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Experimental research results on the treatment of watermelon seeds with ultraviolet light

Tarvuz urug'lariga ultrabinafsha nur bilan ishlov berish bo'yicha eksperimental tadqiqot natijalari

Результаты экспериментальных исследований по обработке семян арбуза ультрафиолетовым светом

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ENGLISH

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Abstract. In increasing watermelon yield, improving the laboratory and field germination of the seeds to be sown and disinfecting them against various diseases are of great practical importance in agriculture. In this regard, developing a special device for ultraviolet (UV) irradiation of watermelon seeds and increasing the efficiency of its use is a pressing issue. The aim of the research is to conduct experimental studies on a laboratory prototype of a device for UV irradiation of watermelon seeds and to determine the most rational irradiation modes. The experiments were carried out on a laboratory stand of the UV device, in four replications, using bactericidal lamps with a power of 120–180 W and wavelengths of 253.7 nm and 300 nm. Different modes, varying in the distance between the seeds and the irradiator and in the treatment time, were compared with one another, and the results of the analysis are presented.

Keywords: watermelon seed; germination; ultraviolet light; irradiation; wavelength; lamp; watermelon; method; stand; bactericidal; power; fungus

O'ZBEKCHA

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Annotatsiya. Maqolada tarvuz hosildorligini oshirishda ekiladigan urug'larning laboratoriya hamda dala unuvchanligini yaxshilash va ularni turli kasalliklardan zararsizlantirish qishloq xo'jaligida muhim amaliy ahamiyatga ega. Shu munosabat bilan tarvuz urug'lariga ultrabinafsha nur (UBN) beruvchi maxsus qurilmani ishlab chiqish va undan foydalanish samaradorligini oshirish dolzarb masala hisoblanadi. Tadqiqotning maqsadi tarvuz urug'iga ultrabinafsha nur berish qurilmasining laboratoriya nusxasida eksperimental tadqiqotlar o'tkazish hamda nurlatishning eng ratsional rejimlarini aniqlashdan iborat. Tajribalar UBN qurilmasining laboratoriya stendida to'rt qaytariqda, to'liq uzunliklari 253,7 nm va 300 nm bo'lgan 120 – 180 Vt quvvatli bakteritsid lampalarda o'tkazildi. Urug'lar va nurlatgich orasidagi masofa hamda ishlov berish vaqti bo'yicha turli rejimlar o'zaro solishtirilib, tahlillar natijalari keltirilgan.

Kalit so'zlar: tarvuz urug'i; unuvchanlik; ultrabinafsha nuri; nurlanish; to'liq uzunligi; lampa; tarvuz; usul; stend; bakteritsid; quvvat; zamburug'

РУССКИЙ

УСМОНОВ Иномжон Исроилович^{1*} , АБДУЛЛАЖОНОВ Сирожиддин Садирдин угли¹ ¹ Кокандский государственный университет, Коканд, Узбекистан

Аннотация. В деле повышения урожайности арбуза повышение лабораторной и полевой всхожести высеваемых семян и их дезинфекция против различных болезней имеют важное

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практическое значение в сельском хозяйстве. В связи с этим разработка специального устройства для ультрафиолетового (УФ) облучения семян арбуза и повышение эффективности его использования является актуальной задачей. Целью исследования является проведение экспериментальных исследований на лабораторном макете устройства для УФ-облучения семян арбуза и определение наиболее рациональных режимов облучения. Эксперименты проводились на лабораторном стенде УФ-установки в четырехкратной повторности с использованием бактерицидных ламп мощностью 120–180 Вт и длиной волны 253,7 нм и 300 нм. Сопоставлены различные режимы, различающиеся расстоянием между семенами и облучателем, а также временем обработки, и представлены результаты анализа.

