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Distant impact of cone-shaped geometrical structures on bio-isometry of seedlings

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***Abstract*—This paper represents the first experimental results on a distant (1450km) impact of cone-shaped geometrical structures on bio-isometry of triticale seedlings. The performed attempts have shown that the system of passive geometrical objects can significantly affect the germination of seeds both directly through their digital representation as well as indirectly through the water, in which they are germinated. This effect depends on the assembly type of cones (0% or 50% focus position).**

I. Introduction

Previous results indicated that geometric shapes such as cylinders, cones, pyramids, domes, and others, can impact architectonic properties (structural dissymmetry or leftism and rightism) of seedlings grown from swelling seeds [1], [2]. There are different hypotheses that try to explain a relationship between leftism and rightism of seedlings and properties of impacting devices and fields [3]. The effect depends not only on the type of geometric shapes, but also on their location in relation to phyto-objects [1], [2], [4], [5]. It is known that plants with the left (L) and right (D) bio-isometry differ in adaptive potential – ecological sustainability and potential productivity [6].

Various geometric shapes of abiotic and biotic origin are widely represented in nature. Considering their morphogenetic impact on structural and functional properties of plants, we expressed a hypotheses that this effect can represent an ecological and agricultural factor [2]. This phenomenon is sometimes denoted as the shape effect [3]. Several attempts are undertaken to verify the existence of the shape effect not only at the organism level, but also at the chromosomal and genetic levels. In this context, the impact of geometric shapes could be considered as unconventional mutagenic factor.

The shape effect at the chromosomal level was investigated in experiments with cylindric shapes. The impact of short and long cylinders (SC and LC) on seeds essentially increased the number of chromosomal aberrations (ChA) in meristematic cells of primary roots of maize seedlings [4], [5]. Multiple iterations of these attempts confirmed that the SC and LC induced changes at the chromosomal level.

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To assess the shape effect at the genetic level a corn hybrid (MKO1y x 2,9M) was used. It represents a multi-marker form, in which the work of specific genes is phenotypically manifested. It was of interest to test whether the SC and LC impact the recombination (rearrangement) of genes and whether it activates specific genes, according to the phenotype of seeds and seedlings. To demonstrate this, the experimental seeds were sown on the field, the mature plants were self-pollinated, from these plants the second generation seeds were obtained. These seeds were used to grow seedlings for the genetic marker analysis, as well as for counting the number of L and D seedlings. The seedlings with the gene gl_1 (glossy shoots, leaves shiny due to lack of their waxy coating surface [7]) were taken into account. The yield of seedlings with gl_1 gene was increased in all experimental variants [5]. These results demonstrated that the SC and LC induced the shape effect on plants at the genetic level. SC and LC also influenced the structural properties (leftism and rightism) of seedlings not only in the first generation, but also in the second generation of plants [4], [5].

Thus, it was proven that geometric shapes (the shape effect) influence plants not only at the organism level, but also at the chromosomal and genetic levels. Hence, the possibility of using the shape effect as an unconventional mutagenic factor was experimentally demonstrated.

The new step of our research on the shape effect concerns the reaction of plant objects on a distant transmission of the impact from geometric shapes. In literature it is known as a non-local interaction, first postulated and proven in quantum mechanics – the system of 'entangled' elementary particles. Multiple hypotheses are expressed about similar effects also in classical mechanics – the system of 'entangled' macro-objects [8]. In the context of signal (stimuli) transmission, it is denoted as non-local communication effect (NCE).

We have previously studied the NCE in macroscopic systems – the system of plant organisms, in particular with germinating seeds and seedlings [9]. These experiments have dealt with a group of co-germinating seeds that was split into two parts. The subgroup with major number of seeds was exposed to different physical and chemical factors. Results demonstrated that a significant change of morphological and genetic parameters appeared not only in the directly exposed seeds, but also in those seeds that were not affected. Farther, the NCE has been detected also

in the system of 'digital representation of seeds – seeds' [10], both in the direct way 'from the image to seeds', and in the opposite direction 'from seeds to their image' [11]. The vast literature mentions this specific type of NCE as the distant imprinting effect [12]. We emphasize that this type of NCE was tested at the distance of 1450 km between Stuttgart (Germany) to Chisinau (Moldova) [10].

