Leaf analysis status of Nitrogen, Phosphorus and Potassium in acid lime (Citrus aurantifolia SWINGLE) through induction of water stress and application of growth regulators

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Abstract— *Application of growth regulators and induction of water stress at different growth stages is known to improve yield in many of the fruit crops. An experiment was carried out at Horticultural College and Research Institute, Periyakulam during the year 2006-2008 on five year old trees of acid lime cv. PKM 1 in the main and off seasons of a year. The trees were subjected to soil water stress conditions at two levels (30 days and 45 days) along with spraying of growth regulators viz., (CCC 500 ppm, ascorbic acid 50 ppm and gibberellic acid (GA3)10 ppm. Soil water stress was taken as one factor and growth regulator was another executed following factorial randomized block design. In general, nitrogen content of leaves was more in main season than off season. Three way interaction between stress, growth regulators and stages of tree growth revealed that the combination S1C2L1 (water stress for 30 days + foliar spraying of ascorbic acid 50 ppm concentration at vegetative stage) registered the highest nitrogen content (2.97 and 2.92 per cent) in the main season of the year 2006 – 07 and 2007 – 08. The phosphorus and potassium content of leaves of acid lime also found significant irrespective of seasons. The combination S1C2 (30 days water stress along with foliar application of ascorbic acid 50 ppm concentration) recorded the highest phosphorus content in the main (0.19 and 0.18 per cent) and off (0.19 and 0.16 per cent) season during the year 2007 - 08 and 2006 - 07 respectively. The interaction between stress, growth regulators and stages of tree growth showed that the combination S1C2L1 recorded the highest potassium content (2.37 and 2.35 per cent) in the main and off season of the year 2006 – 07 and 2007 – 08. It was followed in the combinations S2C3L1 (2.30 and 2.27 per cent) and S1C1L1 (2.13 and 2.12 per cent) in the year 2006 - 07 and 2007 - 08 respectively.*

Keywords— Acid lime, water stress, growth regulators and nutrient uptake.

I. INTRODUCTION

Acid lime is the third most important fruit crops in citrus sp. It plays an important position in daily life of human beings for reliving thirsty during summer period and contributes an important place in rituals and festivals. Though its production is confined to homestead garden in parts of Tamilnadu in India, it is considered for the vast medicinal properties. Plant growth regulators are found to be widely used in many of the fruit crops for modifying plant growth and development.

II. MATERIALS AND METHODS

The experiment was conducted on four year old trees of acid lime cv. PKM 1 spaced at 6 X 6 m at a village near Horticultural College and Research Institute, Periyakulam. The treatments consist of two levels of soil moisture stress (SMS) or water stress (30 days and 45 days) along with aqueous sprays of growth regulators viz., ascorbic acid 50 ppm, Gibberellic acid (GA3) 10 ppm and CCC (Cycocel) 500 ppm concentrations. Thus there were seven treatments replicated three times following randomized block design. Water stress was considered as one factor and growth regulator was another.

The field experiment was carried out for two consecutive years from 2006 – 07 and 2007 – 08. The sprays were given during the autumn flush starting from a fortnight before flowering. The observations were recorded both in main and off season of a year. The leaf nutrient analysis was carried out to assess the nutrient uptake in the leaves at the time of vegetative (L1), flowering (L2) and harvesting (L3) stages by collecting 30 leaves from each tree and pooled per treatment. The nitrogen content of leaves on dry weight basis was estimated by Micro kjeldahl method and expressed in per cent (Humphries, 1956). Phosphorus content of leaves was estimated by triple acid wet digestion method by Jackson (1973) using photo–electric calorimeter and expressed in per cent on dry weight basis. The potassium content of leaves on dry weight basis was estimated using triple acid wet digestion method as suggested by Jackson (1973) and expressed in per cent.