Ключевые слова: семена арбуза; всхожесть; ультрафиолетовый свет; облучение; длина волны; лампа; арбуз; метод; стенд; бактерицидный; мощность; грибок

1. INTRODUCTION

Producing and using high-quality seed material is of great importance for obtaining high and stable yields from cucurbit crops. Seed production differs from ordinary crop production technology and includes a number of special agrotechnical measures, such as preserving the biological characteristics of the variety, ensuring the quality indicators of the seeds, harvesting on time, and separating, drying, sorting and storing the seeds. In particular, seed production of cucurbit crops is labor-intensive to a certain degree and requires the use of technical means adapted to the efficient performance of technological processes [1-2].

Studies note that an insufficient level of mechanization in the cultivation of cucurbit crops and the production of seed material increases labor costs and reduces production efficiency. In particular, because special implements and machines for treating cucurbit crops are produced in limited quantities, farms sometimes adapt the technical equipment they already have. Therefore, improving seed production and cultivation technology for cucurbit crops, reducing labor costs, and using modern, resource-saving mechanization tools are among the important scientific and practical tasks [3-4].

Not many works have been devoted to studying the effect of ultraviolet light on biological objects; the published works note its environmental cleanliness, low cost and convenience. Using ultraviolet light for pre-sowing seed treatment improves seed health and increases the yield of agricultural crops by 35% to 45% [5-6].

Seed emergence is one of the important stages of the seedling-growing process. In watermelon, delayed and uneven seed emergence are frequently encountered problems. Therefore, it is important to use stimulating technologies aimed at ensuring fast, uniform and high-quality seed emergence.

A number of factors affect the seed emergence process. In particular, seed germination energy, ambient temperature, the moisture level required for emergence, and other external and internal factors are important for the speed and uniformity of seed emergence and development.

It is known that ultraviolet radiation is a part of the natural solar spectrum. Because of its diverse effects, it has attracted the attention of physicians, biologists and scientists in other fields. In Uzbekistan, increasing crop yields is considered one of the important factors for boosting the production of agricultural products. At present, in addition to improving traditional agrotechnical measures, the rational use of new resources is

required. Among these is the regulation of physiological processes in plants through methods of exposing plants to UV light and the use of growth stimulators [7-8].

In obtaining a high yield from agricultural crops, including watermelon, one of the cucurbit crops, the quality indicators of the seeds prepared for sowing play an important role alongside other agrotechnical measures. This is because using select seeds that are close to one another in biological properties, with high laboratory and field germination and high potential yield, is the guarantee of an abundant harvest. Taking this into account, experimental studies were conducted on irradiating watermelon seeds with ultraviolet light [8-9].

For this purpose, the laboratory germination of “Dilnoz” variety watermelon seeds in the control variant was first determined in four replications.

2. METHODS

Experimental studies on irradiation on the stand for UV treatment of watermelon seeds were developed, and the experiments were carried out in four replications [9-10].

3. RESULTS

In recent years, as a result of scientific research, an irradiation stand for UV treatment of watermelon seeds has been developed. Based on the analysis of the results, the following conclusion can be drawn: the experiment was conducted at heights of 6, 9 and 12 cm, at time intervals of 3, 5 and 7 minutes, at wavelengths of 253.7 nm and 300 nm, using bactericidal lamps with a total power of 180 W. With a distance of 9 cm from the irradiator to the seeds, a seed irradiation time of 5 minutes, and bactericidal lamps of 253.7 nm wavelength and 60 W power together with 300 nm wavelength and 90 W power, germination was 98.3% (Table 2). Compared with the other UV parameters and modes, the best sprout emergence was observed in this mode.

This research consists in creating a technology for disinfecting and stimulating watermelon seeds before sowing by means of electrotechnological methods. Therefore, we conducted studies to determine the microflora of watermelon seeds before and after treatment by electrotechnological methods.

Figure 1 shows the experimental samples used to determine fungal infection in watermelon seeds. The experiments were carried out in the laboratory of the Department of Chemical Technologies of Kokand State University.

