European Journal of Research Development and Sustainability (EJRDS)
Available Online at: https://www.scholarzest.com
Vol. 3 No. 10, October 2022
ISSN: 2660-5570

DETERMINATION OF HYDRAULIC PARAMETERS OF SOIL MOISTURE

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Article history:

Received: 11th August 2022
Accepted: 11th September 2022
Published: 20th October 2022

Abstract:

One of the most important tasks in the conditions of our republic is the application of methods for determining the dynamics of soil moisture during drip irrigation of agricultural crops in order to mitigate the negative effects of water scarcity and efficient use of water resources, the development of elements of irrigation procedures and irrigation methods appropriate to soil conditions, as well as the improvement of existing ones.

Keywords: Intensive apple orchards, irrigation methods, depth of soil moistening, drip irrigation method, method for determining the contour of soil and soil moistening, mathematical model of mass migration in the field of soil and soil moistening, irrigation procedure, elements of irrigation methods

INTRODUCTION. Today, scientists of our country and around the world are conducting comprehensive research aimed at establishing the norms and timing of drip irrigation of agricultural crops, determining the hydraulic and soil-soil parameters of the system, modeling soil-soil moisture processes.

Comprehensive work is underway in our country to introduce advanced water-saving technologies in the cultivation of agricultural crops, the development of irrigation methods and technologies that ensure the efficiency and productivity of irrigation water use in preventing water scarcity. The "Strategy of actions on five priority areas of development of the Republic of Uzbekistan for 2017-2021", approved by Decree of the President of the Republic of Uzbekistan dated February 7, 2017 No. PF-4947, provides for further improvement of the reclamation condition of irrigated lands, development of networks of reclamation and irrigation facilities, introduction of intensive methods, primarily water- and resource-saving modern methods, into agricultural production agrotechnologies. special attention is paid to wide implementation .

In this regard, a number of countries around the world: Austria, USA, Canada, Israel, China, India and other countries, as well as their research centers, higher education institutions, namely the United States Department of Agriculture (USDA), Food and Agriculture Organization (FAO), Colorado State University, California University Institute of Business and Irrigation (USA), Cotton Research Institute (ICR, CAAS), Shehezi University (China), Stockholm University of Technology (Sweden), International Institute of Water Resources Management (IWMI), (Sri Lanka), Australian Cotton Research Institute (Australia), Scientific research conducted at the Indian Institute of Agricultural Research (India), international organizations for Viticulture and Winemaking (MOVV) on growing crops on irrigated lands, determining optimal agrotechnical measures, and introducing water-saving technologies are of great importance.

A.M.Oleinik, M.K.Gadzhiev, A.S.Ovchinnikova, B.B.Shumakov, A.S.In shtanko's research papers, it was proposed to introduce drip irrigation technology in the form of a ratio of humidification and calculated surfaces, as well as correction coefficients corresponding to irrigation conditions, taking into account climate features. However, the calculated expressions involving these correction coefficients remain practically inapplicable to solving scientific and technical issues in practice due to the lack of a scientific basis for a complete description of the physical process under consideration.

Taking into account the above, one of the urgent scientific and technical problems is the development of methods for determining irrigation standards for drip irrigation of apple orchards.

Research styles. Field, laboratory and special studies were carried out aimed at determining changes in the dynamics of the contour of the field of soil moisture during drip irrigation based on the method of determining the contour of soil-soil moisture during drip irrigation of agricultural crops, the Prandtl criterion, the stochastic method and the Green function while improving the mathematical module of mass transfer in the field of soil-soil moisture.

RESEARCH RESULTS: drip irrigation technology the shape of the spatial contour of humidification varies depending on the water flow rate in droppers with watering cans and the physical and mechanical properties of the soil. Droppers from irrigation tape at large values of water flow, the humidification contour on heavy soils expands in the horizontal direction, and at small values of water flow changes in the vertical direction on light soils. According to experimental studies, during drip irrigation of intensive apple orchards, the soil-soil moisture contour takes a shape close to an elliptical paraboloid (Fig.1).

The canonical equation of an elliptical paraboloid looks like this:

$$\frac{x^2}{p}+\frac{y^2}{q}=2z \qquad (1)$$

The height of the elliptical paraboloid, as well as the first and second semi-axes of the ellipse change over time, characterizing the change in the contour boundaries.

