Analysis of the effect of fertilizer on tree development by remote sensing and technology of giving liquid organic fertilizer to tree root system in intensive gardens

Ulugbek Kuziev[1], *Sanjar* Khikmatullaev[1,*], *Sevara* Abdullaeva[2], *Umirzoq* Xoliyorov[1], and *Kodir* Nosurullayev[1]

[1]Tashkent Institute of Irrigation and Agricultural Mechanization Engineers, Tashkent, Uzbekistan
[2]Tashkent State University of Economics, Tashkent Uzbekistan

Abstract. Intensive garden yields and soil fertility are increased by giving liquid organic and mineral fertilizer locally to the soil. Each tree root system in the row is carried out on the basis of technical hydrodynamic legislation of the liquid pouring liquid organic fertilizer in the specified amount by opening the furrow next to it. Based on the results of the presented calculation, each tree is provided 10÷11L of liquid organic fertilizer to the root system in accordance with the aggregate movement speed, maintaining this mode was based on the dimensions of the working part and the capacity in it. Also it is presented the graphs of changes in the duration of pouring liquid organic fertilizer depending on the surface of the cracks, the rate of leakage and the rate of aggregation. Also, as a result of fertilization directly to the root of the tree, NDVI (Normalized Difference Vegetation Index) analysis was carried out through remote sensing techniques for monitoring development of surface fertilization and root system fertilization gardens, and the results revealed with a compartable NDVI map. According to NDVI analysis, fertilizing roots with liquid organic and minerals, development of intensive gardens had significantly positive with 7 percent comparing to other.

1 Introduction

According to longitudinal distance, pouring liquid organic fertilizer from to an owner 10-12 l in width to the root system of each tree which is 0.35 to 0.45 m in length and an average depth of 5 cm is shown to be effective by agronomists [1, 2, 5-9]. The offered working part has liquid organic fertilizer storage capacity, from it, the liquid fertilizer is poured when the aggregate reaches the opposite tree, the beginning and end of the pouring, that is, the duration of the pouring, is considered to be factor, which affects the quality of work, for this reason, it is important to link the duration of pouring to the speed of aggregate

---

[*] Corresponding author: skhikmatillayev@mail.ru

movement. To find a solution to this issue, the hydrodynamic laws of liquids were used [1, 3, 10-13]. We will consider the spilling of liquid organic fertilizer from the working part on the basis of Newton's laws for the situation expressed in Fig. 1.

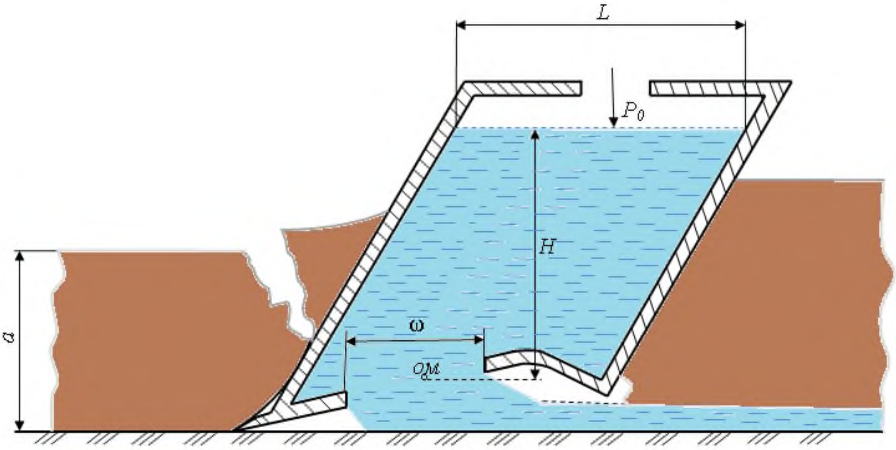


Fig 1. Pouring liquid organic fertilizer from the working part to the bottom of the furrow.

Where, P_0-external pressure acting on the free surface of the liquid, Pa; ω-liquid organic fertilizer spilled slit surface, m^2; L - the length of the working section the capacity occupied by liquid organic fertilizer, m; and, N-the distance from the center of gravity to the spilled slit from the level of liquid organic fertilizer, m.

