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Note

Effect of pre-sowing treatment with permanent magnetic field on germination and growth of chilli (*Capsicum annum.* L.)

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A b s t r a c t.The effect of a weak permanent magnetic field (PMF) with a strength of 62 μT on chilli (*Capsicum annum.* L.) seed germination, growth and development was investigated. Four pre-sowing treatments at different times (4, 8, 12, and 24 h exposure) of chilli seeds were carried out in the experiment to compare with the untreated control. PMF had a stimulating effect on the first stages of growth of chilli seeds for all exposure times studied. Statistically processed experimental data suggest that the effect of PMF significantly increased seed germination and initial development and growth compared with the untreated control. It was also identified that variation in seed germination, emergence and development existed between the north and south poles, and the seeds treated with south pole were showing maximum growth status as compared to north pole and untreated control.

K e y w o r d s: permanent magnetic field, chilli, stimulating effect, germination

INTRODUCTION

The growing need of ecological agricultural products together with increased demand of vegetable raw materials for food production as well as for other branches of industry imposed pressure over agricultural scientists for searching new, safer decisions for raising the agricultural production. Agricultural sciences take an interest not only in common and valued crop-forming factors, but also in those less expensive and generally underestimated, though more pro-ecological ones, such as ionising, laser or ultraviolet radiation, and electric and magnetic fields (Galland and Pazur, 2005; Moon and Chung, 2000). These factors, generally considered as harmless for the environment, most often modify the course of some physiological and biochemical processes in the seeds, increasing their vigour and ensuring better plant development at later stages (Carbonell *et al*., 2000; Garcia, *et al*., 2002). The magnetic field is especially worth our attention, since its impact on seeds can change the course of some processes taking place in the seeds and thus stimulate plant development. There have been several reports on the effects of magnetic fields on remarkable increases of seed germination, plant growth, activated protein formation, root growth and productivity (Podleśny *et al*., 2005; Samy, 1998; Soltani *et al*., 2006). The biostimulation methods using magnetic fields, such as pre-sowing seed treatment and crop irrigation with magnetically treated water, were commercially applied in Central Europe and Russia for increasing the crop production and quality (Bugatin *et al*., 1999; Chou, 2007; Maria *et al*., 2000; Leelapriya *et al*., 2003; Radeva and Mamaroca, 1988; Tenuzzo *et al*., 2006; Trebbi *et al*., 2007).

Having in mind the possible application of magnetic field treatment in agricultural practice we investigated the PMF influence on the early stages of development of chilli.

MATERIALS AND METHODS

The chilli seeds used for the experiment were collected from the National Seed Corporation, Kerala, in order to ensure high viability and homogeneity of seeds, and Petri dishes with tissue paper were used as germinators. The chilli seeds were washed with distilled water and dried at room temperature. Round permanent magnets having 62 μT magnetic induction were used for the magnetic bio-stimulation of chilli seeds. The experiment was carried out with 23 seeds in triplicate (3x23), divided into three experimental groups; eight samples were separated and kept for magnetic treatment (two groups) and another one as control. The

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magnetic treatments were carried out by hollow round magnets with an external diameter of 145 mm, and height of 70 mm. For exposure to magnetic field, the chilli seeds were arranged in a scattered manner in Petri dishes containing soaked tissue paper and placed over the magnets. In each treatment, the permanent round magnets, arranged in bipolar configuration (facing the magnetic poles), were used and the opposite sides were designated as N and S poles (for confirming the bipolar nature of the permanent magnets, a bar magnet with marked north and south pole was also used). The local geomagnetic field in the room was approximately 40 μT, measured by a portable MG-7D magnetometer/ gaussmeter. The different experimental treatments carried out using both north and south poles were as follows:

T_1 – exposure to 62 μ magnetic field for 4 h,
T_2 – exposure to 62 μ magnetic field for 8 h,
T_3 – exposure to 62 μ magnetic field for 12 h,
T_4 – exposure to 62 μ magnetic field for 24 h,
C – Control, exposure to the local geomagnetic field, in the absence of any other magnetic field.

The experiment was carried out in laboratory conditions, in natural light (11 h day^{-1}); the average room temperature was 26±4°C with relative humidity of 87%. All the experiments were stopped by the 10th day of seeding. The Petri dishes were examined each day and the numbers of seeds germinated *ie* with testa split and root showing were noted. At 7 and 10 days after the beginning of the experiment, the seedlings were taken off the filter paper and the stem length and total length of plant were measured individually with 0.1 cm precision. Statistical analysis was accomplished by means of average values, standard error and t-test (treatments *vs.* control) with the significance criterion of 0.05.

