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RESEARCH ON DAMAGES CAUSED BY "IRON CHLOROSIS" TO POPLARS
(Preliminary notes)

by

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INTRODUCTION

The term "Iron Chlorosis" indicates a chlorosis of the normal green parts of plants caused by a deficiency or a deactivation of iron. As it has been predominantly noticed in calcareous soil, it has often been defined as "calcareous chlorosis".

Ever since the initial research work done by Gris in 1844, intense studies have been carried out (e.g., Brown and Holmes, 1955-1959; Brown, 1956-1961; Wallace and Lunt, 1960; Zhiznevskaya, 1971; Prich, 1968; etc.) in several countries to clarify the various complex sides of this chlorosis. Many of its aspects are still unknown, particularly the one that concerns the process of interaction among various determining factors of Fe deficiency in both preabsorption (edaphic phase) and postabsorption (physiologic phase) and the effects of these on numerous cultivations of which poplar is one.

Even on poplar, the disease generally commences with a chlorosis - at times a type of whitening - of the internerval zones of the lamina which could, in more serious cases, affect the entire leaf surface. The leaves which are largely affected, particularly the growing ones, can progressively get apical and marginal necrosis and can fail prematurely. The pathologic symptoms of leaves generally have a basipetal course. In spite of this, when certain pedoclimatic conditions restore the iron available to plants, this usually allows the well-provided apical top leaves to turn green again. In this case, the chlorosis assumes an acropetal distribution.

In addition to the leaves, even shoots and less-lignified branches can come up against a leaf drop, necrosis and, finally, death. Following this degeneration and shoot reduction, fresh shoots (from reaction) grow along the middle and higher part of the trunk. The plants deform, assuming a weak, disharmonious, cachetic aspect, slacken growth and could still die.

Due to the importance of this disease on poplar in Italy, this Institute has been for several years carrying out research work on etiology and symptomatology, the relative damages incurred in nurseries and plantations and control of chlorosis. As the primary results of studies concerning disease factors such as chemical and nutritive characteristics of the soil have been set out in another paper (Frison et al., 1982), this one refers to some pathologic aspects, such as alterations and damages caused in nurseries and the relative consequences on diseased material in plantations.

OBSERVATIONS ON DAMAGE IN THE NURSERY

The greater part of this research was carried out at the nursery farms "Volpares" (Palazzolo dello Stella, Friuli) and "Carpaneta" (Mantova, Lombardy) under different climatic conditions, in soil from which the poplar plants often encounter chlorosis.

In 1981, during the vegetative season, the chlorosis symptoms of a considerable number of 2-year old nursery plants (about 900 at the "Carpaneta" farm and about 1,440 at the "Volpares" farm, clone "I-214") with different chlorosis intensities, were kept under observation. The height diameter and the intensity of the disease of all the examined plants was observed.

Early in November, in both farms, our observations on chlorosis also included the clone "L. Avanzo" (1,500 plants at the "Volpares" farm and 900 at the "Carpaneta" one), which is becoming more and more important in our country and is gradually being substituted for the "I-214". On this clone, observations were also conducted on 1-year old nursery stock established with different spacing at the Sarmato farm, Piacenza.

The evaluation of chlorotic symptoms was made using the following evaluation scale in 8 distinct classes of intensity on the basis of preliminary research work which allowed us to correlate

various symptoms with harmful effects to plants. This includes the distribution of chlorosis at various levels of the canopy, giving more importance to what was found on the top part of the canopy, then to the lower part, and other symptoms that increased damages (leaf chlorosis, leaf-drop, necrosis of shoots).

Evaulation Scale

Intensity Class	Basipetal distribution	Acropetal distribution
0	No chlorosis	
1	Chlorosis on less than 10% of foliage	Chlorosis on less than 30% of foliage
2	Chlorosis on more than 10% up to 40% of foliage	Chlorosis on over 30% and up to 60% of foliage
3	Chlorosis on more than 40% and up to 70% of foliage	Chlorosis on over 60% and up to 90% of foliage
4	As in class 3 with considerable necrosis or Most of the foliage with chlorosis (> 70% of leaves)	Most of the foliage with chlorosis (> 90% of leaves)
5	Foliage totally with chlorosis and with considerable necrosis	
6	Almost total leaf fall	
7	Necrosis of shoots	
8	Dead plants	

Contents of Dry Matter, Ash and Chlorophyll

Testing carried out in July of healthy and chlorotic leaves of 2-year old plants in the nursery (-clone "I-214) points out that the leaves affected with Fe chlorosis have:

- lower contents of dry subtance, particularly in growing leaves (less than 15 days old) (Table 1-2);
- higher contents of ash particularly in young leaves (Tables 3 and 4);
- reduced quantity of chlorophyll, both in type A and B, correlated (correlation coefficient = 0.96) in a linear way to the intensity of chlorosis (Fig. 1).

From an average quantity of about 14-15 mg/g of fresh weight in completely green leaves, the chlorophyll decreased to respectively one-third and under one-fifth in leaves completely "chlorosised" and also with considerable necrosis.

Influence of Spacing on Chlorosis

In Spring 1981 at the Sarmato farm (Piacenza), in fundamentally calcareous soil, a nursery of clone "L. Avanzo" was established in groups of 4 rows with a distance (of groups) of 2.5 m from one another with plants in groups placed in 4 different densities: 40 m x 60 m, 60 m x 60 m, 40 m x 80m, 60 m x 80m. An experimental scheme on randomized blocks with 4 replications was adopted (experimental unit = 120 plants per plot).

A progressive appearance of chlorosis on plants starting from August was first noticed in very dense spacing. According to a test carried out in October, it appears that the intensity of chlorosis was significantly correlated to both the spacing and the position of the row (Table 5-6). The plants in external rows and those that had wider spacing (60 x 80 m) had a lower intensity of chlorosis.

Chlorosis in Relation to Dimensions of Plants

From the beginning of July 1981, about 500 of 2-year old plants in the nursery of the "Carpaneta" farm, were periodically kept under control. These plants varied in height and were located in plots where, during that period, the disease was in the initial stages.

The disease attacked the small poplars prematurely and more intensively, spreading progressively to the more developed ones (Table 7). At times, due to the change in pedoclimatic conditions, the foliage turned green once more and this usually begins in bigger and competitive plants.

Influence of Chlorosis on Growth of Plants in Relation to its Persistance

From July 10 to October 10, 1981, at the "Carpaneta" farm, the increase in height of suppressed (less than 4 m), intermediate and dominating (more than 6 m) 2-year old plants in nursery-clone "I-214" was measured. At that time, these plants were subject to Fe chlorosis at different levels of intensity and persistency.

It appears (Table 8, Figure 2) that the influence of this disease on the increased height of the plant is correlated with the persistency and intensity of chlorosis and depends on the dimension of the plant, with significant interactions in such factors (Table 9). The suppressed poplars are the ones which sustain major damages. An intense and continuous chlorosis, in all cases, causes an arrest in the growth of the plant no matter how big the plant is and no matter which vegetative season it occurs in.

Incidence of Chlorosis on Nursery Production

At the end of the vegetative season, the 2-year old nursery material kept under control was examined and the results showed that on both "I-214" and "L. Avanzo" Fe chlorosis had caused a considerable loss of production.

From Table 10 it appears that in comparison with plants free from chlorosis, the ones with chlorosis produce smaller and, therefore, commercially less valuable poplars. This is particularly evident (Table 10) in the "I-214" clone, especially at the "Volpares" farm, where the chlorosis began together with the starting of the new vegetation of the second year in the nursery.

In zones with chlorosis, discarded poplars (ø < 2.35 cm) and those of lower commerical classes (ø < 2.35 < 3.32 cm) average 24.17% and 30.56%; instead, in zones without chlorosis average 3.59% and 21.01% respectively. This is confirmed by the strict linear correlation (correlation coefficient = 0.99) existing between the intensity of chlorosis and the height of the plants recorded at the end of the vegetative season (Figure 3).

It should be emphasied that in the situation under question the reduced growth recorded in plants with intense chlorosis is almost completely due to the disease which had not been worsened by competition phenomena, as the yellowing which appeared on most parts of the plants had started from the beginning of the new vegetative period. In other cases, such as clone "L. Avanzo" (see Figure 4) or clone "I-214" of the "Carpaneta" farm, for which chlorosis occurred during the vegetative

season, intense spreading started from the month of July, the ratio between cause (chlorosis) and effect (smaller dimensions of plants) is not tight.

Moisture Content of Poplars

To enable us to verify if Fe chlorosis can influence the lignification of plants and their dehydration during winter, measurements were taken of the vegetative season (Nov. 10, 1981) and before transplanting of poplars (March 20, 1982), of the moisture content (as % of fresh weight of wood) of the lower part, median and apical part (the last 70 cm of the top) of 2-year old poplar trunks (-clone"L. Avanzo"-) with analogous diameters but with different symptoms of chlorosis. At the end of the vegetative season, the moisture content did not vary considerably (Table 11) in the media-basal part of the trunk while in the apical part the moisture content was highly correlated (correlation coefficient = 0.95) with intense chlorosis (Figure 5). The top part of the plants with greater intensity of chlorosis presented about 72% of moisture content to only 57% in healthy plants.

It appears, from tests carried out after winter, that while the median-lower part of the poplars, in all cases, was not very dehydrated, the decreased moisture content in the top part of the plant was highly correlated (correlation coefficient = 0.94) to the intensity of chlorosis (Table 11, Figure 5). The top part of the plants with the highest intensity of chlorosis were nearly completely dehydrated (less than 20% water).

CONSEQUENCES OF CHLOROSIS ON PLANTATIONS ESTABLISHED WITH DISEASED MATERIAL

Poplars with different diameter (- clone "I-214" -) from which during the last month of vegetative growth in the nursery, the intensity of the presence of Fe chlorosis was taken, were placed in habitats having four different types of soil: sandy, compact, fundamentally calcareous and naturally very calcareous. Each plant was identified with a special colour to distinguish the various diameters and the intensity of the presence of chlorosis in the nursery.

All plants placed in the different habitats were periodically checked for:
- the course of the new vegetative growth;
- striking;
- presence of cortical necrosis due to parasites (Dothichiza, Cytospora, etc.) and non-parasite ("Brown spots").

A detailed analysis regarding the behaviour of planting material of each type of soil, mentioned above, will be referred to in another paper; in this one we refer to overall results.

Course of new Vegetative Growth

On the basis of a number of observations made regarding the quality of the starting of vegetative growth of new plants, it appears that poplars with high intensity chlorosis have:

(a) a poor and slow sprouting, sending forth suffering and chlorotic shoots. Most of the buds appear to be without life and they do not open, particularly those on the apical part of the tree; the living ones begin to open a few days after the ones on healthy plants. The shoots, generally suffering, grow slowly, and present leaves with chlorosis which often get necrosis on the marginal and internerval parts of the lamina. The leaves to have an elevated transpiration (see Anselmi, 1982) compared to normal ones (Table 12-13). Both chlorosis - probably connected to the lack of iron in the trunk of plants - and the suffering state of shoots are generally correlated with the intensity of the disease which attacked plants in nursery. The above-mentioned state of chlorosis and the suffering of the new vegetation gradually disappear with the formation of new roots when the plants are able to attain nutrients from the soil. This generally takes places within 15-20 days after the appearance of the shoots.

(b) a marked death-rate of the plant tops, particularly on smaller plants and the ones with a high intensity of chlorosis (Table 14);

(c) delayed and difficult rooting. Compared to healthy plants, the ones with chlorosis rooted one week later, and the plants with a high intensity of chlorosis showed very slow root growth. A month after the beginning of vegetative growth, some of the plants had roots only 5-6 cm long compared to 15-20 cm of healthy plants. Due to this delay and poor rooting, some of the young poplars died being unable to balance absorption and transpiration of water in their shoots.

Striking

The striking in plantation of poplars attacked in nursery by iron chlorosis has been strongly manifested. Table 16, relative to partitioning of Chi^2 concerning data on stricken plants (Table 15), shows a highly significant clear influence on striking of both chlorosis intensity in nursery and of the plants' diameter with symptoms 4 and 5.

The plants in nursery showing chlorosis symptoms lower or equal to 3 have been stricken almost normally; those with symptom 4 (completely yellow plants) showed a high death-rate in the two lower commerical classes; those with symptom 5 (extensive leaf necrosis) showed a high death-rate, particularly in the last three commerical classes and, finally, those with symptom 6 (intense leaf fall and necrosis on shoots) are mostly dead, without distinction between diameter classes.

Cortical Necrosis Attacks

The part of non-stricken plants attacked by hemiparasite fungi (Dothichiza, Cytospora, Phomopsis, Trichothecium) was the trunk; also the surviving ones showed attacks of cortical necrosis, both of parasitic origin, mainly Dothichiza populea, and of physiological nature, such as "Brown spots." Both Dothichiza and "Brown spots" attacks were significantly stronger on plants which were more severely attacked by chlorosis (Table 17-18). This is probably due to the weakness and to the physiological differences of these plants due to the poor accumulation of reserve substances in the trunk and to the high dehydration suffered during winter.

TECHNIQUE FOLLOWED TO DECREASE THE NEGATIVE CONSEQUENCES OF CHLOROSIS ON TRANSPLANTED PLANTS

In order to single out techniques suitable for reducing the above-mentioned damages' the new plantations which were established with "chlorosised" plants in appropriate plantations attached to those taken into consideration the non-treated plants have been compared to others for:

- tip-lopping 1 - 1.5 m at the time of planting;
- soaked in water before planting.

Tip-lopped Plants

This technique, which had no influence on the number of non-vegetated plants and on the cortical necrosis attackes, has considerably reduced the number of plants with withered-tips (Table 19). Moreover, even without statisitical approval, the tip-lopping seemed to favour shoot development and to decrease the number of dead plants after the process of vegetative growth had started.

Soaked Plants

Table 21, relative to partitioning of the Chi^2 concerning data on striking of plants whether or not soaked in water (Table 20), shows how water soaking prior to planting has significantly increased their striking. This technique has improved the rooting and the shooting, decreasing cortical necrosis attacks both by Dothichiza populea and "Brown spots" (Table 22-23). It should be finally emphasized how water soaking has cancelled the death-rate of plants having chlorosis intensity 4 in nursery, even of those having smaller dimensions.

CONCLUSIONS

Poplar is highly damaged by iron chlorosis. In nurseries the disease decreases plant growth, reduces vitality and the success of planting. The most "chlorosised" plants in nursery can easily get cortical necrosis, especially the smaller ones, due to the physiological imbalance endured during vegetative growth, the decreased reserve substances in the trunk and the high dehydration during winter following transplanting. These plants can show a poor and slack rooting and vegetative growth. Water soaking of plants for a few days before planting highly increased the success of even the most damaged individuals.

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Table 1

Carpaneta Farm, End of July 1981 - 2-Year Old Poplar Nursery
- Clone "I-214" - Contents of Dry Weight (% of Fresh Weight)
Of Samples of 20 Leaves of Differerent Ages,
Healthy and with Heavy Chlorosis

Leaf position on shoot	Age (days)	% dry weight Healthy leaves	"Chlorosised" leaves	Difference
1	< 1	25.94	23.31	- 2.63
2		24.89	21.58	- 3.31
3		24.19	20.99	-3.20
4	1-15	23.74	21.39	- 2.35
5		24.70	22.0	- 2.70
6		25.4	23.1	- 2.30
7	15-25	26.34	24.5	- 1.84
8		26.10	24.19	- 1.91
9		27.99	25.94	- 2.05
10		26.92	25.02	- 1.90
11		27.84	25.89	- 1.95
12	> 25	27.04	24.94	- 2.10
13		26.72	25.82	- 0.90
14		27.39	25.92	- 1.47

Table 2

Analysis of Variance of Data Recorded in Table 1

Source of variation	Deviance	Degrees of freedom	Variance	F
Chlorosis	84.1801	1	84.1801	413.2021**
Age of leaves	211.8962	13	16.2997	80.0079**
Interaction	13.9018	13	1.0694	5.2490*
Error	11.4087	56	0.2037	
Total	321.3868	83		

* the value at F is significant at P = 0.05

** the value at F is significant at P 0.01

Table 3

Volpares Farm - 2-Year Old Poplar Nursery of "I-214" -
Ash Contents (As % of Dry Weight) in Leaves of Different Ages
Affected by Iron Chlorosis

Age of leaves	Chlorosis			
	absent	slight	average	heavy
5-8	8813	-	-	9827
25-30	8706	8766	8855	8918

Table 4

Analysis of Variance of Data Concerning
Chlorosis Absent and Heavy of Table 3

Source of Variation	Deviance	Degrees of Freedom	Variance	F
Chlorosis	0.039	1	0.039	483.7523**
Age of leaves	0.020	1	0.020	244.8201**
Interaction	0.007	1	0.007	84.2319**
Error	0.001	8	0.000	
Total	0.067	11		

** the value at F is significant at P = 0.01

TAB. 5 SARMATO, SEPTEMBER 1981 - 1-YEAR OLD POPLAR NURSERY OF CLONE "L. AVANZO" - SYMPTOM INTENSITY OF IRON CHLOROSIS ON ACCOUNT OF SPACING AND POSITION ON THE ROW

Spacing (cmxcm)	Internal row		External row	
	Symptom intensity	Chlorophyll* (mg/g fresh weight)	Symptom intensity	Chlorophyll* (mg/g fresh weight)
60 x 40	3.10	0.064	2.30	0.0823
60 x 60	3.00	0.066	1.76	0.0946
80 x 40	2.70	0.0732	1.32	0.1047
80 x 60	2.13	0.0861	1.17	0.1079
220 x 40**	0.8	0.126	0.70	0.120

* taken from Fig. 1

** not included in tests

Table 6

Analysis of Variance of Table 5 Regarding Chlorosis Symptoms

Source of Variation	Deviance	Degrees of Freedom	Variance	F
Spacing	4.9259	3	1.6420	4.33*
Row position	9.6141	1	9.6141	25.38**
Interaction	0.4148	3	0.1383	0.36
Error	9.5066	24	0.3788	
Total	24.046	31		

* Significant at P = 0.05

** Significant at P = 0.01

Table 7

Carpaneta Farm - 2-Year Old Poplar Nursery - Clone "I-214"
Evolution of Chlorosis During the Period July10-October 10, 1981 on Suppressed, Intermediate and Dominating Plants: Percentage of Plants with Slight or Absent, Average and Heavy Chlorosis on Different Dates

Type of plant on 7.7.82	No. of plants examined	Chlorosis Intensity											
		10.7.1981			31.7.1981			30.8.1981			10.10.1981		
		Slight or absent	Average	Heavy	Slight or absent	Average	Heavy	Slight or absent	Average	Heavy	Slight or absent	Average	Heavy
Suppressed	50	10	80	10	4	56	40	2	30	68	2	22	78
Intermediate	200	75	25	0	20	60	20	11	51	38	8	52	40
Dominating	250	85	15	0	30	60	10	15	60	30	10	60	30

Table 8

Carpaneta Farm, 2-year Old Plants - Clone "I-214" in Nursery
The First Three Columns Show the Average Length of Time (months) of Chlorosis During July 10-October 10, 1981. The Last Three Columns Show the Corresponding Average Increases in the Height (cm) of Suppressed, Intermediate and Dominating Plants Obtained During the Same Period

Chlorosis intensity*			Type of plants**		
None or slight	Average	Heavy	Suppressed	Intermediate	Dominant
3	0	0	145	216	234
1.5	1.5	0	100	195	216
0.5	2.5	0	90	169	203
0.5	1	1.5	65	135	162
0	1.5	1.5	59	125	155
0	3	0	0.85	160	1.95
0	0	3	0.22	0.45	0.45

* symptom index: <1 = slight; $\geq 1 < 4$ = average; ≥ 4 = heavy

** tall on July 7, 1981: <4 m suppressed ones; $\geq 4 < 6$ m intermediate ones; ≥ 6 m dominating ones.

Table 9

Analysis of Variance of Data Recorded in Table 8 Regarding Height.

Source of Variation	Deviance	Degrees of Freedom	Variance	F
Persistence of chlorosis	755,677.46	6	125,946.24	460**
Plant dimension	452,894.76	2	226,447.38	827**
Interaction	58,706.35	12	4,892.19	17**
Error	80,454.00	294	273.65	
Total	1,347,732.57	314		

** the value at F is significant at P = 0.01

Table 10

Volpares and Carpaneta Farms, Autumn 1981 - Sample Areas in Poplar Nurseries Attacked by Iron Chlorosis: Total Amount of Plants (healthy+diseased) and Those in "Plots" of Healthy Ones

Commercial Class	Diameter Class	"I-214" Healthy		"I-214" Healthy+Deseased		Difference	"L. Avanzo" Healthy		"L. Avanzo" Healthy+Deseased		Difference
		# Plants	%	# Plants	%	%	# Plants	%	# Plants	%	%
Volpares											
	≤ 2.35	15	3.59	265	24.17	+ 20.58	2	0.48	17	1.10	+ 0.62
I	>2.35<3.03	87	21.01	335	30.56	+ 9.55	20	4.87	60	3.90	- 0.97
II	>3.03<3.32	147	35.50	278	25.40	- 10.10	80	19.51	488	31.79	+ 12.28
III	>3.32<4.62	150	36.23	191	17.42	- 18.81	180	43.90	701	45.67	+ 1.77
IV	>4.62<5.4	12	2.9	25	2.29	- 0.61	120	29.27	261	17.00	- 12.27
V	<5.4	3	0.72	2	0.02	- 0.70	2	1.95	8	0.52	- 1.43
		414	100.00	1096	100.00	0.00	410	100.00	1535	100.00	0.00
Carpaneta											
	<2.35	1	0.41	20	2.92	+ 2.51	1	0.34	3	0.34	+ 0.00
I	>2.35<3.03	1	0.41	20	2.92	+ 2.51	1	0.34	3	0.34	+ 0.00
II	>3.03<3.32	24	9.76	100	14.60	+ 4.84	15	5.14	59	6.58	+ 1.44
III	>3.32<4.62	75	30.49	176	25.69	- 4.80	50	17.12	182	20.31	+ 3.19
IV	>4.62<5.4	93	37.80	232	33.9	- 3.90	105	35.96	304	33.92	- 2.04
V	<5.4	52	21.14	137	20	- 1.14	120	41.09	345	38.50	- 2.59
		246	100.00	685	100.00	0.00	292	100.00	896	100.00	0.00

Table 11

Palazzolo Dello Stella, 1981-1982 - Two Year Old Nursery of "L. Avanzo" Clone. Water Content (% of fresh weight) of the Wood From Top, Middle and Basal Part of the Stem and Levels of Pathological Symptoms Caused by Iron Chlorosis on Plants of Similar Basal Diameter

	Before leaf fall (10.11.81)			Before leaf appeared (10.3.82)		
Symptoms	Top	Middle	Basal	Top	Middle	Basal
0	56,76 a	54,72 a	52,49 ab	38,63 a	51,87	57,22
1	58,85 ab	54,95 a	51,38 a	37,57 a	54,36	57,28
2	62,01 bc	57,37 ab	55,50 abc	32,37 b	54,83	56,15
3	64,33 cd	57,12 ab	56,06 bcd	29,28 b	53,35	56,98
4	67,98 de	58,87 b	55,79 cd	20,05 c	48,35	55,39
5	70,70 e	58,99 b	57,45 cd	19,69 c	51,27	54,19
6	72,11 e	60,56 b	59.87 d	19,27 c	48,93	54,48
7	-	-	-	18,96 c	47,48	55,7

The values marked by different letters differ significantly from one-another at P = 0.05

Table 12

Casale Monferrato, May 1982 - Newly Established Poplar Plantation with 2-Year Old Plants Attacked by Iron Chlorosis: Transpiration of Different Aged Healthy and "Chlorosed" Leaves ($g/m^2/10'$)

Age of leaves (days)	Transpiration ($g/m^2/10'$) Healthy	Chlorosed
1	0.6447	0.7433
6 - 8	0.7327	0.9200
18 - 20	0.5380	0.6337

Table 13

Analysis of Variance of Data Recorded in Table 12

Source of variation	Deviance	Degrees of freedom	Variance	F
Age of leaves	0.1741	2	0.0871	33.8476*
Presence of chlorosis	0.0728	1	0.0728	28.3195*
Interaction	0.0081	2	0.0041	1.5819
Error	0.0309	12	0.0026	-
Total	0.2859	17		

* the value at F is significant at P = 0.01

Table 14

Newly Established Poplar Plantation with 2-Year Old Plants Attacked in the Nursery by Iron Chlorosis with Different Intensities: Data on Wither-tip on Living Plants

Comm. class	I			II			III			IV			V			Total		
Dia.(cm)	2.35 3.03			3.03 3.32			3.32 4.62			4.62 5.4								
Plants Symptoms	Total No	Affected No	%	Total No	Affected No	%	Total No	Affected No	%	Total No	Affected No	%	Total No	Affected No	%	No	No	%
0	9	0	0	136	1	0,7	43	0	0	48	0	0	28	0	0	264	1	0,38
1	57	0	0	78	0	0	60	0	0	54	0	0	30	0	0	279	0	0,00
2	33	0	0	51	1	1,9	59	0	0	50	0	0	7	0	0	200	1	0,50
3	62	1	1,6	72	0	0	39	0	0	35	0	0	17	0	0	225	1	0,44
4	47	2	4,3	51	2	3,9	21	1	4,8	22	0	0	14	0	0	155	5	3,23
5	55	9	17,0	61	9	14,8	24	4	16,7	13	0	0	4	1	25,0	157	23	14,65
6	14	6	42,8	9	5	55,6	5	3	60,0	1	0	0	-	-	-	29	14	48,27
Total	277	18	65	458	18	3,93	251	8	3,19	233	0		100	1	1,00	1309	45	3,44

Table 15

Newly Established Poplar Plantation with 2-Year Old Plants Attacked in the Nursery by Iron Chlorosis with Different Intensities: Data on Stricken Plants

Commercial class	I			II			III			IV			V			Total		
Dia.(cm)	>2.35-3.03			>3.03-3.32			>3.32-4.62			>4.62-5.4			>5.4					
Plants chlor. Symptoms	Total No	Stricken No	%	Total No	Stricken No	%	Total No	Stricken No	%	Total No	Stricken No	%	Total No	Stricken No	%	No	No	%
0	10	9	90	139	136	97.8	44	43	97.7	48	48	100	28	28	100	269	264	98.14
1	57	57	100	79	78	98.7	60	60	100	54	54	100	30	30	100	280	279	99.64
2	33	33	100	53	51	96.2	60	59	98.3	50	50	100	7	7	100	203	200	98.52
3	62	62	100	73	72	98.6	40	39	97.5	35	35	100	17	17	100	227	225	99.11
4	75	47	62.7	68	51	75.0	29	21	72.4	23	22	95.7	15	14	93.3	210	155	73.80
5	100	55	55	105	61	57.0	40	24	60.0	16	13	81.2	4	4	100	265	157	59.24
6	34	14	41.2	27	9	33.3	18	5	27.8	6	1	16.7	0	0	0	85	29	34.11
Total	371	277	74.66	544	458	84.19	291	251	86.25	232	223	96.12	101	100	99.0	1539	1309	85.05

Table 16

Partitioning, According to Brandt and Snedecor Method, of Total Chi^2 Concerning Table 15 for Comparisons in Levels of Study Factors (Stricken Plants).

Comparisons		Degrees of freedom	Chi^2
In symptoms		6	497.7383**
"	(symptom 0)	4	0.6854
"	(" 1)	4	0.0658
"	(" 2)	4	0.3465
"	(" 3)	4	0.1528
"	(" 4)	4	18.9636**
"	(" 5)	4	12.3468*
"	(" 6)	4	3.9237
Total		34	534.2232
Table 15 inclusive		34	534.2232

* the value at F is significant at P = 0.05

** the value at F is significant at P = 0.01

Newly Established Poplar Plantation with 2-Year Old Plants Attacked in the Nursery by Iron Chlorosis with Different Intensities: Data on Dothichiza Populea on the Living Plants

Commercial class	I			II			III			IV			V					
Dia.(cm)	>2.35<3.03			>3.03<3.32			>3.32<4.62			>4.62<5.4			>5.4			Total		
Plants chlor. Symptoms	Total No	Stricken No	%	Total No	Stricken No	%	Total No	Stricken No	%	Total No	Stricken No	%	Total No	Stricken No	%	No	No	%
0	9	0	0	136	0	0	43	0	0	48	0	0	28	1	3.6	264	1	0.38
1	57	5	8.8	78	2	2.6	60	1	1.7	54	0	0	30	0	0	279	8	2.87
2	33	1	3.0	51	6	11.8	59	2	3.4	50	0	0	7	0	0	200	9	4.50
3	62	5	8.1	72	4	5.6	39	0	0	35	0	0	17	0	0	225	9	4.00
4	47	15	31.9	51	21	41.2	21	4	19.0	22	2	9.0	14	0	0	155	42	27.10
5	55	29	53.0	61	34	55.7	24	11	45.8	13	1	7.7	4	2	50.0	157	77	49.04
6	14	7	50.0	9	4	44.4	5	5	100.0	1	1	100	-	-	-	29	17	58.62
Total	277	62	22.38	458	71	15.50	251	23	9.16	223	4	1.79	100	3	3.0	1309	163	12.45

Table 18

Newly Established Poplar plantation with 2-Year Old Plants Attacked in the Nursery by Iron Chlorosis with Different Intensities: Data on "Brown Spots" on the Living Plants

