# Methods of teaching the subject "Capillary phenomena" on the basis of innovative technologies in the field of agrophysics for students of agronomic education in agrarian higher education institutions

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***Abstract: The article explores the topic of "Capillary phenomena" in agrophysics, which is taught to students of agronomy on the basis of innovative technologies, ie the specific features of future agronomists, the content of its components, the study of innovative technologies in agrophysics, the information model of agrophysical processes.***

***Key words: Capillary, pressure, osmotic, diffusion, surface tension, spherical surface, radius, particle, wetting, edge angle, wetting fluid, transpiration, electrical resistance, thermal conductivity.***

## 1. INTRODUCTION

Research is being conducted in the world to ensure interdisciplinary links in the teaching of agrophysics in the agrobiological context of physics, to develop the scientific basis of forms and methods of teaching, to study the factors of intellectuality and competence, to increase motivation to learn. Scientific approaches aimed at improving the quality of teaching and methodological support to increase the competence of teachers of agrophysics in agricultural higher education institutions, the introduction of virtual forms of practical training, competent approaches to teaching agrophysics, practical training reflecting the interaction of agrophysics with science and agriculture and serves to increase efficiency. Today, one of the main achievements of applied physics or agrophysics is widely introduced in various spheres of life, as well as in agriculture using nanotechnology. Due to the work on the cultivation of low-cost, high-quality products, the facilitation of human labor, special attention is paid to the teaching of agrophysics in agricultural universities. In particular, practical work on improving the science of agrophysics in the agrobiological context of physics, training teachers in this area, the development of integrative methodological support of teaching provides rapid integration of physics and agriculture.

The Action Strategy for the further development of the Republic of Uzbekistan identifies priorities as "increasing the capacity of quality educational services, training highly qualified personnel in line with modern needs of the labor market, equipping them with modern teaching and laboratory equipment and teaching aids." In this regard, it is important to ensure the connection of physics with practice on the basis of modern didactic and methodological requirements and to accelerate the study of this connection, to expand the possibilities of teaching aids in the study of physics in depth.

Educational materials on agrophysics for students of agronomy in agricultural higher education institutions are divided into the following criteria, depending on the student's professional activity, the possibility of using innovative technologies in lectures, practical classes, problem solving and laboratory work:

- level of motivation and knowledge of the use of innovative technologies in professional activities;

- The level of formation of the student's skills in the use of innovative technologies in professional activities;

- The degree of formation (creative mastery) of the creative position of the student.

The structure of the initial educational situation is based on the development of a model of formation of agrophysical knowledge in students of agronomy education through innovative technologies.

There were cases when students create the conditions for the formation of agrophysical knowledge through innovative technologies, that is, the specific features of the activities of future agronomists, the content of its components, the study of innovative technologies in agrophysics as an object of activity. The object of student activity is also the information model of the agrophysical phenomenon or process studied in teaching through innovative technologies.

A necessary condition of pedagogical support for the formation of agrophysical knowledge in students through innovative technologies is the readiness of the teacher for this process. The teacher should have a program of formation of agrophysical knowledge and skills based on the study of agrophysics using innovative technologies. He can create such a program only if he has the following qualities:

- The teacher of agrophysics has a high pedagogical education, high professionalism;
- Knowledge of the important professional qualities, professional skills, professional abilities of the future agronomist and their formation and development in the process of professional activity.

It is also important that the learner himself be prepared to develop agrophysical knowledge and skills.

Methods of formation of agrophysical knowledge (professional culture) are different: direct explanation of individual characteristics, professional business games, competitions, work in small groups, effective use of graphic organizers, the ability to demonstrate the effectiveness of professional formation and development.

It is based on the need to develop an object of activity in accordance with the content of agrophysical education, taking into account the level of readiness of students, which is the third condition for the formation of agrophysical knowledge on the basis of innovative technologies. Interactions take place in the learning process. In the model, the block "Formation of agrophysical knowledge on the basis of innovative technologies" corresponds to this. The formation of agrophysical knowledge in the educational process through innovative technologies is carried out in the teaching of general and special subjects.

Students with different levels of agrophysical knowledge are admitted to the field of agronomy education of agricultural higher education institutions. Therefore, in the educational process it is necessary to take into account the level of formation of agrophysical knowledge in the student. The student can further develop their practical knowledge and skills according to the level of agrophysical knowledge formed in them. It is possible to distinguish low, medium, high levels of formation of agrophysical knowledge in students.

Special methodological training has a special place in the whole system of preparation of students for the use of innovative technologies in the process of professional activity.

