второй фазами удара.

Получена аналитическая зависимость величин текущей и максимальной деформаций зерна от времени с учетом потерь энергии на окончательные пластические деформации во время первой и второй фаз удара, которая входит в основные выражения для технических расчетов параметров удара: силы удара, ударного импульса, максимальных контактных напряжений.

Ключевые слова: удар, энергетический баланс, коэффициент восстановления скорости, коэффициент распределения потерянной энергии, аналитическая зависимость.

Sirenko V.F., Zubko V.N., Kuzina T.V. A mathematical model of shock interaction of grain and steel plate

The analysis of the mechanical and technological properties couderay bodies (grain , steel) showed their significant difference.

Equation of energy balance included the following components:

- kinetic energy of the grain when approaching the obstacle in the form of a metal plate and during impact deceleration to a full stop;

the potential energy of elastic strain of the compressed material and energy loss.

Confirmed energy the meaning of the coefficient of restitution of the velocity at impact.

The energy loss by dissipation is considered as the unused part of the total elastic energy . The ratio between these components of the energy balance is determined on the basis of the coefficient of restitution of the velocity.

To account for the characteristics of different physical models of the loss of mechanical energy during the impact phenomenon is introduced the distribution coefficient of the parts of the energy lost between the first and second phases of the impact.

The relationship of the current values and the maximum deformation of grain from time to time taking into account the energy loss on the final plastic deformation during the first and second phases of the impact, which is included in the basic expressions for engineering calculations of parameters of shock: the impact force, impulse, maximum contact stresses.

Keywords: impact, energy balance, rescue rate, loss ratio, analytical dependence.

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PROTECTION OF FRUIT PLANTATIONS BY INTENSIVE TYPE FROM SPRING FROSTS

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The model of the thermal state of the leaf was refined. The possible condensation of moisture on the leaves upon their cooling was taken into account. When con-sidering radiative heat-exchange, it is necessary to take into account the fact that bodies not only emit their own, but also reflect the energy received from outside. The sum of the body's own emission and reflected emission is called effective radiation. In this paper, we propose to delay the radiative cooling of the soil by in-stalling a foggy screen and to estimate the "lifetime" of this veil against to the environmental conditions. When considering radiative heat-exchange, it is necessary to take into account the fact that bodies not only emit their own, but also reflect the energy received from out-side. The sum of the body's own emission and reflected emission is called effective radiation. The obtained re-sults give an approximate estimate of the heat ex-change rate between soil and air, because the convec-tive heat exchange between the soil, air and the accu-mulated heat of the soil is not taken into account. The force of the aerodynamic resistance is directed opposite to the drop movement vector. In our case it is directed opposite to gravity force.

Key words: *fruits, protection, atomization, method, temperature, in-tensive, spring frosts.*

Introduction. According to the recommendations of physicians, annually an adult should consume at least 80 kg of fruit and berries. These products are of particular value as a source of vitamins. They play a major role in hu-man activity because of increasing the body's vital tone, its physical and mental efficiency, and disease re-sistance. A sufficiently high level of consumption of these products (in the range 100...160 kg per person in a year) has established in the developed countries of the world. In Ukraine this level is very low and does not exceed 25...30 kg.

During 1991-2007 the area of fruit and berry plan-tations in Ukraine has decreased by 73,3%. To date, their areas in agricultural enterprises make up 109,4 thousand of hectare. Reducing the scale of operations of this product is occurring not only due to the reduction of areas of fruit plantations, but also due to the reduc-tion of their yields. The main reasons of this are the lack of proper logistical support, non-compliance of land treatment, and high labour coefficient of production. One of the reasons of the low yield of fruit trees is the loss of their generative organs during spring frosts.

Frosts are observed at night in the spring, during the flowering and fruit-setting. The temperature of the air drops below zero, lasts for 3...4 hours and more, what leads to damage or destruction of the generative organs (0...-10C).

Many methods are known to protect spring plant-ing of an intensive type from spring frosts. The most common are the covering of trees, smoking, air heating in the row-spacing, the mixing of air layers with helicopters and stationary propellers, and irrigation. But today in Ukraine they do not find wide application in the pro-duction either because of their low efficiency, or be-cause of high costs of energy resources. Despite of the development of a number of measures, the task of fruit plantations protecting has not resolved. Today there is no efficient and economical method of protecting from this phenomenon of nature.

