and Mn relieved the trees from chlorosis and produced the healthy green leaves which in turn resulted in higher assimilate synthesis and partitioning to the fruit growth and resulted in higher fruit yield.

REFERENCES

CHADHA, K.L., RANDHAWA, N.S., BINDARA, O.S., CHOHAN, J.S. and KNORR, L.C. (1970). Citrus decline in India causes and control. **Joint publication by Punjab Agricultural University. Ohio State University. United State Agency for International Development. Ludhiana India.** p.1.

DESAI, V.T., CHOUDHARI, S.M., SHIRSATH, N.S. and KALE, P.N. (1991). Studies on the effect of foliar application of micronutrients on Mosami sweet orange. **Maharashtra J. Hort., 5**: 29-31.

KANWAR, J.S., DHINGRA, D.R. and RANDHAWA, N.S. (1963). Chemical composition of healthy and chlorotic leaves of citrus plants in the Punjab. **Indian J. Agric. Sci., 32**: 268-271.

MANCHANDA, H.R. (1967). Effect of different micronutrient sprays on chlorosis, granulation, fruit fall, yield and fruit quality of sweet orange var. Blood Red. **J. Res. Punjab Agric. Univ., 4**: 508- 515.

MANCHANDA, H.R., SHUKLA, U.C. and RANDHAWA, N.S. (1972). Effect of soil and foliar application of Zn and foliar application of Cu, Mn, Fe alone and in combination with Zn on the incidence of chlorosis, fruit fall, granulation and fruit quality in sweet orange variety Blood Red. **Indian J. Hort., 29**: 19-29.

NIJJAR, G.S. and BRAR, S.S. (1977). Comparison of soil and foliar applied zinc in kinnow. **Indian J. Hort., 34**: 130-136.

SINGH, M.I. and CHOHAN, G.S. (1982). Effect of nutritional sprays on granulation in citrus fruits cv. Wilking mandarin. **Punjab Hort. J., 22** : 52-59.

(Received : July 1996 Revised : December 1996)

Madras Agric. J., 84(8): 463-465 August 1997
https://doi.org/10.29321/MAJ.10.A00896

PHYSIOLOGY OF CHLOROSIS IN SATHGUDI ORANGE

D.DURGA DEVI, P.S.SRINIVASAN and K.BALAKRISHNAN

Horticultural College and Research Institute
Tamil Nadu Agricultural University
Coimbatore 641 003

ABSTRACT

Studies were conducted in chlorotic trees of Sathgudi orange to find out the physiological components of chlorosis. The results revealed that the chlorotic leaves recorded low levels of zinc, iron and manganese and a higher activity of chlorophyllase and thus low chlorophyll content (yellowing of leaves). Reduced photosynthetic rate combined with low yield was recorded in chlorotic trees. Correlation analysis revealed that chlorosis had positive association with chlorophyllase activity and negative association with zinc, iron and manganese content, photosynthetic rate, chlorophyll content and yield.

KEY WORDS : Sathgudi orange, chlorosis, physiology

In Tamil Nadu, chlorosis of Sathgudi orange is assuming a serious problem. The yellowing or reduction in chlorophyll content of the leaves (chlorosis) has been reported to be due to the micronutrient deficiency (Dhingra and Kanwar, 1963). Chlorosis generally increases with the decrease in chlorophyll content which is activated by an increase in the chlorophyllase activity (Purvis and Barmore, 1991). However, much work remains to be done to find out the changes in the chlorotic component which ultimately leads to chlorosis of the leaves due to micronutrient deficiency. Hence, the present study was undertaken to find out the physiological components of chlorosis in Sathgudi orange.

MATERIALS AND METHODS

The studies were conducted on six years old, chlorotic Sathgudi orange trees in the Horticultural College and Research Institute, Coimbatore during 1994-95. The soil was sandy loam, with pH 7.5 and low in available zinc (1.04 ppm), iron (1.50 ppm) and manganese (2.50 ppm). The percentage of the chlorosis was worked out as suggested by Manchanda *et al.*, (1972) in randomly selected 22 trees. The third leaf from the top of the branch was selected for the estimation of chlorophyll (Yoshida *et al.*, 1971), photosynthetic rate (Portable Photosynthesis System), chlorophyllase activity (Almela *et al.*, 1990) and zinc, iron and manganese content (Atomic absorption spectrophotometer). The data on the fruit yield was also collected and

