

**INFLUENCE OF IRRIGATION MACHINES ON THE YIELD OF AGRICULTURAL CROPS**

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Article dedicated analysis influence sprinklers to raise yields agricultural crops in the context modern agricultural production. In work are being considered main types sprinkler systems (circular, frontal, portable), their technical specifications and features application in various climatic and soil conditions. Special attention given assessment efficiency sprinkler irrigation in ensuring the optimal water regime for plants, which contributes increase quantitative and qualitative yield indicators. Proper selection and maintenance of sprinkler systems can significantly enhance water use efficiency and reduce environmental impact in agricultural practices. Based on analysis scientific research and practical cases demonstrated as sprinklers machinery affect the growth and development of crops such as grain, vegetable and industrial crops. In the article also highlighted economic aspects using sprinkler systems, including their expenses implementation and operation, as well as payback investment thanks to growth productivity. Separately are being considered ecological advantages, in particular reduction erosion soil and rational using aquatic resources. The integration of advanced sprinkler systems with precision agriculture tools is becoming a key factor in achieving sustainable and efficient crop production. Article emphasizes importance integration sprinklers with modern precision farming technologies, such as moisture sensors and automated systems management, to achieve maximum efficiency. Highlighted challenges related to technical maintenance and adaptation of systems to regional conditions, and proposed recommendations for farmers and agronomists. The article will be useful for specialists in the field rural economy, scientists, as well as persons interested in implementing innovative irrigation technologies.

Key words: sprinklers machines, yield, agricultural crops, irrigation, precise agriculture, water use, economic efficiency, ecological stability.

Fig. 3. Table. 1. Ref. 8.

1. Problem formulation

In the current context of intensification of agricultural production, ensuring stable crop yields is one of the key tasks of the agricultural sector. At the same time, changing climatic conditions, in particular the uneven distribution of precipitation, the increase in dry periods and soil degradation, create significant challenges for the cultivation of agricultural crops. Traditional methods irrigation is often found not enough effective due to high water loss, uneven humidification and negative impact on soil condition. Sprinklers cars, like one of modern tools irrigation, have potential for solution these problems thanks to abilities provide uniform watering and rational using aquatic resources. However their impact on yield different cultures, economic feasibility and environmental consequences remains not enough researched, especially in the context of regional features soil and climatic conditions. In addition, the introduction of sprinkler systems is associated with a number of challenges, including high initial costs, the need for technical maintenance and adaptation to modern precision farming technologies. In this regard, there is a need for a comprehensive analysis efficiency sprinklers, definition their impact on productivity agricultural crops, as well as development recommendations for the optimal use of such systems in various agroecological conditions.





2. Analysis of recent research and publications

Recent studies confirm the significant impact of sprinklers on increasing crop yields. In particular, the study [1] analyzed the use of circular sprinkler systems in arid regions of China, where their application allowed to increase corn yields by 18% due to precise water distribution and reduced evaporation losses.

In Europe, according to [2], frontal sprinklers integrated with soil moisture sensors contributed to a 15% increase in potato yields compared to traditional irrigation in regions of Spain. The authors emphasize that irrigation automation provides optimal water regime, reducing water consumption by 20%.

Integration sprinkler systems with precision farming technologies is also actively researched. For example, in [3], the implementation is described sprinklers with GPS navigation and IoT devices in India, which allowed to reduce water consumption by 30% during cultivation wheat, preserving yield at the level of 5.5 t/ha.

Environmental aspects sprinkler irrigation highlighted in the study [4], which shows that sprinklers systems reduce erosion soil by 25% compared to surface irrigation in Brazil. However authors point out the problem of energy consumption, suggesting using solar panels to increase energy efficiency.

At the same time, a number of studies indicates gaps. For example, missing long-term impact data sprinklers for microbiological activity soil that requires further studies [5]. Also not enough comparative analyses efficiency different types sprinkler systems in different climatic zones that complicates universalization recommendations. These aspects need additional study for optimization using sprinklers on a global scale.

