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Studies on the Effect of Nitrogen and Phosphorus on the Growth and Flowering of Chrysanthemum CV. Yellow (*Chrysanthemum indicum* Linn) IV. Critical Levels of Leaf Nutrients*

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The leaf nitrogen concentration in the leaves of chrysanthemum CV. Yellow decreased with the progressive development of the plant, while P and K increased slightly and then decreased. The Ca and Mg level increased with advancement of growth. The optimum N : K ratio to obtain good flower yield was assessed as 1 : 2 at pre-bloom and flowering stages of the plant growth.

Periodical leaf analysis can pravide a continuous record of the changing nutritional status of the plant, its peak and low periods of absorption, which when considered along with the development changes in the plant, may provide indications of requirements of specific nutrient elements at the initial stages. Leaf analysis might also serve as a diagnostic and elegant tool for understanding the inner physiology of the plant at various phases of growth. With this in view, the study of nutrient levels of chrysanthemum leaves were undertaken.

MATERIAL AND METHODS

The experimental details in respect of the manurial doses applied were reported earlier (Vijayakumar and Shanmugavelu, 1978). Leaf samples were collected from 10 plants per treatment. The youngest matured 3rd, 4th and 5th pairs of leaves subtending from the apex were collected between 9 and 10 am, dried, powdered and employed for analyses. Sampling of the leaves was done at vegetative (60th day after planting) pre-bloom (100th day after planting) flowering (140th day after planting) and post-bloom (180th day after planting).

RESULTS AND DISCUSSION

Nitrogen: The leaf N progressively increased as substrate N increased (2.783% in No level to 2.957% in N_3 level at vegetative stage). Application of high doses of N significantly increased the leaf N at vegetative stage. In general, the leaf N concentration was maintained at the highest level in the vegetative stage compared to all other stages indicating the necessity of nitrogen requirement at the early stages

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TABLE I. Leaf nutrient leavels (%) at different stages of plant growth in Chrysanthemum

Treatment kg/ha	Growth stages: Vegetative	Pre bloom	Flowering	Post-bloom
		N		
N0	2.782	2.665	2.013	1.797
N1 (50)	2.886	2.118	2.540	1.890
N2 (75)	2.907	2.602	2.030	1.371
N3 (100)	2.957	2.700	2.170	1.488
		P		
N0	0.060	0.370	0.371	0.345
N1 (50)	0.178	0.338	0.331	0.316
N2 (75)	0.128	0.360	0.377	0.347
N3 (100)	0.293	0.415	0.385	0.295
		K		
N0	2.500	4.740	4.425	3.737
N1 (50)	3.050	4.400	4.175	3.360
N2 (75)	3.020	4.920	3.968	3.777
N3 (100)	3.940	4.950	4.256	3.657
		N		
P0	2.782	2.527	2.135	1.502
P1 (75)	3.010	2.670	2.030	1.890
P2 (100)	2.931	2.717	2.001	1.343
P3 (125)	2.820	2.592	2.065	1.810
		P		
P0	0.125	0.360	0.340	0.317
P1 (75)	0.145	0.363	0.356	0.304
P2 (100)	0.195	0.383	0.371	0.321
P3 (125)	0.193	0.378	0.396	0.355
		K		
P0	2.460	4.280	4.306	3.545
P1 (75)	3.310	5.090	4.206	3.670
P2 (100)	3.160	4.870	4.188	3.601
P3 (125)	3.570	4.770	4.125	3.640
		Ca		
N0	0.626	1.124	1.175	1.524
N1 (50)	0.837	1.399	1.364	1.249
N2 (75)	0.799	1.450	0.874	1.549
N3 (100)	0.995	1.395	1.438	1.474
		Mg		
N0	0.220	0.788	0.526	0.888
N2 (50)	0.470	0.683	0.686	0.775
N2 (75)	0.950	0.650	0.463	1.163
N3 (100)	0.538	0.838	1.149	1.297

[Contd.

		Ca		
P0	0.599	1.339	1.324	1.525
P1 (75)	0.713	1.099	1.075	1.485
P2 (100)	0.874	1.544	1.138	1.425
P3 (125)	1.074	1.387	1.313	1.362
		Mg		
0P	0.450	0.950	0.936	0.800
P1 (75)	0.475	0.688	0.775	0.632
P2 (100)	0.363	0.477	0.438	0.426
P3 (125)	0.901	0.850	0.675	1.275

(Table I). Lunt and Kofranek (1958) reported that a high supply of N in the early growth period of chrysanthemum is essential. They also claimed that even if moderate deficiencies of N developed during this period, it may affect the yield and flower quality adversely and subsequent N application may not be effective to recapture the flower quality. Proportionate increase of leaf N levels due to the soil application of N seen in the study is in accordance with the results. Waters (1965) who reported linar increases in N content of leaves with the rate of N application. After the vegetative phase, a gradual decline in the N level was evident. This may be due to greater photosynthetic rate and dilution caused by accumulation of carbohydrate reserves as suggested by Boodley and Meyer (1965). Reduction in leaf N level was noticed at pre-bloom stage. It is plausible that this stage may be the critical period when most of the N may be utilised for the production of carbohydrate reserves for the development of floral primordia.