Denote the semi-axes of the ellipse respectively as:

$$a=\sqrt{2pH} \text{ and } b=\sqrt{2qH} \qquad (2)$$

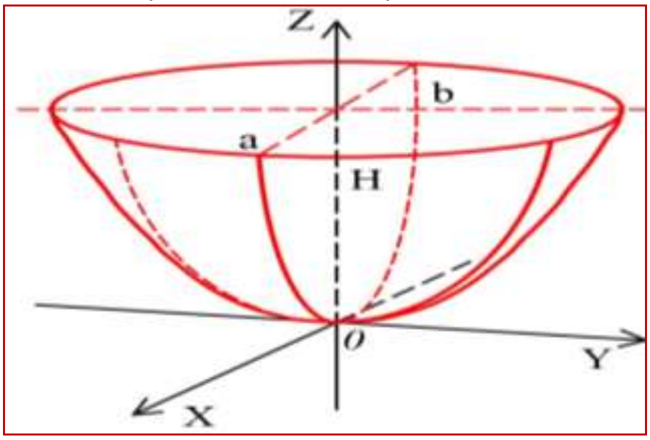

Figure 1. Elliptical paraboloid.

Where: **H**-is the height of the elliptical paraboloid; **p**-is the focal parameter of the first parabola; **c**-is the focal parameter of the second parabola; **a**-is the first half—axis of the ellipse; **b**-is the second halfaxis of the ellipse.

Then equation (1) will look like this:

$$\frac{2x^2\cdot H}{a^2}+\frac{2y^2\cdot H}{b^2}=2z \qquad (3)$$

Considering that in horizontal planes equation (9) will look like this:

$$\frac{x^2}{a^2}+\frac{y^2}{b^2}=1 \text{ or } y=b\sqrt{1-\frac{x^2}{a^2}} \qquad (4)$$

Based on the results of field studies to determine the contour of soil-soil moisture, numerical solutions of equation (14) were obtained.

Now we define the derivative of the elliptic parabola as follows:

$$W_{el\ parab}=\iiint_{\frac{x^2}{2p}+\frac{y^2}{2q}\le z\le H}\theta dxdydz \qquad (5)$$

Here: - soil with the volume of an elliptical paraboloid-humidity in the soil,%

We implement the numerical solution of equation (5) :

$$W_{el\ parab}=\int_{-\sqrt{2pH}}^{\sqrt{2pH}}dx\int_{-\sqrt{2q\left(H-\frac{x^2}{2p}\right)}}^{\sqrt{2q\left(H-\frac{x^2}{2p}\right)}}dy\int_{\frac{x^2}{2p}+\frac{y^2}{2q}}^{H}\theta\, dz \qquad (6)$$

After the corresponding mathematical actions, equation (6) will look like this:

$$W_{el.parab}=\frac{\theta}{6p}\sqrt{\frac{q}{p}}6p^2H^2 2arcsin1 \qquad \text{or}$$

$$W_{el.parab}=\theta\sqrt{pq}H^2 \quad (7)$$

From expressions (3) and (7) we get expression (8):

$$W_{el.parab} = \theta\pi\frac{ab}{2}H \qquad (8)$$

Now we find (8 expressions). Generating an expression is described in detail in the next section of this chapter.

With drip irrigation of intensive apple orchards, a mass migration process occurs in the soil-soil moistening zone. In the soil-soil humidification zone, a complex hydrodynamic process occurs, associated with a change in the humidity regime depending on the movement of the mass.

We use the one-dimensional Richards equation for mathematical modeling of humidity dynamics in connection with drip irrigation in hydromorphic media:

$$\frac{\partial\theta}{\partial t} + \frac{\partial u\theta}{\partial z} = k\frac{\partial^2\theta}{\partial z^2} \qquad (9)$$

Where: $\boldsymbol{\theta}$ – soil moisture,% , **I** – infiltration flow rate, **c** – filtration coefficient, **t** – time, **z** – vertical coordinate axis.

Now let's do mathematical modeling. That is, we use the baking criterion to characterize the structure of the infiltration flow during convective migration of moisture in hydromorphic media. In the field of aeration, we use the Prandtl criterion to express the relationship between the velocity field of the infiltration flow and the concentration of the dispersed mixture. Alternatively, assume that the displacement of the mass changes only along the vertical axis.

