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STUDIES ON OPTIMUM NUTRITIONAL AND WEED MANAGEMENT PRACTICES IN RESPONSE TO DIAGNOSTIC SURVEY AT THE MANDARIN ORANGE ORCHARD OF DARJEELING HILLS

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ABSTRACT

A diagnostic survey was carried out at four different locations (Kalimpong, Kurseong, Mirik and Darjeeling) of Darjeeling district revealed that lack of nutrition and weed management along with selection of exhaustive intercrops like ginger, maize and millets even in full bearing orchards resulted in poor reserve soil nutrient content (total nitrogen, available phosphorus and potassium) as well as lower nutrient content in foliage particularly of nitrogen, potassium, iron, manganese, zinc and copper. Among weed control measures studied, herbicidal control proved superior to hand weeding and integrated control (hoeing + herbicide + hand weeding). Two sprays of Glyphosate @ 2.0 litre/ha. followed by one spray of glyphosate @ 1.0 L/ha in the month of April, july and September was observed effective in suppressing weed population.

INTRODUCTION

Darjeeling mandarin locally known as "Suntala" was once considered excellent in the world for its taste and flavour. Presently, its a carage, production and fruit quality have been declined drastically. A wide spread disease syndrome "Citrus decline" has been emerged as major problem for citrus cultivation which arises mainly due to lack of proper orchard management practices especially of nutrient management (macro and micronutrient), weed control measure and judicious selection of intercrops especially in the fruit bearing orchards. A citrus orchard producing 18 tones of fruit remove about 21 kg N, 5kg P, 41kg Ca, 3.6 kg Mg, 2.3 kg S, 45 gm B, 9gm cu, 50 gm Fe, 13 gm Mn and 13 gm Zn (Chapman et al., 1945) which vindicated the essentiality of maintaining proper balanced nutrition in the citrus orchard to achieve desirable tree health and productivity. Chadha (1966) reported that inadequate plant nutrition as one of the causes responsible for citrus decline. It is also reported that the chlorotic condition and die-back in citrus could effectively be corrected by spraying micro-nutrients like Zn, Fe, B (Chowdhury, 1954), Zn and Cu (Dikshit, 1959), Zn and B (Singh and Mishra, 1980). Apart from inadequate use of plant nutrients, citrus decline may also be happened due to weed infestation particularly of annuals and bermuda grass (Cynodon dactylon), causing reduction in trunk and canopy growth, leaf nitrogen level, fruit yield and fruit quality (Jordan et al., 1982). Herbicidal weed control measure proved better over manual and mechanical measure in controlling perennial weeds which cause less injury to the roots, reduce soil erosion and produce higher fruit yield of better quality (Jordan, 1978).

In the present investigation, a series of studies were undertaken to mitigate this citrus decline problem particularly with the help of macro and micro nutrients use and herbicidal weed control measure.

MATERIALS AND METHODS

During assessing the intensity of inadequacey of plant nutrient use in Darjeeling hills, eight orchards distributed at four different locations viz., Kalimpong, Kurseong , Mirik and Darjeeling, were selected for diagnostic survey in relation to citrus decline problem. Soil samples upto 30 cm depth around each tree were collected for the estimation of organic matter, pH, nitrogen, phosphorus, potassium, iron, manganese, zinc and copper content. In the leaf sampling, only third leaf from the non- bearing Terminal was collected from ten twigs of a plant and after washing in running water, the sampled leave were oven dried at 68 = 2. c for 48 hours, then ground and user for the analysis of N, P, K, Fe, Zn, Mn and Clucontents of the leaf. After observing the results from this diagnostic survey, studies on plant nutrients (both macro and micro-) were carried out on nine to ten year old mandarin orange plants. In macro-nutrient study, nitrogen was applied @ 200 g (N_1), 400 gm (N_2) and 600 gm (N_3) per plant per year in the form of urea, phosphorus @ 100 gm (P_1), 200 gm (P_2) and 400 gm (P_3)/ plant/ year in the form of single super phosphate and potash. (Table 2 a). The fertilizers were applied in two equal splits during the months of June and September. This experiment was laid out in a 33 confounding design with four replications.

