Biological Forum – An International Journal **15(10): 945-949(2023)**

ISSN No. (Print): 0975-1130
ISSN No. (Online): 2249-3239

Visual Method for Non-destructive Scoring of Iron Deficiency in Aerobic Rice Cultivars

B. Soumya[1*], K.P. Vani[2], Kadasiddappa M.M.[3] and Ranjitha P.[3]
[1]Assistant Professor, Livestock farm complex,
College of Veterinary Science, Korutla (Telangana), India.
[2]Professor, Department of Agronomy,
College of Agriculture, Rajendranagar, Hyderabad (Telangana), India.
[3]Assistant Professors, Department of Agronomy,
Professor Jayashankar Telangana State Agricultural University (Telangana), India.

(Corresponding author: B. Soumya)*
(Received: 14 August 2023; Revised: 17 September 2023; Accepted: 30 September 2023; Published: 15 October 2023)
(Published by Research Trend)

ABSTRACT: The aerobic rice is grown under non-puddled, non-flooded and non-saturated soil conditions as other upland crops such as wheat and maize, by cultivating high-yielding rice varieties in aerobic soils with irrigation facilities. Under aerobic soil condition iron deficiency induced chlorosis is the common encountered problem which reduces the crop yield drastically. To overcome this problem, a field experiment was conducted at Professor Jayashankar Telangana State Agricultural University, Hyderabad, in sandy clay loam to observe the iron chlorosis in aerobic rice cultivars to varying levels of iron nutrition. The experiment was laid out in a split plot design, comprising twelve treatment combinations of iron (F_0 to F_{11}) and three rice cultivars (V_1, V_2 and V_3) which were repeated three times. Iron treatments include two sources of iron i.e., iron sulphate and iron chelate and their combinations like foliar application, soil application and combination of both soil and foliar applications. The results indicated that iron deficiency intensity i.e. iron scoring at 15, 30, 45 and 60 DAS was significantly influenced by cultivars and iron application. Similarly, SPAD values at 30, 60, 90 DAS and at harvest was significantly influenced by cultivars and iron application. Among the cultivars tested, KRH 2 was more tolerant to iron deficiency induced chlorosis and maintained its greenness at different stages of crop growth. Iron nutrition treatments also decreased the chlorosis of rice plants, between them basal application of iron chelate @ 25 kg ha^{-1} along with 3 foliar sprays of iron sulphate from 21 DAS @ 7 days interval was ideal for field application.

Keywords: Aerobic rice, Fe deficiency, Rice cultivars, SPAD, Chlorosis, Iron deficiency intensity.

INTRODUCTION

Rice is a crucial cereal that is the primary food source over half of the world's population. It is the second most widely grown crop worldwide, covering 167.1 million hectares and generating a production of 782 million tons (FAOSTAT, 2021). Although rice is an important food source, it still faces significant challenges in cultivation, like drought, cold, heat, salinity, acidic soils, deficiencies in soil nutrients, toxicities and also requires high water for cultivation (Munns and Millar 2023). Irrigated agriculture accounts for 70% of global water usage, with rice being one of the most water consuming crops (Boretti and Rosa 2019). The use of excessive water in rice cultivation has led to the depletion of groundwater at an alarming rate in areas intensively utilized for rice (Surendran *et al*., 2021). Groundwater depletion is posing a threat to rice production in many high-yielding regions, and it is necessary to produce more rice with less water to sustain productivity. In addition, the labor intensive nature of transplanted rice has led many farmers to abandon rice cultivation and switch to other efficient rice cultivation practices.

Thus, Aerobic rice cultivation has many advantages over traditional rice cultivation methods, such as increased water use efficiency and decreased greenhouse gas emissions, lower cultivation costs, and decreased labour requirements (Arouna *et al*., 2023). Aerobic rice could be grown under non-puddled, non-flooded and non-saturated soil conditions as other upland crops such as wheat and maize, by cultivating high-yielding rice varieties in aerobic soils with irrigation (Soumya *et al*., 2017). This method of cultivation could potentially serve as an alternative to deal with depleting underground water and labour shortages in rice production (Farooq *et al*., 2011).

