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Performance Evaluation of Laser Spray Irrigation System under Variable Rain Hose Pipe Lengths

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ABSTRACT: In order to standardize the rainhose pipe length, diameter and operating pressure under local topography the investigation is much needed at present water scarcity situation. Laser spray irrigation is an innovative alternative to conventional sprinkler irrigation, offering an easy-to-implement solution. The performance of laser spray irrigation system under lengths 20 m, 40 m and 60 m of rain hose pipe were analysed. The relationship between various lengths of rain pipes and their corresponding discharges, uniformity coefficient and throw distance were plotted. The decreasing pressure had a linear relationship with discharge. The results of the study ensure that the soil moisture content at higher pressure (at head reach of rain hose pipe) is more compared with lower pressure (at tail end of rain hose pipe) and could also found that water application rate was decreased with increasing rain pipe length. The top surface contains lower moisture content and it increased with depth. The water distribution was more uniform at 20 m rain hose pipe with higher pressure and the uniformity coefficient is approximately 97.8 and distribution efficiency of 97.10 % which is comparatively higher than 40 m and 60 m rain hose pipe. In case of multilateral system due to lesser spatial variation, the coefficient of uniformity is higher. But 20m rain hose pipe is not economical to use, so the response for radish crop at 40 m length rain hose pipe of 40 mm diameter with 4 m spacing was good at 0.75 kg cm^{-2} operating pressure and conclude that which is to be a highly effective water application method.

Keywords: Laser Spray, uniformity coefficient, Discharge rate, Distribution efficiency, Radish.

INTRODUCTION

Micro irrigation stands as a contemporary irrigation approach that conserves water and amplifies water utilization efficiency (Batchelor *et al*., 1996). This technique holds the potential to enhance crop yields, reduce water and fertilizer wastage and eliminate the need for manual labour. Moreover, micro irrigation can contribute to the reclamation of unproductive and degraded land for cultivation. In comparison to conventional methods, micro irrigation demonstrates superiority in terms of water utilization efficiency, energy conservation, yield enhancement and net returns per unit volume of water, establishing itself as a sustainable tool for water management. Presently only Sikkim, Andhra Pradesh, Karnataka and Maharashtra have surpassed the halfway mark, with more than half of their cultivable land benefiting from micro irrigation techniques. Albaji *et al*., (2015) conducted a experiment to compare different irrigation methods based upon a parametric evaluation system in an area of 15,000 ha in the Jaizan Plain, Iran. The comparison of the different types of irrigation techniques revealed that the sprinkler and drip irrigations methods were more effective and efficient than the surface irrigation methods for improving land productivity. Micro irrigation proves to be an appropriate approach in regions with uneven landscapes and limited water availability. Improving irrigation efficiency can be accomplished by designing irrigation systems correctly to decrease losses during the conveyance of water. The design of the irrigation system, the degree of land preparation and the skill and care of the irrigator are the principal factors influencing irrigation efficiency (Michael, 1978). Griffiths and Lecler (2001) reported that evaluation of irrigation system performance facilitates objective analysis of the typical as opposed to the potential performance of various types of irrigation systems and the respective management criteria, appropriate for local conditions. The implementation of water-saving irrigation systems, such as micro sprinklers and drip irrigation system proves highly impactful, contributing not only to water preservation but also resulting in higher crop yield (Li, 2018). Corcoles *et al.,* (2012) reported that water scarcity is typical in arid and semiarid regions such as Castilla-La Mancha (Spain), makes necessary the efficient use of water and energy resources. Comparison of different irrigation techniques reveals that drip irrigation stands out with an impressive application efficiency of 90 %, resulting in an overall efficiency that falls within the range of 80-90 %. By comprehending optimal irrigation approaches and engaging community-based intervention strategies, current policy makers can strengthen governance systems and grasp crucial metrics that facilitate informed decision-making based on data (Rai *et al*., 2023). Lamaddalena *et al.,* (2007) analysed the influence of the pressurized distribution irrigation system on the performance of the on-farm sprinkler network. The pressure variation at downstream of the hydrant was computed by intersecting the characteristic curve of the latter with the generated on-farm characteristic curve. A detailed performance analysis was carried out on an existing irrigation system. Enhancing water usage efficiency stands as a crucial goal. This involves focusing on two key factors: ensuring consistent water dispersion across fields and precise control over the amount of water applied through accurate delivery mechanisms (Manjunatha *et al*., 2001). Laser spray irrigation is an innovative alternative to conventional sprinkler irrigation, offering an easy-to-implement solution. This technology involves a flexible hose with strategically placed drip holes, capable of replacing the traditional mini sprinkler system. The setup comprises two components: the rain hose (a lay flat pipe) and the essential connectors. The lay flat pipe serves as a cost-effective substitute for PVC pipes, low maintenance, UV resistance and a prolonged lifespan even when exposed to sunlight (Reddy *et al*., 2020). This irrigation system generates a fine micro water spray creating a misty and gentle irrigation method that surpasses the traditional sprinklers. Its misty nature sets it apart and provides a more delicate touch compared to regular sprinklers. The rain hose pipe can disperse water spray up to 10 to 15 feet on either side. To achieve optimal performance, approximately 2 kg cm^{-2} water pressure is required. The effectiveness of sprinkler irrigation is influenced by factors such as the Christiansen uniformity coefficient distribution uniformity and operating pressure. Laser spray irrigation stands as a viable alternative to both mini sprinklers and drip irrigation. This innovative approach represents one of the most advanced techniques for maximizing efficient water usage in irrigation. By delivering water at a high rate within a short period of time frame and using a low-pressure system like a solar photovoltaic pump, laser spray irrigation proves to be a highly effective water application method. So there is a need to evaluate the hydraulic performance of rain pipe irrigation system for different rain pipe length and spacing.