About 25 year old mandarin orange plants of uniform size, spaced 6 m in both the ways were selected as study plant where each plant received an uniform dose of 600 gm N, 400 gm P_20_5 and 600 gm K_2O per year in two equal splits during June and September. Foliar application of magnesium, copper, zinc and boron were made in the form of 0.2% magnesium sulphate, 0.4% copper sulphate, 0.5% Zine sulphate and 0.1% boric acid respectively. These micronutrients were applied both singly and in different combinations Table 3). The control plants were sprayed with water. The foliar application of micro-nutrients were made during the month of May and September. This experiments was laid out in a randomized block design with four replications.

The experiment on weed control measure was carried out by employing seven to eight year old bearing healthy mandarin plants, receiving each with equal amount (600 gm) of Nitrogen, Phosphorus and Potassium per year and seven different approaches of weed control (Table 4a). This experiment was laid out in a randomized block design with three replications.

RESULTS AND DISCUSSION

Information generated from diagnostic survey

Organic matter content was found to be higher in the healthy orchards compared to the declining ones in all four locations (Table 1a). Soil reaction did not show any definite trend. Total nitrogen, available phosphorus and Potassium content of the soils of healthy orchards were comparatively higher than those of the declining orchards (Table 1a).

In the leaf, nitrogen, potassium, iron, manganese, zinc and copper content were higher in the plants of healthy orchards as compared to declined ones. However, the phosphorus content in the leaves of healthy and declining orchard plants did not exhibit any definite trend (Table 1b). Both manganese and zinc showed deficient level in relation to optimum levels in the leave of mandarin orange plant.

Hence, lack of chemical fertilizer application, negligence in proper management practices and intercropping with exhaustive crops like zinger, maize and millets even in the full bearing orchards may be the major causes for poor nutrient status of the declining as well as seemingly healthy orchards in the Darjeeling district.

Effect of different levels of N, P and K on fruit yield components of mandarin orange

Total fruit weight /plant and number of fruits/ plant were significantly increased with the increasing levels of nitrogen while those were also showed similar trends with the increasing levels of phosphorus and potassium but the increase was less pronounced in comparison to nitrogen application (Table 2a). Number of fruits/plant was significantly influenced by N and P and P and K combinations whereas total fruit, weight/plant affected significantly with the combinations of N and P and N and K. The increase in fruit number/plant due to higher level of N was mainly for better vegetative growth and improvement in the physiological condition which causes higher percentage of fruit set and retention (Lal and Sharma, 1985). Although combined application of N, P and K did not show any significant effect, maximum fruit number/plant was recorded with the application of 600 gm N, 400 gm P_2O_5 and 400 gm K_2O/plant/year.

Peel weight/fruit also influenced similarly with fruit number/plant due to both singly and combined application of N, P and K (Table 2a) while there was no significant combined effect N, P, K on pulp weight/fruit.

N, P, K effect on fruit quality

Except ascorbic acid content, all other quality parameters like juice content, T.S.S., Total sugar, total acidity were increased with the increasing levels of N (Table 2b). Like N, K showed similar effect on all quality parameters of mandarin fruit.

Hence, it was observed that application of a nutrient schedule of 600 g N, 400 gm P_2O_5 and 400 gm K_2O per plant per year was found optimum which can accommodate different effects of N, P, K on both front yield and quality.

Effect of foliar application of different micro-nutrients on fruit yield and yield parameters of mandarin orange

Foliar application of zinc showed increasing effect in increasing the number of fruits per plant. However, higher number of fruits per plant (545) was produced with the combined application of 0.2% magnesium sulphate, 0.5% zinc sulphate and 0.4% copper sulphate which also showed relatively higher total fruit weight/plant (Table 3). Somoladas (1965) reported a yield increase of 20% over control following zinc application in mandarin trees on alluvial soil. Hag gag et al. (1987) also reported that both soil and foliar application of Mg So_4 caused a marked increase in fruit yield.

Micro-nutrient spraying effect on fruit quality

Zinc, magnesium and copper were found more effective in increasing the pulp weight of fruit (Table 3). Other quality parameters of the fruit like T.S.S., sugar content, ascorbic acid content did not influence significantly with the application of micronutrients spray. However, maximum pulp : peel ratio, T.S.S, juice content, total sugar and ascorbic acid content were observed with T_8 (Cu+Zn), T_6 (Mg + Cu + Zn), T_4 (B), T_3 (Zn) and T_5 (Mg + Cu + Zn + B) treatments respectively.