2 Materials and methods

Based on the legislation of the movement of fluid at variable pressure from the puncture in technical gidrodynamics, the surface Ω and liquid fertilizer spilling in the capacity can be expressed in terms of pressure N dependence Ω=f(H) function [1]. Using the Bernoulli label, we determine the indicators of liquid organic fertilizer spilling from the working part. Liquid organic fertilizer is freely poured into the tank, while pouring to the specified place it flows through a small slit. The ratio of the slit surface to the full surface Ω determines the degree of flow compaction ε (1):

$$\varepsilon = \frac{\omega}{\Omega}, \tag{1}$$

where, ε-compression coefficient.

From the Bernoulli equation we write the expression of determining the average speed of a fully compressed liquid organic fertilizer in a slit and putting it in the equation of continuity of the flow, determining the fertilizer consumption spilled (2) [3]:

$$\varepsilon\varphi\omega\sqrt{2gH} = -\frac{\Omega dH}{dt}, \tag{2}$$

where, φ-the coefficient of speed, we take the value φ=0,97 for the position facing; g - free fall acceleration, m/sec^2; and, μ - the coefficient of expenditure [2, 3].

The coefficient of consumption can be expressed as (3):

$$\mu = \varepsilon\varphi = 0{,}97\frac{\omega}{\Omega}. \tag{3}$$

From the Equation 2, we determine the duration of pouring liquid organic fertilizer from livestock (4) [4, 6]:

$$dt = -\frac{\Omega dH}{\mu\omega\sqrt{2gH}}. \tag{4}$$

In the horizontal plane, we denote the full surface Ω by means of the pressure N, we get the following equation (5) [_]:

$$\Omega = 2L\sqrt{H(4R-H)}. \tag{5}$$

Change of pressure in the Equation 4 by replacing dH with the expression d (4R-H) and by integrating it, we form the following label (6) [1]:

$$t = \frac{2L}{\mu\omega\sqrt{2g}}\int_{4R}^{0}\sqrt{4R-H}\,d(4R-H). \tag{6}$$

The Equation 6 allows to determine the time of complete pouring of liquid organic fertilizer from the working part for the changing state of the pressure (7):

$$t = \frac{32LR}{3\mu\omega}\sqrt{\frac{R}{2g}}, \tag{7}$$

where, *R* – hydraulic radius, m.

If we take into account the dependence of the volume of fertilizer on the surface Ω and the perimeter where the liquid organic fertilizer is located (moulded), moving in the working part, then the volume of fertilizer R (8) [1-3]:

$$R = \frac{\Omega}{\chi}. \tag{8}$$

The perimeter of the liquid organic fertilizer is located (moulded) is connected as follows with the width of the working part χ V and the length of the capacity occupied by the liquid organic fertilizer of the working part L (9) [4]:

$$\chi=2(L+B), \tag{9}$$

where, *B*-length of working part, m.

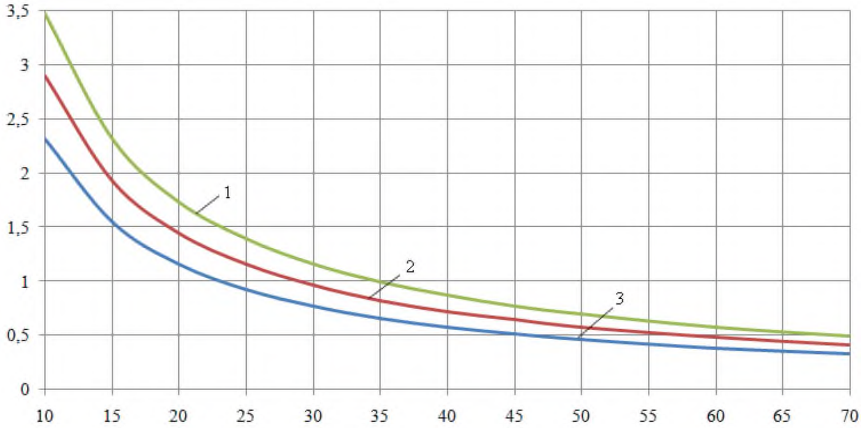
By Equations 7-9, we can express the expression as follows (10) [1-4]:

$$t = \frac{32L\Omega\sqrt{\Omega}}{3\mu\omega\chi\sqrt{2g\chi}}. \tag{10}$$

3 Results and discussion

According to the law of continuity of the liquid, the correct functional bond between the liquid organic fertilizer spilling duration and the surface of the workpiece spitting was laid out in the graphs. In particular, the dependence of the time of spilling of liquid organic fertilizer on the surface change of the spatter is given in Fig. 2.