The technology of preparing future agricultural workers-agronomists for the use of information and communication technologies includes the task of developing students' research work, creative independence and the ability to study and generalize best practices.

To ensure the quality of training of future agronomists, effective technologies based on the integration of pedagogical and innovative technologies were used in the educational process. The basis of such technologies was modern didactic means of teaching (e-learning tools).

In the creation of e-learning tools, a set of requirements for their quality will be developed, compliance with which is a key element of the technology of creating e-learning tools.

Assimilation of educational material using components of e-learning tools with modern scientific research methods (experiment, comparison, observation, abstraction, generalization, concretization, analogy, induction, deduction, analysis, synthesis, modeling method, including mathematical modeling method and systematic analysis method) should be constructed accordingly.

## 2. METHODS

The article pays special attention to the use of innovative technologies in the organization of practical training.

Agrophysics is the study of physical methods and tools used to control the physical processes in the soil and plants, the physical conditions of plant life (soil temperature, lighting, humidity, etc.) in order to increase the growth, development and maturity and productivity of agricultural crops.

Hence, agrophysics jointly examines the processes of plant life activity, the physical conditions of the environment surrounding plants. In other words, by managing environmental conditions, it deals with the issues of improving the growth and development of plants and, ultimately, increasing their productivity.

In this regard, the correct interpretation of the physical and agronomic aspects of this phenomenon in the passage of the topic "Capillary phenomena" in agrophysics is one of the most pressing pedagogical issues.

Capillary events play a major role in nature. Different organs of plants perform different functions.The leaves of the plant synthesize organic matter, so water and nutrients must come

to it constantly.The roots absorb water and minerals and require the arrival of organic matter. All this creates the movement of water and dissolved substances in the plant.
The water received by the root system and the substances dissolved in it rise upwards through the conductive tubes of the plant. This is called upward flow.
The process of photosynthesis is called top-down flow, given the top-down movement of organic matter formed in the leaves.
The upward flow occurs under the influence of the following forces:

[1.] Root compressive strength
[2.] 2.Swelling power of leaf cells
[3.] The bond between water molecules
[4.] Gravitational force of conducting capillary tubes.

Thus, the mechanism by which water rises through the body and stems of plants is much more complex and can only be explained by the action of a few forces.

The significance of the capillary phenomenon in agriculture is that plants are only able to assimilate well the types of capillary and gravitational water in the soil.

For plants to grow and develop normally, the soil must have effective moisture, i.e., excess moisture from the plants to sustain wilting moisture. One of the effective ways to collect moisture in the soil is by means of a capillary phenomenon.

In agriculture, measures are taken to reduce the rise of water along the capillaries in order to improve the moisture retention in the soil during the growing season and before planting. This means that the root is actively exposed to the growing environment to improve plant growth. For this reason, the study of this topic in practical training in agrophysics has a positive impact on students' knowledge.

Students in physics can begin with the physical aspects of the topics "Surface Tension of Liquids, Wetting, Capillary Phenomena", and therefore demonstrate to students the experience of rising water in thin, double-sided glass tubes. To do this, take water in a larger container. Three tubes of different radii are then immersed in water in a large vessel to the same depth. As the water soaks the glass tubes, the water in the tubes stops rising at different heights relative to the water level in the container. As the water soaks the glass tubes, the water in these tubes rises and stops at different heights relative to the water level in the wide container. Students directly observe that the water level rising in the thinnest tube is higher than the others.

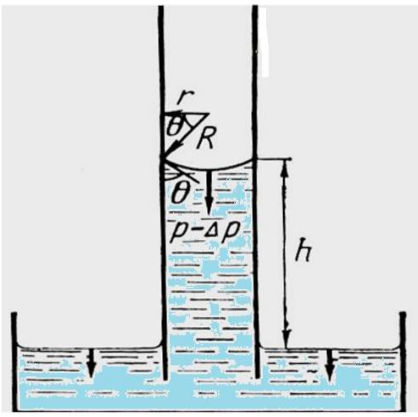
If the inner diameter of the tube is very small, the surface of the water rising inside it will be almost in the form of a sunken hemisphere. Such thin tubes are capillary tubes, the capillaries of the wetting fluid

the phenomenon of rising along the tubes is called the capillary phenomenon.

Note that the sunken spherical surface of the water rising in the tube is called the meniscus.

We then create a problematic situation by asking the students, “Why did the water in the thin tube rise a little higher than the water level in the large container?”.

