Path coefficient analysis (Table 3) revealed that boll number and boll weight were the principal yield attributes. The high correlations of these traits with yield resulted mainly from their direct effects. Seeds per boll showed equally high correlations with yield as that of boll weight but had a low magnitude of direct effect. Plant height showed significant and positive association with yield but its direct effect was negative and low. Similarly, other traits like seed index, lint index, ginning outturn and micronaire were associated significantly and positively with yield but their direct effects were of lower magnitude. The positive correlation of yield with seeds per boll, seed index and lint index resulted mainly through indirect effects *via* boll weight. The direct effects of fibre traits on yield of seed cotton were of minor significance. In conclusion, selection prospects for high yield seemed to be better through boll number and boll weight.

REFERENCES

BURTON, G.W. 1952. Quantitative inheritance in grasses. Sixth Int. Grassland Cong. 1: 277-83.

BUTANY, W.T., MUNSHISINGH and MEHRA, R.B. 1968. Path analysis of yield components in cotton. Indian. J. Genet. 26: 262-68

CHRISTIDIS, G.B., and HARRISON, G.J. 1955. **Cotton Growing Problems.**, Mc Graw Hill Book Co. Inc. London. pp. 633.

DEWEY, D.R. and LU, K.H. 1959. A correlation and path coefficient analysis of components of crested wheat grass seed production. Agron. J. 51: 515-18.

FALCONER, D.S. 1960. **Introduction to Quantitative Genetics.** The Ronald Press Company, New York.

GOVILA, O.P. and SHARMA, S.B. 1981. Path analysis and its implications in breeding for early maturity and high yield in cotton. ISCI Journal. b : 69-72.

JOHNSON, H.W., ROBINSON, H.F. and COMSTOCK, R.F. 1955. Estimates of genetic and environmental variability in soybeans, Agron. J. 47: 314-18.

MILLER, P.A., WILLIAMS (Jr.) J.C., ROBINSON, H.F. and COMSTOCK R.E. 1958. Estimates of genotypic and environmental variances and covariances in upland cotton (G. **hirsutum** L.) and their implications in selection. Agron. J. 50: 126-31.

PANSE, V.G. 1957. Genetics of quantitative characters in relation to breeding. Indian. J. Genet., 17: 318-81.

SIKKA, S.M. and JOSHI, A.B. 1960. **Cotton in India**, a monograph. I.C.C.C. Bombay.

SINGH B.B., GUPTA, M.P., MOR, B.R. and JAIN, D.K. 1968. Variability and correlation studies on yield and quality characters in **hirsutum** cotton. Indian J. Genet., 28: 216-22.

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PHYSIOLOGICAL ASPECTS OF IRON DEFICIENCY IN GROUNDNUT (*Arachis hypogaea* L.) AND BLACKGRAM (*Vigna mungo* L.)

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ABSTRACT

Variation was observed between groundnut and blackgram cultivars in Fe absorption and utilisation. Cultivars of groundnut belonging to spanish (bunch) group

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(J 11 and JL 24) were highly susceptible to Fe deficiency whereas virginia (spreading) type cultivars (TMV 3 and K 3) were less susceptible. In blackgram, T 9 and Sel 37 were highly susceptible to Fe stress. Cultivar PV 26 was moderately susceptible and cultivars LBG 17 and UG 201 were less susceptible and performed well under Fe stress conditions. Ortho-phenenthroline Fe gave good indication of plant Fe status and it can be used as an index for screening the genotypes for their ability in Fe absorption and utilisation.

KEY WORDS: Groundnut, Blackgram, Iron deficiency, Physiology.

Iron (Fe) is essential for plant growth because of its involvement in activation of several enzyme systems including chlorophyll formation. A continued supply of Fe is essential for good plant health. Any factor that interfers with the absorption of Fe by plant roots or utilization within the plant for only a short period may cause the plant to rapidly develop symptoms of severe Fe deficiency. It is well known that there are considerable differences among plant species in their ability to take up mineral nutrient from relatively unavailable sources. There are also marked differences in Fe absorption among genotypes, inbreds and hybrids of different crops. However, no serious study has been carried out to investigate the influence of Fe on growth and nutrient uptake in grain legumes. So, the present investigation was undertaken to study the physiological aspects of Fe deficiency in different cultivars of groundnut and blackgram.