When calculating the Equation 10 to build a graph on the expression Ω=56 cm^2, μ=0.064, χ=122 cm, g=9.81 m/s^2 is accepted.



1.*L*=20 cm; 2. *L*=25 cm; 3. *L*=30 cm.

Fig. 2. Graph of the change in the duration of organic fertilizer spilling depending on the surface of the spatter.

As it can be seen from the Fig. 2, the duration of pouring liquid fertilizer is reduced with the increase in the length of the cutting surface and the capacity of the working part.

For example, when the length of the working part capacity is 25 cm, and the slit surface is 60 cm^2, the duration of pouring liquid fertilizer is 0.3-0.4 sec.

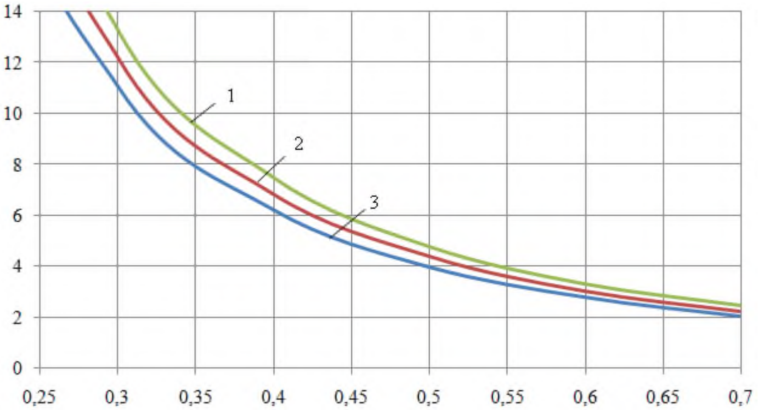
It is possible to determine the rate of its flow corresponding to this time after it is known that the duration of pouring organic fertilizer from the working part (11) [2, 3] :

$$\vartheta_c = \frac{V}{\omega t}, \tag{11}$$

where, *V* - volume of liquid organic fertilizer spilled from the working part is *V*=0,01-0,012 m^3.

The graph of the change in the rate of flow of liquid organic fertilizer from the working part, depending on the duration of its pouring, is given in Fig. 3.

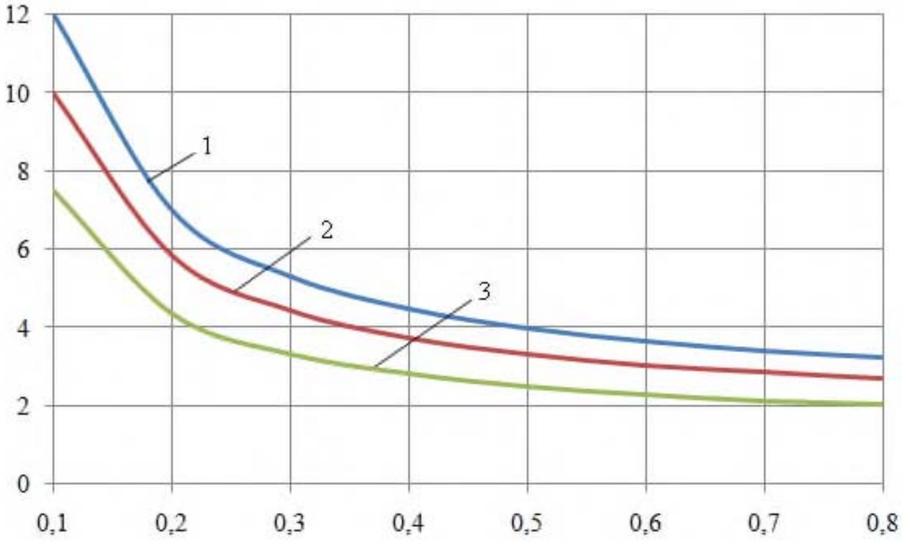
When calculating the Equation 11 to build a graph on the expression *V*=0,011 m^3, ω=0.006 m^2, t=0.4 sec is accepted.



1. V=0,01 m^3; 2. V=0,011 m^3; 3. V=0,012 m^3.

Fig. 3. The graph of the change in the rate of flow of liquid organic fertilizer from the working part depending on the duration of its pouring.