Iron is an essential mineral in rice plants and plays a crucial role in various chemical processes for example, the formation of chlorophyll, the essential pigment necessary for photosynthesis, which is the most crucial physiological process in plants (Vale *et al.*, 2022). In plants, 80–90% of cellular Fe is found in chloroplasts (Hantzis *et al*., 2018). Iron element is the fourth most abundant element in the earth's crust (Taylor and Konhauser 2011). However, Under aerobic conditions, particularly in alkali and calcareous soils, Fe is sparingly soluble (Masuda *et al.*, 2019). Aerobic rice cultivation faces significant challenges due to chlorosis caused by iron deficiency. The chlorosis first occurs in the interveinal areas of the emerging leaf followed by yellowing of entire leaf and finally turns white. If there is a severe deficiency, the plant will turn chlorotic and die altogether. Despite having a variety of ways to reduce the economic impact of iron chlorosis, planting tolerant cultivars remains the most cost-effective approach to address the negative effect of iron chlorosis in aerobic rice (Goos and Johnson 2000).

The present work is therefore aimed at investigating some of selected aerobic rice cultivars with different sources and modes of iron application to reduce the iron chlorosis. There are various parameters to measure severity of iron chlorosis. In this study SPAD meter values and visual scoring methods were used for assessing the variation of chlorosis in rice cultivars. Both the parameters have great importance, Because of the strong correlation between chlorotic symptoms and yield.

MATERIALS AND METHODS

The field experiment was conducted at the College Farm, Professor Jayashankar Telangana State Agricultural University, Rajendranagar, Hyderabad during two consecutive years 2012 and 2013. The soil of the experimental site was sandy clay loam in texture, slightly alkaline in reaction (pH 7.2), low in available N (210 kg ha^{-1}), medium in available P (22.6 kg ha^{-1}) and available K (250 kg ha^{-1}). The iron is adequate in the study location (4.18 mg kg^{-1}).

Experiment was laid out in split plot design with three replications. The treatment combinations were 36 consisting of three rice cultivars Tellahamsa (V_1), MTU 1010 (V_2) and KRH 2 (V_3) and twelve sources and mode of iron application. The fertilizer treatments were basal application of iron alone or foliar sprays of iron alone or combination of basal and foliar sprays i.e., control (F_0), iron sulphate @ 25 kg ha^{-1} as basal application (F_1), iron chelate @ 25 kg ha^{-1} as basal application (F_2), three foliar sprays of $FeSO_4$ from 21 DAS @ 7 days interval (F_3), three foliar sprays of $FeSO_4$ from 21 DAS @ 10 days interval (F_4), three foliar sprays of $FeSO_4$ from 21 DAS @ 15 days interval (F_5), basal application of $FeSO_4$ @ 25 kg ha^{-1} + three foliar sprays of $FeSO_4$ from 21 DAS @ 7 days interval (F_6),basal application of $FeSO_4$ @ 25 kg ha^{-1} + three foliar sprays of $FeSO_4$ from 21 DAS @ 10 days interval (F_7), basal application of $FeSO_4$@ 25 kg ha^{-1} + three foliar sprays of $FeSO_4$ from 21 DAS @ 15 days interval (F_8), basal application of iron chelate @ 25 kg ha^{-1}+ three foliar sprays of $FeSO_4$ from 21 DAS @ 7 days interval (F_9), basal application of iron chelate @ 25 kg ha^{-1} + three foliar sprays of $FeSO_4$ from 21 DAS @ 10 days interval (F_{10}), basal application of iron chelate @ 25 kg ha^{-1}+ three foliar sprays of $FeSO_4$ from 21 DAS @ 15 days interval (F_{11}).

$FeSO_4$ and iron chelate @ 25 kg ha^{-1} were applied at the time of sowing as per the treatment combinations. Three foliar sprays of $FeSO_4$ @ 2% + citric acid 2.0 g L^{-1} of water were sprayed starting from 21 days after sowing at 7, 10 and 15 days interval respectively.