Table 1. Physiological components of chlorotic leaves of Sathgudi orange

Treatments	Chlorosis	Total chlorophyll (mg/g)	Photosynthetic rate (mg CO_2)	Chloro-phyllase activity (mol(chl) kg^{-1} (protein) S^{-1})	Zinc content (ppm)	Iron content (ppm)	Manganese content (ppm)	Yield (kg/tree)
1	56.4	0.591	10.31	6.28	13.0	22.4	19.2	12.12
2	29.1	1.549	13.75	2.71	40.1	32.5	40.9	22.26
3	40.2	1.063	13.95	2.84	36.2	27.6	39.8	18.38
4	27.3	1.666	15.10	2.91	58.3	29.8	46.3	24.11
5	39.8	1.183	14.08	3.08	17.9	21.4	85.4	17.03
6	27.8	1.664	15.09	3.18	16.9	25.6	82.5	19.58
7	30.7	1.359	14.75	3.34	14.5	23.9	87.8	18.07
8	30.3	1.390	14.82	2.14	15.1	71.6	20.4	19.46
9	35.4	1.236	14.29	2.17	14.9	91.3	18.7	17.80
10	30.2	1.502	14.98	2.08	15.7	82.5	23.5	19.60
11	34.3	1.312	14.54	3.51	32.9	29.5	74.7	20.48
12	31.2	1.332	14.65	3.68	31.6	23.1	75.3	19.60
13	26.3	1.756	15.67	3.43	33.5	21.6	40.3	40.59
14	25.1	1.750	15.70	2.23	30.9	92.1	35.2	41.38
15	28.4	1.724	15.48	2.31	30.3	90.5	39.2	30.62
16	26.3	1.763	15.69	2.21	31.5	95.2	71.9	44.10
17	26.9	1.732	15.57	2.39	14.2	85.4	65.8	30.11
18	27.1	1.740	15.65	2.47	13.9	87.4	72.5	32.17
19	28.1	1.681	15.17	2.45	15.0	91.8	60.4	23.53
20	28.3	1.692	15.29	2.51	26.9	84.2	58.8	25.26
21	27.9	1.709	15.37	2.68	24.9	79.8	50.4	29.74
22	24.5	1.775	15.73	2.48	27.5	85.9	61.7	40.39
SEd	3.817	0.046	0.657	0.269	1.375	1.344	2.292	16.94
CD (p=0.05)	7.533	0.090	1.299	0.533	2.746	2.659	4.533	34.19

were subjected to statistical analysis. The simple correlation coefficient was worked out between chlorosis and other physiological attributes.

RESULTS AND DISCUSSION

Significant variations in physiological attributes were found among the chlorotic trees (Table 1). The chlorosis ranged from 24.5 per cent to 56.4 per cent, photosynthetic rate from 10.31 to 15.37 mg CO_2 dm^{-2} h^{-1}, chlorophyllase activity from 2.17 to 6.28 mol (chl) kg^{-1} (protein) S^{-1}, zinc content from 14.5 to 40.1 ppm, iron content from 21.4 to 95.2 ppm and manganese content from 18.7 to 87.8 ppm. The yield of fruits also varied widely from 12.12 to 40.59 kg $tree^{-1}$ and differed significnatly. The trees with higher chlorosis of the leaves recorded lower chlorophyll content, reduced photosynthetic rate, higher activity of chlorophyllase enzyme and low content of zinc, iron and manganese which would have probably resulted in low fruit yield. Conversely, the trees with lower chlorosis were found to have higher chlorophyll content, higher photosynthetic rate, low activity of chlorophyllase, slightly higher content of zinc, iron and manganese which may probably lead to slightly higher yield. In this context, Manchanda *et al.* (1972) classified the chlorosis in Red Blood sweet orange and found the results similar to the present investigation.

Data on simple correlation coefficient and linear regression revealed that a positive and significant correlation ($+0.959^{**}$) existed between chlorosis and chlorophyllase activity (Table 2). Rodgriguez *et al.* (1987) also reported that chlorophyllase enzyme (chlorophyll-chlorophyllido-hydrolase EC 3.1.1.14.) activity resulted in the catabolism of chlorophyll. They have also obtained a positive correlation between chlorophyllase activity and chlorosis. The chlorosis had negative and significant association with chlorophyll (-0.816^{**}), photosynthetic rate (-0.927^{**}), zinc content (-0.733^{**}), iron content (-0.702^{**}) and manganese content (-0.568^{**}). The increased activity of

Table 2. Simple correlation and linear regression between chlorosis and its components and yield