We reduce equation (9) to a dimensionless parametric form. To do this, we enter dimensionless parameters. Where: ***l*,*v***, dimensional values, the average distance traveled by moisture, respectively, as well as Kinematic viscosity. $Re = \frac{ul}{v}$ the Reynolds criterion, $Pe = \frac{ul}{k}$ the Peckle criterion and $\frac{Pe}{Re}$ the Prandtl criterion. Taking into account the above and after the corresponding mathematical actions, equation (7) will have the following form:

$$\frac{\Pr\partial\theta}{\partial\tau} + Pe\frac{\partial\theta}{\partial\bar{z}} = \frac{\partial^2\theta}{\partial\bar{z}^2} \qquad (10)$$

We solve equation (10) by stochastic systems methods. To do this, we define the numerator on the right side of the equation as:

$$\frac{\partial^2\theta(\tau,\bar{z})}{\partial\bar{z}^2} = \delta(\bar{z} - \tau) \qquad (11)$$

$$\delta(o,\tau) = \delta(a,\tau) = 0 \qquad (12)$$

At $\bar{z} = 0$ and $\bar{z} = a$ points, the function tends to zero, then this function can be decomposed into a Fourier series in terms of sines:

$$\delta(\bar{z} - \tau) = \sum_{m=1}^{\infty} . \; g_m(\tau) \cdot \sin\frac{m\pi\bar{z}}{a} \qquad (13) \text{ or}$$

$$\delta(\bar{z} - \tau) = \frac{2}{a} \cdot \sin\frac{m\pi\tau}{a} \qquad (14)$$

We will reduce the expression (14) to (10):

$$\frac{\partial^2\theta(\tau,\bar{z})}{\partial\bar{z}^2} = \frac{2}{a} \cdot \sin\frac{m\pi\tau}{a} \qquad (15)$$

Now we reduce expression (15) to equation (10):

$$\frac{\Pr\partial\theta}{\partial\tau} + Pe\frac{\partial\theta}{\partial\bar{z}} = \frac{2}{a} \cdot \sin\frac{m\pi\tau}{a} \qquad (16)$$

$L_\tau = \frac{\partial}{\partial\tau}$ and $L_z = \frac{\partial}{\partial z}$ introduce linear partial differential operators. Then equation (16) looks like this:

$$PrL_\tau\theta + PeL_z = \frac{2}{a} \cdot \sin\frac{m\pi\tau}{a} \qquad (17)$$

L_τ^{-1} – two parts of equation (18), where there is an inverse operator

L_τ^{-1} - multiplied by the operator:

$$Pr\theta + PeL_\tau^{-1}L_z = \frac{2}{a}L_\tau^{-1} \cdot \sin\frac{m\pi\tau}{a} \qquad (18)$$

As a result, we obtained a mathematical model of mass movement in the field of soil and soil moistening (19) based on the methods of stochastic theory.

$\theta = \sum_{n=1}^{\infty} \lambda^n H_n \cdot \frac{2}{a} \cdot \frac{n\pi\tau}{a}$ assuming that, then

$$\sum_{n=1}^{\infty} \lambda^n H_n \cdot \frac{2}{a} \cdot \frac{\sin n\pi\tau}{a} = \frac{2}{a \cdot Pr} L_\tau^{-1} \cdot \frac{\sin n\pi\tau}{a} - Pe/Pr\, \lambda L\_\tau\text{^}(-1) \cdot L\_\bar{z}\ (\sum\_(n = 1)\text{^}\infty \lambda\text{^}n\ H\_n \cdot 2/a \cdot \sin n\pi\tau/a) \cdot (\sum\_(m = 1)\text{^}\infty \lambda\text{^}m\ H\_m \cdot 2/a \cdot \sin n\pi\tau/a)$$

(19)

for n=1

$$\lambda \cdot H_1 \cdot \frac{2}{a} \cdot \frac{\sin \pi\tau}{a} = \frac{2}{a \cdot Pr} L_\tau^{-1} \cdot \frac{\sin \pi\tau}{a} - \frac{Pe}{\Pr \lambda L_\tau^{-1}} \cdot L_{\bar{z}} \left(\lambda H_n \cdot \frac{2}{a} \cdot \frac{\sin \pi\tau}{a}\right)^2 \quad (20)$$

$$\frac{\theta = \frac{2}{a \cdot Pr} L_\tau^{-1} \sin \pi\tau}{a} - \frac{Pe}{Pr} \cdot \lambda \cdot L_\tau^{-1} L_{\bar{z}} \left(\lambda H_1 \frac{2}{a} \cdot \frac{\sin \pi\tau}{a}\right)^2 \quad (21)$$