The intensity of iron deficiency in terms of percent clumps affected were measured in randomly selected one meter square area in each plot at 15, 30, 45 and 60 DAS (Venkata Subbaiah *et al*., 1994).

$$\text{Deficiency Intensity (\%)} = \frac{\text{Number of clumps affected}}{\text{Total number of clumps}} \times 100$$

Leaf chlorophyll content was estimated with a chlorophyll meter (SPAD 502) at the middle portion of a fully matured leaf. SPAD 502 was used for chlorophyll measurement on ten top fully expanded leaves (that is, index leaves) per plot at 30, 60 and 90 days after sowing and at harvest. Twenty leaf SPAD readings were averaged to represent the mean SPAD readings of each plot.

RESULTS AND DISCUSSION

A. Effect of cultivars

(i) On visual scoring. Perusal of the data (Table 1) shown that remarkable iron deficiency intensity observed among rice cultivars at 15, 30, 45 and 60 DAS. The deficiency intensity decreased with the advancement of crop age in all the cultivars. During 2012 at 15 DAS, among the three cultivars KRH 2 recorded lower intensity (24.38%) which was significantly lower compared to MTU 1010 (40.49 %) and Tellahamsa (45.98%).

In 2013, also similar variation among cultivars was observed with respect to iron deficiency intensity and was found lowest in KRH 2 with 20.22 % followed by MTU 1010 (36.33 %) and highest with Tellahamsa which, recorded 41.64 %. Similar lower iron deficiency intensity was observed in KRH 2 at 30, 45 and 60 DAS.

(ii) On SPAD values. The observations on SPAD values of different cultivars were recorded periodically and the data tabulated in Table 2. Within the cultivars, significant variation was observed in SPAD values at different phases of crop growth. The values increased with the advancement of crop age in all the cultivars and slightly reduced at the harvest. KRH 2 registered significantly higher SPAD values over the remaining two cultivars at 30 DAS during 2012 and 2013 years. The corresponding values were 27.48 and 27.83. MTU 1010 recorded higher SPAD values next to KRH 2, with 25.47 and 26.37. The significantly lowest values were recorded in case of Tellahamsa (20.21, 20.33) in both the years of study.

Similar higher SPAD values were registered at 60, 90 DAS and at harvest with KRH 2 cultivar. Higher SPAD values with KRH 2 cultivar might be due to improved plant height, higher dry matter build up and leaf area that enabled more assimilation rate and consecutively maintained the greenness of the leaves (Basavaraja *et al.*, 2010).

B. Effect of iron fertilizer

(i) On visual scoring. The iron deficiency intensity was significantly influenced by iron nutrition treatments. During 2012 and 2013 at 15 DAS, lower iron deficiency intensity was observed in treatments having basal application of iron chelate i.e., F_9, F_{10}, F_{11} and F_2. Next in the order were treatments with basal application of iron sulphate i.e., F_1, F_6, F_7 and F_8. Only foliar sprays of iron sulphate at 7, 10 and 15 days interval i.e., F_3, F_4, F_5 and control i.e., F_0 recorded higher deficiency intensity compared to all other treatmental combinations as they did not received any iron nutrition through basal application.

However, at 30 DAS, treatments with three foliar sprays of iron sulphate at 7 days interval recorded lower iron deficiency compared to 10 and 15 days interval sprays since it had received two sprays of iron sulphate one at 21 DAS and second spray at 28 DAS i.e., F_9, F_6 and F_3. Next in the order, treatments which received foliar sprays of iron sulphate at 10 days interval registered lower deficiency intensity i.e., F_{10} and F_7. These treatments were on par with F_{11} i.e., Iron chelate @ 25 kg ha^{-1}+ three foliar sprays $FeSO_4$ @ 15 days interval. These were followed by iron sulphate basal and foliar sprays at 15 days interval (F_8) during both the years of study. The intensity registered though was non significant between F_1 and F_2 but still F_2 recorded lower intensity than F_1. Only foliar sprays of $FeSO_4$ at 10 days interval i.e., F_4 and at 15 days interval i.e., F_5 recorded higher intensity compared to all other treatmental combinations. Highest intensity was noticed with the control plot (F_0) which was not supplemented with iron nutrition through foliar or basal method. At 45 DAS, there is a slight decrease in iron deficiency intensity with the crop growth in all the treatments.