Currently, the Research center of advanced robotics and environmental science (Cybertronica Research, Stuttgart) developed the cone-shaped generator 'Contur' shown in Figure 1. The generator is an experimental product intended for: 1) passive generation of weak 'non-electromagnetic emission' based on the shape effect; 2) modulation of this emission by using the imprinting effect and feedback loops; 3) structural amplification for sensors or generators in non-local communication at large distances. Each cone is made from organic polymer coated from both sides by a copper. Cones are placed into each other so that a top of the next cone enters into the previous cone on 1/3 or 1/2 of its height or lies on the baseline. This placement is denoted as the focus position. Experiments are performed with 0%, and 50% focus position and with systems of 5 cones, as shown in Figure 3.

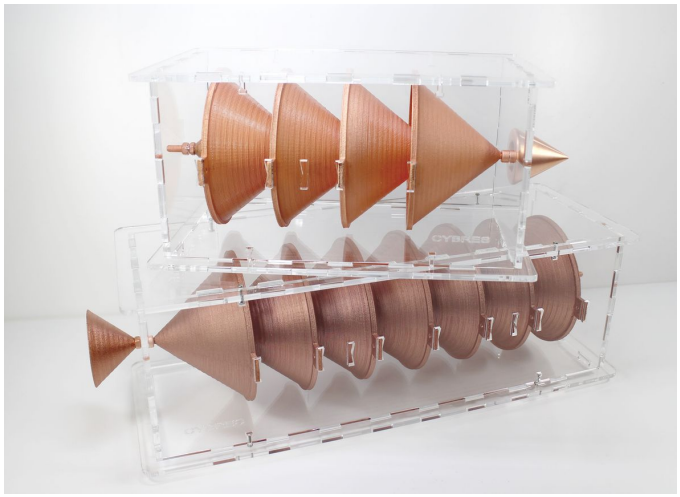

Fig. 1. Examples of cone-shaped generators 'Contur' with the focus position of 0% and 33%, image courtesy of Cybertronica Research.

This publication represents the first experimental results on the distant impact transmission from the cones on a digital image of seeds. The new element of these experiments is related to distant properties of the shape effect, where impact on bio-object (seeds) is exposed not directly but distantly through their digital representation. Results are analyzing by bio-isometry of seedlings grown from these seeds. The biological part of these experiments is carried out in Chisinau, the technical part – in Stuttgart.

II. Experiments

The first experiment. The seeds are placed in Petri dishes with tap water (50 seeds per Petri dish). Each variant of the experiment has 9 such Petri dishes. They are photographed with a digital camera (Figure 2). Digital image is forwarded by e-mail from Chisinau to Stuttgart, where they are exposed by the cone-shaped system of '0% focus position' and '50% focus position' (Figure 3) during the whole period of germination. The seeds are germinated in the dark at 20°C until the first leaf in seedlings is appeared. This takes about 7 days. The results are counted by the number of seedlings with the right bio-isometry in %. Seedlings with the right bio-isometry have the first leaf wrapped in a clockwise direction, with the left bio-isometry – counterclockwise (Figure 2) [9].

(a)

(b) (c)

Fig. 2. **(a)** Petri dishes with triticale seeds in tap water (each experimental variant has 9 of such dishes); **(b,c)** Seedlings with the left (L) and right (D) bio-isometry (L seedlings have the first leaf wrapped counterclockwise, the D seedlings – clockwise).

