MOLYBDENUM DEFICIENCY ON POINSETTIAS, A CAUSE OF LEAF DAMAGE*

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The production of Euphorbia pulcherrima increased so much in the last ten years that it reached considerable economic significance. During the culture, however, frequent leaf damage appears, which appreciably impairs the quality of the plants. In severe cases they are unsalable.

The damage shows itself in the middle in younger leaves through first of all, marginal yellowing, which then flows to the areas between the main nerves or to the entire layer. The yellowed parts of the leaf edge dry up and heavily damaged leaves fall off later.

Besides this often grave damage, a single leaf more or less grown together with unsymmetrical indentation or perferations are observed. Their coloration is ordinarily normal.

These appearances point to a nutrient disturbance. In the following is reported over experiments to clarify their causes.

Influence of pH and Fertilization Intensity on Growth and Leaf Injury

Observance from the practice and our experiments point thereupon, that between the pH-value of the substrates, the fertilization intensities, and the appearance of injury symptoms there existed a connection. To clear up this question, a fertilization experiment served, whose results are reported in the diagram. In this experiment begun on June 5, 1969, poinsettias of the varieties 'Paul Mikkelsen', 'Eckespoint C-1', and 'Annette Hegg' were planted as rooted cuttings in peat in 12 cm plastic pots. Fertilization was begun on June 17. Evaluation followed on July 23 and September 18, 1969.

As experimental fertilization were used:

Lime given: 1.5 and 4.0 grams of lime ($CaCO_3$) per pot (675 ml peat), corresponding to 2.2 and 5.9 kg per cubic meter. Lime was mixed with the peat in containers prior to potting of the plants. The pH values (0.1 N KCl) increased through it by 4.5 to 6.7 respectively.

Liquid fertilization: At the start all the pots respectively received 0.7 gm of complete fertilizer 'Hokaphos-Perfect' corresponding to 100 mg N, 70 mg P_2O_5, and 100 mg K_2O. From June 17 to July 17, 1969, 100 ml of liquid fertilizer was given each pot weekly, altogether 500 ml. The con-

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*Editors' Note: Portions of this article were taken from the original article especially printed for Gartenwelt, (1970/No. 2 from 17 January 1970, pp. 31-35) and translated by Mr. R. Kent Kimmins.

centrations yielded a solution of 1.2, 3.6, 7.2, 10.8, and 14.4 g of salts per liter. The mixture for the post fertilization produced individual salts and contained 18% N, of that one-third NH_4 and two-thirds NO_3 nitrogen, 22% K_2O, 6% P_2O_5 and 1.5% Mg O. Each of the 30 experimental subjects was repeated 16 times. The water sprinking with tap water resulted with the weight control of the pot. The square-built base hindered wash out losses.

The effect of the fertilizer on the linear growth and leaf damage after six weeks of experimental duration (by July 23) is evident in the diagram. In a .36 per cent fertilizer solution the plants are the largest. Higher concentrations led to shorter, more compact plants. This influence of the fertilizer is markedly stronger at pH 4.5 than at 6.7.

In the beginning leaf damage which was described, we recorded results through appraisment of the productivity which is taken up in the diagram. From these it followed that leaf damages resulted only in a low dosage of lime. Besides it only appeared in the middle and high fertilizer concentrations. Finally the varieties are variously susceptible. 'Eckespoint' remained nearly damage free even in the low doses of lime. In comparison 'Paul Mikkelsen' showed especially severe damage with leaf drop just as exhibits by the higher plant range.

In order to establish how fertilizer doses worked out on the nutrient content of the peat, on July 17, samples were removed and the N, P and K levels were found by the Formate method. In summary 1 the mean averages of three kinds are listed and both lime doses, since the difference between these is only slight.

The numbers again reflect the distinctly high fertilizer very plainly. The supply of substrate extended from insufficient to very high generally which are to be considered as far above optimal values.