Phosphorus: Leaf P showed an increasing trend when P was applied in the soil (Table I). It was the heighest with P_2 at vegetative stage. Joiner (1967).

TABLE II. Level of N, P and K in leaf tissue (%)

Kg/ha	N_0 N	N_0 P	N_0 K	N_1 N	N_1 P	N_1 K	N_2 N	N_2 P	N_2 K	N_3 N	N_3 P	N_3 K	Mean N	Mean P	Mean K
							Vegetative								
P_0	2.800	0.06	1.80	2.520	0.20	2.40	2.940	0.14	2.78	2.870	0.10	2.89	2.782	0.125	2.46
P_1	2.800	0.06	4.53	3.220	0.17	2.93	3.080	0.20	2.90	2.940	0.15	2.90	3.010	0.145	3.31
P_2	2.300	0.10	1.70	2.860	0.14	3.48	2.940	1.07	3.50	3.080	0.47	3.98	2.921	0.195	3.16
P_3	2.730	0.02	1.98	2.940	0.20	3.40	2.670	0.10	2.90	2.940	0.45	6.00	2.820	0.193	3.57
Mean	2.782	0.060	2.50	2.886	0.178	3.05	2.907	0.128	3.02	2.975	0.293	3.94			
							Flowering								
P_0	2.100	0.400	4.725	2.240	0.298	4.000	2.030	0.368	4.200	2.170	0.295	4.300	2.135	0.340	4.305
P_1	1.960	0.340	4.300	2.030	0.343	4.325	1.960	0.370	3.900	2.170	0.373	4.300	2.030	0.356	4.206
P_2	2.030	0.373	4.375	2.100	0.340	4.175	2.170	0.370	3.875	2.100	0.403	4.325	2.100	0.371	4.198
P_3	1.960	0.370	4.300	2.100	0.343	4.200	1.960	0.400	3.900	2.240	0.470	4.100	2.065	0.396	4.125
Mean	2.013	0.371	4.425	2.118	0.331	4.175	2.030	0.377	3.968	2.170	0.385	4.256			
							Pre-bloom								
P_0	2.520	0.40	4.70	2.380	0.30	2.50	2.640	0.37	5.23	2.570	0.37	4.70	2.527	0.360	4.28
P_1	2.660	0.34	4.78	2.520	0.34	5.63	2.730	0.37	5.00	2.770	0.40	4.98	2.670	0.363	5.09
P_2	2.740	0.37	4.90	2.740	0.34	4.78	2.660	0.40	4.58	2.730	0.42	5.23	2.717	0.383	4.87
P_3	2.740	0.37	4.60	2.520	0.37	4.70	2.380	0.30	4.88	2.730	0.47	4.90	2.592	0.378	4.77
Mean	2.665	0.370	4.74	2.540	0.338	4.40	2.602	0.360	4.92	2.700	0.415	4.95			
							Post-bloom								
P_0	1.878	0.368	3.900	2.030	0.223	2.880	1.960	0.340	3.700	0.140	0.338	3.700	1.592	0.317	3.545
P_1	1.890	0.360	3.780	1.890	0.303	3.100	1.680	0.343	3.900	1.100	0.273	3.900	1.890	0.304	3.670
P_2	1.530	0.373	3.730	1.680	0.300	3.580	0.203	0.340	3.830	1.960	0.270	3.530	1.343	0.321	3.667
P_3	1.890	0.340	3.500	1.960	0.440	3.880	1.640	0.340	3.680	1.760	0.300	3.500	1.810	0.355	3.640
Mean	1.797	0.345	3.737	1.890	0.316	3.360	1.371	0.347	3.777	1.488	0.295	3.657			

stated that increased P in the substrate increased tissue P. P levels increased with advancement of the growth of the plant and such an increase was considerable upto pre-bloom stage. This may be attributed to the requirement of P for root development and its ample supply needed for flower development during which period the cell elongation would be at a rapid rate. It is also possible that application of P would have resulted in a beneficial effect on the final size of flowers which is of prime economic importance in chrysanthemum. The translocation of 'P' from leaves to apical meristems at the time of flower initiation would have greatly contributes for this quality.

Thus, the need for P in large quantities is in accordance with the findings of Boodly and Meyer (1965) and Kazimirova (1973). P was needed mainly at the initial stages of growth and during flowering period in chrysanthemum.

Pottasium: Leaf K content increased corresponding to the increase in N levels particularly at N_1 and N_3 (Table I). This is in agreement with Waters (1967) who stated that N and K content of leaves increased as the supply of N and K in the substrate was increased. The K content increased with advancement of the development stages and it was maximum at pre-bloom and flowering stages. It indicates the translocation of K from the leaves to the developing flower buds as suggested by Lunt and Kofranek (1958) Boodly and Meyer (1965).