RESULTS AND DISCUSSION

The results of the present study appeared extremely interesting, showing a decisive effect of PMF on the germination and growth of chilli. The percentage of seeds germinated during the sprouting stage is shown in Table 1. The seeds were considered to be germinated when their radicles exceeded the length of 1mm. The rate of germination obtained after 72 h was considered final and was not changed in subsequent counts, since this time was considered the end of the sprouting stage. A significantly higher percentage of seed germination was observed in Petri dishes having treated chilli seeds in comparison with the non-treated seeds (control). The highest percentage of germinating seeds, 100%, was recorded when the seeds were exposed to T_4, followed by 82% in T_3. These results corroborate the early sprouting of chilli seeds exposed to PMF. The results indicate that germination was intensely affected by the magnetic treatment.

Growth data measured at days 7 and 10 after seedling stage are summarised in Tables 2 and 3. Stem length data corresponding to day 3 are not provided because, at that stage, the stem had not developed. These data allow to distinguish differences between lengths (stem length and total length) of chilli plants subjected to magnetic fields for different times and control plants. Three days after seedling, a stimulatory effect was observed, where total plant length increased with magnetic treatment. At day 7, all the treatments produced an increase in the stem and total lengths of chilli plants and the effect was more for T_3 (4.99 -5.15 cm) and T_4 (5.66-6.03 cm). All the magnetic treatments increased the stem length *vs*. control; statistical analysis of the data reveals significant differences for all the treatments against control.

Stem length of control plants (3.55 cm) measured at day 10 was significantly less than that obtained for treatments T_2 (6.29-6.65 cm), T_3 (7.30-7.84 cm) and T_4 (9.94-10.55 cm). Total length was also increased when seeds were magnetically treated, and the greatest differences were obtained for T_2 (7.30-8.05 cm), T_3 (9.07-10.17 cm) and T_4 (12.33-14.69 cm) compared with the control (4.16 cm). From the results obtained, it is possible to confirm that exposure of seeds to a magnetic field exerts a positive effect on initial growth and length, and that maximum increases were obtained for T_3 and T_4 ($P < 0.001$). It was also noted that, among the treatments, seeds treated with south pole were showing maximum growth and development as compared with seeds treated with north pole and untreated control. Figure 1 allows observation of the remarkable differences between chilli plants exposed to different treatments (north and south pole) and control at day 7 after seedling.

T a b l e 1. Percentage of germinated seeds during the sprouting stage

T_1 (4 h)		T_2 (6 h)		T_3 (12 h)		T_4 (24 h)		Control
N	S	N	S	N	S	N	S	
(%)								
52.17	56.52	65.22	73.91	82.61	82.61	100	100	43.48

T a b l e 2. Stem and total length (stem + root) of chilli when seeds were exposed to 62 μT stationary magnetic field (both North and South Poles) measured 7 days after seeding

Length (cm)	T_1 (4 h)		T_2 (6 h)		T_3 (12 h)		T_4 (24 h)		Control
	N	S	N	S	N	S	N	S	
Stem[a]	2.93±0.08	3.08±0.07	3.28±0.12	3.81±0.05	4.34±0.07	4.41±0.09	4.85±0.07	5.04±0.08	2.14±0.09
Significance	***	***	***	***	***	***	***	***	
Total[a]	3.50±0.10	3.61±0.07	3.88±0.20	4.33±0.07	4.99±0.08	5.15±0.07	5.66±0.10	6.03±0.05	2.61±0.09
Significance	***	***	***	***	***	***	***	***	

a – mean ± SE (standard error), *significant differences *vs*. controls, ***P <0.001.

T a b l e 3. Stem and total length (stem + root) of chilli when seeds were exposed to 62 μT stationary magnetic field (both North and South Poles) measured 10 days after seeding

Length (cm)	T_1 (4 h)		T_2 (6 h)		T_3 (12 h)		T_4 (24 h)		Control
	N	S	N	S	N	S	N	S	
Stem[a]	3.54±0.07	3.99±0.06	6.29±0.09	6.65±0.42	7.30±0.08	7.84±0.08	9.94±0.07	10.55±0.08	3.55±0.10
Significance	ns	***	***	***	***	***	***	***	
Total[a]	4.29±0.07	5.59±0.01	7.30±0.07	8.05±0.04	9.07±0.07	10.17±0.07	12.33±0.10	14.69±0.13	4.16±0.08
Significance	ns	***	***	***	***	***	***	***	

ns – not significant, other explanations as in Table 2.