Analysis of researches and publications. Spray irrigation has been used for a long time to protect gardens from frosts [1-3]. The phenomenon of radiative frost is considered in the literature [4]. The main cause of it is the predominance of the thermal radiative flow from the soil over the incoming heat flow from warmer air. Also the phenomenon of latent frost is considered [4]. It can be attended by below the maxi-mum permissible value of the temperature the leaf or flower for the current phase of vegetation. In that time the air temperature can be several times higher than the maximum permissible value of the temperature.

The model of the thermal state of the leaf was re-fined. The possible condensation of moisture on the leaves upon their cooling was taken into account [5, 11].

Objectives – There is a part of the garden correctly geometry and relief. The structure of the planting is known, as well as the geometry of the row-spacing and the height of plants. The rated value of air temperatures which dose not damage plants and provide their survival is given. There are known climatic conditions of the region where fruits are cultivated. At the same time, providing the predetermined thermal regime of the open agroecosystem (gardens and nursery-garden of seedlings which are cultivated on the open ground) at extreme seasons of a year is the urgent problem. Especially these ques-tions worry gardeners in the three main extreme seasons of the year: during the first autumn frosts (-50C, -100C and below); during the winter season (-15oC, -20 0C and below); during the first spring frosts (-1oC, -2oC and be-low). Short-term frosts are not as dangerous as long-term frosts. Although they are less significant in strength.

The main results of the research. In the case of radiation freezing, the temperature lowering of the sheet can occur due to heat-exchange of radiation with colder bodies as are soil and sky. As the reflectivity (albedo) of the soil is usually worse than that of the leaves, so, according to the laws of Stefan-Boltzmann and Kirchhoff [6, 7, 12-16], by the same temperature, the body with a smaller reflectivity radi-ates more than the body with greater reflectivity. In our case this means that the soil will chill faster than the leaves, and the leaves will be more strongly chill from radiation heat-exchange with the soil than with the atmosphere. If we manage to stop or delay the radiative cooling of the soil, then frost may not occur.

In this paper, we propose to delay the radiative cooling of the soil by installing a foggy screen and to estimate the "lifetime" of this veil against to the environ-mental conditions [17-19].

We will try to estimate the loss of thermal energy by soil due to radiation in the cloudless sky on basis of the approaches which were described in the literature [4, 5, 20, 21]. In this article, the reflectivity values were taken as equal 0,05 for the soil and 0,15 for the leaves and flowers. Though, permissible temperature of the leaf (which equals + 2°C) is slightly higher than the maximum permissible temperature for flowers and leaves of apple and pear. This temperature rise provides certain reserve for carrying out frost protection measures.

The specific radiation heat flow rate of the emit-ting surface is determined on the basis of the Stefan-Boltzmann law [6, 7]:

$$q_r = \varepsilon \cdot \sigma_0 \cdot T^4, \qquad (1)$$

where: ε – the rate of the body blackness, according to Kirchhoff's law (ε = 1-A); A – Albedo (reflectivity) of the surface; T – surface temperature, K; σ_0 – the Stefan-Boltzmann radiation constant of an absolutely black body (σ0 = 5,67·10-8 W/(м^2·K^4).

The specific heat flow rate of soil intrinsic radiation:

$$q_{rsoil} = \varepsilon_{soil} \cdot \sigma_0 \cdot T_{soil}^4, \qquad (2)$$

where: T_{soil} – Kelvin temperature; ε_{soil} – coefficient of soil blackness.

The specific heat flow rate of the intrinsic radiation of a sheet is written as follows:

$$q_{rleaf} = \varepsilon_{leaf} \cdot \sigma_0 \cdot T_{leaf}^4, \qquad (3)$$

where: T_{leaf} – Kelvin temperature; ε_{leaf}– Blackness factor of sheet surface.

In a cloudless sky, the specific radiation heat flow from the atmosphere per unit surface area will be writ-ten as [8]:

$$q_{ra} = \varepsilon_a \cdot \sigma_0 \cdot T_a^4 = \sigma_0 \cdot \left(0{,}526 + 0{,}065 \cdot \sqrt{P_{va}}\right) \cdot T_a^4,$$

where: P_{va} –the partial vapour pressure (Pa) in atmospheric air by the counterpart of humidity.