III. TREATMENTS

S1C1 – Soil moisture stress 30 days + CCC 500 ppm

S1C2 – Soil moisture stress 30 days + Ascorbic acid 50 ppm

S1C3 – Soil moisture stress 30 days + GA3 10 ppm

S2C1 – Soil moisture stress 45 days + CCC 500 ppm

S2C2 – Soil moisture stress 45 days + Ascorbic acid 50 ppm

S2C3 – Soil moisture stress 45 days + GA3 10 ppm

S0C0 – Control

IV. RESULT AND DISCUSSION

Data presented in the Table 1 shows that the three way interaction between stress, growth regulators and stages of tree growth revealed that the combination (S1C2L1 water stress for 30 days + foliar spraying of ascorbic acid 50 ppm concentration at vegetative stage) registered the highest nitrogen content (2.97 and 2.92 per cent) in the main season of the year 2006 – 07 and 2007 – 08 compared to control treatment. The lowest nitrogen content (1.82 and 1.82 per cent) was observed in the combination S2C1L3.

TABLE 1
EFFECT OF WATER STRESS AND GROWTH REGULATORS ON LEAF NITROGEN (%) DURING MAIN AND OFF SEASON

Treatments	Main season (2006-07)	Main season (2007-08)	Pooled Mean	Off season (2006-07)	Off season (2007-08)	Pooled Mean	Pooled Mean (2006-07 & 2007-08)
$S_1C_1L_1$	2.66	2.70	2.68	2.61	2.67	2.64	2.66
$S_1C_1L_2$	2.26	2.32	2.29	2.20	2.28	2.24	2.27
$S_1C_1L_3$	1.85	1.94	1.90	1.82	1.90	1.86	1.88
$S_1C_2L_1$	2.95	2.99	2.97	2.90	2.94	2.92	2.95
$S_1C_2L_2$	2.35	2.40	2.38	2.30	2.35	2.33	2.35
$S_1C_2L_3$	1.97	2.00	1.99	1.95	1.98	1.97	1.98
$S_1C_3L_1$	2.73	2.76	2.75	2.70	2.72	2.71	2.73
$S_1C_3L_2$	2.30	2.35	2.33	2.27	2.30	2.29	2.31
$S_1C_3L_3$	2.01	2.08	2.05	1.82	1.86	1.84	1.94
$S_2C_1L_1$	2.39	2.40	2.40	2.35	2.37	2.36	2.38
$S_2C_1L_2$	2.10	2.15	2.13	2.05	2.11	2.08	2.10
$S_2C_1L_3$	1.84	1.80	1.82	1.81	1.82	1.82	1.82
$S_2C_2L_1$	2.45	2.48	2.47	2.39	2.44	2.42	2.44
$S_2C_2L_2$	2.26	2.27	2.27	2.20	2.30	2.25	2.26
$S_2C_2L_3$	1.91	1.85	1.88	1.86	1.89	1.88	1.88
$S_2C_3L_1$	2.80	2.86	2.83	2.78	2.85	2.82	2.82
$S_2C_3L_2$	2.34	2.40	2.37	2.30	2.32	2.31	2.34
$S_2C_3L_3$	2.03	2.07	2.05	1.89	1.90	1.90	1.97
$S_0C_0L_1$	2.50	2.55	2.53	2.46	2.53	2.50	2.51
$S_0C_0L_2$	2.08	2.15	2.12	2.10	2.11	2.11	2.11
$S_0C_0L_3$	1.90	1.93	1.92	1.85	1.80	1.83	1.87

	Main (2006-07)		Main (2007-08)		Pooled Mean		Off (2006-07)		Off (2007-08)		Pooled Mean		Pooled Mean	
	SEd	CD	SEd	CD	SEd	CD	SEd	CD	SEd	I. CD	SEd	CD	SEd	CD
Control vs Rest	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
CXSXL	0.22	0.45	NS	NS	0.22	0.45	0.21	0.42	0.23	0.46	0.22	0.44	0.31	0.62

In the present study, induction of water stress upto 30 days and application of ascorbic acid 50 ppm during vegetative stage observed significant up take of major leaf nutrient contents compared with other treatments probably increased photosynthetic activity and solutes translocation by growth regulators application.