The second experiment. Digital images of Petri dishes with the tap water without seeds are prepared and forwarded from Chisinau to Stuttgart, where they are exposed by the same cone-shaped systems for 4 days. After that, seeds are added to these Petri dishes and they germinated in the exposed water. Results are also counted by the number of seedlings with the right bio-isometry.

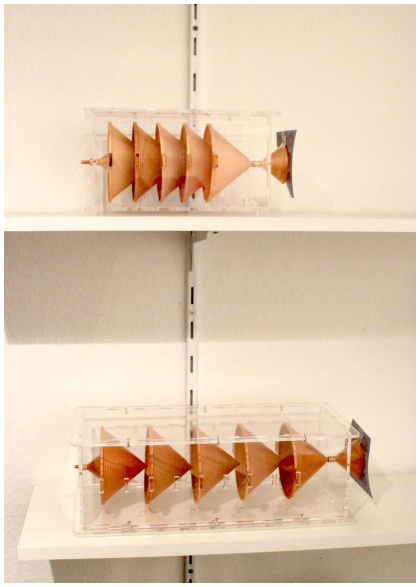

Fig. 3. Two types of cone-shaped geometries used in experiments, upper image – the generator with 50% focus position, lower image – the generator with 0% focus position. Output cone has a digital image of seeds or water, image courtesy of Cybertronica Research.

Since in both experiments each Pitri dish was initially filled with 10 ml of water, it was not necessary to add water during 4 days. In this time the coleoptile is already appeared, thus the future bio-isometry (leftism-rightism) of seedlings became deterministic, so that no additional distortion was introduce into the germination process.

III. Results and discussion

Table I summarizes data from two experiments. In the first experiment with '0% focus position' of cone-shaped system, the number of seedling with right bio-isometry is significantly increased compared to control (0.1% significance level) and compared to the system with '50% focus position' (1% significance level). In the second experiment with impacting the water, in which the seeds are germinated, the differences are less pronounced. Here the number of seedling with the right bio-isometry was significantly increased for the system with '0% focus position' compared to control (only 0.5% significance level), and there are no differences between experimental variants.

TABLE I
The number of seedlings with the right bio-isometry distantly impacted by the cone-shaped system on the digital images of 'seeds in water' and 'only water', in which they are germinated, in %.

N	Variant	the first attempt 'seeds in water'	the second attempt 'only water'
1	Control	50,2 ± 1,46	51,3 ± 1,45
2	0% focus position	63,4 ± 1,74	56,4 ± 1,39
3	50% focus position	52,9 ± 2,01	52,9 ± 2,66

Remarks: for the attempt 'seeds in water' $t_{1,2} = 5,81(\leq t_{001})$, $t_{2,3} = 3,95(\leq t_{01})$; for the attempt 'only water' $t_{1,2} = 2,54(\leq t_{05})$.

Thus, the cone-shaped geometries can significantly impact seeds directly through their digital representation, or indirectly through the water, in which they are germinated. The distantly transmitted shape effect is more pronounced:

- under the influence of cone-shaped geometries on the digital images of seeds in water, in comparison with the impact only on digital images of water, in which the seeds will germinate;
- under the influence of the cone system '0% focus position' in comparison with the impact from the cone system '50% focus position'.

These experiments have shown that the non-local interaction in the system of 'digital representation of biological object – the biological object' can be performed not only by using active generators of electromagnetic or complex (EM/non-EM) fields [10], [13], but also by purely passive sources of non-EM (torsion) fields, in particular by geometric shapes. By analogy with [5], the receiver (a biological object) can change its morpho-physiological and genetic properties. If the primary receiver of NCE is a water, then the physico-chemical and informational changes can be estimated indirectly – by means of seeds, germinated in the water [11], and directly – by using equipment, measuring properties of water (dpH, ORP, conductivity, and others) [13], [14].

Further objectives of these studies can consist in evaluating the distant shape effect depending on the number of shapes and geometric features, combination of fields from other sources and their ability to serve as a translator of properties useful for a vital status of biological receivers (by using the imprinting effect).

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