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POSSIBILITIES OF APPLYING DIFFERENTIAL MICRO-SPRAYING TECHNOLOGY IN SMALL FARMS

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Abstract. This article analyzes the theoretical foundations of differential micro-spraying technology used in plant protection processes in small-scale farming and household plots. It also highlights the disadvantages of traditional spraying methods, including excessive resource consumption and the resulting environmental issues, while demonstrating the advantages of differential micro-spraying technology. The relationship between droplet size, pressure, and spraying efficiency in the micro-spraying process is theoretically substantiated. The research findings indicate that differential micro-spraying technology plays a significant role in reducing pesticide consumption, increasing crop yields, and ensuring environmental sustainability.

Keywords: differential micro-spraying, agro-robot, pesticide saving, sensors, smart agriculture, empirical coefficient.

Introduction. Currently, the efficient use of resources in agriculture is one of the pressing issues. In particular, the excessive consumption of pesticides and liquid fertilizers used in plant protection causes both economic damage and environmental problems. In traditional spraying methods, liquids are sprayed in equal amounts across the field, which does not take into account the real needs of the plants [1,2].

Differential micro-spraying technology is proposed as one of the modern approaches. This technology allows for individual assessment of plant conditions and spraying only the necessary amount of liquid in the required areas. As a result, resource savings and increased efficiency are achieved [3].

Materials and methods. Differential spraying is the process of providing plants with liquid individually according to their needs. In this technology, the condition of plants is determined using sensors and cameras, and spraying is carried out only in areas that are affected or require
nutrients [4].

Traditional spraying has the following drawbacks:

• excessive pesticide consumption

• environmental pollution

• low economic efficiency

The differential approach significantly reduces these problems.

When protecting plants from diseases and treating pests, it is the size of the drop that directly affects the following [5]:

• adherence to the plant surface

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• wind-blown
• Coverage quality
For example:
• Very small drop (<100 μm) → disappears in the wind
• Very large drop (>400 μm) → flows down
The optimal range is usually within 100-300 μm (see Figure).

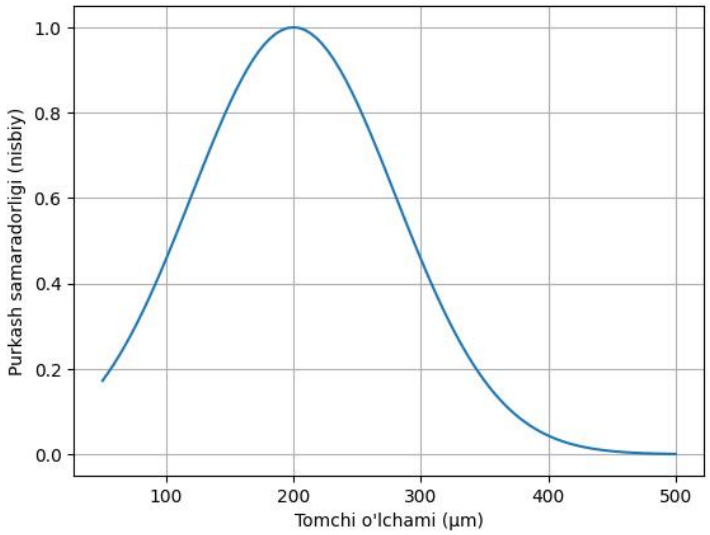

Figure. Graph of the relationship between droplet size and spraying efficiency

From the graph in the figure, it can be seen that the spraying efficiency varies according to a curvilinear dependence depending on the droplet size and reaches a maximum value in a certain optimal range. Deviation from this range leads to a decrease in efficiency.

This is the widely accepted range in agricultural spraying technology.

The micro-spraying process is based on the formation of droplets and their reaching the plant surface. The droplet size is expressed by the following formula:

$$D \sim \left(\frac{\sigma}{\rho \cdot \vartheta^2}\right)^{1/3} \qquad (1)$$

here:

• D - droplet diameter

• σ - surface tension;

• ρ - density of the liquid

• v - output speed

However, in practical spray systems (for nozzle spraying), the drop size is determined not only by these parameters, but also by the following factors:

• injector diameter;

• working pressure;

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• degree of turbulence of the flow;

• constructive features.

Therefore, in engineering calculations, the empirical correction coefficient is introduced:

$$D = K\cdot\left(\frac{\sigma}{\rho\cdot\vartheta^2}\right)^{1/3} \qquad (2)$$

where K is a coefficient depending on the spraying conditions and is taken in practice in the range (0.02 ÷ 0.05).

Here, for an aqueous solution: σ = 0.072 N/m, ρ = 1000 kg/m^3, v = 15 m/c, K = 0.03, according to expression (2), we find that D = 204 μm.

The obtained result is about 200 μm, which corresponds to the range of 100-300 μm, which is considered optimal in agricultural spraying technologies.

Consequently, for the effective operation of the differential micro-injection system, the droplet size must be within this range.

Small-diameter drops adhere better to the plant surface and increase efficiency. At the same time, very small droplets can be blown away by the wind, therefore it is necessary to choose the optimal size [6].

Results and their analysis. According to theoretical calculations, differential micro-spraying technology leads to the following results:

• pesticide consumption is reduced by 30-50%;

• water consumption is reduced;

• spraying efficiency increases.

If in the traditional method 100 liters of solution are used per 1 hectare, then in the differential approach this indicator can be 50-70 liters.

The introduction of differential micro-spraying technology in small and medium-sized household plots provides the following advantages:

• achieving high efficiency through energy and resource saving;

• reduction of manual labor and increasing the level of agricultural automation;

• ensuring environmental safety.

It is also expected that further efficiency will be achieved through the integration of this technology with smart agro-robot platforms.

Conclusion. Differential micro-spraying technology is a modern solution that allows for the rational use of resources in agriculture. Theoretical analysis shows that this technology serves to increase yields while reducing pesticide and water consumption. Its implementation in small farms is also economically and environmentally expedient to integrate this technology with a smart agro-robot platform.

References

1. N.R.Yusupov, Qishloq xo‘jaligi monitoringida raqamli texnologiyalarning tutgan o‘rni // Scientific Journal of Actuarial Finance and Accounting Vol. 4 No. 11, 2024, B. 57-62.
2. T.P. Jiemuratov, O‘zbekistonda qishloq xo‘jaligini raqamlashtirish va ASMga raqamli texnologiyalarni joriy etish // “Innovations in Science and Technologies” илмий-электрон журнали ISSN: 3030-3451. 2 / 2025 B 383-390.
3. Zhang, Q. *Precision Agriculture Technology for Crop Farming*. CRC Press, 2015.

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Journal: https://www.academicpublishers.org/journals/index.php/ijai

4. Lee, W.S., Alchanatis, V., Yang, C. "Sensing technologies for precision agriculture." *Computers and Electronics in Agriculture*, 2010.
5. Matthews, G.A. *Pesticide Application Methods*. Wiley-Blackwell, 2008.
6. FAO. *The State of Food and Agriculture*. Rome, 2020.