Hence, two sprayings with a nutrient combination of 0.2% magnesium sulphate, 0.4% copper sulphate and 0.5% zinc sulphate in the months of May and September increased fruit number and fruit quality conspicuously.

Effect of different weed control measures on weed population, weed dry weight and weed control efficiency

All the weed control measures significantly made influence on weed population (Monocot and dicot), weed dry weight and even on weed control efficiency (Table 4a). Among the control measures,

two sprays of glyphosate @ 2.0 L/ha followed by one spray of glyphosate @ 1.0 L/ha was most effective in reducing weed population, weed dry weight and showed higher weed control efficiency (93.90%) against monocots and dicots upto 60 days which kept weed population negligible even at the end of 90 days from the spray. Prates et al. (1980) obtained 80% weed control efficiency at 90 days after application of glyph sate @ 1.5 L/ha.

Weed control effect on fruit yield and quality

Weed control measures exerted significant effect on fruit yield and different quality parameters of mandarin orange (Table 4 (b)). Application of two sprays of glyph sate @ 2.0 L/ha followed by one spray of glyphosphate @ 1.0 L/ha showed maximum number of fruit/plant, total fruit weight/plant, juice content (%), sugar: acid ratio and ascorbic acid content whereas 3 sprays of gramoxone @ 1.81/ ha + 0.2% urea caused maximum T.S.S. content of the fruit.

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Table 1a. Information on mandarin orange plants, nutrient contents in soil and leaf of different locations in Darjeeling hills

Location	Condition of the orchard	Altitude (m)	Age of the plants (year)	Manuring Schedule (Kg/tree/year)	Yield/ tree (fruit no.)	Soil					Plant (leaf)		
						Organic C (%)	pH	Total N(%)	P_2O_2 (ppm)	K_2O (ppm)	N(%)	P(%)	K(%)
1. Kalimpong	Healthy	1050	18-20	50Kg FYM	2000-3000	2.25	6.5	0.231	24.6	287.5	2.59	0.0905	1.35
2. Kalimpong	Declined	850	20.25	25 Kg FYM	200-400	1.45	5.6	0.189	19.7	268.9	2.25	0.0865	1.20
3. Kurseong	Healthy	750	25-30	40-100 Kg FYM	1750-2000	1.50	5.6	0.133	6.5	258.0	2.73	0.1040	1.25
4. Kurseong	Declined	750	25-30	20 Kg FYM	200-300	1.40	5.3	0.126	7.0	262.5	2.36	0.0995	1.10
5. Mirik	Healthy	1350	25-30	50-60 Kg FYM	1500-2000	1.60	6.5	0.266	12.0	437.5	2.52	0.0905	1.35
6. Mirik	Declined	1350	20-25	30 Kg FYM	200-300	1.70	5.5	0.217	6.5	250.0	1.54	0.0975	1.20
7. Darjeeling	Healthy	900	15.20	10-50 Kg FYM	800-1000	1.60	6.2	0.175	12.7	287.5	2.41	0.0865	1.25
8. Darjeeling	Declined	900	25-30	20-25 Kg FYM	200-500	1.50	6.2	0.056	3.9	237.5	2.24	0.1040	1.40

Table 1b. Micro-nutrient status of soil and plant of mandarin orange distributed at different locations of Darjeeling hills

Location	Condition	Soil (ppm)				Plant (leaf) (ppm)			
	of the plant	Fe	MN	Zn	Cu	Fe	Mn	Zn	Cu
1. Kalimpong	Healthy	18.42	4.13	0.62	0.770	78.5	33.2	18.2	8.5
2. Kalimpong	Declined	8.84	3.25	0.54	0.345	68.4	25.5	15.02	3.5
3. Kurseong	Healthy	16.50	3.50	0.656	0.568	76.6	27.2	16.32	7.0
4. Kurseong	Declined	15.50	2.27	2.56	0.452	55.7	12.7	13.02	3.0
5. Mirik	Healthy	17.74	4.50	0.67	0.674	77.9	38.9	20.32	10.5
6. Mirik	Declined	8.21	3.3.	0.45	0.328	49.2	16.8	17.02	4.0
7. Darjeeling	Healthy	10.62	3.80	0.72	0.757	60.6	25.7	19.02	9.0
8. Darjeeling	Declined	9.54	3.65	0.59	0.652	49.8	20.7	15.32	3.3

Table 2a. Effect of different levels of N, P and K on yield and yield components of Darjeeling mandarin orange (Pooled data of two years)