When analyzing the graph in Fig. 3, it is possible to see that the root system of trees is able to completely shed liquid organic fertilizer from the ingress in the amount indicated in the agrotechnical requirements. This means that liquid organic fertilizer with a volume of V=0,011 m^3 (11 l) begins to pour out at the specified time from the spout. The graph of the change in the rate of flow of liquid organic fertilizer from the working part, depending on the duration of its pouring, is presented in Fig. 4.



1. ω=0,003 m^2; 2. ω=0,005 m^2; 3. ω=0,007 m^2.

Fig. 4. Graph of the change in the rate of flow of liquid organic fertilizer from the working part depending on the duration of its pouring.

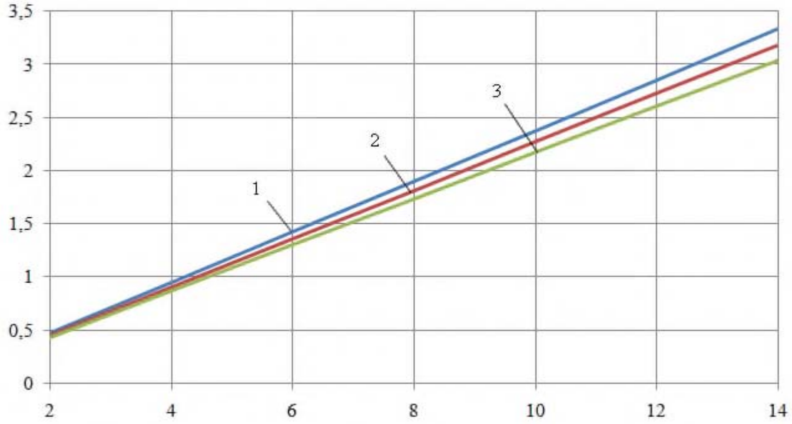
As it can be seen from Fig. 4, the surface of the slot ω=0.005 m^2 for complete quality execution of the technological process and if the duration of pouring Is t=0.3-0.4 sec, then the speed of the liquid fertilizer in the pouring can vary in the range of ϑ_s=4-5 m/s.

After determining the speed at which the liquid fertilizer flows from the above workpiece slit, the expression of the dependence of this indicator on the speed of action of the aggregate was derived λ (12) [1]:

$$\lambda = \frac{\vartheta_s}{\vartheta_a} = \frac{Vt_0}{\omega t S_0}. \tag{12}$$

Where t_0-the time spent on the passage of the aggregate at a distance of 0.35-0.45 m; t_0=0,3 – 0,4 s; and, S_0-the time spent when the aggregate speed is ϑ_a=1,5-1,7 m/s distance S_0=0,35-0,45 m.

The graph of the change in the rate of aggregate depending on the rate of leakage of liquid organic fertilizer from the working part is shown in Fig. 5.



1. λ=4,2; 2. λ=4,4; 3. λ=4,6.

Fig 5. Schedule of change of aggregate rate depending on the speed of flow of liquid organic fertilizer from the working part.

As it can be seen from Fig. 5, when the values of λ are different, the aggregate speed ϑ_a=0.35-0.45 m/s should be in order to ensure the spilling of liquid organic fertilizer in the amount of 10-12 l per owner with a length of 1.2-1.5 m/s. The research results has been tested and applied in Chinabad neighborhood, Kibray District of Tashkent region, in the fields of 17 and 13 of farmer's farm. The analysis which carried out showed that when the trees are given a diluted fertilizer locally, we can see that their development as well as the yield has changed significantly when analysed by NDVI in Fig.6.