The teacher states the following when summarizing the students 'answers. It is known from physics that since the surface of a rising wetting fluid (water we are looking at) is a submerged hemisphere, the additional pressure Δp it creates is equal to:




**1-расм** **2-расм**

$$\Delta p = 2\frac{\alpha}{R} \quad (1)$$

here: $\alpha -$ coefficient of surface tension of water. The additional pressure created by the water in the tube is directed upwards in the opposite direction of the force of gravity. Therefore, the resulting additional pressure is called negative pressure. We see that the water in the capillary tube rises under the influence of the surface tension force. The pressure below the surface of the water rising in the capillary tube is less than the pressure of the liquid in the large vessel, the additional pressure created by the curved surface of the water in the tube. Therefore, the water in the tube rises to such a height that the hydrostatic pressure created by it in it compensates for the lack of pressure in the liquid. In other words, the water level in the tube rises until the hydrostatic pressure of the water column in the tube is equal to the additional pressure:

$$\rho g h = \frac{2\alpha}{R} \quad \text{henceforth} \quad h = \frac{2\alpha}{\rho g R} \quad (2)$$

From Figure 1 above $r = R\cos\theta$ Given that is equal to, we write (2) as follows:

$$h = \frac{2\alpha . \cos\theta}{\rho g r}$$

Because the water completely soaked the bottle $\theta = 0^0$ equal to $\cos\theta = 1$ because

$$h = \frac{2\alpha}{\rho g r} \quad .....(3)$$

we create. Assuming that the water temperature is 200 C, we simplify the formula as follows:

$$h = \frac{2.73.10^{-3} H/м}{10^{3к} к/м^2.9{,}8 м/с^2.r} = \frac{0{,}15}{r} см^2 .....(4)$$

The teacher mentions here that such a simplification can be done for any temperature that occurs in practice above the water. We then give examples of calculating the heights of water rising due to capillary in tubes of different radii at the temperature obtained. For example, $r_1 = 10^{-2} см$ if , $h_1 = 15см, r_2 = 10^{-3} см$ if $h_2 = 150см, r_3 = 10^{-4} см$ if $h_3 = 1500см = 15м$ is equal to.

We see that the smaller the radius of the capillary tube, the higher the water rises. In fact, the water does not rise above 10 m due to capillaries. Because at this value of h ninig the hydrostatic pressure of the water column is equal to atmospheric pressure and then the water level in the tube does not rise. We recommend that students calculate for several radius values of the tube that the value of h decreases as the radius of the capillary tube increases. For example, $r_4 = 1см$ $h_4 = 0{,}15см; r_5 = 2см$ if $h_5 = 0{,}075см$ is equal to

This means that the capillary rise is greatly reduced after the tube radius exceeds 1 cm.

From the point of view of agrophysics, in addition to the height of the rise of water in the capillary tube, the rate of rise of water in the capillary tube is also of great practical importance.

Here it is necessary to explain to the students that the smaller the radius of the capillary tube, the higher the rise, but the lower the rate of rise of water along the capillary tube, and the lower the radius of the tube, the higher the rate of rise of water in the capillary tube.

Following the above considerations, the occurrence of capillary phenomenon in soil and plants, the measures used to maintain moisture in the soil are studied. First it is necessary to explain the meaning of the word capillary tubes in the soil.

It is known that in the soil layers are always different: there are large, small, very small pores. In soil science, such a system of interconnected pores is called capillary tubes or short capillaries, and the water that fills the capillaries is called capillary water. Water has good wetting properties. Therefore, when water touches soil particles, menisci with different curvatures are formed on the water surfaces in the capillaries. The smaller the diameter of the cavity, the greater the curvature of the meniscus.

Because water moistens the soil, the capillary forces only form the sunken meniscus. Capillary forces occur when the pores between soil particles are less than 8 mm in diameter. capillary forces are particularly intense when the diameters of the pores are 100 to 3 μm. In cavities larger than 8 mm, no capillary properties are formed, as in this case a concave concave surface is not formed; most of the surface remains flat, the curvature occurs only near the vessel wall. Pores smaller than 3 mm in size are mainly occupied by bound water and menisci are not formed.

Since the system of capillaries in the soil consists of capillaries of different sizes and different shapes, they form menisci with different curvatures. The result is a pressure difference not only between the capillary water surface in the soil and between the flat surfaces, but also between the menisci of different curvatures.

Above $h = \frac{0,15}{r} см^2$ in the formula $r$ This formula can also be written as follows to express h directly in cm and to determine h in cm: $h = \frac{0,15}{r} ...(4^1)$

$4^1$ the calculation of h according to the formula gives satisfactory results for sand, but in the calculation of h in sandy soils the results are different from those observed in practice.