Parameters	N_1	N_2	N_3	$CD_{0.05}$	P_1	P_2	P_3	$CD_{0.05}$	K_1	K_2	K_3	$CD_{0.05}$	N×P	$CD_{0.05}$	N×K	$CD_{0.05}$	N×K	CD0.05	N×P×K	$CD_{0.05}$
1. No. of fruits/plant	131	135	162	1.908	139	141	147	1.908	135	144	147	1.908		3.305		NS		3.305		NS
2. Total Fruit	11.77	13.23	17.37	0.276	13.09	13.89	15.38	0.276	13.24	14.15	14.97	0.276		0.479		0.479		NS		NS
3. Peel Weigh/ Fruit (gm)	18.48	21.06	22.53	0.713	19.80	20.11	22.16	0.713	19.74	20.68	21.65	0.713		1.24		NS		1.235		
4. Pulp Weight/ Fruit (gm)	70.26	74.81	82.87	1.391	72.84	76.24	78.84	1.391	74.44	75.36	78.14	1.391		NS		NS		NS		NS
5. Juice Content	43.03	46.09	49.03	0.570	44.24	45.86	48.00	0.570	44.29	46.23	47.64	0.570		NS		NS		NS		NS

(%)

* NS - Not Significant.

Table 2 b : Effect of different levels of N, P and k of various quality parameters of Darjeeling mandarin orange

Parameters	N_1	N_2	N_3	$CD_{0.05}$	P_1	P_2	P_3	$CD_{0.05}$	K_1	K_2	K_3	$CD_{0.05}$	N×P	$CD_{0.05}$	N×K	$CD_{0.05}$	P× $CD_{0.0}$	N×P×K	CD0.05
1. Total Soluble Solid (T.S.S. in Brix)	9.90	10.00	10.30	0.222	10.10	10.00	10.00	NS	9.90	10.00	10.20	NS		0.384		0.384	0.384	NS	
2. Total Sugar (%)	6.59	6.90	7.02	0.218	6.75	6.85	6.91	NS	6.31	6.84	7.36	0.218		0.378		NS	NS	NS	
3. Total acidity (%)	0.672	0.685	0.751	0.032	0.721	0.712	0.676	0.032	0.676	0.627	0.697	0.784		0.032		NS	NS	NS	
4. Ascorbic acid (mg/100ml of juice)	32.48	31.86	26.38	1.289	30.24	30.90	29.58	NS	27.67	30.52	32.53	1.289		2.333		NS	NS	NS	

* NS-Not significant.

Table 3. Effect of foliar application of Mg, Zn, Cu and B both singly and in combinations of fruit yield and quality of Darjeeling mandarin orange (Pooled data of two years)

Treatment	No. of fruits Per plant	Total fruit weight/plant (Kg)	Pulp weight/ fruit (gm)	Pulp : Peel ratio	Juice content (%)	T.S.S. (Brix)	Total Sugar (%)	Total acidity (%)	Ascorbic acid content (mg/100ml, of juice)
1. Mg	508.75	48.44	71.73	3.33	46.70	10.9	7.16	0.566	29.15
2. Cu	490.38	45.74	71.58	3.54	45.31	11.2	7.15	0.585	29.20
3. Zn	539.50	53.09	76.49	3.79	46.80	10.8	8.07	0.580	30.44
4. B	504.13	46.79	69.36	3.17	48.31	11.0	7.20	0.473	27.04
5. Mg+Cu+Zn+B	530.75	53.96	76.70	3.39	48.31	11.3	7.57	0.565	33.59
6. Mg+Cu+Zn	545.00	55.52	78.87	3.73	47.64	11.4	7.90	0.540	29.20
7. Mg+Cu	493.75	46.94	70.21	3.25	46.59	11.0	8.02	0.548	29.69
8. Cu+Zn	542.13	53.69	77.51	3.98	47.39	11.1	7.81	0.621	31.76
9. Cu+B	496.25	47.76	70.63	3.59	46.06	11.2	7.36	0.521	29.91
10. Zn+B	508.50	30.31	74.98	3.40	47.29	11.1	7.56	0.523	30.52
11. Mg+B	482.13	46.13	71.90	3.31	47.14	10.9	7.56	0.506	28.80
12. Control	387.75	32.76	65.22	3.37	43.26	10.5	6.96	0.434	25.75
$CD_{0.05}$	44.90	5.78	7.63		NS	NS	NS	0.101	NS

Table 4a. Effect of different weed control measures on weed population, dry matter and weed control efficiency in the orchard of Darjeeling mandarin orange.