During both the years at 60 DAS, further decrease in iron deficiency intensity was noticed and significantly lower intensity was with basal application of iron chelate in combination with three foliar sprays of $FeSO_4$ at 7 days interval (F_9) followed by basal application of iron chelate with foliar sprays of iron chelate at 10 days interval (F_{10}) and 15 days interval (F_{11}).The next order treatmental combination which produced lower intensity were F_6, F_7 and F_8 i.e., basal application of iron sulphate + 3 foliar sprays of iron sulphate at 7, 10 and 15 days interval respectively. The basal and foliar combination of iron nutrition followed by only foliar application of iron sulphate i.e., three foliar sprays of 2.0 % $FeSO_4$ at 7 days interval (F_3) followed by F_4 and F_5. Control produced highest iron deficiency intensity but significantly differed with F_2 i.e., basal application of iron chelate @ 25 kg ha^{-1} and F_1 i.e., basal application of iron sulphate @ 25 kg ha^{-1}. The interaction effect on iron deficiency intensity was found non significant between cultivars and iron nutrition in aerobic rice. In aerobic rice higher chlorophyll content with foliar sprays of iron was also reported by Nogiya *et al*. (2019).

(ii) On SPAD values. SPAD values were significantly influenced by iron nutrition treatments. At 30 DAS, treatment with foliar sprays of $FeSO_4$ at 7 days interval had edge in recording more SPAD values compared to 10 and 15 days interval sprays since it had received 2 sprays one at 21 DAS and second spray at 28 DAS. Thus maximum SPAD values were observed in treatments F_9, F_6 and F_3 which received foliar iron sulphate sprays at 7 days interval and significant difference was not observed. In the order of descent, the SPAD values recorded with basal application of iron chelate with 3 foliar sprays of $FeSO_4$ @ 10 days interval i.e., F_{10} but was on par with F_7. These were followed by foliar sprays of $FeSO_4$ at 15 days interval in combination with basal application of $FeSO_4$ i.e., F_8 or in combination with iron chelate i.e., F_{11} in both the years of study. Next set of SPAD values were recorded with basal application of iron chelate @ 25 kg ha^{-1} (F_2) and $FeSO_4$ @ 25 kg ha^{-1}(F_1). Only foliar sprays of $FeSO_4$ at 10 days interval i.e., F_4 and foliar sprays of $FeSO_4$ at 15 days interval i.e., F_5 recorded lower SPAD values compared to all other treatmental combinations. Lowest values were noticed in the control plot which was not supplemented with iron nutrition through foliar or basal method (F_0).

At 60 DAS, significantly high SPAD values were noticed with basal application of iron chelate @ 25 kg ha^{-1}+3 foliar sprays $FeSO_4$ at 7 days interval (F_9) followed by F_{10} and F_{11}. The next cluster of treatments which produced higher SPAD values were F_6, F_7 and F_8 i.e., basal application of iron sulphate + 3 foliar sprays of iron sulphate at 7, 10 and 15 days interval respectively. The above mentioned basal and foliar combination of iron nutrition treatments were followed by only foliar application of iron sulphate i.e., three foliar sprays of 2.0 % $FeSO_4$ from 21 DAS at 7 days interval (F_3) followed by F_4 and F_5 during both the years. Lower SPAD values were noticed with basal application of iron chelate (F_2) which was on par with basal application of iron sulphate i.e., F_1 and followed by F_0 i.e., control. At 90 DAS there is increase in SPAD values of aerobic rice. Similar variation among iron treatments was also observed at 90 DAS and at harvest of crop. SPAD values at harvest, decreased slowly with the crop growth during the two years of investigation. Interaction effect on SPAD chlorophyll meter values of aerobic rice at 30, 60, 90 and harvest was not influenced by cultivars and iron nutrition and was found non significant.

