

# THE INFLUENCE OF THE MAGNETIC FLUIDS ON SOME PHYSIOLOGICAL PROCESSES IN *PHASEOLUS VULGARIS*

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The reactions of *Phaseolus vulgaris* L. plants treated with different concentrations of magnetic fluids were investigated. The effects on photosynthesis rate, assimilatory pigments content and fresh and dry biomass content were recorded. The bean plants were grown in culture pots filled with polystyrene granules and moistened with Arnon nutritive solution, at which magnetic fluid was added in increasing concentrations from 0.25 to 1 ml/l.

A stimulation effect on photosynthesis and assimilatory pigments content from the bean leaves was noticed for 0.25‰ and 0.5‰ concentrations of the magnetic fluid on the 7<sup>th</sup> day of the experiment.

After 7 days from the beginning of the treatment, all three concentrations of magnetic fluid increased the total biomass and the dry matter from each organ, but the effect of the 1‰ concentration was weaker (for this concentration the highest increase of dry matter was recorded for roots).

*Key words:* *Phaseolus vulgaris*, magnetic fluids, photosynthesis, assimilatory pigments, biomass.

## INTRODUCTION

A special interest is presented by the plant behaviour in biocompatible magnetic fluids.

Previous researches in this field showed that plant metabolism is influenced by treatments with magnetic fluids, which are able to induce phenotypic and genotypic effects able to stimulate the productivity.

Magnetic fluids are colloidal suspensions of metallic magnetic particles obtained by thermal decomposition of metallic carbonyls:  $\text{Ca}(\text{CO})_8$ ;  $\text{Fe}(\text{CO})_5$ ;  $\text{Fe}(\text{CO})_9$  in the presence of a polymeric or anionic stabilizing agent.

A new research direction in the general subject of plant – magnetic field interactions was opened by the researches on the influence of magnetic fluids on plants in different development stages, researches started in Timișoara several years ago at the Research Centre for Hydrodynamics, Cavitation and Magnetic Fluids – Technical University of Timișoara.

One may point out that through treatments of seeds, seedlings and mature plants with magnetic fluids, magnetic particles penetrate into different plant structures where they develop a strong local magnetic field in a small volume with a ray of several tens of Å.

Many researchers like Tenforde (6); Haque and Kreuzberg (4), Asashima *et al.* (1) showed that through treatments with biocompatible magnetic fluids the plant metabolism is changed and it is possible to induce some phenotypic and genotypic effects able to stimulate the plant productivity.

Also, Corneanu *et al.* (3), in experiments carried out on *Mammillaria duwei* observed a stimulation of the growth after adding the magnetic fluids in the culture medium.

The reactions of *Phaseolus vulgaris* L. plants treated with different concentrations of magnetic fluids were investigated and the main results (the effects on photosynthesis rate, assimilatory pigments content and fresh and dry biomass content) are presented in this paper.

### MATERIALS AND METHODS

The bean plants were grown in the culture pots filled with polystyrene granules and moistened with Arnon nutritive solution (2), at which different amounts of magnetic fluid were added. The Arnon nutritive solution contains the ions of all absolutely necessary mineral elements of the photoautotrophic plants in optimal amount and ratios. These plants take the mineral elements from soil with the roots.

To avoid the effects of individual variations we used plants with the same size and with a uniform aspect because the number of plants, which can be cultivated in a pot, was small (4). We obtained these plants as follows: we put more seeds with the same size and weight to germinate than the necessary number of plants in the experiment.

The experiment was made with bean plants in the following variants:

- the control ( $V_1$ ): cultivated plants on Arnon nutritive solution without magnetic fluid;
- $V_2$  – cultivated plants on Arnon nutritive solution with magnetic fluid in 0.25 ml/l concentration;
- $V_3$  – cultivated plants on Arnon nutritive solution with magnetic fluid in 0.5 ml/l concentration;
- $V_4$  – cultivated plants on Arnon nutritive solution with magnetic fluid in 1 ml/l concentration;

The results represent average values of two repetitions for each variant.

The photosynthesis rate and the assimilatory pigments content were recorded after seven days of the experiment.

The photosynthesis rate was investigated with the Warburg method using the Warburg buffer solution number 6 (25 ml  $\text{Na}_2\text{CO}_3$  0.1 M + 25 ml  $\text{NaHCO}_3$  0.1 M) (2). The determinations were made at a 25 °C temperature and at an illumination of 8 000 lux. The results were expressed in  $\text{cm}^3\text{O}_2/\text{dm}^2/\text{h}$ .