This discrepancy is due to the fact that the capillaries in the soil are not ideally cylindrical and other factors are not taken into account.

AA Roze (4), a scientist who has done a lot of research in studying soil moisture to calculate the height of water rise in a capillary tube, corrected the porosity to formula (4) depending on the different types of particles in the soil.

If the particles are in the form of a cube, empty, the radius of the thin pores $0,41^1$ e, while the radius of the wide pores 0,73 $r^1$ be equal to ($r^1$ q particle radius).

In this case, the limit values of capillary rise change in the following range:

$h = \frac{0,15}{0,41.r^1}$ and $h = \frac{0,15}{0,73.r^1}$ inspections Capillary rise of water in light sandy soils $h = \frac{0,15}{0,73.r^1}$ (5) and $h = \frac{0,15}{0,155r^1}.....(5^1)$ and in this case the results of the calculations will be very close to the observed results in practice.

Students are told that the calculation of water rise height according to formulas often does not give satisfactory results and therefore the capillary rise height of water can be determined experimentally.

The speed of upward movement of capillary water between soil layers depends on the size of the particles. As the particles enlarge, the capillary water rises faster. For example, capillary water moves at a higher rate in coarse-grained (sandy and sandy) soil layers than in fine-grained (sandy and loamy) soil layers. But the height of their rise is the opposite.

This is because in large-grained soils the capillaries are thinner than in fine-grained soils. Therefore, in sandy soils the capillary water rises by 3-4 m, in sandy and loamy soils it rises by 0.40-0.80 m. In soil science, r in formula (4) should be understood as the average radius of the capillary.

After the above information, the types of capillary water were described in the training: the characteristics of ascending (ascending) and suspended capillary waters.

In plants, too, water moves from capillary to leaf through capillary-conducting tubes. However, in addition to capillary forces, other forces of nature are also involved in the rise of water and nutrients in plants.

Capillary water plays an important role in providing moisture to the pumping layer. Here it is explained to the students that plowing the land in the fall, plowing the fields, and cultivating the land between rows after irrigating or rain-fed crops are aimed at keeping the soil moist by breaking the capillaries.

At the end of this part of the lesson, it is recommended to solve the question and calculation problems to reinforce the materials covered.

## 3. CONCLUSION

Students of agronomy of agrarian higher educational institutions

In addition to knowledge of the general laws of agriculture and some of its branches, they must also study in depth the sciences of agrophysics, agrometeorology in order to grow, develop and care for various crops in rural areas, to get high yields from them. Because among the agricultural sciences, the science of agrophysics makes observations on the effects of the external environment and climatic conditions for agricultural crops, and then studies their organic dependence qualitatively and quantitatively.

At the end of the lesson, the teacher checks the students' mastery of the new learning material. In the active conduct of the lesson, the teacher observes the growing interest, aspiration, responsibility of students. During the lesson, the topic is gradually linked with other subjects studied by the student, and the necessary solutions are found through short discussions.

In short, the introduction of new innovative technologies in the transition of agrarian higher education institutions to the bachelor's degree in agronomy in the field of agrophysics "Capillary phenomena" will help students to master the disciplines and increase their professional content.

## 4. REFERANCE

[1] Shein E.V, Goncharov V.M. Agrophysics. Textbook. -Rostov - na - Donu: Phoenix, 2006

[2] Abdullaev A.Q., Arginbaev X.A., Abdullaev X.U. Agrometeorology. Study guide. -Tashkent: State Scientific Publishing House "National Encyclopedia of Uzbekistan", 2006.

[3] Turopov I.T. Soil physics. Texts of lectures for master's students. -Tashkent: Tash DAU, 2004.

[4] 4.Xushvaqtov T. In lectures on agrophysics "Thermal properties of soil. The method of transition to the topic "Thermal regime of the soil." -Tashkent. ToshDAU, 2005.

[5] Abdullaev A.Q. Agrometeorological service to agriculture / Journal of Agriculture of Uzbekistan, №5, 1999, pp. 13-14.

[6] Bobokhojaev I .., Uzoqov P. Soil Science.-T .: Mexnat, 1995.

[7] Abdullaev A.K. A method for forecasting available moisture reserves and consumption for land under cotton as a function of agrometeorological factors (Report to CAgM-XII on the Validation of Information Requirements on Available Moisture Reserves for Irrigated Cotton) WMO Commission for agricultural meteorology CagM Report No 80 WMO / TD No.997. - Geneva, Switzerland, 2001. -R.101-107.