Higher level of leaf chlorophyll content was maintained with application of iron nutrition which caused an increase in photosynthetic efficiency. Actively photosynthesizing leaves helped in maintaining higher SPAD values by ensuring a sufficient supply of nutrients to the leaf (Mahajan and Khurana 2014).

Table 1: Visual scoring for iron deficiency at 15, 30, 45 and 60 DAS of aerobic rice as influenced by cultivars and iron nutrition.

Treatments		% of clumps affected							
		15 DAS		30 DAS		45 DAS		60 DAS	
Cultivars (V)		2012	2013	2012	2013	2012	2013	2012	2013
V1- Tellahamsa		45.98	41.64	39.64	38.93	32.54	31.25	20.55	18.3
V2 - MTU 1010		40.49	36.33	34.46	31.86	25.64	23.73	18.37	17.08
V3- KRH 2		24.38	20.02	19.53	15.37	8.33	7.37	4.59	1.68
SEm±		1.08	0.55	0.59	0.73	0.73	0.70	0.92	0.31
CD (*p*=0.05)		4.25	2.16	2.31	2.87	2.87	2.73	3.61	1.05
Fe nutrient (F)									
F_0- Control (No Iron)		42.56	39.55	38.76	37.67	37.95	35.37	24.01	20.43
F_1-BA of IS @ 25 kg ha^{-1}		35.03	32.18	34.42	31.55	32.16	29.26	20.51	17.57
F_2- BA of IC @ 25 kg ha^{-1}		32.49	30.71	30.16	30.93	28.99	28.88	19.3	16.87
F_3-3 FS of IS from 21 DAS @ 7 DI		43.08	38.85	27.53	23.03	21.15	20.47	16.79	14.21
F_4- 3 FS of IS from 21 DAS @ 10 DI		41.94	39.77	34.84	32.99	22.88	21.08	17.68	15.15
F_5- 3 FS of IS from 21 DAS @ 15 DI		42.63	38.46	35.94	33.90	25.36	24.48	19.09	15.57
F_6- BA of IS @ 25 kg ha^{-1} +3 FS of IS from 21 DAS @ 7 DI		34.49	31.01	24.86	21.00	12.02	10.58	10.41	9.24
F_7- BA of IS @ 25 kg ha^{-1} +3 FS of IS from 21 DAS @ 10 DI		36.29	31.5	30.57	27.21	14.48	14.05	13.39	11.95
F_8- BA of IS @ 25 kg ha^{-1} +3 FS of IS from 21 DAS @ 15 DI		36.07	31.59	32.38	30.44	25.09	24.59	14.97	13.62
F_9- BA of IC @ 25 kg ha^{-1} +3 FS of IS from 21 DAS @ 7 DI		31.99	29.87	22.36	19.65	8.19	8.85	2.42	1.82
F_{10}- BA of IC @ 25 kg ha^{-1} +3 FS of IS from 21 DAS @ 10 DI		30.97	29.18	28.76	25.38	13.21	11.89	5.74	3.27
F_{11}- BA of IC @ 25 kg ha^{-1} +3 FS of IS from 21 DAS @ 15 DI		32.88	30.29	29.95	28.86	20.53	19.92	9.71	8.54
SEm±		1.05	0.81	1.21	0.93	0.06	1.37	0.84	1.00
CD (*p*=0.05)		2.97	2.27	3.43	2.62	2.99	3.86	2.38	2.91
Interaction									
Main at sub	SEm±	1.82	1.40	2.10	1.61	1.83	2.37	1.46	0.55
	CD (*p*=0.05)	NS	NS	NS	NS	NS	NS	NS	NS
Sub at main	SEm±	2.05	1.44	2.10	1.70	1.90	2.37	1.67	0.60
	CD (*p*=0.05)	NS	NS	NS	NS	NS	NS	NS	NS

BA: Basal application; IS: Iron Sulphate; IC: Iron Chelate; FS: Foliar spray; DI: Days interval

Table 2: SPAD chlorophyll meter values at 30, 60, 90 DAS and at harvest of aerobic rice as influenced by cultivars and iron nutrition.