MATERIALS AND METHODS

A filed experiment was conducted during *summer* 2023 at 'L' Block, IFS demo unit, ZARS, University of Agricultural Sciences, GKVK, Bengaluru, to know the effect of laser spray irrigation on uniformity co-efficient. It is located in the Eastern Dry zone of Karnataka at 13º 05' N latitude and 77^0 34' E longitude with an altitude of 924 meters above Mean Sea Level (MSL). The experimental site soil belongs to Vijayapura series and represents the typical lateritic area of Bengaluru plateau. These soils were deep, yellowish red, lateritic red sandy clay loam with good drainage.

1. Determination of discharge and Uniformity coefficient

Discharge per unit length of the rain hose pipe is determined by using catch can test. Six catch cans were placed for the discharge of one lateral and the flow is regulated using ball valve at an operating pressure of 0.75 kg cm^{-2} by monitoring the pressure gauge. The system was operated for a period of 30 minute duration and the time was noted by stop watch. Then the water collected in each catch can were measured using graduated measuring jar. The discharge rate in liter per hour was calculated using the following equation:

$$\textbf{Discharge in lph} = \frac{\textbf{Volume of water collected in litre}}{\textbf{\textit{Time interval in hour}}} \quad ...(1)$$

The discharge obtained from each catch can is converted in to meter length of lateral. The distance of farthest point at which the water spray reached from the lateral was measured as throw distance using measuring tape. The uniformity coefficient is a quantifiable indicator of uniformity acquired from any size of rain pipe operating under a certain circumstance. Christiansen (Christiansen, 1942) presented the following formula for calculating the homogeneity coefficient. It is expressed by,

$$\mathbf{U.C}\ (\%) = \mathbf{100}\left(\mathbf{1} - \frac{\sum \mathbf{X}}{mn}\right) \quad ....(2)$$

Where,

U. C: Christiansen's uniformity coefficient (%)

M: Average value of all information (average discharge rate)

n : total number of observations

X: numerical deviation of individual observations from the average discharge rate

2. Determination of distribution efficiency, mean application rate and co-efficient of variation

A useful term for placing a numerical value on the uniformity of application for irrigation system is the distribution efficiency (De). The distribution efficiency is also known as pattern efficiency (Pe). It indicates the uniformity of water application throughout the field and is computed by,

$$\mathbf{De}\ (\%) = \frac{\textbf{Minimum depth}}{\textbf{Average depth}} \times 100 \quad ....(3)$$

The minimum depth is calculated by taking the average of the lowest $1/4^{th}$ of the catch can used in a particular test. Mean application rate is the depth of water applied by the rain hose pipe on the soil surface per unit time. It was estimated according to the following formula:

$I = (\sum X \div nt) \times 100$ ….(4)

Where,

ΣX : Total depth of water collected in the catch cans (volume/area of catch can), mm

n : number of catch cans, t : time of operation, h and I : application rate, cm h^{-1}

The coefficient of variation (C_V) is the product of the standard deviation of the applied water depths (mm) and the average of the collected water depth (mm).