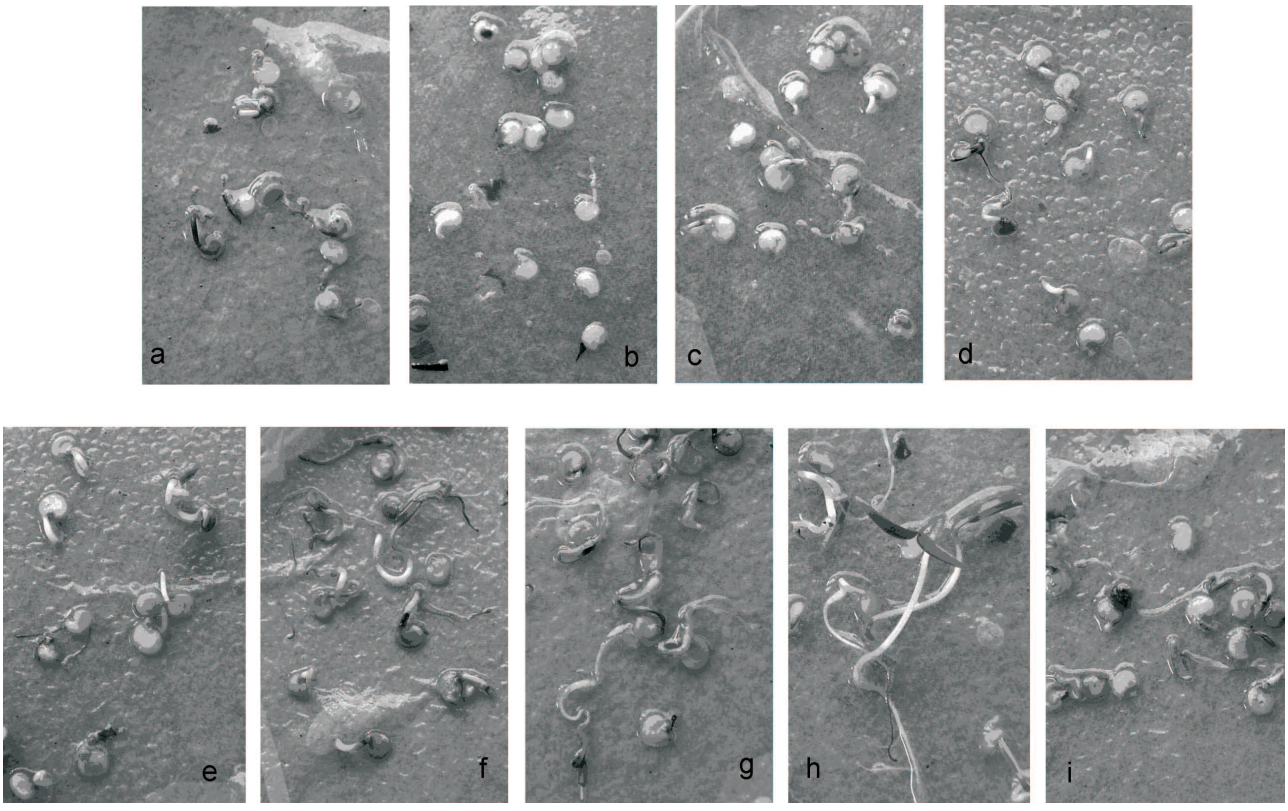

Fig. 1. Chilli plants at 7 days after seedling. Comparison between treatments: T_1 – 4 h (a* and b**), T_2 – 8 h (c* and d**), T_3 – 12 h (e* and f**), T_4 – 24 h (g* and h**) with control – untreated (i), (*N, **S).

Results obtained indicate that this type of magnetic treatment clearly affects germination and the first stages of growth of chilli plants. Our findings also agree with the positive effects on germination and development of plants observed by many scientists using different magnetic field exposure (Aladjadjiyan and Ylieva, 2003; Celestino *et al*., 2000; De Souza *et al*., 2006; Masafumi *et al*., 1998; Smith *et al*., 1993).

CONCLUSIONS

1. A static magnetic field of 62 μT has a stimulating effect on the first stages of growth of chilli seeds. Both magnetic poles with different treatment times reveal increases in germination speed and total length of plants.

2. Over the total experimental period, all the measured parameters in treatments for 8, 12 and 24 h of exposure (T_2, T_3 and T_4) showed significant differences *vs*. control.

3. It was also noted that among the magnetic treatment groups, seeds treated with south pole were showing maximum influence of PMF on growth and development of chilli.

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