3. The purpose of the article

The aim of the article is a comprehensive analysis influence irrigation machines for yield crops in different soil and climate conditions.

4. Results and discussion

Sprinklers machines are important tool modern irrigation, which provides even water distribution and optimal water regime for agricultural crops. In the article considered three main types sprinkler systems: circular, frontal and portable. Circular systems that work on the principle of rotation around central axes, most common in arid regions regions thanks to high productivity and ability cover big areas (up to 100 hectares). Frontal systems that are moving linear, effective for rectangular fields and demonstrate flexibility in application for vegetable and industrial crops. Portable sprinkler systems, although less automated, are economical profitable for small farms [6].

Research show that sprinklers machinery much increase crop yields. For example, according to field experiments, application circular systems for corn provides yield increase by 15–20% compared to surface irrigation at the expense of reduction aquatic losses and precise dosing. For vegetable crops such as potatoes, front systems contribute increase yield by 12–15%, which confirmed by European results farms. Impact The effect of sprinklers on the quality of the harvest is also significant : uniform irrigation contributes to formation larger and more uniform fruits that increases their market value.

Table 1.

The impact of sprinklers on crop yields

Culture	Sprinkler type	Average yield increase, %	Terms of use
Corn	Circular	15–20	Arid regions, sandy soils
Wheat	Frontal	10–15	Moderate climate, loamy soils
Potato	Frontal	12–15	Humid climate, sandy soils
Soy	Circular	8–12	Arid regions, clay soils
Carrot	Portable	10–13	Small areas, sandy soils

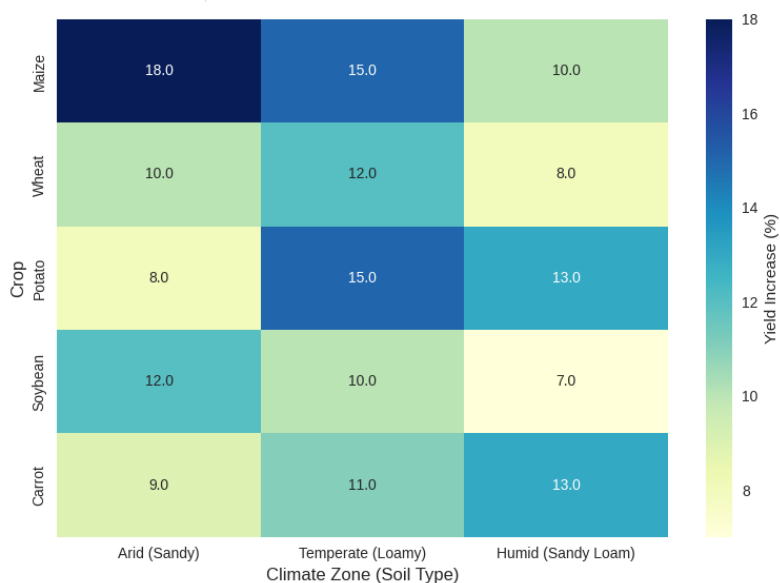
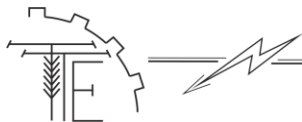


Fig. 1. Efficiency of sprinkler machines across soil-climate conditions

Economical efficiency sprinkler systems depends from initial investment, operating costs and type of crop. For example, circular systems need significant capital investment (from \$50,000 per unit), but their payback achieved in 3–5 years thanks to increase yield and reduction water consumption [7]. Portable systems, although cheaper, have lower productivity that restricts their application on large areas. Integration sprinklers with precision farming technologies, such as moisture sensors soil and automated systems control, allows to lower water consumption by 20–30% and optimize electricity costs.