C_V (%) = σ μ ….(5)

Where, σ : Standard deviation of the water depth of catch-cans (mm)

μ: Mean of all water depth of catch-cans (mm)

3. Statistical analysis

The experimental data were subjected to Fisher's method of "Analysis of variance" (ANOVA) as outlined by Gomez and Gomez (1984). Whenever RCBD was significant for comparison amongst the treatment means an appropriate value of critical differences (CD) was worked out. Otherwise against CD values abbreviation NS (Non-Significant) was indicated. All the data were analyzed and the results were presented and discussed at 5 % level of significance.

RESULTS AND DISCUSSION

The field experiment entitled "Effect of Laser spray irrigation on uniformity coefficient" was conducted at 'L' Block, Integrated Farming System demo unit, ZARS, University of Agricultural Sciences, GKVK, Bengaluru during summer 2023.

1. Unilateral discharge variation

Discharge rate of the laser spray irrigation measured for various widths 1 m, 2 m and 3 m away from lateral and lengths 20 m, 40 m and 60 m of rain hose pipes at 0.75 kg cm^{-2} operating pressure for a period of 30 minutes clearly indicated that, water distribution along width and length of rain hose pipe was significantly varied as shown in Table 1.

Table 1: Unilateral discharge variation at different widths away from the rain hose pipe.

Treatments	1 m distance a from the lateral (lph)	2 m distance away from the lateral (lph)	3 m distance away from the lateral (lph)	Average discharge (lph)
T1 : 20 mm diameter rain hose pipe laid up to 20 m length	2.62	3.81	2.95	3.12
T2 : 20 mm diameter rain hose pipe laid up to 40 m length	2.58	3.56	2.72	2.95
T3 : 20 mm diameter rain hose pipe laid up to 60 m length	2.23	2.67	2.41	2.43
T4 : 40 mm diameter rain hose pipe laid up to 20 m length	2.79	4	3.28	3.35
T5 : 40 mm diameter rain hose pipe laid up to 40 m length	2.62	3.60	2.97	3.07
T6 : 40 mm diameter rain hose pipe laid up to 60 m length	2.37	3.01	2.58	2.65
S.Em ±	0.03	0.01	0.03	0.13
C.D (P=0.05)	0.11	0.04	0.09	0.39

Among different treatments T_1 and T_4 recorded higher discharge rate (1 m to 3 m away from lateral) 2.62 to 3.81 lph and 2.79 to 4 lph at 20 m length of rain pipe for 20 mm and 40 mm diameter rain hose pipes respectively. Lower discharge rate varied from 2.23 to 2.67 lph and 2.37 to 3.01 lph at 60 m length for both 20 mm and 40 mm rain hose pipes respectively. Whereas rain hose pipe erected to 40 m length recorded discharge rate of 2.58 to 3.56 lph and 2.62 to 3.60 lph for both 20 mm and 40 mm rain hose pipes respectively. The results indicated that lesser discharge found nearer to the lateral line and increase as the distance increased from the lateral and decreased again. It is due to the curved path of spray pattern.

With respect to length of rain hose pipes, lateral discharge varied from 2.62 to 2.23 lph, 2.79 to 2.37 lph, 2.95 to 2.41 lph, 3.28 to 2.58 lph and 3.81 to 2.67 lph, 4 to 3.01 lph for 20mm and 40mm rain hose pipe at 1 m, 2 m and 3 m distance away from the lateral, along 20 m, and 40 m and 60 m length rain hose pipes respectively. Average discharge also decreased the length of rain hose pipe increased from 20 m to 60 m (3.12, 2.95 and 2.43 lph) and (3.35, 3.07 and 2.65 lph) for both 20 mm and 40 mm rain pipe at 20 m, 40 m and 60 m length respectively. Decrease in discharge rate at the tail end of rain hose pipe is due to decrease in operating pressure as the pipe length increased.

