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Laser – a Controlled Assistant in Agriculture

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Introduction

The results achieved in the application of laser irradiation of plant organisms still continue to attract the scientific interest – in the past realized by He-Ne lasers, and nowadays – by semiconductor lasers. The effect of the spectral influence of the laser radiation, according to Inyushin, Ilyasov, Fedorova [1] in the near past, and nowadays by I n a n a [3], B u r g e s [10], M o r i and T a k a t s u j i [14], T a z a w a [17] and others, provokes a change in the plants functions, activates the faster cell-division, and that results in faster initial rate of growth and development, better resistance to unsuitable conditions and increase of the productivity and the quality of the production. These conclusions were confirmed by the investigations of a team of researchers from IIT-BAS and the former Agricultural Academy, according to a contract between IIT-BAS and the Ministry of Education and Science in 1998-2003, the results being positive and very hopeful. In present times the agricultural producers are extremely embar-rassed financially and are not ready to risk in the application of new technologies. Besides, 2005 was an year of floods, caused both by natural elements, as well as by neglected cares in agriculture. Since money is needed anywhere, we remind the tested and having proved its influence method of increasing the production of bread grain and maize per unit of area, implementing new technologies. In this direction investigation of the physical factor impact on the live organism is a reliable tool for the positive change in the productivity possibilities of plants, but now in new, stricter conditions: receiving certified seeds from the Executive Agency Plant

Variety testing Approbation and Seed Control – a division of the Ministry of Agriculture and Forestry, and after application of the tested by us radiation technology, representing them back to the laboratory of this Agency for implementing outdoors tests. The specialists of the laboratory accepted, by agreement, must carry out investigation on the degree of energy increase of germination, as a main parameter, the vitality of out springs, elec-trical conductivity, and moisture content in the radiated seeds, compared to the control ones (i.e., not radiated).

Purpose of the research

The investigations carried out in the years 1998-2003 gave good expectations that laser systems based on semiconductor lasers could be successfully applied in agriculture. It was necessary to check the cultivation of such plants, coming up from certified seeds, and after testing the degree of energy increase of germination, as a main parameter, the vitality of out springs, electrical conductivity, and moisture content in the radiated seeds, compared to the control ones (i.e. not radiated), on larger areas – i.e. in production conditions.

Equipment used

Fig. 1 represents the general mechanical diagram of "Laser System for presowing seed radiation – SOLAR – 2M" designed and manufactured by the IIT-BAS team. The system consists of a basic massive board **9** on one side of which by hinges the non-radiated seeds container is attached **3**, continued by an inclined plane on which the sowing seeds roll during the radiation. Shutter **5** for controlling the quantity of the seeds passed through enables the operator adjust this level and by the mechanism for changing the system inclination **7** to control the passing speed in the zone where radiation is carried out, and thus – the radiation time of the sowing seeds rolling on the inclined plane. The laser emitter **1** is tightly attached to the front side of the non-radiated seeds container by the attaching device **2** with the possibility for moving along its longitudinal axis in order to adjust the dimension of the spot of the laser emission falling on the zone where the laser radiation is carried out.

The mechanical construction of the laser emitter is analogous to the one reported at the National Conference with International Participation ELECTRONICS 1999, September 23-25, 1999, Sozopol [3] but with some alterations and improvements, reported at the seminar in 2002 and reflected in the Work Paper – "A New Laser System in Agriculture", IIT/WP-141B, November 2002, with authors St. Dinoev, M. Antonov, T. Stoyanov.

For the purpose of increasing the efficiency of this system we came back to the previous experience and namely to the design of the system SOLAR 25 XH85, working with 25 mW He-Ne laser and additional preheating neon tubes emitting normal red light Fig. 1 [10] for preliminary warm up of seeds.

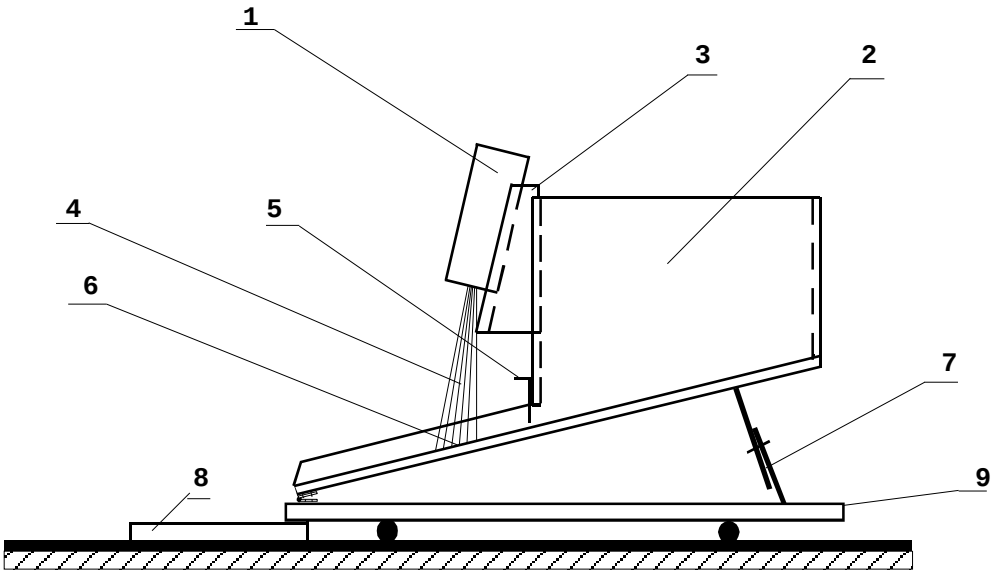

Fig.1. General mechanical diagram of`Laser system for pre-sowing irradiation of seeds` SOLAR-2M: **1** – laser emiter containing semiconductor laser, mounted in a cooling radiator to which the power suppli cars is attached; **2** – fastening device under a fixed angle of the laser diode; **3** – container for the non-treated seeds; **4** – laser beam; **5** – shutter for controlling the qantity of the seeds passed; **6** – zone where seeds are radiated; **7** – adjusting mechanism for changing the system inclination; **8** – collector for tge radiated seeds; **9** – basic board of the system; **10** – matrix light emitting diodes for red light