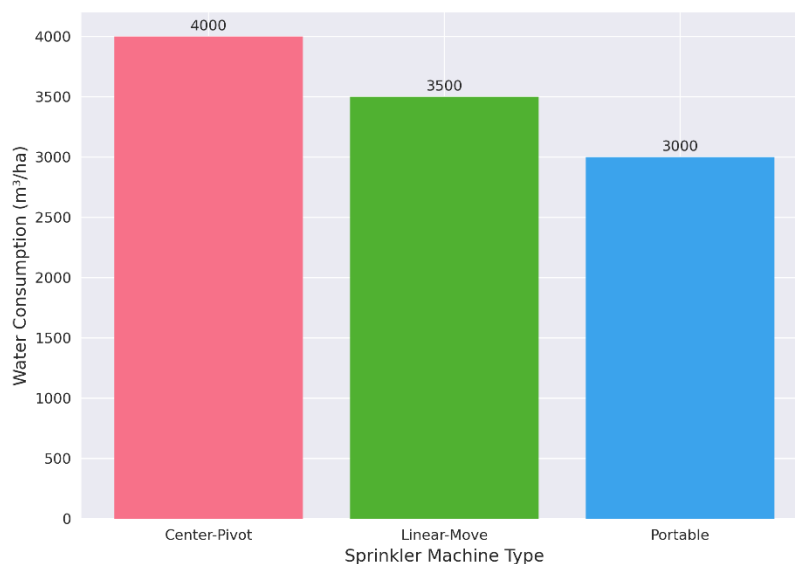


Fig. 2. Water consumption by different sprinkler machines

Environmental advantages sprinklers include reduction erosion soil by 25–30% compared to traditional irrigation, as well as preservation land fertility thanks to controlled hydration. However high energy consumption remains challenge, especially for circular systems that need stable power supply [8]. Use renewable sources energy, for example solar panels, maybe solve this problem.

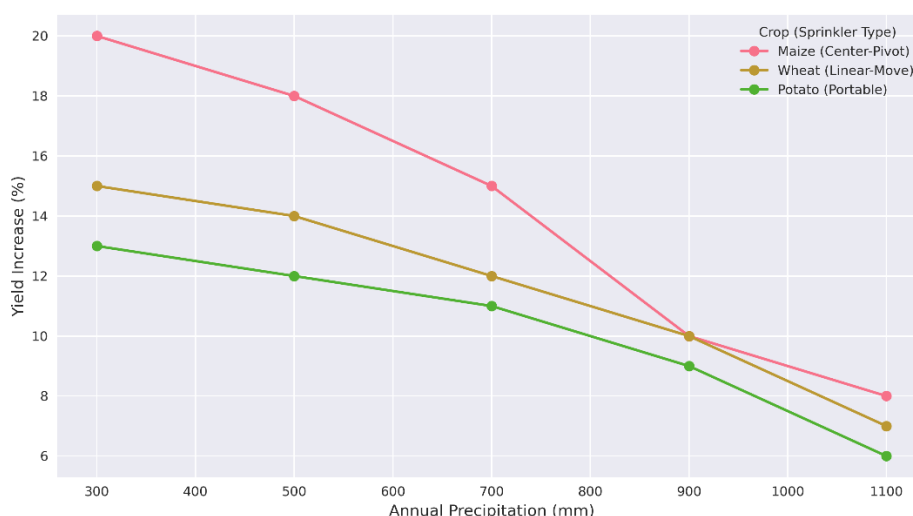
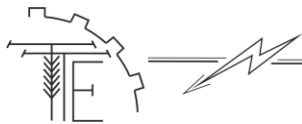


Fig. 3. Efficiency of sprinkler machines by annual precipitation

Analysis regional features showed that efficiency sprinklers depends from climatic conditions and soil type. In arid regions from sandy soils sprinklers systems are critical to ensuring yields, while in humid zones their application could be less justified by high operational expenses. To maximize effect necessary adaptation of systems to local conditions, including choice appropriate machine type and settings irrigation modes.