When considering radiative heat-exchange, it is necessary to take into account the fact that bodies not only emit their own, but also reflect the energy received from outside. The sum of the body's own emission and reflected emission is called effective radiation. The resulting heat flow which is establishing between the bodies is equal to the difference of the effective heat flows from the bodies. For two opaque infinite parallel plates, the specific resultant heat flow will be written so:

$$q_{r12} = \varepsilon_{12} \cdot \left(\sigma_0 \cdot T_1^4 - \sigma_0 \cdot T_2^4\right), \tag{5}$$

where: ε_{12} – the reduced rate of the bodies system blackness, equal to:

$$\varepsilon_{12} = \frac{1}{1/\varepsilon_1 + 1/\varepsilon_2 - 1}. \tag{6}$$

As the formula (5) indicates when the bodies temperatures are equal – the resultant heat flow equals zero.

In the case when one of the plane-parallel bodies does not reflect the incident on it radiation. That is, it can only flow and emit heat flow. The resulting heat flow will be written as follows (the body 1 reflects and absorbs, the body 2 only absorbs):

$$q_{r12} = \varepsilon_1 \cdot \left(\sigma_0 \cdot T_1^4 - \varepsilon_1 \cdot \sigma_0 \cdot T_2^4\right). \tag{7}$$

For our problem, atmospheric air has the proper-ties of body 2. According to the ratio (7), as a result we will obtain the next formula for the resulting heat flow between soil and air:

$$q_{rsa} = \varepsilon_{soil} \cdot \left(\sigma_0 \cdot T_{soil}^4 - \varepsilon_a \cdot \sigma_0 \cdot T_a^4\right). \tag{8}$$

Using the ratios (1)-(8), the results presented in fig. 1 are obtained.

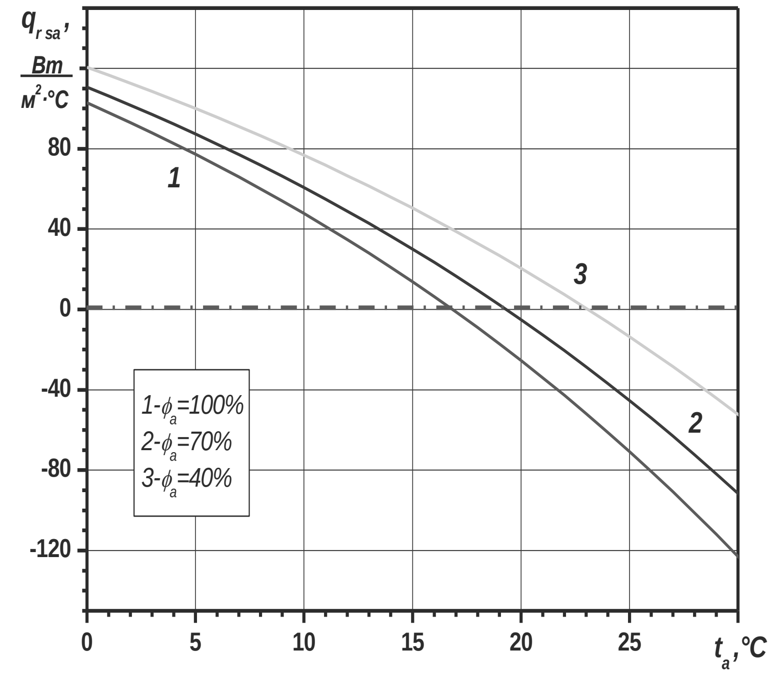

Fig. 1. The specific resultant heat flow from air, soil and leaf, depending on air temperature and relative humidity. 1, 2, 3 - air when relative humidity is 100%, 70%, 40% properly

Figure 1 presents the specific resultant radiative heat flow rate between atmospheric air and the soil surface, at different relative humidity of atmospheric air and at soil temperature equal to the leaf temperature.

As we can see from figure 1, for the resultant radiative heat flow between soil (when the temperature is + 2°C) and air was zero - the air temperature (when a relative air humidity is 40%, 70%, 100%) should be equals 23°C, 19°C and 17°C properly.

The obtained results give an approximate estimate of the heat exchange rate between soil and air, because the convective heat exchange between the soil, air and the accumulated heat of the soil is not taken into account.