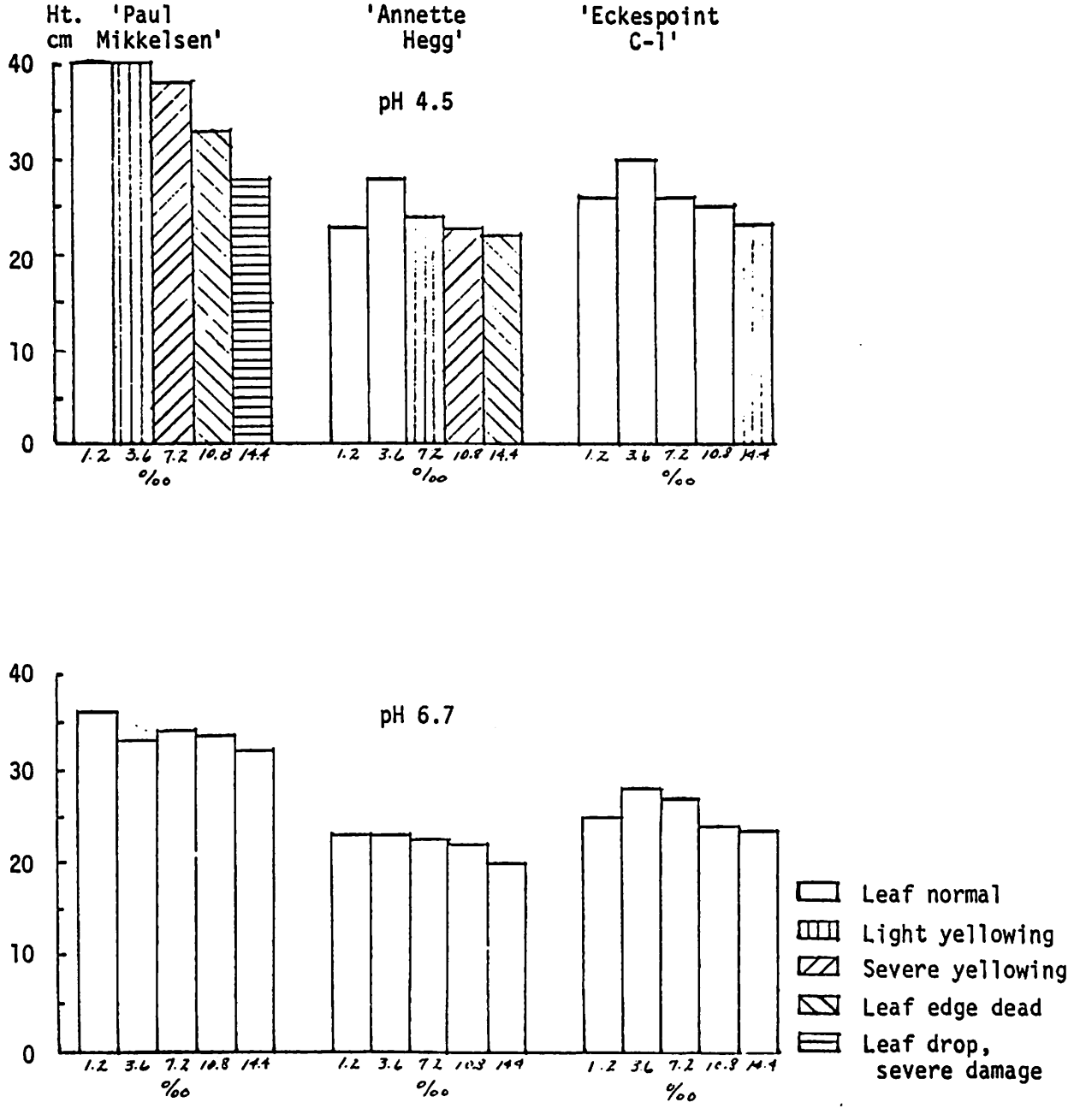
Four plants of each experimental part were placed under short day conditions from July 17 to September 18 to induce flowers. Thus the effect of the fertilizer on the formation of the bracts could be followed. The plants received no fertilizer during this time.

It is perceived that in high fertilization, leaf damage henceforth occurs in spite of high lime doses. To go beyond it is evident how the concentration of the fertilizer solution not only had strong influence on the growth and the leaf development, but also on the bracts. At lower fertilization insufficient bracts are cultured late. The optimum shifted since July 17 from 1.2% to 7.2%, which probably is to be led back to the deposition of fertilizer from July 17 on.