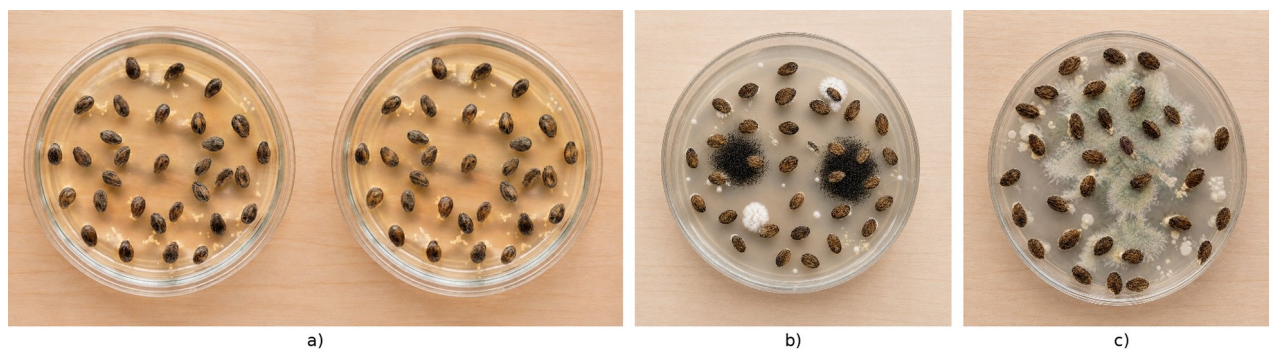


Fig. 1. “Dilnoz” variety watermelon seeds: infection by (a) *Bacillus* spp., (b) *Streptomyces* spp. and *Actinomyces* spp., (c) *Micrococcus* spp. and *Fusarium* spp. fungi

As a result of the research, when seeds of the “Dilnoz” watermelon variety were studied microbiologically, microorganisms were found to occur in relatively high amounts. The isolated microorganisms were identified taxonomically as belonging to the groups *Bacillus* spp., *Micrococcus* spp., *Fusarium* spp., *Streptomyces* spp. and *Actinomyces* spp. fungi.

The laboratory germination of “Dilnoz” variety watermelon seeds was 84% in the control variant and 98.3% after irradiation, which is 14.3% higher than the control.

The UV treatment of the seeds was carried out in the laboratory of the Department of "Electrical Technologies" of Kokand State University.

A lighting stand fitted with bactericidal lamps of 253.7 nm and 300 nm wavelengths, with a total power of $P = 180$ W, was used as the ultraviolet light source. For each variant, 30 watermelon seeds were selected.

The selected seeds were irradiated using the stand shown in Figure 2.



Fig. 2. General view of the UV treatment stand

After irradiation, the seeds were placed on moist filter paper in laboratory Petri dishes and left in a dark place at a temperature of 21–23 °C. The germination of the watermelon seeds was assessed visually and by counting. Sprouts began to appear within the first two days. After six days, seed emergence stabilized, and on the eighth day all viable seeds were identified [10-11].



Fig. 3. Appearance of watermelon seeds when irradiated with ultraviolet light

As can be seen from Figure 3, it was found that *Bacillus* spp., *Micrococcus* spp., *Fusarium* spp., *Streptomyces* spp., *Actinomyces* spp. and other fungi died in the seeds treated with UV light.

The tables present the results of determining the germination of watermelon seeds treated with ultraviolet light. In the tables, H_{UV} is the distance from the UV lamp to the seeds (cm), t is the irradiation time (min), and germination is given in %.

