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MINERAL DEFICIENCY IN MULBERRY PLANTS, *MORUS ALBA* L. AND ITS EFFECT ON ECONOMIC CHARACTERS OF SILK WORM, *BOMBYX MORI* L.

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The effect of mineral deficiency on mulberry plant was studied under pot culture with Kanva-2 mulberry variety, under different deficient nutrient conditions. The leaves were chemically analysed and discussed. To test the quality of leaves, a feeding experiment was conducted by feeding the hybrid worm, LX NB_4D_2 from III stage upto cocoon formation. The larval, cocoon and silk characters revealed that deficiency in N P and K affected the growth and nutrient content of mulberry leaves which in turn affected the growth and economic characters of silk worm. Among the three elements, 'P' deficiency affected the cocoon characters and silk characters very badly; because deficiency in 'P' affected the uptake of other elements in mulberry leaves

In recent years, considerable interest has arisen on the effects of nutritional changes in host plant upon insect development and behaviour. Several workers have conducted number of experiments and reported on this aspect (Allen and Selma, 1956, Watson, 1964, Shyamala and Bhat, 1965; Dahms and Fenton, 1940, Haseman, 1946, Barker and Tauber, 1951 a, Arant and Jones, 1951, Evans, 1938, Smith and Northcott, 1951, Hedge, 1963 and Smith, 1959). In the present investigation the effect of deficiency in N, P, K, Ca, Mg and S on mulberry growth and the effect of mineral deficient mulberry leaves on the economic characters of silkworm, *Bombyx mori* L. are studied and reported.

MATERIALS AND METHODS

Two months old rooted cuttings of Kanve-2 were removed and washed thoroughly to remove the adhering soil and planted in the pots containing sterile soil and were irrigated with nutrient solutions *viz.*, complete nutrient solution(Hoagland and Arron, 1938); nutrient solution deficient in nitrogen, deficient in phosphorus, deficient in potassium, deficient in calcium, deficient in magnesium and deficient in sulphur (Table 1). The above seven treatments were replicated 10 times. The plants were watered with nutrient solution @ 100 ml/ pot at weekly intervals. Daily the pots were watered uniformly to keep the soil in a moist condition.

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Establishment of mulberry cuttings under different nutritional conditions was recorded by the end of the first month. The shoot length, root length, shoot weight, and root weight were recorded. Shoot weight/root weight ratio was calculated. The leaf area, and moisture content of the leaf grown under different dificient nutritional conditions were recorded and analysed.

The progress of visual deficient symptoms were also noted. Nitrogen was estimated by following Microkjeldhal method (Humphries, 1956); phosphorus by Vanadomolybdate method (Jackson, 1973), potassium by flame photometry method (Piper, 1966) and calcium and magnesium by EDTA method (Piper, 1966).

Feeding experiment

The effect of mulberry leaves grown under different deficient nutritional conditions on the growth and economic characters of silkworm were studied by conducting a feeding experiment, by using *III* stage hybrid worms of L x NB_4D_2. For feeding purpose four sets of pots were maintained. The leaves harvested from these plants were used for feeding the worms from *III* stage upto cocoon formation There were three replications and each replication consisted of 10 worms of uniform size and age.

The larval duration, larval length and weight before spinning, cocoon length, cocoon width, cocoon weight, shell weight, silk filament length and silk weight were recorded. The effective rate of rearing (E.R.R.) was calculated.

RESULTS AND DISCUSSION

The effect of different deficient nutrients on mulberry plants are presented in Table 2. Establishment of mulberry plants under different deficient nutrient solutions ranged from 33.3 per cent to 83.3 per cent. The maximum establishment was noted in complete nutrient solution, whereas the minimum was noted in potassium deficient and magnesium deficient solutions.

In this study, both the shoot weight and root weight were affected very badly in all deficient nutrient solutions. Among all treatments, the reduction in both the characters were more in potassium deficient nutrient solution. It shows that among all the elements, potassium plays a major role in the growth of the mulberry plants. Shyamala and Bhat (1965) also showed, marked, reduction in shoot eight and root weight of mulberry in deficient nutrient treatments.