Chlorotic components	Y = a+bx	Correlation coefficient('r' value)
Chlorophyll	Y = 55.06 + (-24.43x)	-0.816**
Photosynthetic rate	Y = 130.97 + (-7.51x)	-0.927**
Chlorophyllase activity	Y = 10.64 + 11.49x	+0.959**
Zinc content	Y = 40.83 + (-4.88x)	-0.733**
Iron content	Y = 48.32 + (-9.31x)	-0.702**
Manganese content	Y = 28.99 + (-1.75x)	-0.568**
Yield	Y = 27.28 + (-0.498x)	-0.523**

chlorophyllase due to reduced levels of zinc, iron and manganese content leads to low chlorophyll content and thus reduced photosynthetic rate. Lopez *et al.* (1991) also obtained reduced photosynthetic rate in chlorotic leaves of citrus. A negative association obtained (-0.523**) in the present study between chlorosis and yield may be attributed to the reduced photosynthetic rate of the chlorotic trees and thus low yield.

It was revealed from the present study that the chlorosis in Sathgudi is due to low levels of zinc, iron and manganese content which may lead to increased activity of chlorophyllase enzyme. This enzyme decreases the chlorophyll content and further leads to chlorosis of the leaves. A strong positive correlation was obtained between chlorosis and chlorophyllase enzyme. Chlorosis had negative association with photosynthetic rate. The fruit yield also had negative association with chlorosis and thus yield decreases with the increase in chlorosis.

REFERENCES

ALMELA, L., LOPEZ, J.A.F. and ROCA, L.(1990). Purification and characterisation of chlorophyllase activity of citrus leaves under iron stress. **Physiol. Plant.**, 79: 66.

DHINGRA, D.R. and KANWAR, J.S. (1963). Soil factors and chlorosis of citrus. **Punjab Hort. J.**,3: 54-59.

LOPEZ, J.A.F. ALMELA, L.,ROCA, J.M.L. and ALCARAZ, C. (1991). Iron deficiency in citrus limon, effects on photochlorophyllase synthetic pigments and chlorophyllase activity. **J. Plant Nutr.**, 14: 1137-1144.

MANCHANDA, H.R., SHUKLA, U.C. and RANDHAWA, N.S. (1972). Effect of soil and foliar application of Zn and foliar application of Cu, Mn, Fe alone and in combination with Zn on the incidence of chlorosis in sweet orange cv. Blood Red. **Indian J. Hort.**, 29: 19-29.

PURVIS, A.C. and BARMORE, C.R. (1991). Involvement of ethylene in chlorophyll degradation in peel of citrus fruits. **Plant Physiol.**, 66 : 624-627

RODGRIGUEZ, M.T., GONZALEU, M.P. and LINARES, J.M. (1987). Degradation of chlorohyll and chlorophyllase in senescing barely leaves. **J. Plant Physiol.**, 129 : 369-374.

YOSHIDA, S., FORNO, D.A. COCK, J.H. and GOMEZ, K.A. (1971). **Laboratory Manual for Physiological Studies in Rice** International Rice Research Institute, Philippines. pp 69-71.

(Received : July 1996 Revised : December 1996)

Madras Agric. J., 84(8): 465-469 August 1997

INTERSPECIFIC HYBRIDIZATION BETWEEN PEARL MILLET AND NAPIER GRASS AND STUDY OF THEIR F_1 HYBRIDS

S. THIRUMENI and L.D. VIJENDRA DAS

Department of Agricultural Botany
Agricultural College and Research Institute
Tamil Nadu Agricultural University
Killikulam, Vallanad 628 252

ABSTRACT

Field trial was conducted involving 15 genotypes of forage pearl millet of diverse origin, 5 genotypes of napier grass and 15 hybrids obtained from them along with a check CO 2 during 1991-92. The hybrids are sterile with abortive pollen grains and the diameter ranged from 24.54 to 29.97 m. Variability and heritability of 13 characters were studied in the hybrids in which 8 traits showed high heritability with high genetic advance. The traits were stem girth, number of tillers per clump, number of leaves per clump, leaf area per clump, leaf:stem ratio, green fodder yield, dry fodder yield and crude protein. Among the 15 hybrids, the hybrid IP 15507 x FD 429 was later promoted as an improved culture (ACK 2). The hybrids showed maximum direct effect of internode length, number of tillers per clump, dry fodder yield and leaf area per clump on green fodder yield.

KEY WORDS : Pearl millet x napier, variability, heterosis, path analysis, ACK 2

Grasses and legumes are the cheapest source of feeds for ruminants and among these, grasses have priority due to their high yield and perenniality. Pearl millet x napier hybrids under irrigated