Table 1

Germination of watermelon seeds irradiated with 253.7 nm lamps of 120–180 W power

$\lambda=253.7$ nm, $P=120$ W			$\lambda=253.7$ nm, $P=150$ W			$\lambda=253.7$ nm, $P=180$ W		
H_{UV} , cm	t , min	Germination, %	H_{UV} , cm	t , min	Germination, %	H_{UV} , cm	t , min	Germination, %
6	3	75.2	6	3	77.5	6	3	74.9
	5	79.1		5	84.1		5	78.7
	7	79.2		7	82.5		7	78.6
9	3	78.4	9	3	79.2	9	3	78.2
	5	76.5		5	84.1		5	76.2
	7	74.7		7	69.2		7	74.3
12	3	74.6	12	3	71.7	12	3	74.0
	5	76.8		5	80.8		5	76.4

$\lambda=253.7$ nm, P=120 W			$\lambda=253.7$ nm, P=150 W			$\lambda=253.7$ nm, P=180 W		
H_{UV} , cm	t, min	Germination, %	H_{UV} , cm	t, min	Germination, %	H_{UV} , cm	t, min	Germination, %
	7	75.7		7	65.8		7	75.4

Table 1 presents the results of the experiments carried out with lamps of 253.7 nm wavelength and 120–180 W power. According to it, the best germination rate, 84.1%, was obtained with a 150 W irradiator at a distance of 6 cm from the seeds and an irradiation duration of 5 minutes.

Table 2

Germination of watermelon seeds irradiated simultaneously with 253.7 nm lamps (30–90 W) and 300 nm lamps (90 W)

$\lambda=253.7$ nm, P=30 W $\lambda=300$ nm, P=90 W			$\lambda=253.7$ nm, P=60 W $\lambda=300$ nm, P=90 W			$\lambda=253.7$ nm, P=90 W $\lambda=300$ nm, P=90 W		
H_{UV} , cm	t, min	Germination, %	H_{UV} , cm	t, min	Germination, %	H_{UV} , cm	t, min	Germination, %
6	3	82.1	6	3	87.5	6	3	83.9
	5	92.0		5	94.1		5	88.0
	7	76.3		7	84.2		7	82.4
9	3	82.1	9	3	95.7	9	3	88.1
	5	91.1		5	98.3		5	88.2
	7	83.8		7	92.4		7	86.7
12	3	74.5	12	3	87.5	12	3	84.1
	5	86.1		5	94.1		5	86.6
	7	84.5		7	84.1		7	82.2

Table 2 presents the results of the experiments carried out with lamps of 253.7 nm wavelength and 30–90 W power, together with lamps of 300 nm wavelength and 90 W power. The best germination rate, 98.3%, was obtained with the 253.7 nm lamp at 60 W and the 300 nm lamp at 90 W, at a distance of 9 cm from the irradiator to the seeds and an irradiation duration of 5 minutes

Table 3

Germination of watermelon seeds irradiated simultaneously with 253.7 nm lamps (60–120 W) and 300 nm lamps (60 W)

$\lambda=253.7$ nm, P=60 W $\lambda=300$ nm, P=60 W			$\lambda=253.7$ nm, P=90 W $\lambda=300$ nm, P=60 W			$\lambda=253.7$ nm, P=120 W $\lambda=300$ nm, P=60 W		
H_{UV} , cm	t, min	Germination, %	H_{UV} , cm	t, min	Germination, %	H_{UV} , cm	t, min	Germination, %
6	3	85.0	6	3	85.8	6	3	81.9
	5	88.9		5	91.2		5	87.3
	7	75.2		7	74.1		7	74.5
9	3	84.3	9	3	85.7	9	3	83.9
	5	93.8		5	94.9		5	89.8
	7	80.3		7	80.8		7	78.1
12	3	78.8	12	3	78.2	12	3	77.5
	5	83.5		5	84.2		5	81.8
	7	75.8		7	74.9		7	74.7

Table 3 presents the results of the experiments carried out with lamps of 253.7 nm wavelength and 60–120 W power, together with lamps of 300 nm wavelength and 60 W power. The best germination rate, 94.9%, was obtained with the 253.7 nm lamp at 90 W and the 300 nm lamp at 60 W, at a distance of 9 cm from the irradiator to the seeds and an irradiation duration of 5 minutes.