According to the methods of stochastic systems:

$$\theta = \frac{2}{a \cdot Pr} \int_0^t l(\bar{z} - \tau) \cdot \frac{\sin \pi\tau}{a} d\tau - \frac{P_e}{P_r} \cdot \lambda \cdot \int_0^t l(\bar{z} - \tau) \cdot \left(\lambda H_1 \frac{2}{a} \cdot \frac{\sin \pi\tau}{a}\right)^2 d\tau \quad (22)$$

Where: - Green's function.

Substituting the expression of Green's function into equation (22), we get the solution of equation (16):

$$\theta = -\frac{4}{\pi^2 Pr} \cdot \sin \frac{\pi\bar{z}}{a} \int_0^t \sin^2 \frac{\pi\tau}{a}\, d\tau + 8 \cdot \frac{\lambda^3 \cdot H_1^2}{\pi^2} \cdot \frac{Pe}{\Pr} \cdot \sin \frac{\pi\bar{z}}{a} \int_0^t \sin^3 \frac{\pi\tau}{a}\, d\tau$$

In equation (23) we introduce the definition:

$$\overline{F_1} = -\frac{4}{\pi^2 Pr} \cdot \sin \frac{\pi\bar{z}}{a} \quad ; \quad \overline{F_2} = 8 \cdot \frac{\lambda^3 \cdot H_1^2}{\pi^2} \cdot \frac{Pe}{Pr} \cdot \sin \frac{\pi\bar{z}}{a} \quad (24)$$

If we take into account the notation (24), then equation (25) looks like this.

$$\theta = \overline{F_1} \int_0^t \sin^2 \frac{\pi\tau}{a}\, d\tau + \overline{F_2} \int_0^t \sin^3 \frac{\pi\tau}{a}\, d\tau$$

Based on the results of field studies conducted at the research objects (Table 1), a numerical experiment was conducted using equation (25). Numerical solutions were compared with the results of field studies. The margin of error averaged 4 percent.

Table 1. The time required to moisten the calculated layer of irrigated soil according to the TST with a water flow rate in a dropper of 2 liters / s, per hour (medium and heavy loamy ordinary turf soil, Kibrai district).

During, hours	The area of soil moisture, m^2/h										
	2	4	6	8	10	12	14	16	18	20	22
Diameter of the wetted perimeter, m	0,16	0,24	0,36	0,52	0,58	0,63	0,69	0,72	0,78	0,83	0,87
Estimated depth of the layer, m	0,09	0,14	0,19	0,26	0,34	0,43	0,51	0,62	0,74	0,86	0,98

Taking equation (13) of the area of water humidity, m^2/h (25) to the expression, we get an expression for determining the volume in the form of an elliptical parabola formed by the configuration of humidification in the area of soil-soil humidification, where the drip irrigation system irrigates the dropper tapes water flow:

$$W_{el.para} = \pi \frac{a \cdot b}{2} \cdot H \left[\overline{F_1} \int_0^t \sin^2 \frac{\pi\tau}{a}\, d\tau + \overline{F_2} \int_0^t \sin^3 \frac{\pi\tau}{a}\, d\tau\right] \quad (26)$$

On the basis of the experimentally identified corresponding (26) soil parameters, graphs of the equation are constructed on the object of study (2-, 3-, 4-, 5- pictures).