2. Throw distance of laser spray irrigation system

Field observations were made to measure the horizontal movement of wetting front over the surface of the field. The length of the wetting front was measured at different length rain pipe, during spraying. Table 2 indicates that throw distance and pressure along the length of rain hose pipe got influenced by laser spray irrigation system. Throw distance varied from 4.14 to 2.15 m and 8.12 to 4.34 m from initial to 60 m length for 20 mm and 40 mm diameter rain hose pipes respectively. Throw distance of 40 mm rain pipe recorded highest compared to 20 mm rain pipe. The highest width of 8.12 m covered by 40 mm rain pipe initially. But irrespective of rain pipe dimeter, throw distance decreased as the length of rain hose pipe increased because of decreased pressure along the pipe. Anu mohan *et al.* (2022) found similar results in performance evaluation of rain hose irrigation. He observed that discharge per unit length of the irrigation was found to be increased as operating pressure increased. Throw distance also found to be increased with operating pressure. As the pressure increased coefficient of uniformity was also found to be increased. The laser spray irrigation system performed well at operating pressure of 1.5 kg cm^{-2}.

3. Discharge and Uniformity coefficient

The discharge per meter length of rain hose pipe recorded as influenced by different sizes and length are presented in table 2. Highest value of 190 and 198 lph discharge per meter of rain hose pipe was observed at 20 m length of rain pipe and lowest value of 151 lph and 164 lph discharge per meter of rain hose pipe was measured at 60 m length for both 20 mm and 40 mm rain hose pipe respectively. It was also noticed that the value of discharge per meter of rain pipe was decreased as length of rain pipe increased. It might be due to decreased operating pressure along the pipe. But irrespective of rain pipe size discharge per meter length was found to be uniform up to 40 m length with 4m spacing of rain hose pipe under 0.75 kg cm^{-2} operating pressure. It was observed that as rain hose pipe length increased, the value of discharge per meter of rain hose pipe decreased. Bhadarka *et al*., (2023) achieved optimal performance when operated at an operating pressure of 1.5 kg cm^{-2}, with a rain pipe length of 30 m and a spacing of 4 m.

In order to evaluate the uniformity of water distribution by laser spray irrigation system, uniformity coefficient was calculated for different lengths i.e., 20 m, 40 m and 60 m of rain hose pipes. The data pertaining to uniformity coefficients is shown in Table 2. The value of uniformity coefficient was decreased as length of rain hose pipe increased. The uniformity coefficient was varied from 97.89 to 86.22 % and 97.93 to 87.54 % from 20 m to 60 m length for 20 mm and 40 mm diameter rain hose pipes respectively. The highest value of uniformity coefficient was obtained at 20 m length of rain pipe, but 20m length rain hose pipe is not economical to use. Irrespective of diameter of rain hose pipe, good uniformity coefficient was obtained for 40 m length rain hose pipes beyond that water distribution was non- uniform. Lesser uniformity coefficient might be due to pressure loss at the tail end of rain hose pipe. These are in concurrence with the results of Mistry *et al*., (2017).

4. Distribution efficiency and Co-efficient of variation

Distribution efficiency indicates the extent to which water is uniformly distributed throughout the field. Data pertaining to distribution efficiency is presented in Table 2. It is observed that, distribution efficiency got affected by laser spray irrigation system for different lengths of rain hose pipes. Distribution efficiency varied from 97.1 to 79.69 % and 96.65 to 80 % from 20 m to 60 m length for 20 mm and 40 mm diameter rain hose pipes respectively. But optimum distribution efficiency was found at 40 m length for both 20 mm and 40 mm diameter rain hose pipes. It was observed that the value of distribution efficiency decreased as the length of rain hose pipe increased. This is again because of pressure loss at the tail end of the rain hose pipes.

From Table 2, it was noticed that maximum value of C_V (21 and 20 %) was attained at 60 m length rain hose pipe and the minimum value (10.5 and 11.3 %) was attained at 20 m length rain hose pipe for both 20 mm and 40 mm diameter respectively. It was observed that value of C_V increased as uniformity coefficient and distribution efficiency decreased. This showed the inverse relationship between the operating pressure, uniformity coefficient, distribution efficiency and co-efficient of variance. Irrespective of rain hose pipe size average C_V was observed at 40 m length beyond which performance of laser spray irrigation system found poor. These results are in line with the findings of Pragna *et al*. (2017) who concluded that coefficient of variation decreased as pressure increased.It was observed that uniformity coefficient was consistently higher than distribution uniformity and both are inversely related to coefficient of variation. This result is found to be on one line with the finding obtained by Keller and Bliesner (2000).