Table 4

Germination of watermelon seeds irradiated simultaneously with 253.7 nm lamps (90–150 W) and 300 nm lamps (30 W)

$\lambda=253.7$ nm, P=90 W $\lambda=300$ nm, P=30 W			$\lambda=253.7$ nm, P=120 W $\lambda=300$ nm, P=30 W			$\lambda=253.7$ nm, P=150 W $\lambda=300$ nm, P=30 W		
H_{UV} , cm	t, min	Germination, %	H_{UV} , cm	t, min	Germination, %	H_{UV} , cm	t, min	Germination, %
6	3	87.6	6	3	92.5	6	3	88.8
	5	84.5		5	87.5		5	85.6
	7	75.7		7	77.4		7	76.3
9	3	78.2	9	3	79.9	9	3	79.1
	5	84.7		5	88.3		5	85.8
	7	77.8		7	78.3		7	78.5
12	3	81.7	12	3	84.1	12	3	82.8
	5	83.5		5	87.4		5	84.7
	7	68.1		7	68.3		7	68.3

Table 4 presents the results of the experiments carried out with lamps of 253.7 nm wavelength and 90–150 W power, together with lamps of 300 nm wavelength and 30 W power. The best germination rate, 92.5%, was obtained with the 253.7 nm lamp at 120 W and the 300 nm lamp at 30 W, at a distance of 6 cm from the irradiator to the seeds and an irradiation duration of 3 minutes.

Table 5

Germination of watermelon seeds irradiated with 300 nm lamps of 120–180 W power

$\lambda=300$ nm, P=120 W			$\lambda=300$ nm, P=150 W			$\lambda=300$ nm, P=180 W		
H _{uv} , cm	t, min	Germination, %	H _{uv} , cm	t, min	Germination, %	H _{uv} , cm	t, min	Germination, %
6	3	87.2	6	3	89.1	6	3	91.2
	5	91.5		5	95.8		5	93.9
	7	79.8		7	82.5		7	84.3
9	3	81.0	9	3	85.8	9	3	88.5
	5	88.9		5	92.4		5	90.4
	7	77.1		7	79.2		7	80.6
12	3	80.5	12	3	83.2	12	3	86.5
	5	88.0		5	91.6		5	91.2
	7	76.8		7	79.1		7	79.6

Table 5 presents the results of the experiments carried out with lamps of 300 nm wavelength and 120–180 W power. According to it, the best germination rate, 95.8%, was obtained with a 150 W irradiator at a distance of 6 cm from the seeds and an irradiation duration of 5 minutes.

Figure 4 shows the best average results obtained when lamps with wavelengths of 253.7 nm and 300 nm are used simultaneously.