Graphs of the dynamics of the contour of the soil and soil moistening zone during drip irrigation of intensive gardens on medium and heavy loamy ordinary soils

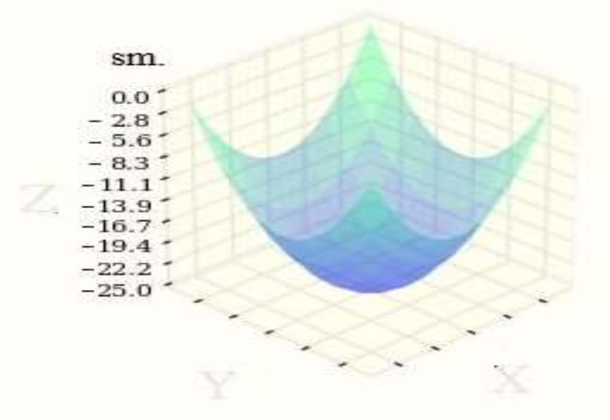

Figure 2. Humidity dynamics in the soil-soil humidification zone for 8 hours. The comparison error is less than 5 percent.

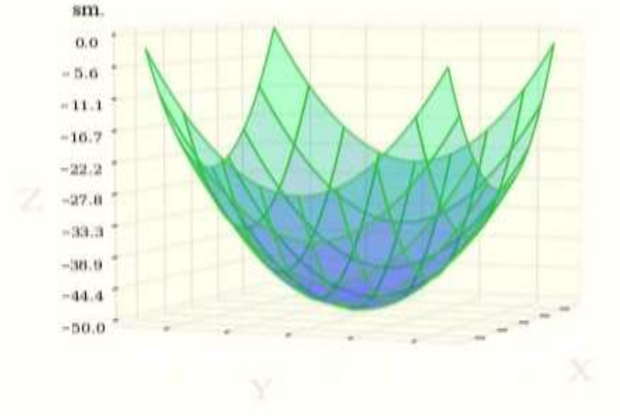

Figure 3. Humidity dynamics in the soil-soil humidification zone for 14 hours. The comparison error is less than 5 percent.

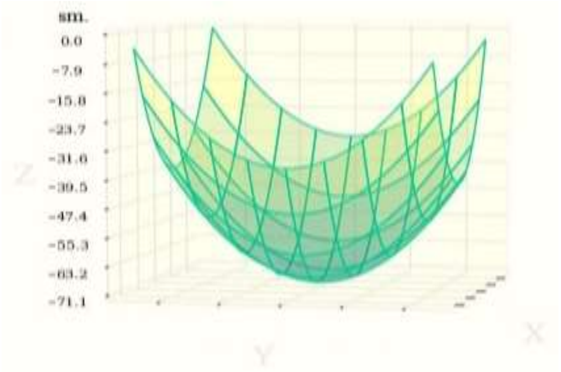

Figure 4. Humidity dynamics in the soil-soil humidification zone for 18 hours. The comparison error is less than 5 percent.

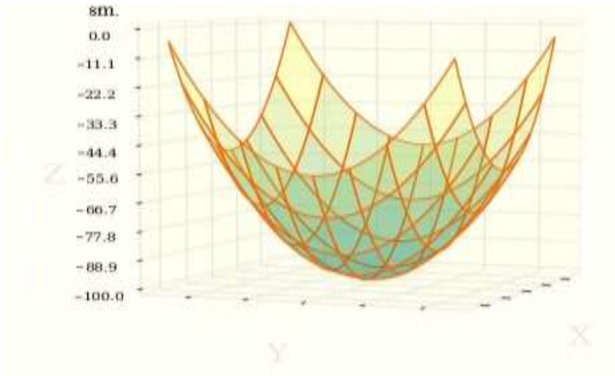

Figure 5. Humidity dynamics in the soil-soil humidification zone for 22 hours. The comparison error is less than 5 percent.

The contour of the calculated moistening of the soil will depend on the type of crop and its agrobiological, as well as water-physical properties of the soil, as well as on the water consumption in droppers and the duration of irrigation. Methods for calculating the irrigation rate when watering crops using drip irrigation technology mainly based on the classical (27) expression proposed by A.N. Kostyakov:

$$N_{wat.rat} = 100 * \gamma_{b.w} * h_{hum} * (\beta_2 - \beta_1) \qquad (27)$$

Where: $\gamma_{b.w}$ - the mass of the soil layer by volume, t/m^3

h_{hum} – depth of moistening of the soil layer, m

β_2 – the amount of soil moisture after watering, %

β_1 – moisture content in moistened soil before watering, %

The above calculation method is suitable for traditional irrigation conditions of the irrigated area. With drip or rain irrigation, it gives a much larger error in calculating irrigation rates by the expression (33) ($8\% <$).