The absorbance of the solution extracted with 100% acetone was measured at 661.6, 644.8 and 470 nm and the calculation of the content in a, b chlorophylls and carotenoids was performed according to Lichtenthaler (1987) (5); the values were expressed in mg/g fresh matter. The assimilatory pigments content was calculated with the following formulas:

$$Ca = 11.24 \times A_{661.6} - 2.04 \times A_{644.8}$$

$$Cb = 20.13 \times A_{644.8} - 4.19 \times A_{661.6}$$

$$Cx+c = (1000 \times A_{470} - 1.90 \times Ca - 63.14 \times Cb) / 214$$

(Ca = chlorophyll a; Cb = chlorophyll b; Cx+c = xanthophylls and carotenoids).

At the end of the experiment (after 2 weeks) the plants were took out from the culture pots. For each organ and for each repetition the following determinations were done:

- the fresh and dry weight of the root;
- the fresh and dry weight of the stem;
- the fresh and dry weight of the leaves;
- the total fresh and dry biomass of the plants.

### RESULTS AND DISCUSSIONS

In accordance with the obtained data, the photosynthesis rate of the bean leaves was strongly influenced by the presence and concentration of the magnetic fluid in the culture medium (Fig. 1).

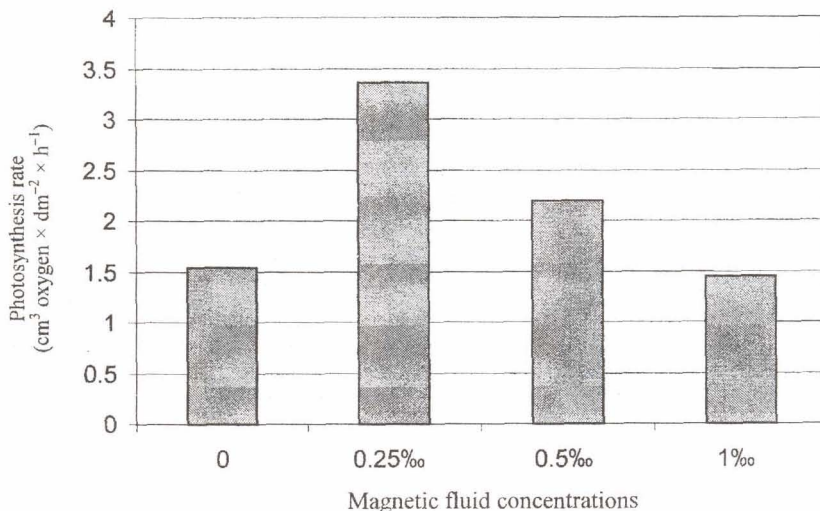


Fig. 1 – The photosynthesis rate of *Phaseolus vulgaris* leaves treated with different concentrations of magnetic fluid on the 7<sup>th</sup> day of the experiment.

Thus, the determinations from the 7<sup>th</sup> day of the experiment showed a stimulating influence of the 0.25‰ and 0.5‰ concentrations comparative with the control. For the concentration of 1‰ magnetic fluid the photosynthesis rate was under the control level. It might be noticed that the effect of the 0.25‰ concentration is higher than that obtained for the 0.5‰ concentration, so one may assume that from the tested concentrations the 0.25‰ concentration was the closest to optimal for this process.

The same stimulating influence of 0.25‰ concentration, followed by the 0.5‰ concentration, was recorded in case of the assimilatory pigments content from the bean leaves treated with different concentrations of the magnetic fluid on the 7<sup>th</sup> day of the experiment (Fig. 2). Unlike the photosynthesis, a relatively weak stimulating effect was noticed, even for the case of the assimilatory pigments content from the plants grown in the medium with 1‰ concentration. The synthesis of the a chlorophyll was stimulated by the 0.25‰ and 0.5‰ magnetic fluid concentrations, but the content of the b chlorophyll decreased under 0.5‰ and 1‰ concentrations. An enhancing effect of the magnetic fluid was noticed in the case of the carotenoid pigments which were present in a lower amount in the control than in the 0.25‰ and 0.5‰ magnetic fluid concentrations, and also for the total pigments content, which attained the maximum at 0.25‰ magnetic fluid (Table 1).