MATERIALS AND METHODS

The experiment was carried out in solution culture during 1984-85 at the department of Plant Physiology, Agricultural College, Bapatla. In groundnut, five cultivars viz., TMV 3 and K 3 virginia (spreading type) and J 11, JL 24 and TMV 7 spanish (bunch type) and in blackgram five cultivars viz., UG 201, T 9, PV 26, Selection 37 and LBG 17 were selected to study their response to Fe stress. Each cultivar received complete nutrient solution with Fe (5.0 ppm control) and nutrient solution deficient in Fe (0 ppm). Each treatment was replicated 5 times which were randomised. The nutrient solution used in this study was a modified Hoagland formula (Johnson *et al.*, 1957). All reagents were of AR grade and were used without further purification. The plants were supported in the holes of a plastic lid with non-absorbent cotton wrapped around the stem. The aeration was done daily and the nutrient solution was replaced at weekly interval. The plants were harvested at the age of 26 and 27 days in groundnut and blackgram respectively.

At the time of sampling plants were separated into leaves, stem and roots, washed twice with distilled water and dried in an oven at 75-80°C. Dry weights of leaves, stem and root por plant were recorded. Observations of the number of leaves and area of leaves and specific leaf weight (SLW) were also determined. The total chlorophyll in leaf was determined by using the formula described by Yoshida *et al.* (1976). The Orthophenanthrolline oxtractable Fe was estimated in the second fully opened young leaf from top, by the method described by Ketyal and Sharma (1980). The lamina was ground to powder by using Braun's plastic grinder, having stainless steel blades (to prevent Fe contamination). The ground material was used for the estimation of phosphorus, total Fe, managanese, zinc and copper. P in

the plant material (lamina) was determined in the tri-acid extract by vanadomolybdate method as described by Jackson (1967). Mn, total Fe, Zn and Cu were determined by direct feeding of the extract to the atomic absorption spectrophotometer (AA 120) as per the method given by Allan (1970). The data were statistically analysed by following factorial randomized block design.

RESULTS AND DISCUSSION

Data on leaf number and dry weight of different plant parts of groundnut and blackgram are presented in Table 1. Under Fe stress conditions except J 11 and JL 24, other cultivars of groundnut differed significantly in the root dry weight. The percentage decrease in root dry weight was higher in JL 24 (51.7) and J 11 (47.6) and minimum in TMV 3 (32.92) and K 3 (33.34). The root dry weight was significantly reduced in blackgram T 9 under stress condition and LBG 17 and UG 20 which did not differ significantly and had low reduction values of 17.3 and 18.6 per cent respectively. Generally, higher amount of Fe was associated with roots of Fe inefficient plants than with the roots of Fe efficient plants indicating the slower rate of Fe translocation in the former one (Elmstorm and Howard, 1969).

The dry weight of lamina decreased due to Fe deficiency in both the species, being maximum in JL 24 and J 11 in groundnut and T 9 and selection 37 in blackgram. The reduction was minimum in K 3 and TMV 3 in groundnut and UG 201 and LBG 17 in blackgram. The results of Reid and York (1958) in groundnut confirm the observed results. The leaf number per plant remained the same at both healthy and cholorotic conditions in both the species. In groundunt Fe stress significantly reduced stem weight. In JL 24 and J 11 the reduction was 54.1 and 48.2 per cent respectively which were on par with each other. The minimum reduction was observed in TMV 3 and K 3. In blackgram, T 9 showed significantly more reduction (24.0%) than the other ones. The minimum reduction was observed in UG 201 (9.0%) and other cultivars were on par with each other. Vanogmand and Aktas (1977) reported that those plants which excrete low amounts of hydroxyl ions considered as Fe efficient and those produce high amounts of hydroxyl ions considered as Fe inefficient.

Data in total dry matter, leaf area, specific leaf weight and total chlorophyll content are presented in Table 2. The Fe deficiency reduced the whole plant dry weight among all the cultivars in both groundnut and blackgram. Under stress condition in groundnut, K 3 produced more dry matter but it was on par with TMV 3. The percentage reduction in dry matter was more in JL 24 (53.56) and J 11 (49.35). In blackgram LBG 17 and UG 201 produced more dry matter both at healthy and chlorotic conditions. The percentage reduction in whole plant dry matter due to Fe stress was maximum in T 9 (26.96), selection 37 (21.8) and minimum in LBG 17 (13.10) and UG 201 (13.9). In groundnut JL 24 and J 11 and in blackgram T 9 and selection 37 cultivars were less efficient in Fe utilization. Agarwala and Sharma (1974) reported that apparent differences in Fe deficiency reduction may be due to differences in the uptake of Fe by the susceptible and non-susceptible cultivars. The depression in phytomass production under Fe deficiency was attributed to reduced size of the leaves.

Table 1. Effect of iron deficiency on leaf number and dry weight of different plant parts of groundnut and blackgram cultivars.