Average leaf area was significantly maximum (47.80 sq. cm) in complete nutrient soultion. Other treatments had a negative influence on the leaf area. So the reduction in leaf area was noted and it ranged from 5.13 per cent to 70. 71 per cent in various deficient nutrient solutions. The maximum reduction of 70 71 per cent was noted in potassium deficient nutrient solution. It was followed by sulphur deficient nutrient solution (38 49 per cent) in this study

Table 1 : Composition of different nutrient solutions (ml/litre)

S. No	Solution	Strength	Complete	-N	-P	-K	-Ca	-Mg	-S
1	$MgSO_4$	1M	12.0	12.0	12.0	6.0	–	–	–
2.	$Ca(NO_3)_2$	2M	18.0	–	18.0	18.0	–	18.0	18.0
3.	KH_2PO_4	1M	9.0	3.0	–	–	–	3.0	3.0
4.	$NH_4H_2PO_4$	1M	6.0	–	–	1.0	18.0	–	–
5.	KNO_3	2M	9.0	–	12.0	–	13.5	–	–
6.	K_2HPO_4	1M	–	12.0	–	–	–	12.0	12.0
7.	$(NH_4)_2SO_4$	1M	–	–	–	6.0	12.0	12.0	–
8.	K_2SO_4	1M	–	–	1.5	–	–	–	–
9.	$Mg(NO_3)_2$	1M	–	–	–	–	12.0	–	12.0
10.	$Mg(PO_4)_2$	1M	–	–	–	30.0	–	–	–

Deficient symptoms

Deficient symptoms exhibited by the plants due to the deficient nutrient solutions are given below

Deficient Solution	Symptoms
Nitrogen deficiency	Chlorosis symptoms and necrotic spots were noted on the leaves
Phosphorus deficiency	Affected the growth of the plant, leaves turned yellow in colour
Potassium deficiency	Stunted growth leaf tip turned brown and gradually dried
Calcium deficiency	Leaves turned light yellow in colour, the size was small
Magnesium deficiency	Leaves turned pale yellow in colour
Sulphur deficiency	The colour of the leaves was light green

Leaf analysis

The moisture and mineral contents of the mulberry leaves grown under different deficient nutrient conditions is presented in the Table 3.

The leaf moisture content ranged from 19.43 per cent to 21.70 percent in various deficient nutrient solution. Whereas in complete nutrient solution it was 22.64 per cent. The leaf moisture was very low (19.43 per cent) in potassium deficient nutrient solution and it was high in magnesium deficient nutrient solution and sulphur deficient nutrient solution (21.70 per cent in both).

Table 3 shows that complete withdrawal of the elements from the solution, resulted in a drastic reduction in its concentration in the leaves. It revealed that with drawal of nitrogen in the solution affected 'P' and 'K' levels in the leaves. Deficiency in phosphorus resulted in lowering of almost all other mineral content in the leaves. In this study 'K', 'Ca' and 'S' deficiency slightly increased the 'N' leavel in the leaves. But 'Ca' deficiency decreased the phosphorus level also in the leaves. It shows 'Ca' had a role in the uptake of the phosphorus by the plants (Shyamala and Bhat, 1965).

Table 2 : Effect of different deficient nutrient solutions on mulberry growth (Average of 10 replications)

S No.	Treatments	Establishment %	Shoot length in (cm)	Shoot length Reduction %	Root length in (cm)	Root length Reduction %	Shoot weight in (g)	Shoot weight Reduction %	Root weight in (g)	Root weight Reduction %	S/R (wt.) ratio	Leaf area in (cm)	Leaf area Reduction %
1.	Complete nutrient	83.3	16.04	—	12.64	—	1.100	—	0.700	—	1.57	47.80	—
2.	— N	67.0	11.83	26.25	10.45	17.33	0.775	29.55	0.530	24.29	1.46	45.35	5.13
3.	— P	50.0	12.90	19.58	12.40	1.90	0.823	24.27	0.500	28.57	1.66	40.00	16.32
4.	— K	33.3	7.35	54.18	7.56	40.27	0.250	77.27	0.250	64.29	1.00	14.00	70.71
5.	— Ca	50.0	13.90	13.34	11.97	5.30	0.690	37.27	0.570	18.57	1.18	31.05	35.04
6.	— Mg	33.3	14.55	9.29	15.30	+ 21.04	0.800	27.27	0.450	35.71	1.77	33.05	30.86
7.	— S	50.0	15.10	5.86	12.40	1.90	0.700	36.36	0.430	38.57	1.63	29.40	38.49
	Significant		5%		1%		1%		NS			1%	
	CD		3.79		2.04		0.282					9.06	