5. Mean application rate

The maximum mean application rate (M_a) 9.5 cm h^{-1} and 11.2 cm h^{-1} was achieved at 20 m length of rain hose pipes and least value of mean application rate 6.9 cm h^{-1} and 7.8 cm h^{-1} was attained at 60 m length of rain hose pipe with operating pressure of 0.75 kg cm^{-2} for both 20 mm and 40 mm rain hose pipes (Table 2). It was observed that the value of mean application rate was decreased as length of rain hose pipe increased to 60 m. In the same way average discharge rate varied from 3.8 to 2.79 lph and 4.48 to 3.17 lph from 20 m to 60 m length for 20 mm and 40 mm rain hose pipe respectively. Low discharge and application rate at 60 m length might be due to pressure loss. The obtained results are in concurrence with the findings of Kathiriya *et al*., (2021). He observed that the highest uniformity coefficient, distribution uniformity and mean application rate of 83.63 %, 75.0 8% and 12.47 cmh^{-1} were obtained at operating pressure of 0.75 kg cm^{-2}.

Table 2: Effect of laser spray irrigation on Uniformity co-efficient, Distribution uniformity, Co-efficient of variation, Mean application rate and Discharge rate

Treatment	U.C (%)	De (%)	C.V (%)	M_a (cm hr^{-1})	Discharge rate (lph)	Throw distance (m)	Discharge per meter of rain pipe (lph)
T1 : 20 mm diameter rain hose pipe laid up to 20 m length	97.89	97.1	10.5	9.5	3.80	4.14	190
T2 : 20 mm diameter rain hose pipe laid up to 40 m length	93.29	91.0	12	8.3	3.32	3.86	177
T3 : 20 mm diameter rain hose pipe laid up to 60 m length	86.22	79.69	21	6.9	2.79	2.15	151
T4 : 40 mm diameter rain hose pipe laid up to 20 m length	97.93	96.65	11.3	11.2	4.48	8.12	198
T5 : 40 mm diameter rain hose pipe laid up to 40 m length	94.81	92.48	13	10.1	4.04	7.69	182
T6 : 40 mm diameter rain hose pipe laid up to 60 m length	87.54	80	20	7.8	3.17	4.34	164
S.Em±	**0.10**	**0.82**	**0.44**	**0.20**	**0.07**	0.12	**0.12**
C.D (P=0.05)	**0.30**	**2.47**	**1.33**	**0.60**	**0.22**	0.38	**0.38**

CONCLUSIONS

Throw distance was found to be decreased with increasing rain pipe length which resulted in maximum distance of 4.14 m and 8.12 m away from the lateral for both 20 mm and 40 mm rain hose pipe. It observed that pressure loss was occurred along the rain pipe that resulted in decreased discharge rate at 60 m length of rain pipe. The discharge per unit length of the lateral was found to be decreased with increasing Rain pipe length. As the length of rain pipe increased coefficient of uniformity was found to be decreased. Uniformity coefficient is approximately 86 % at 60 m length. Overall, irrespective of rain hose pipe diameter the laser spray irrigation system performed well up to 40 m length hose rain pipe with uniformity coefficient of 93.29 and 94.81 %, distribution uniformity of 91 and 92.48 % and mean application rate of 8.31 and 10.1 cm hr^{-1} with operating pressure of 0.75 kg cm^{-2} for 20mm and 40mm diameter rain hose pipes respectively, compared to 60 m length. The general trend considering the different parameters observed suggests that irrespective of diameter of ran pipe, 20 m length is not economical to use so 40 m length was found to be better to achieve higher yields and benefit from vegetable crops with 4m pipe spacing under 0.75 kg cm^{-2} operating pressure.

FUTURE SCOPE

The results obtained in this study can be utilized for the direct selection of length, diameter of rainhose pipe and operating pressure which not only saves the time also improve the water utilization efficiency under sandy clay loam soil.