Cultivar	Leaf number		Root dry weight (mg Pl^{-1})		Stem dry weight (mg Pl^{-1})		Leaf dry weight (mg Pl^{-1})	
	(+Fe)	(-Fe)	(+Fe)	(-Fe)	(+Fe)	(-Fe)	(+Fe)	(-Fe)
Groundnut								
TMV 3	7.0	6.0	185.3	124.3	201.6	141.0	450.0	280.0
K 3	7.0	6.0	197.1	131.6	212.5	145.5	458.0	278.0
TMV 7	7.0	6.0	183.3	107.3	197.6	121.6	468.0	275.0
J 11	7.0	6.0	174.4	91.4	182.6	94.6	437.0	226.0
JL 24	7.0	6.0	179.7	86.7	189.7	87.0	446.0	211.0
LSD (0.05)								
Cultivars	NS		9.1		7.8		9.29	
Fe level	NS		5.77		4.91		5.87	
Cultivar x Fe	NS		12.94		11.05		13.14	
Blackgram								
U.G. 201	2.0	2.0	132.7	108.0	102.4	93.2	320.0	280.0
LBG 17	2.0	2.0	140.4	116.0	107.7	95.8	336.0	291.0
PU 26	2.0	2.0	122.7	96.0	104.5	88.5	310.0	256.0
Selection 37	2.0	2.0	127.0	96.2	100.3	82.0	312.0	243.0
T 9	2.0	2.0	117.6	81.4	92.0	70.0	295.6	220.0
LSD (0.05)								
Cultivars	NS		8.07		7.58		10.60	
Fe level	NS		5.10		4.80		6.72	
Cultivar x Fe	NS		NS		NS		15.05	

Table 2. Effect of iron deficiency on total drymatter (TDM), leaf area, specific leaf weight (SLW) and total chlorophyll of groundnut and blackgram cultivars.

Cultivars	TDM (mg Pl^{-1})		Leaf area (cm Pl^{-1})		SLW (mg cm^{-2})		Total chlorophyll (mg g^{-1} fr.wt.)	
	(+Fe)	(-Fe)	(+Fe)	(-Fe)	(+Fe)	(-Fe)	(+Fe)	(-Fe)
Groundnut								
TMV 3	979.3	622.7	130.43	90.33	3.45	3.10	9.98	4.90
K 3	1035.8	655.3	136.30	93.91	3.36	2.96	10.32	5.01
TMV 7	1001.9	583.9	141.80	94.17	3.30	2.92	10.95	5.25
J 11	933.7	473.7	127.70	72.44	3.42	3.13	10.86	4.47
JL 24	961.0	446.3	131.17	64.72	3.40	3.26	10.12	3.06
LSD (0.05)								
Cultivars	27.31		7.15		0.10		0.351	
Fe level	17.27		4.52		0.07		0.222	
Cultivar x Fe	38.61		10.12		NS		0.488	
Blackgram								
U.G. 201	617.5	537.2	156.0	117.6	2.05	2.38	8.60	3.52
LBG 17	644.6	555.2	162.0	124.1	2.07	2.34	9.00	3.40
PU 26	602.8	495.3	147.0	96.7	2.10	2.64	8.50	2.42
Selection 37	599.4	468.3	154.0	101.6	2.02	2.39	9.42	2.72
T 9	562.8	413.9	145.0	95.6	2.04	2.30	8.56	1.57
LSD (0.05)								
Cultivars	13.92		11.27		NS		0.419	
Fe level	8.81		7.13		0.10		0.265	
Cultivar x Fe	19.60		NS		NS		0.593	

Thus complete nutrient solution produced significantly more leaf area over Fe deficient nutrient solution both in groundnut and blackgram cultivars. In groundnut, at both healthy and chlorotic conditions, TMV 7 followed by K 3 produced maximum leaf area. However the leaf area was more in LBG 17 followed by UG 201 and less in T 9 blackgram cultivars at both the conditions.

The specific leaf weight (SLW) was decreased due to Fe deficiency in groundnut cultivars. The high SLW in healthy plants may be due to immobilisation of photosynthates in the lamina. But in blackgram cultivars, although the size of the leaves was reduced under Fe deficiency, the weight was not reduced proportionately, thus resulting in the thick leaves. This fact was also revealed by an increased specific leaf weight under Fe deficiency. This type of increased SLW was also observed at Zn deficiency in Mustard cultivars by Ghildiyal *et al.* (1981). The total chlorophyll content was also decreased in Fe stress treatment among all the cultivars. In groundnut, under chlorotic conditions, TMV 7 and K 3 had high chlorophyll values and less in JL 24 and J 11. In blackgram also, chlorophyll content reduced under Fe stress conditions and T 9 had significantly low chlorophyll content with a reduction of 81.6 per cent. UG 201 and LBG 17 had less reduction and produced more amount of chlorophyll.