Treatments		30 DAS		60 DAS		90 DAS		At harvest	
Cultivars (V)		**2012**	**2013**	**2012**	**2013**	**2012**	**2013**	**2012**	**2013**
V1- Tellahamsa		20.21	20.33	26.82	27.06	29.83	30.33	26.65	27.17
V2 - MTU 1010		25.47	26.37	28.84	29.17	31.62	32.34	28.54	29.06
V3- KRH 2		27.48	27.83	33.22	33.76	35.92	36.71	31.99	32.51
SEm±		0.33	0.41	0.48	0.38	0.51	0.54	0.49	0.53
CD (*p*=0.05)		1.28	1.62	1.87	1.49	1.92	2.13	1.8	2.0
Fe nutrient (F)									
F_0- Control (No Iron)		17.21	17.95	25.25	25.53	24.05	24.72	19.97	20.48
F_1-BA of IS @ 25 kg ha^{-1}		21.67	22.09	26.07	26.23	26.78	27.45	22.84	23.32
F_2- BA of IC @ 25 kg ha^{-1}		22.66	22.91	26.69	26.78	27.64	28.31	23.76	24.22
F_3-3 FS of IS from 21 DAS @ 7 DI		28.08	29.11	28.83	29.28	32.33	33.00	28.55	29.20
F_4- 3 FS of IS from 21 DAS @ 10 DI		19.92	20.73	28.31	28.72	30.90	31.57	27.28	27.89
F_5- 3 FS of IS from 21 DAS @ 15 DI		18.64	19.42	28.01	28.43	29.46	30.13	25.65	26.23
F_6- BA of IS @ 25 kg ha^{-1} +3 FS of IS from 21 DAS @ 7 DI		29.71	30.89	31.63	31.91	35.68	36.35	32.78	33.26
F_7- BA of IS @ 25 kg ha^{-1} +3 FS of IS from 21 DAS @ 10 DI		26.35	27.22	30.81	31.15	34.72	35.39	31.88	32.35
F_8- BA of IS @ 25 kg ha^{-1} +3 FS of IS from 21 DAS @ 15 DI		24.59	24.70	29.92	30.69	33.98	34.65	31.24	31.69
F_9- BA of IC @ 25 kg ha^{-1} +3 FS of IS from 21 DAS @ 7 DI		30.25	31.75	33.90	34.29	38.85	39.52	35.86	36.37
F_{10}- BA of IC @ 25 kg ha^{-1} +3 FS of IS from 21 DAS @ 10 DI		26.83	27.74	33.15	33.61	37.69	38.36	34.62	35.15
F_{11}- BA of IC @ 25 kg ha^{-1} +3 FS of IS from 21 DAS @ 15 DI		25.07	25.26	32.94	33.37	37.41	38.08	34.29	34.79
SEm±		0.95	0.90	0.53	0.60	0.98	0.92	0.94	0.97
CD (*p*=0.05)		2.68	2.55	1.49	1.70	2.88	2.59	2.65	2.8
Interaction									
Main at sub	SEm±	0.02	0.04	0.02	0.05	1.5	1.6	1.6	1.7
	CD (*p*=0.05)	0.81	0.93	0.92	1.04	NS	NS	NS	NS
Sub at main	SEm±	NS	NS	NS	NS	1.7	1.6	1.6	1.7
	CD (*p*=0.05)	0.84	0.98	1.00	1.07	NS	NS	NS	NS

BA: Basal application; IS: Iron Sulphate; IC: Iron Chelate; FS: Foliar spray, DI: Days interval

CONCLUSIONS

KRH 2 was more tolerant to iron deficiency induced chlorosis under aerobic method of rice cultivation.

Iron nutrition treatments also decreased the chlorosis of rice plants, between them basal application of iron chelate @ 25 kg ha^{-1} along with 3 foliar sprays of iron sulphate from 21 DAS @ 7 days interval was ideal for field application.

REFERENCES

Arouna, A., Dzomeku, I. K., Shaibu, A. G. and Nurudeen, A. R. (2023). Water Management for Sustainable Irrigation in Rice (*Oryza sativa* L.) Production: A Review. *Agronomy*, *13*(6), 1522.