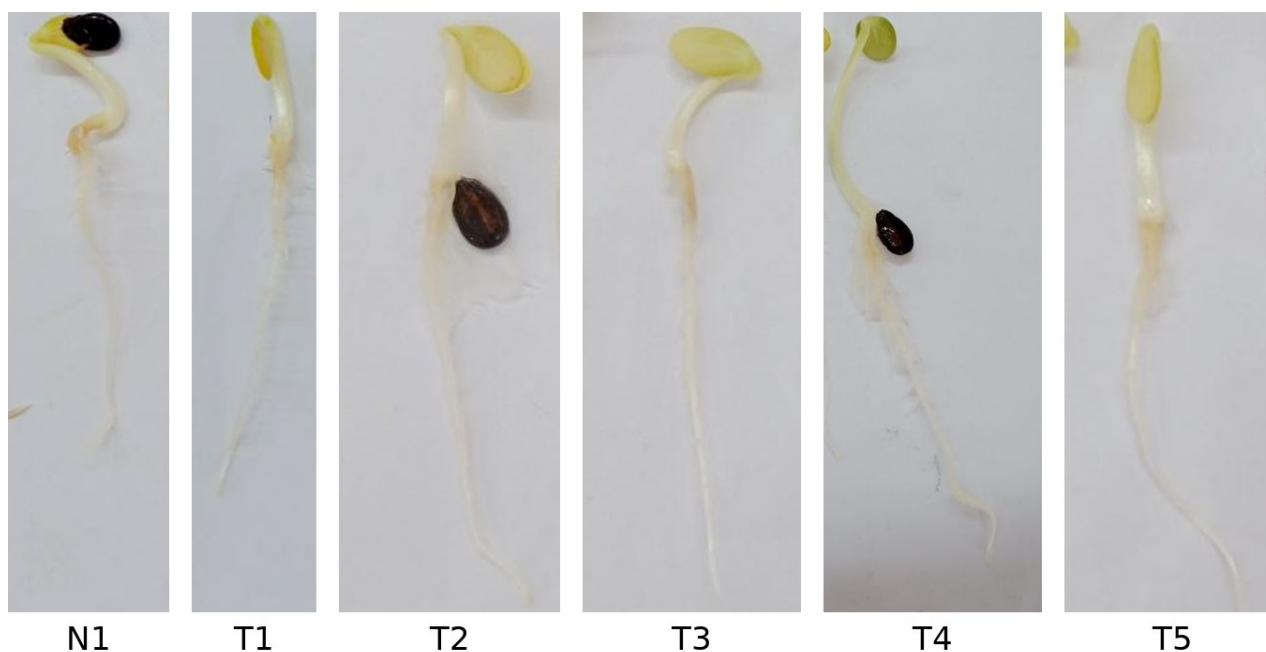


Fig. 4. N1 – control; T1, T2, T3, T4, T5 – experimental

4. DISCUSSION

Based on the analysis of the results presented in the tables, the following conclusion can be drawn: depending on the radiation dose, wavelength and exposure time, the effect of ultraviolet (UV) light on seeds can be both positive (stimulating) and negative (harmful). Light with a wavelength of 253.7 nm has the property of disinfecting microorganisms in seeds when applied for the required duration, whereas light with a wavelength of 300 nm has a stimulating property. Thus, using both lamps simultaneously prevents the seeds from becoming diseased and increases their germination. In agricultural and laboratory practice, treating seeds with ultraviolet light before sowing is an effective method for increasing yield and for disinfecting the seeds and increasing their germination.

Thus, it turns out that with the proposed stand for UV treatment of seeds, it is possible to obtain select seed material that is disease-resistant, ecologically clean and highly germinating.

5. CONCLUSION

The experimental studies conducted showed that ultraviolet radiation (UV) is highly effective in disinfecting “Dilnoz” variety watermelon seeds and increasing their germination under laboratory conditions. While the germination rate of seeds in the ordinary control variant was 84%, it reached 98.3% when treated with ultraviolet light in the optimal mode, and germination increased by 14.3%.

According to the results obtained, the highest value was recorded when lamps were used together at a distance of 9 cm from the irradiator to the seeds, an irradiation duration of 5 minutes, and wavelengths of 253.7 nm at 60 W and 300 nm at 90 W, a total power of 150 W (Table 2).

In conclusion, treating watermelon seeds with ultraviolet light before sowing, with correctly selected parameters and modes, increases the biological activity of the seeds and is an effective agrotechnical method that ensures yield.

DECLARATIONS

Author contributions CRedit

Conceptualization; Methodology; Investigation; Data curation; Writing – original draft; Writing – review & editing. All authors have read and agreed to the published version of the manuscript.

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Ethics approval

The study was carried out under laboratory conditions on watermelon seeds only; no human participants or animals were involved, and no ethics committee approval was required.

Informed consent

All authors have read and approved the final version of the manuscript and have given their consent to its submission and publication. The study involved no human participants and no personal data.

Data availability statement

The data obtained in the study are presented in the tables and figures of this article; the primary records are available from the authors on reasonable request.

Conflict of interest

The authors declare no conflict of interest.

Generative AI disclosure

Generative AI (Claude, Anthropic) was used in the editorial preparation of this article: for language editing, translation of the title, abstract and keywords between Uzbek, Russian and English, preparation of the extended English summary from the authors' text, and formatting of the reference list. No data, results or conclusions were generated by AI. The authors are responsible for the content of the publication.

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