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THE DISINFESTATION OF SOIL IN GREENHOUSES

Taymuraz Khambievich Kabaloev[1], Sarra Abramovna Bekuzarova[2], Rafik Jamovich Nurmetov[3], Irbek Khadzhimuratovich Esenov[4], Carolina Kermenovna Gatueva[5], