INFLUENCE OF URBAN SLUDGE USED AS FERTILIZER ON IDARED APPLE BEHAVIOR

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Abstract

The ever increasing town – planning worldwide and in our country as well has had as a result the increased waste water and sludge amounts resulted from their clearings in special plants. The utilization of this sludge as fertilizer in agriculture is a practical solution in the environmental protection against the pollution caused by it. The studies undertaken in this sense were particularly focused on the cereals and less on the fruit species crops. To emphasize the effects of urban sludge application on Idared apple cultivar grafted on M9 rootstock, an experiment at RIFG was organized in 2006. The following experimental scheme with planting pots was used: **A factor** = depth of planting substrate for applying the organic matter on it, with two graduations: a_1 = 0 - 30 cm; a_2 = 0 - 60 cm; **B factor** = type and amount of organic matter applied (g/l substrate), with the following graduations: b_1 = 0; b_2 = manure 340 g/l; b_3 = sludge 170 g/l; b_4 = sludge 340 g/l; b_5 = sludge 510 g/l; b_6 = sludge 680 g/l. Therefore, it was a bi-factorial experiment like 2 x 6, designed as subdivided blocks, with 4 replications. Each planting pot consists in a concrete cylinder of 1 m height and diameter, and 0.785 m^3 volume. To sum up the effects of the experimental factors on the trees response, the following readings were recorded: dynamics of trunk diameter growth, length growth of annual shoots, number of flower buds/tree and fluorescence. In the first year after planting, the depth of the planting substrate did not significantly influence the annual increase in the trunk cross sectional area (TCSA). Nevertheless, in the case of a_1 = (0 – 30 cm) substrate, the total annual shoot growth per tree was significantly higher by 113% versus a_2 = (0 – 60 cm). Manure application as 340 g/l substrate versus the unfertilized control influenced by far the annual increase in TCSA (167%) and of total annual growth (182%). Urban sludge application (170-680 g/l substrate) versus the unfertilized substrate led to a significantly higher increase (140-155%) in TCSA. The total annual shoot growth showed also higher values (141-184%) in the case of more than 340 g/l sludge application (b_4 – b_6) versus the unfertilized control. The same rate of manure (340 g/l) determined a significant increase in total annual growths by 129% vs. sludge application, but did not significantly influence the TCSA.

1. Introduction

The ever increasing town – planning worldwide and in our country as well has had as a result the increased waste water and sludge amounts, resulted from their clearings in special plants. The utilization of this sludge as fertilizer in agriculture is a practical solution in the environmental protection against the pollution caused by this (3). The studies undertaken in this sense were particularly focused on the cereals and less on the fruit species crops. To emphasize the effects of urban sludge application on Idared apple grafted on M9 rootstock, an experiment at RIFG Pitesti Maracineni, Romania, was organized in 2006.

2. Material and methods

The following experimental scheme with planting pots was used:

A factor = depth of planting substrate for applying the organic matter on it with two graduations: a_1 = 0 - 30 cm; a_2 = 0 - 60 cm;

B factor = type and amount of organic matter applied (g/l substrate), with the following graduations: b_1 = 0; b_2 = manure 340 g/l; b_3 = sludge 170 g/l; b_4 = sludge 340 g/l; b_5 = sludge 510 g/l; b_6 = sludge 680 g/l; Therefore, it was a bifactorial experiment like 2 x 6, designed as subdivided blocks in four replications. Each planting pot consists in a concrete cylinder of 1 m height and diameter, with a volume of 0.785 cm^3 (foto.1)

To sum up the effects of the experimental factors on the trees response, the following readings were recorded: dynamics of trunk diameter growth; dynamics of length growth of annual shoots, number of flower buds/tree; fluorescence of the leaves (F_0 = minimum fluorescence; F_m = maximum fluorescence; F_v/ F_m –

ratio between the fluorescence range and maximum fluorescence; F/F_m = ratio between the total fluorescence/ maximum fluorescence.

3. Results

3.1. Influence of urban sludge application on tree growth and fruiting

3.1.1. Influence on growth

3.1.1.1. Growth of trunk cross sectional area (TCSA)

Data in fig. 1 show that in 19.06.2007 (35 days after the beginning of tree growth), the values of trunk cross sectional area (TCSAI) did not significantly vary related to the application depth of fertilizers. Also, on the average for the 2 depths the manure and urban sludge application did not induce a significant increase in TCSA. But, in case of fertilizers application at 0-30 cm, depth (340 g manure / l substrate vs. urban sludge, 170 g/l substrate) TCSA by 138%.increased significantly.

Foto.1. Partial wiew of the experiment

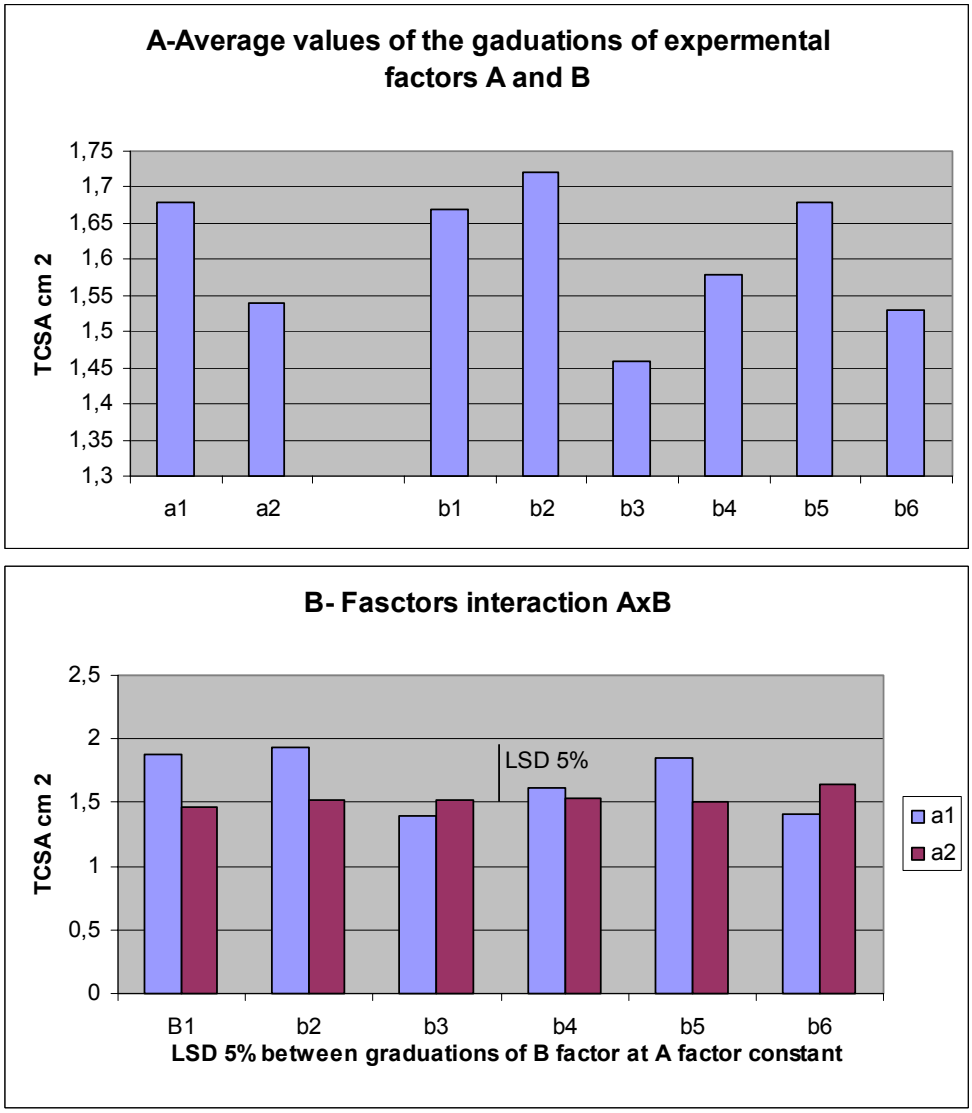

Fig.1 Influence of urban sludge application on the trunk cross sectional area (TCSA) on 19/06/2007, the significance of experimental factor graduations is shown in text at chapter „Material and methods"

The annual growth of TCSA did not significantly vary related to the application depth of fertilizers On average, at the rate of 340 g/l manure applied at two various depths; the increase in TCSA was 166% higher versus the unfertilized, control treatment.
When 170 g/l sludge was applied to the 680 g/l substrate, the same parameter was significantly increased by 140-155% versus the untreated control treatment. When the rate of urban sludge was increased from 170 g/l to 680 g/l, it was noticed a certain influence on TCSA growth, anyhow these differences were not significant. Effects of the organic fertilizers (manure and urban sludge) on the growth of tree trunk cross sectional area were more obviously at 0-30 cm, than at 0-60 cm depth. (fig.2).

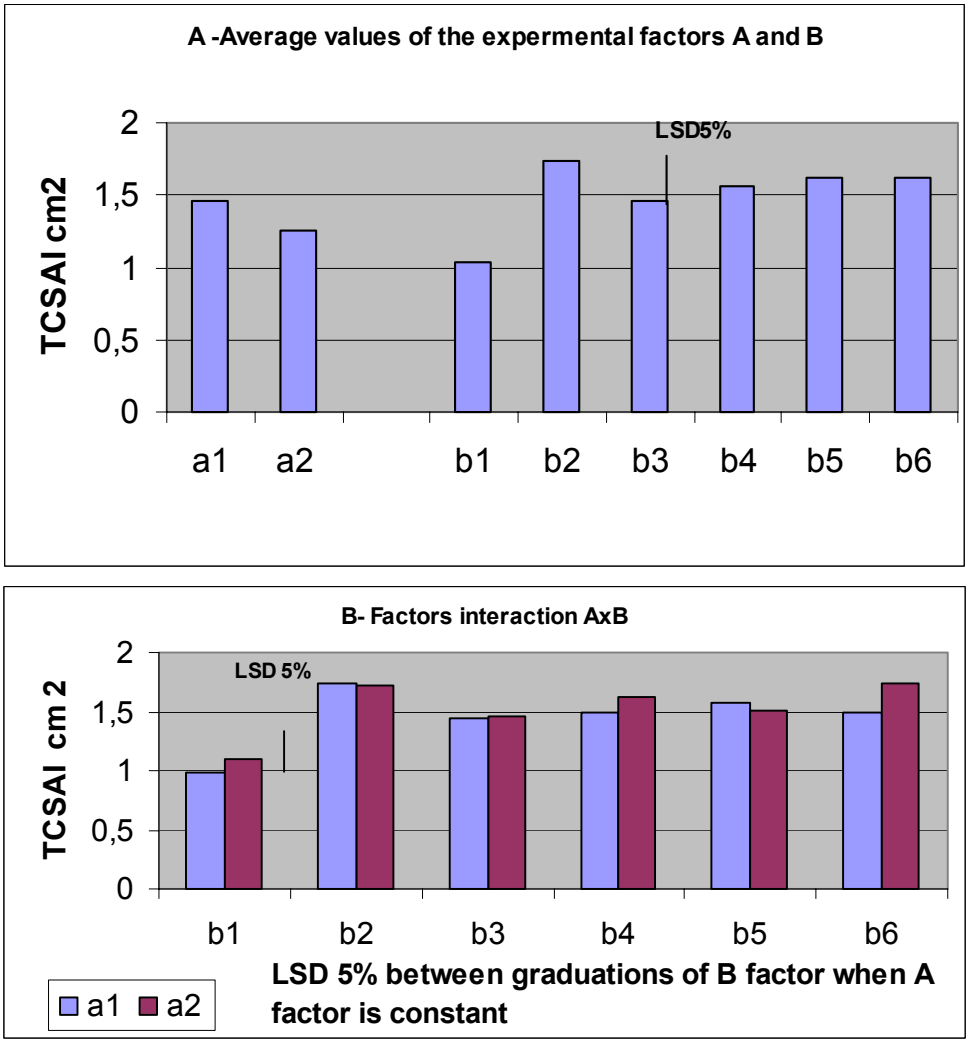

Fig. 2. Influence of application of urban sludge on the trunk cross sectional area growth(TCSA); the significance of experimental factor graduations is shown in text at chapter „Material and methods"

3.1.1.2. Shoots growth

After 30 days since the beginning of shoots growth their length did not vary related to the application depth of fertilizers. On average, the application of manure and urban sludge with 340 g/l substrate at two depths induced a growth of shoot in length by 225-255% versus the unfertilized control treatment. The other application rates of sludge did not significantly influence the shoot length (fig.3). The total annual length of shoots was not significantly influenced by the application depth. On the average, for the 2 depths, manure application whith 340 g/l substrate, versus the un fertilized control determined an increase in annual length of the shoots by 171%.

Under the same conditions, urban sludge application with 170 g/l substrate to the 680 g/l substrate determined an increase in annual shoot length by 149 – 164%. The effects of fertilizer application on annual shoot grouth were better for the 0-30 cm depth 0-60 cm depth (fig. 4).

Fig. 5 clearly shows that in the first half of the growing season, the daily growth of shoots was higher when the fertilizers were applied at 0-30 cm depth in all treatments.

In the 2nd half of the growing season it was just conversely, the shoot growth was better when fertilizers were applied at 0-60 cm depth vs. 0-30 cm depth. The rate of shoot growth as it is indicated by the annual curves (fig. 5) was also influenced by the temperature. In table 1, one can see the positive significant correlations between the daily average temperatures and the average growth of shoots over various periods of time in the growing season.

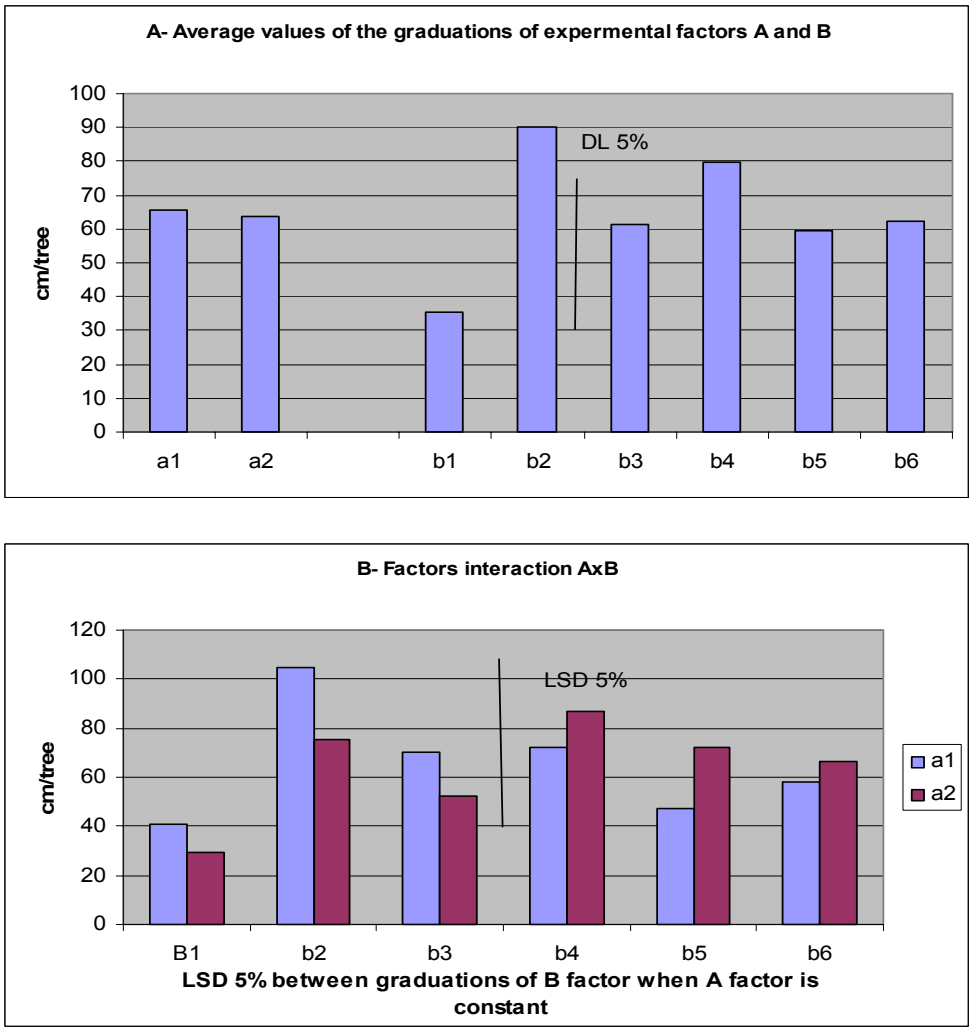

Fig.3. Influence of application of urban sludge on the annual shoot growth in cm per tree at 19/06/2007,the significance of experimental factor graduations is shown in text at chapter „Material and methods"

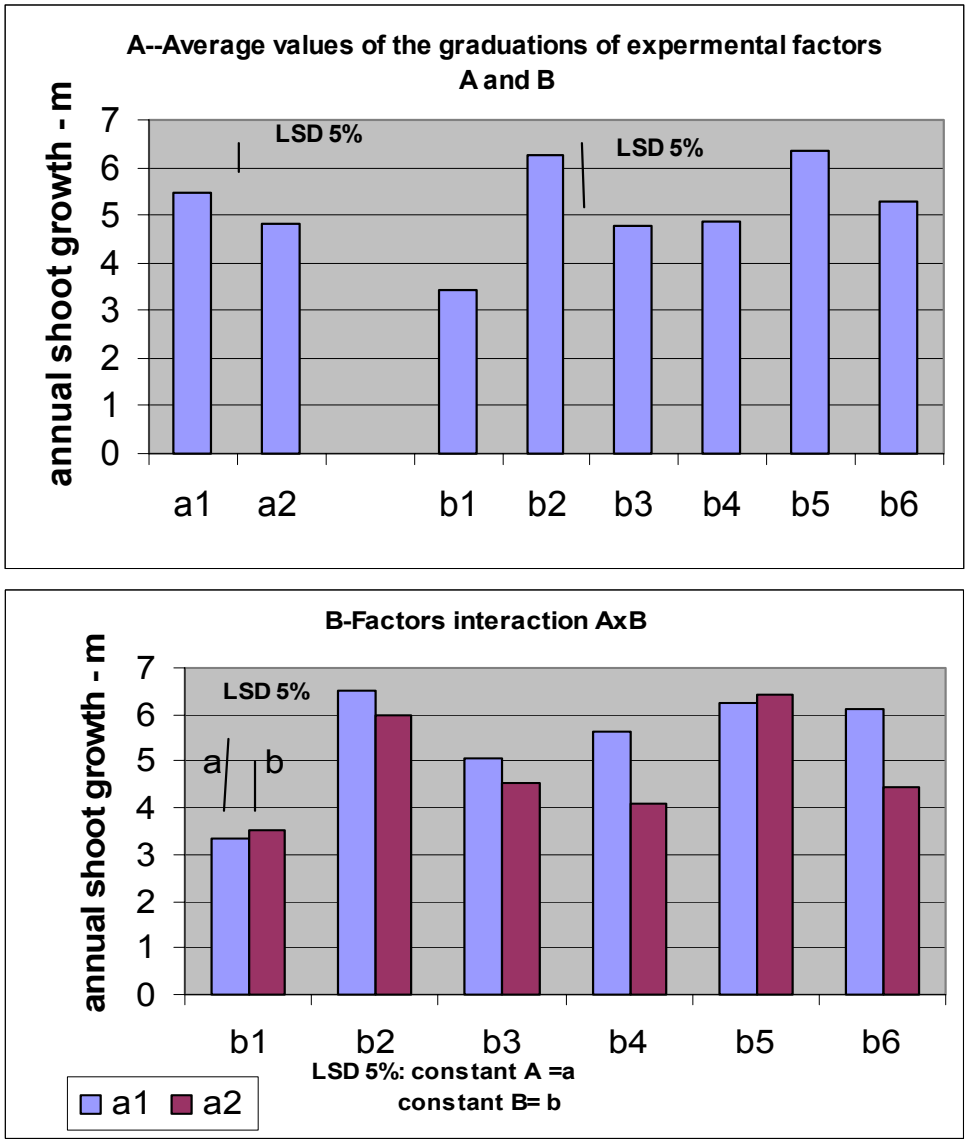

Fig.4 Influence of application of urban sludge on the annual shoot growth (m per tree)

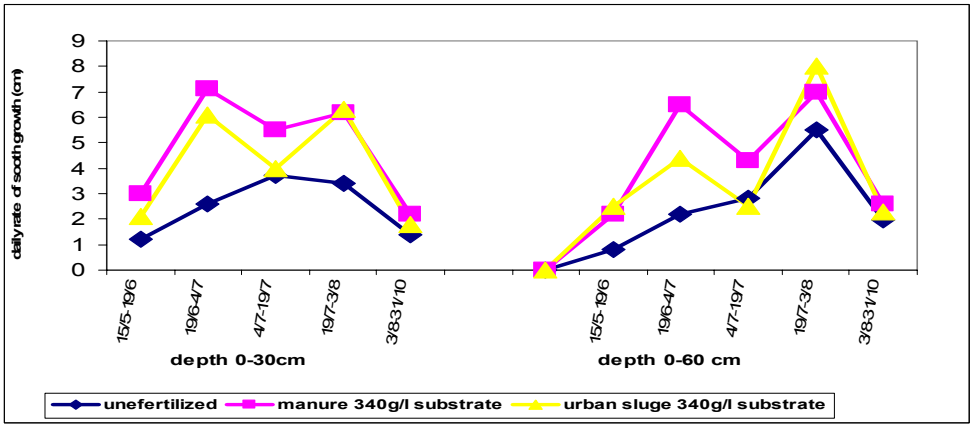

Fig. 5. Influence of application of urban sludge on the daily rate of shoot growth for the Idared cv., 2007

Table 1. Influence of application of municipal sludge on the correlation coefficients (R) between mean daily temperature (X) and daily rate of shoot growth (y)

	b_1	b_2	b_3	b_4	b_5	b_6
a_1	0,473*	0,543*	0,66**	0,575**	0,455*	0,501*
a_2	0,561*	0,709*	0,563**	0,485*	0,516*	0,635*

The significance of experimental factor graduations (a_1, a_2; b_1- b_6) is shown in the text, chapter „Material and methods".

3.1.2. Influence on the flower buds

The depths of fertilizers application (0-30 cm and 0-60 cm) did not significantly influence the number of flower buds/tree. There were not obtained differences in the six treatments and two application depths regarding the number of flower buds/tree. The manure application of 340 g/l substrate at 0-30 cm depth induced a number of flower buds/tree which was 16 times higher versus the unfertilized control treatment. Although the sludge application had a certain influence on increasing the number of flower buds, the differences were not statistically significant (fig.6).

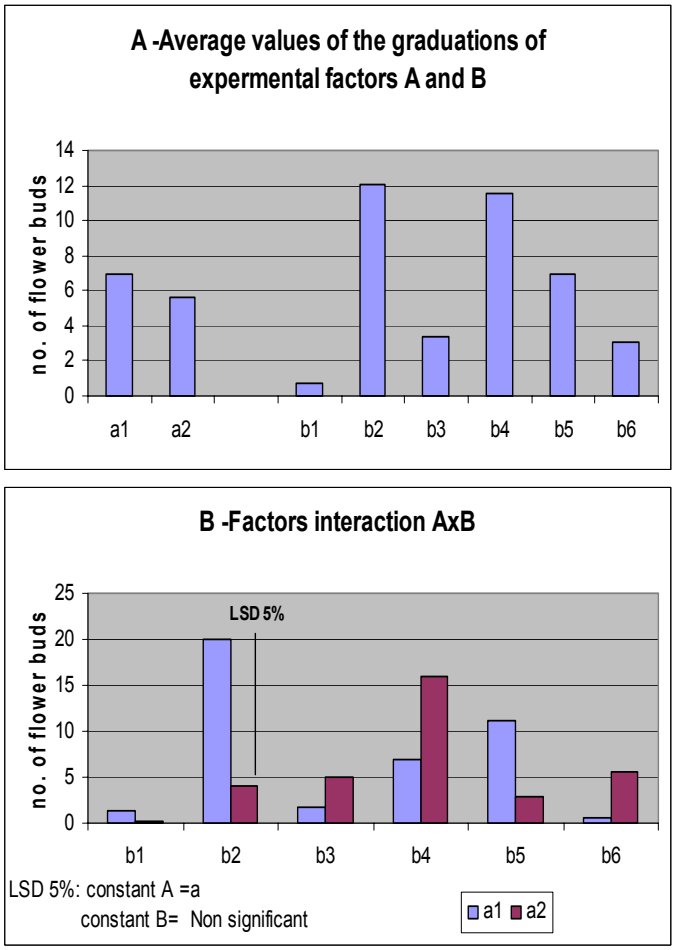

Fig. 6 Influence of urban sludge application on the number of flower buds per tree.

3.2. Influence of some parameters on the fluorescence of leaves

The four parameters related to the fluorescence of leaves did not significantly influence the experimental factors analyzed (table 2).

Table 2. Influence of municipal sludge application on some indicators of leaf flourescence for Idared apple cv., Maracineni, 2007

A. Average values of the experimental factors (A, B)										
Flourescence indicators	**a1**	**a2**	**LSD 5%**	**b1**	**b2**	**b3**	**b4**	**b5**	**b6**	**LSD 5%**
F/Fm	0,101	0,110	NS	0,093	0,121	0,113	0,119	0,100	0,088	NS
Fo	152,4	197,1	NS	152,2	148,5	199,1	174,5	201,6	172,8	NS
FM	601,7	633,4	NS	580,4	585,0	625,9	631,6	686,5	595,0	NS
Fv/Fm	0,735	0,712	NS	0,734	0,738	0,649	0,720	0,731	0,727	NS

B. Factors interaction (A/B)									
		b1	**b2**	**b3**	**b4**	**b5**	**b6**	**LSD 5%**	
								1	**2**
F/Fm	**a1**	0,122	0,099	0,101	0,094	0,104	0,084	0,060	NS
	a2	0,064	0,143	0,126	0,143	0,095	0,091		
Fo	**a1**	166	140	139	166	175	128		
	a2	138	157	259	183	227	217		
FM	**a1**	615	552	573	615	698	557	NS	NS
	a2	546	620	678	648	674	633		
Fv/Fm	**a1**	0,72	0,73	0,72	0,72	0,76	0,77	NS	NS
	a2	0,75	0,74	0,66	0,72	0,71	0,69		

LSD 5% = least significant differences for factors interaction A/B 1 = constant factor A; 2 = constant factor B. The significance of experimental factor graduations is shown in the text, chapter „Material and methods"; NS = non-significant.

4. Discussion

The data above mentioned have proved that the application of manure and urban sludge at various rates influenced significantly the tree growth since the 1st year after planting, confirming other experimental trials (Mihalache et. al., 2006; Dumitru et al., 1983; Vajiala et al., 1992).

The earlier and better effects were noticed in the case of manure application versus sludge. In the second half of the growing season, the effects of the two fertilizers were practically the same. The earlier positive effects of the manure vs. the sludge could be explained by the faster decomposition of the former, enabling thus the releasing of nutrients in a shorter time.

Increasing the rates of sludge from 170 g/l to 680 g/l did not induce a significant growth increase in the plant organs, probably due to the lower needs of the aged trees. The same explanation can be done for the fertilizer application performed deeper (0-60 cm) vs. 0-30 cm depth, when no significant differences on tree growth were noted.

The positive effects of these fertilizers application were more obviously in shoot length than in TCSA. This answer may be explained by the shorter way in the case of shoots than the growth of trunk, which the substances of photosynthesis run from leaves to the growth points.

The physiological indicators related to the fluorescence compared to the morphological indicators were less sensitive in detecting the positive effects of the fertilizers application on the tree response.

The number of flower buds per tree varied largely from tree to tree (data not presented).

Among the experimented factors, the manure application at a rate of 340 g/l of substrate at 0-30 cm depth induced a significant formation of flower buds per tree versus the unfertilized control. Also, there were not significant correlations between the tree growth (increase in TCSA and total shoot length) and number of flower buds per tree (data not presented).

5. Conclusions

Application of the same amounts of manure and sludge per planting substrate volume at 0-30 cm versus 0-60 cm depth did not show a significant difference in tree growth;
At the same application rates, the manure induced a more intensely and earlier growth of the annual shoots and tree trunk cross sectional area versus the urban sludge.
The daily rate of annual shoots growth during the growing season was significantly correlated with the average daily temperature;
The physiological indicators related to fluorescence versus the indicators related to TCSA growth and shoot length proved to be less sensitive in detecting the positive influence of the organic fertilizers on the tree behaviour.

6. References

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