Commercial class	I			II			III			IV			V			Total		
Dia.(cm)	>2.35<3.03			>3.03<3.32			>3.32<4.62			>4.62<5.4			>5.4					
Plants Chlor. Symptoms	Total No	Stricken No	%	Total No	Stricken No	%	Total No	Stricken No	%	Total No	Stricken No	%	Total No	Stricken No	%	No	No	%
0	9	0	0	136	13	9.6	43	1	2.3	48	0	0	28	0	0	264	14	5.30
1	57	5	8.8	78	10	12.8	60	6	10.0	54	1	1.9	30	0	0	279	22	7.89
2	33	6	18.2	51	7	13.7	59	0	0	50	0	0	7	0	0	200	13	6.50
3	62	11	17.7	72	8	11.1	39	1	2.6	35	0	0	17	0	0	225	2	8.89
4	47	17	36.2	51	14	27.4	21	2	9.5	22	0	0	14	0	0	155	33	21.29
5	55	26	47.0	61	27	44.3	24	5	20.8	13	1	7.7	4	1	25.0	157	60	38.22
6	14	7	50.0	9	2	22.2	5	4	80.0	1	1	100	0	0	0	29	14	48.28
Total	277	72	25.99	458	81	17.68	251	19	7.57	223	3	1.35	100	1	1.00	1309	176	13.45

Table 19

Newly Established Poplar Plantation with 2-Year Old Plants Attacked in the Nursery by Iron Chlorosis: Data on Wither-tip of Normal and Tip-lopped Plants

Chlorosis Symptoms	Normal Plants			Tip-lopped plants		
	Total No	Affected No	%	Total No	Affected No	%
0	48	0	0.00	49	1	2.04
1	83	1	1.20	84	0	0.00
2	45	1	2.22	44	0	0.00
3	55	0	0.00	54	1	1.85
4	60	9	15.00	61	0	0.00
5	129	30	23.26	120	9	7.50
6	40		40.00	36	3	8.33

Table 20

Newly Established Poplar Plantation with 2-Year Old Plants Attacked in the Nursery by Iron Chlorosis: Data on Stricken Plants Soaked in Water and Not Before Planting

Chlorosis Symptoms	Normal plants			Soaked in water plants		
	Total No	Stricken No	%	Total No	Stricken No	%
0	45	44	97.78	49	49	100
1	59	58	98.31	56	56	100
2	46	44	95.65	45	45	100
3	44	41	93.18	46	46	100
4	61	48	78.69	64	61	95.31
5	81	45	55.56	77	64	83.12
6	29	12	41.38	29	16	55.17

Table 21

Partitioning, According to Brandt and Snedecor Method, of Total Chi^2 Concerning Table 20 for Comparisons in Levels of Study Factors

Comparisons		Degrees of freedom	Chi^2
In symptoms		6	155.6839**
In treatment	(symptom 0)	1	0.0964
"	(" 1)	1	0.0687
"	(" 2)	1	0.3581
"	(" 3)	1	0.8707
"	(" 4)	1	7.1887**
"	(" 5)	1	24.9748**
"	(" 6)	1	2.2976
Total		13	191.5392
Table 20 inclusive		13	191.5392

** the value at F is significant at P = 0.01

Table 22

Newly Established Poplar Plantation with 2-Year Old Plants Attacked by Iron Chlorosis in the Nursery: Data on Dothichiza Populea of Living Plants Soaked in Water and Not Before Planting

Chlorosis Symptoms	Normal plants			Soaked in water plants		
	Total No	Attacked No	%	Total No	Attacked No	%
0	44	3	6.82	49	1	2.04
1	58	5	8.62	56	0	0.00
2	44	5	11.36	45	1	2.22
3	41	9	21.95	46	1	2.17
4	48	26	54.17	61	10	16.39
5	45	24	53.33	64	17	26.56
6	12	9	75.00	16	8	50.00

Table 23

Newly Established Poplar Plantation with 2-Year Old Plants Attacked by Iron Chlorosis in the Nursery: Data on "Brown Spots" of Living Plants Soaked in Water and Not Before Planting

Chlorosis Symptoms	Normal plants			Soaked in water plants		
	Total No	Attacked No	%	Total No	Attacked No	%
0	44	5	11.36	49	2	4.08
1	58	7	12.07	56	3	5.36
2	44	3	6.82	45	2	4.44
3	41	9	21.95	46	1	2.17
4	48	19	39.58	61	8	13.11
5	45	21	46.67	64	16	25.00
6	12	6	50.00	16	4	25.00