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GROWTH AND MINERAL NUTRIENT COMPOSITION OF SIX CULTIVARS OF GREEN GRAM GROWN AT NORMAL AND DEFICIENT LEVELS OF IRON SUPPLY

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ABSTRACT

Iron deficiency caused two to three fold reduction in photosynthetic rate, leaf area specific leaf weight and total chlorphyll content in green gram Kondaveedu cultivar. The total dry matter increased proportionately as the Fe level increased in the medium. Variation was observed between green gram cultivars in Fe absorption and utilisation. LAM 88-4 was highly susceptible to Fe stress. CVS. PIMS-4 and ML 267 were moderately susceptible and RGG 79-1-12 and PS 16 were less susceptible and performed well under Fe stress conditions. The concentration of total Fe, Zn and Mn antogonistic to iron increased and orthophenanthorline Fe gave good index of chlorosis in green gram cultivars.

KEY WORDS : Iron deficiency, mineral composition, green gram cultivars

Iron is essential for plant growth because of its involvement in photosynthetic activity. The deficiency of Fe in the growth media may alter the inorganic composition and growth of the plants. It is well known that plant species and cultivars within species differ in their response to Fe stress. Since no serious effort was made to investigate the effect of iron deficiency on growth and mineral nutrient composition in green gram (*Vigna radiata* L.) cultivars, this experiment was conducted.

MATERIALS AND METHODS

The experiment was conducted in solution culture. Seed of green gram (*Vigna radiata* L.) Cv. Kondaveedu were sown in plastic troughs containing acid washed quartz sand. One week old seedlings were transferred to 7 l capacity plastic containers containing modified Hoagland nutrient solution (Johnson *et al.*, 1957) having 0, 0.10, 0.50, 1.0 and 5.0 ppm of Fe. Each treatment had five replications and each replication three seedlings were maintained. The culture solution was aerated by bubbling air into the solution. The solutions were changed at weekly intervals and the plants were sampled 25 days after transplanting. The sampled plants were dried at 80°C for 48h and dry weights determined. The leaves were analysed for P, total Fe, physiologically active Fe, Zn, Mn and Cu contents through routine methods. Specific leaf weight (SLW), net photosynthetic rate (NPR) and total chlorophyll content (TCC) were also determined.

In a separate experiment five cultivars of green gram *viz.*, RGG 79-4-12, PS 16, PIMS 4, ML 267 and LAM 88-4 were selected to study their response to Fe stress. Each cultivar received complete nutrient solution with Fe (5.0 ppm, control) and nutrient solution defecient in Fe (0

ppm). Each treatment was replicated five times which were randomised. The plants were harvested at 32 DAS for recording the above observations.

RESULTS AND DISCUSSION

Plant height increased with increase in Fe level and the reduction was 49 per cent at 0 ppm Fe compared to other treatments (Table 1). The tap root length, leaf area (LA) and TCC also increased with increase in Fe level, but the effect was distinct from 0.50 ppm level onwards. The NPR decreased sharply due to Fe deficiency because of low CC per unit leaf area. SLW was low at 0 ppm due to low and negative PR and DMA. SLW was high at 0.50 ppm Fe and gradually decreased with increased Fe perhaps due to immobilisation of photosynthates in the lamina. This type of increased SLW was also observed by Narayanan and Reddy (1993) in groundnut due to P and B deficiencies. It also reduced the phytomass of all plant parts and consequently that of the whole plant. Fe deficiency decreased the photosynthetic activity by impaired formations of PS I and PS II light reactions which resulted in reduced phytomass production in plants (Gerhard Sandhan, 1985).

Total Fe (Fe^{3+}) and orthophenanthroline (OP) Fe (Fe^{2+}) content increased with an increase in Fe. The OP iron (Fe^{2+}) content was significantly low even at 0.10 ppm, where mild chlorosis was observed, but the total Fe content at this level and PR were closely related to O.P, Fe rather than total Fe content. Hence, total Fe of leaves was not satisfactory index of Fe deficiency and OP iron gave good index of chlorosis. The contents of P, Zn, Mn and Cu showed antagonistic effect with Fe and recorded high amounts under chlorotic conditions. Suresh *et al.* (1994) reported antagonistic effect of Fe on P, Zn, Mn and Cu in sesame. Ratios of P, Zn, Mn, Cu and total Fe with OP Fe also decreased with increase in Fe concentrations due to low physiologically active Fe in the Fe-deficient plants.