The combination S1C2L1 recorded the highest phosphorus (Table 2) content (0.25 and 0.24 per cent) in the main and off season of the year 2006 – 07 and 2007 – 08. The lowest phosphorus content (0.05 and 0.05 per cent) was observed in the combination S2C2L3 in the main and off season of the year 2006 – 07 and 2007 – 08. The highest potassium content (Table 3) was recorded in the combination of S1C2L1 (2.37 and 2.35 per cent) in the main and off season of the year 2006 – 07 and 2007 – 08. The lowest potassium content (1.00 and 0.95 per cent) was observed in the combination S1C1L3 in the main and off season of the year 2006 – 07 and 2007 – 08.

TABLE 2
EFFECT OF WATER STRESS AND GROWTH REGULATORS ON LEAF PHOSPHORUS (%) DURING MAIN AND OFF SEASON

Treatments	Main season (2006-07)	Main season (2007-08)	Pooled Mean	Off season (2006-07)	Off season (2007-08)	Pooled Mean	Pooled Mean (2006-07 & 2007-08)
$S_1C_1L_1$	0.18	0.19	0.19	0.17	0.18	0.18	0.18
$S_1C_1L_2$	0.12	0.13	0.13	0.10	0.13	0.12	0.12
$S_1C_1L_3$	0.07	0.07	0.07	0.05	0.08	0.07	0.07
$S_1C_2L_1$	0.24	0.26	0.25	0.23	0.25	0.24	0.25
$S_1C_2L_2$	0.19	0.21	0.20	0.18	0.20	0.19	0.20
$S_1C_2L_3$	0.12	0.11	0.12	0.08	0.13	0.11	0.11
$S_1C_3L_1$	0.19	0.20	0.20	0.17	0.17	0.17	0.18
$S_1C_3L_2$	0.15	0.13	0.14	0.12	0.12	0.12	0.13
$S_1C_3L_3$	0.10	0.09	0.10	0.06	0.09	0.08	0.09
$S_2C_1L_1$	0.15	0.15	0.15	0.13	0.14	0.14	0.14
$S_2C_1L_2$	0.11	0.12	0.12	0.09	0.10	0.10	0.11
$S_2C_1L_3$	0.05	0.05	0.05	0.04	0.05	0.05	0.05
$S_2C_2L_1$	0.16	0.17	0.17	0.14	0.15	0.15	0.16
$S_2C_2L_2$	0.10	0.12	0.11	0.08	0.12	0.10	0.11
$S_2C_2L_3$	0.04	0.05	0.05	0.05	0.04	0.05	0.05
$S_2C_3L_1$	0.22	0.23	0.23	0.20	0.20	0.20	0.21
$S_2C_3L_2$	0.17	0.18	0.18	0.15	0.14	0.15	0.16
$S_2C_3L_3$	0.11	0.12	0.12	0.07	0.10	0.09	0.10
$S_0C_0L_1$	0.21	0.24	0.23	0.20	0.21	0.21	0.22
$S_0C_0L_2$	0.16	0.17	0.17	0.16	0.15	0.16	0.16
$S_0C_0L_3$	0.10	0.10	0.10	0.07	0.08	0.08	0.09

	Main (2006-07)		Main (2007-08)		Pooled Mean		Off (2006-07)		Off (2007-08)		Pooled Mean		Pooled Mean	
	SEd	CD	SEd	CD	SEd	CD	SEd	CD	SEd	II. CD	SEd	CD	SEd	CD
Control vs Rest	0.006	0.013	0.007	0.013	0.004	0.008	0.006	0.012	0.006	0.013	0.004	0.008	0.007	0.014
CXSXL	0.015	0.030	0.015	0.030	0.013	0.025	0.014	0.027	0.015	0.029	0.013	0.025	0.022	0.043