Basavaraja, M. K., Murali, K., Siddaram., Ramesha, Y. M., Yogeeshappa and Prakash, H. (2010). Effect of spacing and genotypes on growth and yield of aerobic rice. *International Journal of Agricultural Sciences, 6* (2), 485-487.

Boretti, A. and Rosa, L. (2019). Reassessing the projections of the World Water Development Report. *NPJ Clean Water*, *2*(1), 1-6.

FAOSTAT (2021). Statistics Data. Food and Agriculture Organization of the United Nations, Rome. http://www.fao.org/faostat/en/#data/QC

Farooq, M., Siddique, K. H. M., Rehman, H., Aziz, T., Lee, D. J. and Wahid, A. (2011). Rice direct seeding: Experiences, challenges and opportunities. *Soil and Tillage Research*, *111,* 87-98.

Goos, R. J. and Johnson, B. E. (2000). A comparison of three methods for reducing iron-deficiency chlorosis in soybean. *Agronomy Journal, 92,* 1135–1139.

Hantzis, L. J., Kroh, G. E., Jahn, C. E., Cantrell, M., Peers, G., Pilon, M. and Ravet, K. (2018). A program for iron economy during deficiency targets specific Fe proteins. *Plant Physiology, 176*(1), 596-610.

Mahajan, G. and Khurana, M. P. S. (2014). Enhancing productivity of dry-Seeded Rice (*Oryza sativa* L.) in North-West India through foliar application of Iron and Potassium Nitrate. *Vegetos*, *27*(2), 301-306.

Masuda, H., Aung, M. S., Kobayashi, T., Hamad, T. and Nishizawa, N. K. (2019). Enhancement of Iron Acquisition in Rice by the Mugineic Acid Synthase Gene with Ferric Iron Reductase Gene and OsIRO2 Confers Tolerance in Submerged and Nonsubmerged Calcareous Soils. *Frontiers in Plant Science, 10,* 1-14.

Munns, R. and Millar, A. H. (2023). Seven plant capacities to adapt to abiotic stress. *Journal of Experimental Botany*, *74*(15), 4308–4323.

Nogiya, M., Pandey, R. N., Singh, B., Singh, G., Meena, M. C., Datta, S. C. and Meena, A. L. (2019). Responses of aerobically grown iron chlorosis tolerant and susceptible rice (*Oryza sativa* L.) genotypes to soil iron management in an Inceptisol. *Archives of Agronomy and Soil Science*, *65*(10), 1387–1400.

Soumya, B., Vani, K. P., Surendra Babu, P., Praveen Rao, V. and Surekha, K. (2017). Impact of iron nutrition on yield and economics of aerobic rice cultivars. *Journal of Pharmacognosy and Phytochemistry, 6*(5), 1096-1100.

Surendran, U., Raja, P., Jayakumar, M. and Rama Subramoniam, S. (2021). Use of efficient water saving techniques for production of rice in India under climate change scenario: A critical review. *Journal of Cleaner Production, 309*(1-2), 1-17.

Taylor, K. G. and Konhauser, K. O. (2011). Iron in Earth Surface Systems: A Major Player in Chemical and Biological Processes. *Elements*, *7*, 83–88.

Vale, R. T., Lacombe, B., Rhee, S. Y., Nussaume, L. and Rouached, H. (2022). Mineral nutrient signaling controls photosynthesis: focus on iron deficiency-induced chlorosis. *Trends in Plant Science, 27*(5), 502-509.

Venkata Subbaiah, B., Sreeman narayana, A., Sairam, P. R., Pawan Kumar and Prabhu Prasadini, P. (1994). Effect of zinc levels and its relative proportion to iron and managanese content in 3rd leaf on Zn deficiency and grain yield of lowland rice. *Journal of Research, APAU*, *22*, 135-136.

How to cite this article: B. Soumya, K.P. Vani, Kadasiddappa M.M. and Ranjitha P. (2023). Visual Method for Non-destructive Scoring of Iron Deficiency in Aerobic Rice Cultivars. *Biological Forum – An International Journal, 15*(10): 945-949.