Table 3 : Mineral content in mulberry leaves grown under different deficient nutrient solution

S. No	Treatments	Leaf Moisture %	% Dry weight of leaves				
			N	P	K	Ca	Mg
1.	Complete nutrients	22.64	3.50	0.331	0.151	3.75	2.40
2.	—N	21.17	0.28	0.219	0.134	2.75	1.80
3.	—P	21.69	2.97	0.225	0.133	2.50	1.05
4.	—K	19.43	3.57	0.331	0.067	4.50	3.30
5.	-Ca	20.42	2.57	0.239	0.428	1.75	1.95
6	-Mg	21.70	3.36	0.350	0.476	4.50	1.20
7.	-S	21.70	5.15	0.375	0.392	4.50	1.95

Feeding experiment

The effect of mulberry leaves grown under different nutritional conditions on the larval characters, larval duration and E.R.R. are presented in the Table 4.

Due to the lower concentration of tha elements in the leaves, the duration was prolonged in the nutrient deficient leaves especially in 'P' and 'K' deficient leaves. Evans (1938) also found that chemical composition of cabbage affects the rate of growth, length of larval period and pupal weight of *Pieris brassicae*.

Effect of mulberry leaves grown under different nutrient soultaion on cocoon characters and silk characters are given in the Table 5. In general the cocoons were very small flimsy in nature and very less in silk content than that of control ones. The cocoon and silk characters were affected very badly by phosphorus deficient leaves and it was followed by nitrogen deficient leaves.

Table 4 : Effect of mulberry leaves grown under different nutritional conditions on silkworm larval haracters, larvel duration and E. R. R.

S. No.	Treatments	Larval length in (cm)	Reduction %	Larval weight in (g)	Reduction %	Larval duration in V stage (in Days)	E. R. R. %
1.	Control (Bush)	6.2	—	1.930	—	8	66.6
2.	Complete Nutrients	6.0	3.22	1.690	12.44	10	50.0
3.	—N	5.2	16.13	0.925	52.07	13	16.6
4.	—P	4.8	22.58	1.250	35.23	15	16.6
5.	—K	5.7	8.06	1.460	24.35	15	16.6
6.	—Ca	5.8	6.45	1.450	24.87	12	25.0
7.	—Mg	5.8	6.45	1.450	24.87	13	16.0
8.	—S	6.0	3.23	1.550	19.69	12	25.0
	Significant	1%					
	C. D	0.36					

Table 5 : Effect of mulberry leaves grown under different nutritional conditions on cocoon and silk characters

S No.	Treatments	Cocoon length		Cocoon width		Cocoon weight		Shell weight		Filament length		Silk weight	
		in (cm)	Reduction %	in (cm)	Reduction %	in (g)	Reduction %	in (mgm)	Reduction %	in (m)	Reduction %	in (mgm)	Reduction %
1.	Control (Bush)	3.2	—	1.7	—	1200	—	200	—	700	—	160	—
2.	Complete Nutrients	2.9	9.38	1.6	5.88	910	24.17	180	10.0	580	17.14	120	25.00
3.	-N	2.5	21.88	1.2	29.41	610	49.16	110	45.0	217	68.00	65	50.38
4.	-P	2.0	37.50	1.1	35.29	510	57.50	80	60.0	110	84.29	30	81.25
5.	-K	2.8	12.50	1.5	11.76	670	44.17	130	35.0	235	66.43	70	56.25
6.	-Ca	2.7	15.63	1.3	23.53	760	36.67	180	10.0	248	64.57	70	56.25
7.	-Mg	2.6	18.75	1.3	23.53	690	42.50	130	35.0	372	46.66	85	46.88
8.	-S	2.6	18.75	1.3	23.53	620	48.33	160	20.0	304	50.57	80	50.00

The above studies ravealed that deficiency in N, P and K affected the growth of the mulberry plant. The quality of mulberry leaves was not suitable for rearing of silkworm. As such the N or P or K deficient leaves affected the growth and economic character of silkworm. Among the three minerals phosphorus deficiency in mulberry leaves affected the cocoon characters and silk characters; because deficiency in 'P' affected the uptake of other elements in the mulberry leaves. Due to this reason the growth of the worms and silk characters were affected more by the 'P' deficient leaves; which is in confirmity with watson, 1964 who reported that phosphorus deficiency was most determental in the care of Tetranyches.

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