TABLE 3
EFFECT OF WATER STRESS AND GROWTH REGULATORS ON LEAF POTASSIUM (%) DURING MAIN AND OFF SEASON

Treatments	Main season (2006-07)	Main season (2007-08)	Pooled Mean	Off season (2006-07)	Off season (2007-08)	Pooled Mean	Pooled Mean (2006-07 & 2007-08)
$S_1C_1L_1$	2.10	2.16	2.13	2.08	2.15	2.12	2.12
$S_1C_1L_2$	1.60	1.65	1.63	1.55	1.60	1.58	1.60
$S_1C_1L_3$	1.00	1.00	1.00	0.90	1.00	0.95	0.98
$S_1C_2L_1$	2.35	2.39	2.37	2.33	2.36	2.35	2.36
$S_1C_2L_2$	1.91	1.96	1.94	1.88	1.95	1.92	1.93
$S_1C_2L_3$	1.14	1.17	1.16	1.08	1.15	1.12	1.14
$S_1C_3L_1$	2.15	2.20	2.18	2.12	1.18	1.65	1.91
$S_1C_3L_2$	1.67	1.73	1.70	1.60	1.70	1.65	1.68
$S_1C_3L_3$	1.08	1.10	1.09	1.05	1.05	1.05	1.07
$S_2C_1L_1$	1.73	1.75	1.74	1.74	1.73	1.74	1.74
$S_2C_1L_2$	1.40	1.45	1.43	1.37	1.40	1.39	1.41
$S_2C_1L_3$	1.05	0.92	0.99	0.98	1.05	1.02	1.00
$S_2C_2L_1$	1.85	1.87	1.86	1.80	1.86	1.83	1.85
$S_2C_2L_2$	1.48	1.52	1.50	1.45	1.50	1.48	1.49
$S_2C_2L_3$	1.00	1.05	1.03	1.00	1.00	1.00	1.01
$S_2C_3L_1$	2.27	2.32	2.30	2.25	2.29	2.27	2.28
$S_2C_3L_2$	1.80	1.88	1.84	1.72	1.82	1.77	1.81
$S_2C_3L_3$	1.10	1.08	1.09	1.07	1.06	1.07	1.08
$S_0C_0L_1$	2.02	2.09	2.06	2.00	2.05	2.03	2.04
$S_0C_0L_2$	1.62	1.70	1.66	1.60	1.60	1.60	1.63
$S_0C_0L_3$	1.03	1.10	1.07	1.08	1.00	1.04	1.05

	Main (2006-07)		Main (2007-08)		Pooled Mean		Off (2006-07)		Off (2007-08)		Pooled Mean		Pooled Mean	
	SEd	CD	SEd	CD	SEd	CD	SEd	CD	SEd	III. CD	SEd	CD	SEd	CD
Control vs Rest	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
CXSXL	0.16	0.32	0.16	0.32	0.16	0.31	0.16	0.33	0.16	0.32	0.16	0.32	0.22	0.45

Very few studies interpreted on water relations in fruit trees and nutrient mobility under water stress conditions. The relationship of these complex relations to the responses of stomata, photosynthesis, transpiration and respiration rates are complex to evaluate. Movement of mineral nutrients through the soil to the plant root is dependent on both mass flow of soil solution driven by water uptake by the plant root and the slow process of diffusion (Lakso, 1985).

High soil water stress restricted the movement of nutrients to the roots both by increased difficulty of movement along the soil particles and the reduction of mass flow when stomatal closure restricts transpiration. The increased nutrient content at low water stress of the present study are in line with the reports of Tromp (1980) and Levin et al (1980) show increased Ca/K ratios with soil moisture stress while leaf content of nitrogen was not greatly affected.

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