Influence of a Molybdenum-Leaf Fertilization on Leaf Damage

Since the liming of 5.9 g/liter of peat had not lasted, in order to prevent the leaf damage completely over the whole growing period, we conducted a further experiment with increased liming and through

Diagram: Effect of the pH value of the substrate and concentration of the fertilizer solution on the growth and leaf damage of poinsettias.



molybdenum fertilization. Rooted cuttings of the varieties 'Paul Mikkelsen' and 'Annette Hegg' were potted on August 20, 1969 in the same manner as in the previous experiment, however, with lime doses of 1.5, 3.0, 6.0, 9.0 and 12.0 g $CaCO_3$/liter of peat. To the formulation all the vessels (12 cm plastic pots, 675 ml) received a fertilizer solution moreover 62 mg N, 22 mg P_2O_5, 75 mg K_2O and 5 mg Mg O per vessel in the form which was used in the above experiment. To this for trace element supply, each received 1 ml A-Z solution according to Hoagland as well as 1 mg Fe as chelate.

The concentration of the liquid fertilizer during the experiment amounted to 1.2, 3.6 and 10.8%. Of this to each vessel begun between August 29 and October 21, 1969 was dispensed altogether 100 mg eight times. Each of the 30 experimental members consisted of 12 vessels.

On September 19 as previously yellowing became visible, half of the plants in every experimental member in each case received a molybdenum leaf spray and indeed 100 ppm Mo, corresponding to 0.184 g of ammonium molybdate $(NH_4)6\ MO7O_{24}+H_2O$ in each liter of water. In addition the plants were sprayed with an atomizer until the leaves were covered with fine little drops. A repetition of the leaf fertilization followed on March 11, 1969.

Summary 1: Nutrient content of substrate in mg per liter

Post-fertilization in 0/00	N*	P_2O_5	K_2O
1.2	15	66	38
3.6	34	84	114
7.2	238	152	395
10.8	438	240	686
14.4	726	330	1010

* NH_{4-} + NO_3-N

The results on December 7, 1969 of the accomplished appraisement of the productivity are compiled in Summary 2.

From Summary 2 it is to be concluded that in stronger post fertilization with a solution of 10.8% resulted again in leaf damage which disappeared with increasing lime doses. In the variety 'Annette Hegg' however, even 12 g $CaCo_3$/liter was not sufficient to prevent chlorosis of this type.

In comparison the molybdenum fertilization almost completely prevented the damage even under the unfavorable conditions of a high fertilizer concentration and lower lime doses. At the time of spraying, slight chlorosis already present even disappeared. In the unsprayed plants the damage increased in comparison very severely. A few of these plants in the meantime died.

Summary 2: Influence of a molybdenum leaf spray in different calcium and fertilizer doses on leaf damage in poinsettias.

g Salts/ liter fertilizer solution	g $CaCO_3$/ liter peat	'Paul Mikkelsen'		'Annette Hegg'	
		Without Mo	With MO	Without Mo	With Mo
1.2	1.5-12	0	0	+	0
3.6	1.5	+	0	+	0
3.6	3.0	0	0	+	0
3.6	6.0-12	0	0	0	0
10.8	1.5	++++	+	++++	+
10.8	3.0	++++	0	++++	0
10.8	6.0	+++	0	+++	0
10.8	9.0	+	0	++	0
10.8	12.0	0	0	+	0

0 - Without damage symptoms
\+ - Light yellowing
++ - Severe yellowing
+++ - Leaf margin necrosis
++++ - Leaf drop; severe damage

The damage can be avoided by prompt and repeated sprayings of the plants. In this case a concentration of 100 mg Mo/liter (corresponding to approximately 0.2 g ammonium or sodium molybdate) turn out to be as effective. Sufficient molybdenum supply to the soil will also safely prevent the injury. The calcification of the substrate from pH 6 to 7 at least contributes to the reduction of the damage by likewise the avoidance of very high nitrate nitrogen doses.