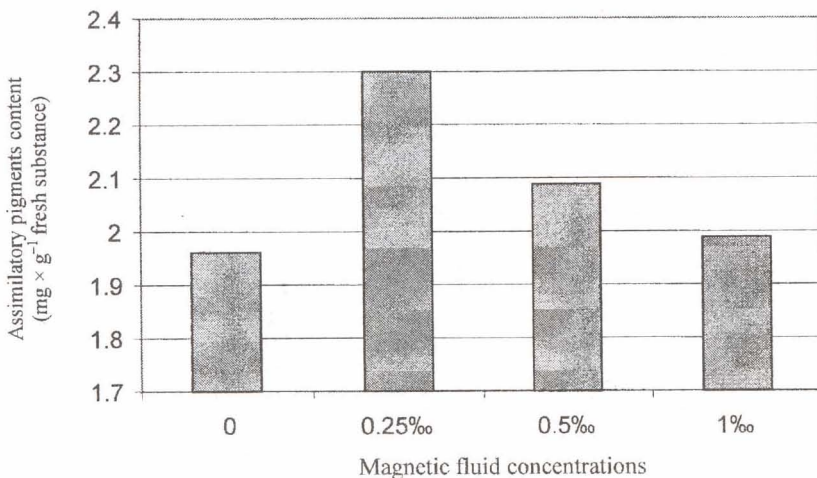


Fig. 2 – The assimilatory pigments content from the *Phaseolus vulgaris* leaves treated with different concentrations of magnetic fluid on the 7<sup>th</sup> day of the experiment.

Table 1

The assimilatory pigments content from *Phaseolus vulgaris* leaves treated with different concentrations of magnetic fluid on the 7<sup>th</sup> day of the experiment

Variant	Mg chlorophyll a / g fresh weight	Mg chlorophyll b / g fresh weight	Mg chlorophyll a+b / g fresh weight	Mg carotenoids / g fresh weight	Mg assimilatory pigments / g fresh weight
Control	1.15	0.57	1.72	0.24	1.96
0.25‰	1.43	0.57	2.00	0.30	2.30
0.5‰	1.30	0.50	1.80	0.29	2.09
1‰	1.24	0.52	1.76	0.23	1.99

Table 2

The influence of the different concentrations of the magnetic fluid on the accumulation of fresh weight and dry matter

Variant	Root		Stem		Leaves		Total biomass/8 plants		Total biomass/1 plant	
	Fresh weight	Dry matter	Fresh weight	Dry matter	Fresh weight	Dry matter	Fresh weight	Dry matter	Fresh weight	Dry matter
Control	4.702	0.218	8.821	0.607	5.465	0.437	18.988	1.262	2.373	0.1577
0.25 ml/l	5.876	0.272	9.270	0.627	7.396	0.571	22.542	1.470	2.819	0.1837
0.5 ml/l	6.225	0.295	10.078	0.674	6.402	0.497	22.705	1.466	2.838	0.1832
1 ml/l	6.965	0.318	9.643	0.665	5.862	0.462	22.470	1.445	2.808	0.1818

It is necessary to point out that generally it is difficult to find a direct relationship between chlorophyll content and intensity of photosynthesis because in many cases the quantity of chlorophyll from the green leaves is considerably higher than the optimal level required for photosynthesis. But in the case of this experiment, the concentrations of magnetic fluid had similar effects both on the content in chlorophyll a (or a + b chlorophylls) and on the photosynthesis rate.

After 14 days from the beginning of the experiment, the fresh weight and dry matter were measured for each variant and organ. From the data shown in Table 2 one may see a considerable biomass accumulation in the roots and stems of the variants with 1‰ and respectively 0.5‰ magnetic fluid. In the case of the leaves the highest increase was recorded for the concentration of 0.25‰ (for which the photosynthesis and the content of assimilatory pigments were at maximum). In the case of total biomass (8 plants from 2 replicates) and for each plant, it was confirmed the enhancing effect of the 0.25‰ and 0.5‰ concentrations, the effect of the 1‰ concentration being weaker; although in this case it was recorded an outrun of the control level.

### CONCLUSIONS

1. The obtained data evidenced a stimulatory effect of the 0.25‰ and 0.5‰ concentrations of magnetic fluids on all the physiological indicators investigated without the chlorophyll b content.

2. The highest concentration used in this study (1‰) had a lower or even inhibitory effect.

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