5. Conclusion

The analysis confirms that sprinklers play a key role in increasing crop yields, ensuring effective irrigation in the face of climate change and limited water resources. Results research demonstrate that circular sprinklers systems provide increase yields corn and soybeans by 8–20%, frontal systems increase productivity potatoes and wheat by 10–15%, and portable installations are effective for carrots in small areas with an increase of up to 13%. Efficiency sprinklers depends depending on the type of crop, soil and climatic conditions and level integration with precision farming technologies such as moisture sensors and GPS navigation, which allow reduce water consumption by 20–30%.

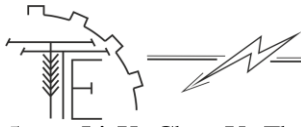
Environmental advantages sprinkler systems include reduction erosion soil by 25–30% and preservation soil fertility, although high energy consumption remains a challenge that can be solved by using renewable sources energy. Economical expediency sprinkler machines confirmed fast payback (3–5 years) due to growth yield and decline water consumption, although initial investments can be a limiting factor for small farms.

Graphic analysis, including columnar diagrams, thermal maps and linear graphics, highlights dependence efficiency sprinklers on factors such as water consumption, soil type and quantity precipitation. In particular, circular systems are the most effective in arid regions from low precipitation (300–500 mm/ year), while portable installations are better suitable for humid conditions.

Thus, sprinklers machines are important a tool for sustainable rural economy, promoting increase productivity, rational use resources and adaptation to climate change calls. To maximize their potential necessary regional systems adaptation, improvement energy-efficient technologies and further research impact on soil microflora and long-term land fertility.

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ВПЛИВ ДОЩУВАЛЬНИХ МАШИН НА ВРОЖАЙНІСТЬ СІЛЬСЬКОГОСПОДАРСЬКИХ КУЛЬТУР

Стаття присвячена аналізу впливу дощувальних систем на підвищення врожайності сільськогосподарських культур у контексті сучасного сільськогосподарського виробництва. У роботі розглядаються основні типи дощувальних систем (кругові, фронтальні, переносні), їх технічні характеристики та особливості застосування в різних кліматичних та ґрунтових умовах. Особлива увага приділяється оцінці ефективності дощувального зрошення у забезпеченні оптимального водного режиму для рослин, що сприяє збільшенню кількісних та якісних показників врожайності. Правильний вибір та обслуговування дощувальних систем може значно підвищити ефективність використання води та зменшити вплив на навколишнє середовище в сільськогосподарській практиці. На основі аналізу наукових досліджень та практичних випадків показано, як дощувальна техніка впливає на ріст та розвиток таких сільськогосподарських культур, як зернові, овочеві та промислові. У статті також виділено економічні аспекти використання дощувальних систем, включаючи їх витрати на впровадження та експлуатацію, а також окупність інвестицій завдяки зростанню продуктивності. Окремо розглядаються екологічні переваги, зокрема зменшення ерозії ґрунту та раціональне використання водних ресурсів. Інтеграція передових дощувальних систем з інструментами точного землеробства стає ключовим фактором у досягненні сталого та ефективного виробництва сільськогосподарських культур. У статті підкреслюється важливість інтеграції дощувальних систем із сучасними технологіями точного землеробства, такими як датчики вологості та автоматизовані системи управління, для досягнення максимальної ефективності. Висвітлено проблеми, пов'язані з технічним обслуговуванням та адаптацією систем до регіональних умов, а також запропоновано рекомендації для фермерів та агрономів. Стаття буде корисною для фахівців у галузі сільського господарства, науковців, а також осіб, зацікавлених у впровадженні інноваційних технологій зрошення.

Key words: дощувальні машини, врожайність, сільськогосподарські культури, зрошення, точне землеробство, водовикористання, економічна ефективність, екологічна стійкість.

Рис. 3. Табл. 1. Літ. 8.

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