture, Vijayapura, University of Agricultural Sciences, Dharwad, Karnataka, India for providing all required facilities of this research.

References

1. Boodi IH, Pattanashetti SK, Biradar BD. Identification of groundnut genotypes resistant to iron deficiency chlorosis. *Karnataka J. Agric. Sci*. 2015;28(3):406-408.
2. Boodi IH, Pattanashetti SK, Biradar BD, Soregoan CD. Biochemical basis of iron deficiency chlorosis resistance in groundnut (*Arachis hypogaea* L.). Elect. J of Plant Breed. 2016;7(4):1188-1199.
3. Brown JC. Iron chlorosis in plants. *Adv. Agron*., 1961;13:329-369.
4. Dekock PC. Iron nutrition of plants at high pH. *Soil Sci.* 1955;79:167-176.
5. Falconer DS. *Introduction to quantitative genetics.* Oliver and Boyd limited. Edinburgh, U.K., 1967.
6. Habib AF, Joshi MS. Combating iron chlorosis in black soils of Malaprabha and Ghataprabha project area. Crop Sci., 1982;11:51-54.
7. Jones JB. Plant tissue analysis for micronutrients In: Micronutrents in Agriculture (ed J J Mortvedt P M Giodan, W L Lindsay) Soil Sci. Soc. Am. Madison, Wisconsin, U S.A., 1972, 319-346.
8. Kulkarni VN, Gowda MVC, Panchal YC, Nadaf HL. Evaluation of groundnut cultivars for iron deficiency chlorosis. *Crop Res.* 1994;7(1):84-92.
9. Kulkarni VK, Gowda MVC, Nadaf HL, Manjunathaiah HM. An evaluation of screening method for iron absorption efficiency in groundnut (*Arachis hypogaea* L.), Karnataka J Agric. Sci. 1995;8(2):54-59.
10. Li G, Yanxi S. Genetic differences in resistance to iron deficiency chlorosis in peanut. J plant nutri. 2007;30(1-3):37-52.
11. Li G, Yanxi S, Jianmin Z. Study on the sensitive period and screening index for iron deficiency chlorosis in peanut. Plant Nutri. Fert. Sci. 2009;15(4):917-922.
12. Lindsay WL, Norvell WA. Development of a DTPA soil test for zinc, iron, manganese, and copper. Soil Sci. Soc. Am J. 1978;42:421-428.
13. Mahurkar DG, Phadnawis BN, Deshmukh DP, Debre WM, Takzure SC. Effect of chlorosis on enzyme activities in leaves of groundnut cultivars. J Sol. Crops. 1995;2(1):5-7.
14. Motagi BN, Gowda MVC, Naidu GK. Screening foliar disease resistant groundnut genotypes for tolerance to lime induced iron chlorosis. International Arachis Newsletter. 2000;20:22-23.
15. Nagarathnamma. Evaluation of groundnut genotypes for lime induced chlorosis tolerance. *M. Sc. (Agri.) Thesis*, submitted to the University of Agricultural Sciences, Dharwad, 2006, p 96-99.
16. Parkyat K. Genetics of iron absorption efficiency and validating putative markers in groundnut (A*rachis hypogaea* L.), *M.Sc. thesis*, Univ. Agric. Sci. Dharwad Karnataka, 2016.
17. Porter LK, Throne DW. Interrelation of Carbon dioxide and bicarbonates ions in causing plant chlorosis. *Soil Sci.* 1953;79:373-382.
18. Potdar MV, Anders MM. Diagnosis and correction in iron chlorosis. In Groundnut- A Global Perspective *Proc. Int. Workshop*. (ed. S N Nigam) Nov 1991, Patancheru, A P India, 1992.
19. 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 nutri. in Soils and Plants, 1995, 111-118.
20. Prasad PVV, Satyanarayana V, Sotdar MV, Crufurd PQ. On farm diagnosis and management of iron chlorosis in groundnut. J Plant Nutri. 2000;23(10):1471-1483.
21. Purnomo J, Novita N, Astanto A. Performance of groundnut tolerance to chlorotic symptoms. Intern. Arachis Newsletter. 1997;17:17-18.
22. Rao JSP, Narayanan A. Physiological aspects of iron deficiency in groundnut (*Arachis hypogaea* L.*)* and blackgrarn (*Vigna mungo* L.). Madras Agric J. 1990;77(3-4):151-157.
23. Samdur MY, Singh AL, Mathur RK, Manivel P, Chikani BM, Gor, HK, *et al*. Field evaluation of chlorophyll

meter for screening groundnut (*Arachis hypogaea* L.) genotypes tolerant to iron deficiency chlorosis. Indian J Agric. Sci. 2000;79(2):211-214.
24. 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 J of Agric. Sci. 1999;69:722-725.
25. Savitha FH, Koti RV. Screening of groundnut germplasm for lime induced iron chlorosis. *Personnel Communication*, Department of Crop Physiology, University of Agricultural Sciences, Dharwad, 2004.
26. Shoaf TW, Lium BW. Improved extraction of chlorophyll ‘a’ and ‘b’ from algae using dimethyl sulfoxide. *Limnoloceanor*. 1976;21:926-928.
27. Singh AL, Chaudhari V. Screening of groundnut (*Arachis hypogaea*) vareties tolerant to iron chlorosis, Indian J Agric. Sci. 1991;61:925-927.
28. Singh AL, Chowdhury 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.
29. Singh AL, Dayal D. Foliar application firm iron recovering groundnut plants from lime-induced iron deficiency chlorosis and accompanying losses in yield. J of Plant Nutri., 1992;15(9):1421-1433.
30. Singh AL, Chaudhari V, Kordia VG, Zala PV. Effect of excess irrigation and iron and sulphur fertilizers on the chlorosis, dry matter production, yield and nutrient uptake by groundnut in calcareous soil. Agrochemica, 1995;39(4):184-198.
31. Singh B, Kumar ANS, Singh BK, Usha K. Improving Zn efficiency of cereals under Zn deficiency. Cur. Sci., 2005;88:36-45.
32. Singh OPK. Minicore evaluation, inheritance and QTL mapping for iron absorption efficiency in groundnut. *M.Sc. thesis*, Univ. Agric. Sci. Dharwad Karnataka, 2015.
33. Srinivas P, Kitsanachandee, Ratanakorn C, Sommanas T, Chanprame W. Inheritence of resistance to iron deficiency and identification of AFLP markers assosiated with the resistence in mungbean. Thailand pl. soil. 2010;335(2):423-437.
34. Tandon HLS. Methods of analysis of soils, plants, water and fertilizers. Fertilizer Development and Consultation Organization. 1998;31(9):9-16.
35. Upadhyaya HD, Bramel PJ, Ortiz R, Singh S. Developing a mini core of peanut for utilization of genetic resources. Crop Sci. 2002;42:2150-2156.