Materials and control method

The laboratory and field experiments carried out in the period 1998-2003 according to a contract between Ministry of Education and Sciences and IIT-BAS, realized on the sites of the Base for Irradiation and Development, Institute "N. Pushkarov", COS – Pazardjik and the Institute of Seed Protection (ISP) – Kostinbrod, showed positive post-effect of the laser irradiation on the growth and development of wheat of sort "Jantar" and maize of sort "Kneja-613". In 2004 some new experiments were accomplished with seeds of wheat of "Jantar" type only on the fields of ISP – Kostinbrod on places of 200 m^2, on total area of 0.4-0.5 h.

These results were achieved by the IIT-BAS team in cooperation with the upper mentioned departments of the former Agricultural Academy. For the purpose of concluding the work and estimation of the developed methodology, estimation also of the designed and constructed laser system SOLAR-2M in 2005 we aimed to test some of the basic parameters by carrying out laboratory experiments in the Executive Agency Plant Variety testing Approbation and Seed Control.

We received 5 kg of seed of normal wheat "Sadovo 1" from the colleagues of the COS – Pazardjik with a certificate No 1319/20.08.2004, issued by the above mentioned agency. The latter accepted to accomplish a study on the degree of energy increase of germination, the vitality, electrical conduc-tivity, and moisture content in the radiated seeds, compared to the control ones.

We again applied the technology, tested already several times for irradiation of seeds by low power laser radiation (under 50 mW/cm^2). The seeds treated in this

way were provided to the specialists in the laboratory of the Executive Agency Plant Variety Testing Approbation and Seed Control for carrying out the respective control measurements.

Results of the control measurements

The measurements were performed according to the methods by the specialists in the Central Laboratory of the Executive Agency Plant Variety Testing Approbation and Seed Control, and namely with no preliminary seed cooling, 10 days stay (incubation period) with following registration of the germination energy on the 4th (Table 1) and then on the 7th day (Table 2).

Table 1

No	Repetition	Germination	Average	Irradiation
1	1 2	91.0 95.0	93.0	5 times
2	1 2	93.0 97.0	95.0	4 times
3	1 2	93.0 95.0	94.0	3 times
4	1 2	93.0 91.0	92.0	Twice
5	1 2	99.0 97.0	98.0	Once
6	1 2	95.0 91.0	93.0	10 s
7	1 2	94.0 93.0	93.5	30 s
8	1 2	92.0 93.0	92.5	1 min
9	1 2	85.0 93.0	89.0	15 min
10	1 2	90.0 94.0	92.0	Control

The results received about the germination energy on the 4th day show doubtlessly the positive influence of the radiation on its increase. It is seen from the table that most expressed is the increase at single time irradiation (seq. number 5).

The results achieved for the germination energy on the 7th day show again unconditionally the positive influence of the laser radiation on it. It can also be seen from the table that mostly expressed the increase at single time irradiation (seq. number 5).

Both tables demonstrate increase of the germination energy up to a level of 99%, which is very high.

Following our technology approved in practice a rest of 7 days in darkness was imposed on the radiated seeds and then they were sown on the terrain of COS – Pazardjik for the purpose of checking the further develop-ment of the plants and in long run – rendering the increase of yield. But as mentioned in the beginning, nature did not have mercy on us and the experiment set was destroyed.

Table 2. Final results of the experiment (7th day)

No	Repetition	Germination	Average	Abnormal	Average	Dead	Average	Irradiation
1	1 2	94.0 98.0	96.0	2.0 1.0	1.5	4.0 2.0	3.0	5 times
2	1 2	96.0 98.0	97.0	0.0 1.0	0.5	4.0 1.0	3.5	4 times
3	1 2	93.0 94.0	93.5	1.0 2.0	1.5	6.0 4.0	5.0	3 times
4	1 2	96.0 92.0	94.0	1.0 1.0	1.0	3.0 7.0	5.0	Twice
5	1 2	98.0 100.0	99.0	0.0 0.0	0.0	2.0 0.0	1.0	Once
6	1 2	96.0 99.0	97.5	1.0 1.0	1.0	3.0 1.0	2.0	10 s
7	1 2	95.0 94.0	94.5	1.0 0.0	0.5	1.0 4.0	2.5	30 s
8	1 2	96.0 93.0	94.5	0.0 2.0	1.0	3.0 5.0	4.0	1 min
9	1 2	94.0 98.0	96.0	2.0 2.0	2.0	4.0 4.0	4.0	15 min
10	1 2	94.0 98.0	96.0	1.0 0.0	0.5	5.0 2.0	3.5	Control

Conclusions

The seeds, irradiated by laser radiation received from semiconductor lasers, generating waves close to that of the He-Ne lasers show positive changes in the germination energy at the 7th day, which unambiguously demonstrates the positive influence of the laser irradiation on it. It can be seen also from Table 2, that most expressed is the increase of germination energy at single time laser radiation (seq. number 5).

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Лазер – управляемый помощник в сельском хозяйстве

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(Р е з ю м е)

Рассматриваются результаты применения облучения растительных организмов при помощи полупроводниковых лазеров. Развитие растений после этого облучения показывает положительное воздействие применения технологии в ускорении их развития. Результаты экспериментов приведены в таблицах.