One of the effective methods of reducing the radiation flow from the soil to the atmosphere on application of measures for the garden protection (open agro ecosystem) from frost is smoking [1-3, 22, 23].

It is known that for small particle sizes (atmospheric fog), infrared radiation scatters less than visible radiation (which is used in infrared photography). And for large drop size (thick fog), infrared radiation scatters as much as visible radiation.

We propose to install a heat-radiating foggy screen to protect the garden from radiation frost. One of the important characteristics of a foggy environment is the drop size, their rate of sedimentation, and evaporation time.

The drop deposition rate is the free-fall velocity, which is achieved when balance of all forces acting on the drop is reached [9].

In our case (fig. 2) the next forces impact on a drop:

1) gravity force – F_g,
2) force of aerodynamic resistance – F_d,
3) buoyancy force – F_{Ar}.

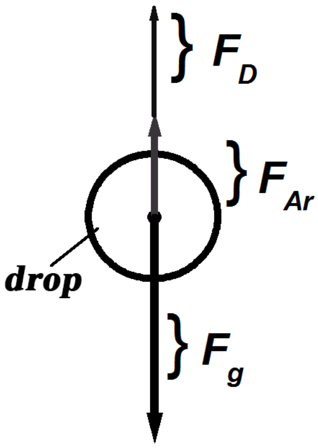

Fig.2. Forces acting on a drop in free fall

The force of the aerodynamic resistance is directed opposite to the drop movement vector. In our case it is directed opposite to gravity force. The buoyancy force is also directed opposite to the vector of gravity force [9]:

$$q_{r12} = \varepsilon_1 \cdot \left(\sigma_0 \cdot T_1^4 - \varepsilon_1 \cdot \sigma_0 \cdot T_2^4\right) \quad (9)$$

Let's take a drop for a solid sphere. The rate of the drop gravity force (10), the buoyancy force (11), and the force of aerodynamic resistance (12) will be written as follows:

$$F_g = m_d \cdot g = V_d \cdot \rho_d \cdot g = \frac{\pi \cdot d^3}{6} \cdot \rho_d \cdot g, \quad (10)$$

$$F_{Ar} = V_d \cdot \rho_0 \cdot g = \frac{\pi \cdot d^3}{6} \cdot \rho_0 \cdot g, \quad (11)$$

$$F_D = A_d \cdot C_D \cdot \frac{\rho_0 \cdot (W_d - W_0)^2}{2}, \quad (12)$$

where: m_d, V_d, A_d – mass, volume, cross-section area of a drop (inferior index *d*); ρ_d, ρ_0 – density of a drop and atmosphere air; W_d – rate of drop sedimentation; W_0 – traverse speed of environmental air, in our case, equals zero.

The coefficient of aerodynamic resistance is a function of the dimensionless Reynolds number and for a solid sphere in the region of friction flow is equal [9]:

$$C_D = \frac{24}{\mathrm{Re}_d}, \quad (13)$$

where: the ratio $\mathrm{Re}_d = \frac{\rho_0 \cdot |W_d - W_0| \cdot d}{\mu_0}$, expresses the relation between the forces of inertia and the forces of viscosity. From the relations (9)-(13), Stokes [9] obtained a formula for calculating the drop sedimentation rate:

$$W_d = \frac{d^2 \cdot (\rho_d - \rho_0) \cdot g}{18 \cdot \mu_d}. \quad (14)$$

The rate of evaporation is estimated by the Maxwell formula [10]:

$$I = 2 \cdot \pi \cdot d \cdot D \cdot (c_d - c_0), \quad (15)$$

where: *D* – diffusion coefficient; c_d – concentration of water vapour by drop; c_0 – concentration of water vapour in atmosphere air.

Table 1 presents the sedimentation rate, the passage time of 1 m (the lifetime of the fog screen), and the rate of drops evaporation of different diameters in the air with a 90% relative humidity.

It can be seen that as the diameter of the drop increases, the drop sedimentation increases. And thereby the possible lifetime of the foggy screen decreases because of falling of the drops to the ground.