The basis of most calculation methods is the determination of irrigation standards by the size of m^3/ha. According to the research conducted within the framework of the dissertation, the above opinion poorly characterizes the features of the formation of moisture contours in a soil environment moistened by droppers from irrigation tapes. In order to fully and accurately account for these features of, the following equation was proposed by the V.N. Shkura:

$$(N_{irr.})_{drip} = \gamma_{b.w} \cdot W \cdot (\beta_2 - \beta_1) \qquad (28)$$

where: W- the volume of the wetting area.

(24) the expression well characterizes the features of the formation of moisture contours in the soil environment wetted by droppers of irrigation tapes. For this reason, we are improving the method of determining irrigation rates for drip irrigation of intensive apple orchards based on the expression (28).

When carrying out measuring works during irrigation using drip irrigation technology in intensive apple orchards, the depth of the soil layer should be at least 1 meter. Samples should be taken every 10 cm of the surface of a meter-long soil layer (through chalk). In these layers (34), the expression parameters are determined and their averaged values for 30, 50, 70 and 100 centimeters are taken. In expression (34) *W*– to calculate the volume of the wetting area, it is necessary to use expression (32).

Taking into account equations (32) and (34), we obtain the following expression:

$$(N_{dr.})_{irr} = \pi \frac{a \cdot b}{2} \cdot H \cdot \gamma_{b.w} \cdot \left[\overline{F_1} \int_0^t sin^2 \frac{\pi\tau}{a} \, d\tau + \overline{F_2} \int_0^t sin^3 \frac{\pi\tau}{a} \, d\tau \right] \cdot (\beta_2 - \beta_1) \quad (35)$$

As a result, we obtained the expression (35) calculation of irrigation rates for drip irrigation of intensive apple orchards.

Based on the results of field research, we have implemented the solution of equation (35). According to the results of the numerical experiment, it turned out that in order to provide the existing 1000 bush of tree seedlings per 1 ha with a developed root soil layer of 0.8 m with a standard humidity at TST, we will need 72.0 m^3/ha of water. This means that 72 liters of water is required for one watering of each tree.

In an experiment conducted in conditions of typical sandy soils (Kibray district) with a slope of more than 0.015, two different irrigation methods were used when watering intensive apple orchards: conventional eglates and transverse eglates from hedges, which were compared with each other. In these methods, the elements of irrigation techniques were determined, namely the duration of irrigation, the flow rate of water supplied to the tank, as well as the calculated layers that provide soil moisture at different depths.

In the experiment, with anaunal egate irrigation (control variant), irrigation was carried out with a soil layer moisture of 1.0 m, and with cross-barrier egate irrigation - with a soil layer moisture of 1.0 m, 0.8 m and 0.5 m. In all variants of the experiment (except control ones), irrigation was carried out by the method of transverse barrier irrigation, providing soil moisture with a layer of 0.5 and 0.8 m and 1.0 m with soil moisture of the order of 75-80-70% relative to the MFMC.

The number of irrigations in the experimental field was 4 times in the control variant with a watering rate of 660 m^3/ha, and seasonal water consumption averaged 2600 m^3/ha over the years. In option 3, where orchards were watered on this experimental field, providing 0.8 m of soil layer with moisture, the number of irrigations increased 5 times, and the seasonal water consumption averaged 2200 m^3/ha.

In this experimental field of scientific research, the amount of leaching of soil particles as a result of irrigation has also been studied.

In areas subject to irrigation erosion, the rate of water runoff varies depending on the slope of the land, in addition, in this case, the level of soil fertility also differs.

In this regard, many scientific studies have been conducted. As a results of O.A.Alikhanov, K.M.Mirzazhanov, Sh.N. Nurmatov field research (at a slope of 4^0-3^0), it is noted that the water flow velocity in the upper part of the field is 0.32 m/sec, in the middle-0.25 and in the lower-0.19 m/sec.

CONCLUSIONS: In conclusion, it should be noted that today the most important thing for us is the preservation and systematic improvement of the fertility of irrigated lands due to the invaluable wealth, as well as increasing the efficiency of the use of natural water and land resources, providing the population of our republic and domestic markets with cheap and high-quality fruit products, ensuring a high and high-quality fruit harvest by increasing export potential countries. advanced water, which provides economical, but at the same time widely introduces scientifically based technologies in agricultural production.

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