Treatment	Mean number of monocot weeds/cm²			Mean number of dicot weeds/cm²			Dry weight of weeds/cm²			Weed control efficiency		
	30 DAT*	60 DAT	90DAT	30 DAT*	60 DAT	90DAT	30 DAT*	60 DAT	90DAT	30 DAT*	60 DAT	90DAT
T_1	13.78 (93.78)**	17.22 (4.21)	20.66 (4.53)	3.11 (1.90)	5.23 (2.39)	6.62 (2.67)	19.47 (4.47)	24.01 (4.95)	27.77 (5.32)	71.92	66.50	59.44
T_2	6.56 (2.66)	8.17 (2.94)	10.28 (3.28)	2.78 (1.81)	3.84 (2.08)	5.39 (2.43)	14.46 (3.87)	18.07 (4.31)	23.30 (4.88)	79.08	74.85	66.09
T_3	0.00 (0.71)	1.06 (1.25)	2.50 (1.73)	0.00 (0.71)	0.95 (1.20)	2.61 (1.76)	0.00 (0.71)	4.59 (2.25)	11.25 (3.43)	100.00	93.90	83.78
T_4	1.34 (1.35)	6.06 (2.56)	9.84 (3.21)	1.17 (1.29)	2.95 (1.86)	4.89 (2.32)	5.18 (2.38)	13.37 (3.72)	22.49 (4.79)	92.43	81.26	67.07
T_5	0.45 (0.97)	1.78 (1.51)	3.17 (1.91)	0.23 (0.85)	1.78 (1.51)	3.28 (1.94)	0.82 (1.15)	6.17 (2.58)	12.49 (3.60)	89.75	91.58	81.92
T_6	15.95 (4.06)	26.23 (5.17)	37.78 (6.19)	12.06 (3.54)	14.11 (3.82)	16.06 (4.07)	24.43 (5.00)	35.11 (5.97)	48.80 (7.02)	64.05	49.99	27.51
T_7	4.95 (6.44)	41.84 (6.51)	42.11 (6.53)	23.23 (4.87)	23.00 (4.85)	22.95 (4.84)	67.63 (8.25)	70.02 (8.40)	67.27 (8.23)	-	-	-
$CD_{0.05}$	0.93	0.092	0.120	0.083	0.146	0.153	0.135	0.096				

T_1-3 sprays of Gramoxone @ 1.8 L/ha + 0.2% urea, T_2-3 sprays of Gramoxone @ 1.8 L/ha, T_3 - 2 sprays of Glyphosate @ 2.0L/ha followed by one spray of Glyphosate @ 1.0L/ha, T_4 - hoeing followed by one spray of Glyphosate @ 1.0L/ha and hand weeding, T_5-2 sprays of Glyphostate @ 2.0 L/ha followed by one spray of Gramoxone @ 1.8 L/ha, T_6-hand weeding, T_7 - unweeded control

* Days after treatment, ** figures in parenthesis are squae root (× + 0.5) transformed vlaue

Table 4b. Effect of different weed control measures on fruit yield and quality of Darjeeling mandarin orange (Pooled data of two years)

Treatment	Number of Fruits/Plant	Total fruit Weight/Plant (Kg	Juice content (%)	T.S.S. (Brix)	Total Sugar (%)	Total Acidity (%)	Sugar : Acid Ratio	Ascorbic Acid (mg/100ml of juice)
T_1	65.00	6.09	51.66	10.80	7.56	0.753	9.67	28.59
T_2	53.00	5.69	48.38	10.50	6.98	0.743	9.66	32.37
T_3	75.00	8.02	50.18	10.70	7.66	0.751	10.20	36.37
T_4	57.00	5.13	47.13	9.40	7.31	0.780	8.71	30.70
T_5	66.00	6.38	49.35	10.70	7.71	0.769	10.03	34.31
T_6	43.00	4.13	44.81	10.40	7.18	0.738	9.43	29.88
T_7	44.00	3.61	39.79	10.20	6.30	0.685	10.69	28.79
$CD_{0.05}$	7.11	0,37	1,05	0.33	0.35	0.026	2.88	