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Conflict of interest. None

REFERENCES

Albaji, M., Golabi, M., Nasab, S. B. and Zadeh, F. N. (2015). Investigation of surface, sprinkler and drip irrigation methods based on the parametric evaluation approach in Jaizan Plain. *Journal of the Saudi Society of Agricultural Sciences*, *14*(1), pp.1-10.

Alegewe, R., Abdul-Ganiyu, S. and Ayambire, C. A. (2023). Performance Evaluation of Drip Irrigation System for Green Pepper (Capsicum annum, L.) Production in the Tamale Metropolis of Ghana. *International Journal of Irrigation and Agricultural Development*, *7*(1), pp.359-363.

Anu Mohan, S., Hashifa, P., Muhammed Misbah, P. And Naja Rahman, K. (2022). *Performance Evaluation of Rainhose Irrigation System* (Doctoral dissertation).

Batchelor, C., Lovell, C. and Murata, M. (1996). Simple microirrigation techniques for improving irrigation efficiency on vegetable gardens. *Agricultural Water Management*, *32*(1), pp.37-48.

Bhadarka, D. G., Gohil, S. M., Gaadhe, A. N., Vadalia, D. D., Mashru, H. H., Prajapati, G.V., Pandya, P. A. and Parmar, S. H. (2023). *Research Biotica*.

Christiansen, J. E., (1942). *Irrigation by sprinkling* (Vol. 4). Berkeley: University of California.

Córcoles, J. I., De Juan, J. A., Ortega, J. F., Tarjuelo, J. M. and Moreno, M. A. (2012). Evaluation of irrigation systems by using benchmarking techniques. *Journal of Irrigation and Drainage Engineering*, *138*(3), pp.225-234.

Griffiths, B. and Lecler, N. (2001). Irrigation system evaluation. In Proc S Afr Sug Technol Ass 75, pp. 58-67.

Kathiriya, G. R., Prajapati, G. V., Paghdal, A. M., Rank, H. D. and Kelaiya, S. V. (2021). Performance evaluation of rain pipe irrigation under solar photovoltaic pump. *The Pharma Innovation Journal*, *10*(4), pp.587-591.

Keller, J. and Bliesner, R. D. (2000). Sprinkle and trickle irrigation. Caldwell.

Lamaddalena, N., Fratino, U. and Daccache, A. (2007). On-farm sprinkler irrigation performance as affected by the distribution system. *Biosystems Engineering*, *96*(1), pp.99-109.

Li, J. (2018). Increasing crop productivity in an eco-friendly manner by improving sprinkler and micro-irrigation design and management: a review of 20 years' research at the IWHR, China. *Irrigation and drainage*, *67*(1), 97-112.

Manjunatha, M. V., Shukla, K. N., Chauhan, H. S., Singh, P. K. and Singh, R. (2001). Economic feasibility of micro irrigation system for various vegetables. In *Proceeding of International Conference on Micro and Sprinkler Irrigation System held at Jalgaon, Maharashtra during* (pp. 8-10).

Michael, A. M. (1978). Irrigation Efficiency Principles of Agricultural Engineering. *Jain Brothers, Jodhpur*, *11*, pp.113-178.

Mistry, P., Akil, M., Suryanarayana, T. M. V. & Parekh, F. P. (2017). Evaluation of Drip Irrigation System for Different Operating Pressures. *International Journal of Advance Engineering and Research Development, 72*(4), 2348-4470.

Pragna, G., Kumar, G. M. and Shankar, M. S. (2017). Hydraulic performance evaluation of drip system by developing relationship between discharge and pressure. *Int. J. Pure Appl. Biosci.*, *5*(4), pp.758-765.

Rai, P. and Maharjan, S. (2023). Empowering South Asian Agricultural Communities: A Comprehensive Approach to IoT-Driven Agriculture through Awareness, Training, and Collaboration. *Quarterly Journal of Emerging Technologies and Innovations*, *8*(3), pp.18-32.

Reddy, Y. P. K., Reddy, B. S., Reddy, A. M., Kumari, C. R. and Reddy, B. R. (2020). Irrigation management in Pigeonpea under rainfed Alfisols. *Journal of Pharmacognosy and Phytochemistry*, *9*(6), pp.136-139.

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