Table 1. Drop sedimentation rate, passage time and drops evaporation rate of different diameters

d, мсм	W_d, м/s	*τ*, s	*I*, kgs
2,5	$1{,}9673 \cdot 10^{-4}$	5083,19	$3{,}3067 \cdot 10^{-13}$
5,0	$7{,}8691 \cdot 10^{-4}$	1270,80	$6{,}6135 \cdot 10^{-13}$
10,0	$3{,}1476 \cdot 10^{-3}$	317,70	$1{,}3227 \cdot 10^{-12}$
20,0	$1{,}2591 \cdot 10^{-2}$	79,42	$2{,}6454 \cdot 10^{-12}$
40,0	$5{,}0362 \cdot 10^{-2}$	19,86	$5{,}2908 \cdot 10^{-12}$
80,0	$2{,}0145 \cdot 10^{-1}$	4,96	$1{,}0582 \cdot 10^{-11}$
100,0	$3{,}1476 \cdot 10^{-1}$	3,18	$1{,}3227 \cdot 10^{-11}$

Conclusion:

The obtained results (the specific resultant radiative heat flow from air, soil and leaf, depending on air temperature and relative humidity) give an approximate estimate of the heat exchange rate between soil and air, whereas convective heat exchange between soil and air and the accumulated heat of the soil are not taken into account.

In order to resultant radiation heat flow between the soil (when the temperature is +2°C) and air equalled zero the air temperature (with relative air humidity of 40%, 70%, 100%) should be 23°C, 19°C and 17°C, properly.

The sedimentation rate, the passage time of 1 m and the rate of drop evaporation of various diameters in air (with a relative humidity of 90%) are calculated. When the diameter of the drop increases, the sedimentation rate increases. And, thereby, the possible lifetime of the foggy screen decreases because of falling of the drops to the ground.

The obtained data allow to substantiate the choice of the spraying equipment for installing a foggy screen.

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Рудницкая А.В., Аникеев А.И., Цыганенко М.А., Сыровицкий К.Г., Гаек Е.А. Защита фруктовых плантаций интенсивным типом от весенних заморозков

Модель термического состояния листа была уточнена. Учитывалась возможная конденсация влаги на листьях при их охлаждении. При рассмотрении радиационного теплообмена необходимо учитывать тот факт, что тела не только излучают свои собственные, но и отражают энергию, полученную извне. Сумма собственного излучения тела и отраженного излучения называется эффективным излучением. В этой статье мы предлагаем отложить радиационное охлаждение почвы путем затупления туманного экрана и оценить «продолжительность жизни» этой завесы в отношении условий окружающей среды. При рассмотрении радиационного теплообмена необходимо учитывать тот факт, что тела не только излучают свои собственные, но и отражают энергию, полученную извне. Сумма собственного излучения тела и отраженного излучения называется эффективным излучением. Полученные результаты дают приблизительную оценку скорости изменения тепла между почвой и воздухом, поскольку конвективный теплообмен между почвой, воздухом и накопленной теплотой почвы не учитывается. Сила аэродинамического сопротивления направлена против вектора движения капли. В нашем случае он направлен против силы тяжести.

Ключевые слова: *фрукты, защита, атомизация, метод, температура, интенсивность, весенние заморозки.*

Рудницька Г.В., Анікєєв О.І., Циганенко М.О., Сировицький К.Г., Гаєк Є.А. Захист фруктових плантацій інтенсивним типом від весняних заморозків

Уточнено модель теплового стану листа. Враховано можливу конденсацію вологи на листі при їх охолодженні. При обговоренні радіаційного теплообміну необхідно враховувати той факт, що тіла не тільки випромінюють власні, але також відображають енергію, отриману ззовні. Сума власного випромінювання тіла та відбитого випромінювання називається ефективним випромінюванням. У цьому документі ми пропонуємо затримати радіаційне охолодження ґрунту шляхом утримання туманного екрану та оцінки "терміну служби" цієї покриви відносно умов навколишнього середовища. При розгляді радіаційного теплообміну необхідно враховувати той факт, що тіла не тільки випромінюють свої власні, але також відображають енергію, отриману ззовні. Сума власного випромінювання тіла та відбитого випромінювання називається ефективним випромінюванням. Отримані результати дають приблизну оцінку швидкості зміни теплоти між ґрунтом та повітрям, тому що конвективний теплообмін між ґрунтом, повітрям та накопичувальною теплотою грунту не враховується. Сила аеродинамічного опору спрямована навпроти вектора руху падіння. У нашому випадку він спрямований навпроти сили тяжіння.

Ключові слова: *фрукти, захист, розпилення, метод, температура, інтенсивні, весняні заморозки.*

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