The Fe deficiency increased the P, Mn, Zn, and Cu contents in the plants when compared with control treatment. But Fe deficiency did not bring any significant difference among five different Cvs each in groundnut and blackgram. However, the percentage increase in these elements due to Fe deficiency was more in JL 24 and J 11 in groundnut and T 9 and selection 37 Cvs in blackgram and indicate the severity of chlorosis and inefficiency of Fe nutrition. TMV 3, K 3 (groundnut), LBG 17 and UG 201 (blackgram) Cvs have shown less increase in these elements indicating the low Fe stress effect.

Fe deficiency significantly reduced the total Fe content in the plants over control. But cultivars did not differ significantly in total Fe contents. The total Fe content was significantly more in complete nutrient solution over Fe deficient solution in both the species. But significant differences were brought among the cultivars in respect of orthophenanthroline extractable Fe content. In groundnut TMV 3 had significantly high amount of this Fe and J 11 and JL 24 had significantly low amounts. The reduction in orthophenanthroline extractable Fe content due to Fe stress was maximum in JL 24 (78.93%) and J 11 (74.49%) and minimum in TMV 3 (65.22%). In blackgram among all the cultivars T 9 had significantly low amount (2.55 ppm) and LBG 17 had high amount (2.92 ppm) of orthophenanthroline extractable Fe. The percentage reduction in orthophenanthvoline extractable Fe. content was maximum in T 9 (86.45%) and 82.6% in selection 37. This was less (76.8%) in UG 201, LBG 17 while in PU 26 it was intermediate. The estimation of orthophenanthroline extractable Fe in young leaves was inversely related to the severity of chlorosis. The orthophenanthroline extractable Fe content based on which cholorophyll content, phytomass production, severity of chlorosis was closely related, rather than total Fe content. It confirms the earlier suggestions that orthophenanthroline ex-

table Fe content of fresh tissue was the physiologically active fraction and this correctly reflected the Fe status of the plant. The genotypic variation in absorption and utilisation of Fe among groundnut and blackgram cultivars was clearly understood here.

REFERENCES

AGARWALA, S.C. and Sharma, C.P. 1974. Non pathogenic disorders of crop plants, specially of high yielding varieties. In "**Current Trends in Plant Physiology**" ed. by Raychaudhari, S.P. Published by Department of Botany, University of Lucknow. P P. 40-52

ALLAN, J.E. 1970. The preparation of agriculture samples for analysis by atomic absorption spectroscopy pp. 5-9.

ELMSTROM, G.W. and Howard, F.D. 1969. Iron accumulation, root peroxidase activity and varietal interaction in soybean genotypes that different in iron nutrition. Pl. Physiology., 44: 1108-1114.

CHILDIYAL, M.C., Sirohi, G.S. and Pandey, M. 1981. Growth and nitrate reductase activity in Mustard varieties as affected by zinc nutrition. Indian J. Plant Physiol., 24: 113-122.

JACKSON, M.L. 1967. **Soil Chemical Analysis.** Published by Prentice Hall of India Pvt. Ltd., New Delhi, pp 49.

JOHNSON, C.M., Stout, P.R., Broyer, T.C. and Carlton, A.B. 1957. Comparative chlorin requirements of different plant species. Plant and Soil., 8: 337-353.

KATYAL, J.C. AND SHARMA, B.D. 1980. A new technique of plant analysis to resolve iron chlorosis. Plant and Soil., 55: 105-119.

REID, P.H. AND YORK, E.T. 1958. Effect of nutrient deficiencies on growth and fruiting characteristics of peanuts in sand culture. Agron. J., 50: 63-70.

VANEGMAND, F. AND AKTAS, M. 1977. Iron nutritional aspects of the ionic balance of plants. Plant and Soil, 48: 685-703.

YOSHIDA, S., FORNA, D.A., COCK, J.H. AND GOMEZ, K.A. 1976. Laboratory Manual for Physiological Studies of Rice. Pub. IRRI, Philippines. pp 43-45.

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GENETIC DIVERGENCE FOR YIELD AND ITS COMPONENTS IN COMMON MILLET (*Panicum miliaceum L.*)

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ABSTRACT

A set of eighty two different strains of common millet (Panicum miliaceum) collected from different places was used for estimation of genetic divergence. D^2 estimates based on 12 characters support that the differences in agroclimatic situations are not necessarily related to genetic divergence and thus the desirable diverse parents may not be selected for hybridization on the basis of climatic regions.

KEY WORDS: Genetic divergence, D^2 statistic, Millet.

Plant breeders have been appreciating the importance of genetic diversity since long. However, the main problem is to recognise and measure such diversity in order to use it in a breeding programme. Selection of

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