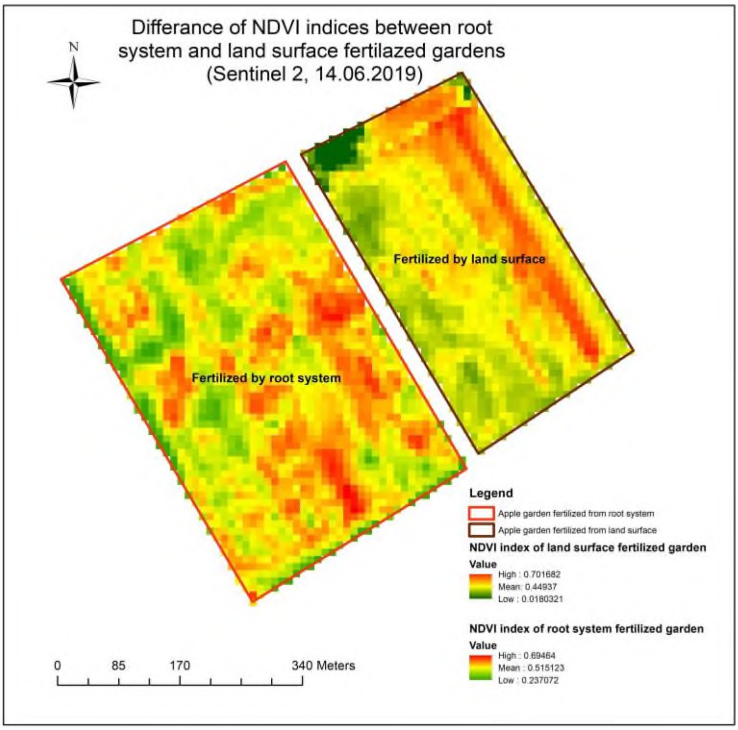


Fig. 6. NDVI comparation of two type of gardens (root system and land surface fertilized).

NDVI (Normalized Difference Vegetation Index) is perfect method for overestimating condition of garden. NDVI is a numerical indicator that uses the Red and NIR bands of the electromagnetic spectrum. It helps to calculate the difference between the reflectance of the NIR and red bands, divided by the sum of the two bands. Green vegetation dynamics was defining the major determinants of vegetation in semi-arid regions in many parts of the world. It is clearly seen from figure 6 that, root system fertilized gardens mean NDVI value 0.51 was higher than surface fertilized gardens value 0.47. As well as development of garden with root system fertilized is much greener with significant harvest.

4 Conclusions

As a result of theoretical research, in order to give 10-12 l of liquid organic fertilizer to the soil on one side of each tree root system in order to increase the yield of fruit trees and soil fertility, the working part dimensions of the aggregate, in particular, the working part capacity should be length L=0,2-0,3 m, the Volume V=0,01-0,012 m^3, the surface of the slit ω=0,003-0,007 m^2, and the duration of the pouring of the fertilizer t=0,3-0,4 sec the movement speed of the aggregate ϑ_a=1,2-1,5 m/s. Application of Remote Sensing in garden monitoring gives more opportunities for analyzing effectiveness of fertilization.

References

1. DA. Kavvadias, E. Psomiadis, M. Chanioti, E. Gala, S. Michas, CEUR Workshop Proc., **1498**, 376–386 (2015)
2. F. Tromboni, L. Bortolini, M. Martello, Irrig. Drain., **63**(4), 440–450 (2014)

3. O. A. Denton, Cogent Food Agric., **3**(1), 1–12 (2017)
4. Y. Qin, Z. Jixian, Geo-spatial Inf. Sci., 5(2), 51–55 (2002)
5. M. Groll, C. Opp, I. Aslanov, Aeolian Research, **9**, 49-62 (2013)
6. N. Sabitova, O. Ruzikulova, I. Aslanov, E3S Web Conf., **227**, 03003 (2021)
7. D. Sharipov, S. Khikmatullaev, U. Islomov, International Conference on Information Science and Communications Technologies: Applications, Trends and Opportunities, 9011860 (2019)
8. Z. Mamatkulov, J. Rashidov, G. Eshchanova, M. Berdiev, Z. Abdurakhmonov, IOP Conf. Ser.: Earth Environ. Sci., **614**(1), 012086 (2020)
9. B. Alikhanov, S. Alikhanova, R. Oymatov, Z. Fayzullaev, A. Pulatov, IOP Conf. Ser.: Mater. Sci. Eng., **883**(1), 012088 (2020)
10. Z. Mamatkulov, E. Safarov, R. Oymatov, I. Abdurahmanov, M. Rajapbaev, E3S Web Conf., **227**, 03001 (2021)
11. B. Sh. Matyakubov, Z. J. Mamatkulov, R. K. Oymatov, U. N. Komilov, G. E. Eshchanova, InterCarto, InterGIS, **26**, 229–239 (2020)
12. I. Musaev, A. Bokiev, M. Botirova, E3S Web Conf., **227**, 05004 (2021)
13. K. Khakimova, I. Musaev, A. Khamraliev, E3S Web Conf., **227**, 02003 (2021)