Ceritical level of N, P and K in the leaf: In chrysanthemum the nutrient levels at the rapid growth period were considered as critical level determining the yield and quality (Kazimirova, 1973). In the present study, the optimum N, P and K levels were 2.95, 0.22 and 2.94 per cent respectively at the vegetative stage. This is in line with the work of Kazimirova (1973) who stated that for chrysanthemum cultivar 'Papakha' the best nutrient conditions at the start of intensive growth of the plant were 2.8 to 2.9 per cent N, 0.5 to 0.6 per cent P, and 3.2 to 3.6 to 3.6 per cent K and for cultivar 'Plyvueschie' 3.2 to 3.6 per cent N, 0.5 to 0.6 per cent N and 3.4 to 4.4 per cent K. Waters (1965) reported that the optimum yields were obtained when young mature leaf contained 3.5-4.5 per cent N and 3.5-6.0 per cent K. These results indicate that the critical levels of these nutrients vary with the genotypes cultivars of chrysanthemum and its interaction due to locality and climate.

The proper balance between the N and K called N:K ratio illustrates the importance of levels of N and K elements to obtain optimum growth and yield. This was examined in the present study. At pre-bloom stage, the ratio was higher than at vegetative stage. However, it is interesting to note that the ratio increased to 1 : 2 and showed a further increase at flowering and post-bloom stages. The N : K ratio was maintained almost at a constant level at flowering and post-bloom stages inspite of the different levels of N and P applied through soil. This indicates, that these levels provided a desirable carbohyderate nitrogen ratio. Similar views were expressed by Hill *et al.* (1934), Joiner and Smith (1962)

TABLE III. Levels of CaO and MgO in leaf form

Treatments Kg/ha	N_0 CaO	N_0 MgO	N_1 CaO	N_1 MgO	N_2 CaO	N_2 MgO	N_3 CaO	N_3 MgO	Mean CaO	Mean MgO
					Vegetative					
P_0	0.598	0.150	0.600	0.750	0.398	0.800	0.800	0.100	0.599	0.450
P_1	0.450	0.098	0.650	0.500	0.803	1.198	0.950	0.103	0.713	0.475
P_2	0.753	0.153	0.798	0.150	0.948	0.503	1.000	0.648	0.874	0.363
P_3	0.700	0.503	1.300	0.503	2.050	1.300	1.248	1.300	1.074	0.501
Mean	0.626	0.226	0.837	0.476	0.799	0.950	0.999	0.538		
					Flowering					
P_0	1.200	0.300	1.850	0.848	0.948	0.398	1.300	2.198	1.324	0.936
P_1	0.898	0.848	1.000	0.950	0.950	0.403	1.453	0.900	1.075	0.775
P_2	1.303	0.553	0.603	0.200	1.150	0.200	1.498	0.798	1.138	0.438
P_3	1.300	0.403	2.003	0.748	0.450	0.850	1.600	0.700	1.313	0.675
Mean	1.175	0.526	1.364	0.686	0.874	0.463	1.438	1.149		
					Pre-bloom					
P_0	1.250	0.900	1.400	0.900	1.203	0.750	1.503	1.250	1.339	0.950
P_1	0.448	0.650	1.398	0.553	1.450	0.648	1.100	0.900	1.099	0.688
P_2	1.300	0.800	1.400	0.550	1.898	0.153	1.578	0.403	1.544	0.477
P_3	1.498	0.803	1.400	0.750	1.450	1.050	1.400	0.798	1.387	0.850
Mean	1.124	0.788	1.399	0.688	1.450	0.650	1.395	0.838		
					Post-bloom					
P_0	1.300	0.650	1.300	0.250	1.350	0.900	1.650	1.400	1.525	0.800
P_1	1.548	0.703	1.298	0.498	1.598	0.598	1.498	0.686	1.485	0.622
P_2	1.300	0.948	1.300	1.203	1.600	1.653	1.500	1.900	1.425	1.426
P_3	1.450	1.250	1.098	1.150	1.650	1.500	1.250	1.200	1.362	1.275
Mean	1.524	0.888	1.249	0.775	1.549	1.163	1.474	1.297		

Lunt and Kofranek (1958), Smith (1965) and Waters (1965) and reported that a range of N : K ratio from 1 : 1 to 1 : 2 is necessary for the optimum yield and quality of chrysanthemum. Development of bloom colour depended on adequate K supply and on the amount of this element in relation to N.

Calcium and Magnesium : In general, the level of Ca and Mg in leaf was increasing with advancement of the growth and it was maximum at post-bloom stage. This may perhaps be due to the increase in the growth of the plant. The uptake also increase with the advancement of growth stages. In the shoot and the root Ca content was less compared to the leaf. Boodley (1962) in lily reported that both Ca and Mg showed an increasing trend which reached its peak at harvest, as observed in case of chrysanthemum.

The trend of P concentration varied with the Mg level which followed a pattern similar to P. This is in agreement with the findings of Miller (1938) who opined that Mg seemed to function as a carrier of P and was more abundant and frequently increased in meristematic areas where rapid development took place.

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