The dry matter production (DMP), LAI and TCC was more in RGG 79-4- 12 and PS 16 and LAM 88-4 recorded lower values both at healthy and chlorotic conditions (Table 2). The percentage of reduction of dry weight due to limited supply of Fe was minimum (54%) in RGG 79-4-12 and maximum with LAM-88 (57%). Rana *et al.* (1988) reported that apparent differences in the uptake of

Table 1. Effect of Fe levels on morphological and photosynthetic and nutrient composition of Kondaveedu green gram

Character	Fe concentration (ppm)					
	0.00	0.10	0.50	1.0	5.0	CD (P=05)
Morphological character*						
Plant height (cm)	9.2	14.4	16.7	18.1	18.9	2.2
Tap root length (cm)	8.2	8.7	10.7	11.0	11.6	0.8
Leaf area (cm^2)	120.7	125.1	148.9	213.6	273.8	7.1
Photosynthetic character*						
Total dry weight (mg pl^{-1})	567.6	777.7	1219.4	1482.1	1521.7	49.6
Total chlorophyll (mg/g)	0.15	0.30	1.37	2.30	2.68	0.22
Specific leaf weight (mg/cm^2)	2.83	3.38	3.67	3.56	2.99	0.29
Photosynthetic rate (mg CO_2/dm^2/day)	-76.0	-84.0	108.2	160.9	179.6	11.8
Nutrient composition*						
Total Fe^{3+} (ppm)	79.0	8.60	128.0	157.0	184.0	10.5
O.P Fe^{2+} (ppm)	0.64	0.73	3.47	4.30	5.98	0.26
P (%)	0.58	0.54	0.51	0.49	0.48	0.11
Zn (ppm)	139.0	118.5	108.4	83.5	54.5	8.70
Mn (ppm)	187.0	160.5	124.0	98.6	72.0	11.93
Cu (ppm)	31.4	27.5	23.9	19.4	15.8	2.25
P : Fe^{2+}	0.90	0.58	0.15	0.11	0.08	-
Zn : Fe^{2+}	217.19	127.42	31.24	19.42	9.11	-
Mn : Fe^{2+}	292.19	172.58	35.73	22.93	12.04	-
Cu : Fe^{2+}	49.06	29.57	6.89	4.51	2.64	-
Fe^{3+} : Fe^{2+}	123.44	92.47	36.89	36.51	30.77	-

* 32 days after sowing. Orthophenanthroline iron (Fe^{2+})

Table 1. Effect of iron deficiency on physiological and nutrient composition of five green gram cultivars

Characters* Cultivars	TDM (mg pl⁻¹)		LAI (cm² pl⁻¹)		Total chl. (mg/g)		Total Fe (ppm)		O.P Fe (ppm)		F (ppm)		Zn (ppm)		Mn (ppm)	
	(+Fe)	(-Fe)	(+Fe)	(-Fe)	(+Fe)	(-Fe)	(+Fe)	(-Fe)	(+Fe)	(-Fe)	(+Fe)	(-Fe)	(+Fe)	(-Fe)	(+Fe)	(-Fe)
RGG 79-4-12	1743.9	800.5	290.1	175.1	2.70	0.19	158	54	7.04	0.98	0.43	0.54	51	123	76	135
PS-16	1678.9	770.1	281.1	163.1	2.68	0.15	161	52	7.05	1.01	0.45	0.56	54	125	77	151
PIMS-4	1649.3	717.0	280.1	168.1	2.58	0.15	172	53	6.51	0.90	0.45	0.56	56	131	80	162
ML-267	1594.0	673.9	263.1	158.2	2.60	0.15	156	55	6.20	0.79	0.48	0.58	52	236	78	168
LAM-88-4	1452.1	620.6	240.7	124.1	2.52	0.10	183	53	6.04	0.72	0.49	0.59	53	141	76	178
CD (0.05)																
Cultivars	16.1		10.4		0.04		4.08		0.57		0.05		NS		7.8	
Fe level	24.6		6.0		0.08		13.5		2.45		0.09		9.2		14.0	
Cultivars x Fe	42.3		17.1		0.11		NS		NS		NS		NS		NS	

* 32 days after sowing

Fe by the susceptible and non-susceptible cultivars. The decrease in DMP under Fe deficiency was attributed to reduced leaf area and total chlorophyll content. PIMS-4 and ML-267 were intermediate in the above characters.

Iron deficiency significantly reduced that total Fe content in the plants over control. But cultivars did not differ significantly in total Fe control. But significant differences were brought among the cultivars in respect of O.P iron content. PS-16 followed by RGG 79-1-12 had significantly high amount of this iron and LAM 88-4 had low amounts. The reduction in O.P Fe content due to Fe stress was maximum in LAM 88-4 (88%) and minimum in P S-16 (85%). The estimation of O.P. Fe in young leaves was inversely related to severity of chlorosis. It confirms the earlier suggestions that O.P Fe content was the physiologically active fraction and this correctly reflected the Fe status of the plant.

The iron deficiency increased that P, Mn and Zn contents in the plants compared with control. But Fe deficiency did not bring any significant differences among five different cultivars of green gram. However, the percentage increase in these elements due to Fe stress was more in LAM 88-4 followed by ML 267 indicating the severity of chlorosis and inefficiency of Fe nutrition. RGG 79-4-12 and PS-16 shown less increase in these elements indicating low Fe stress effect.

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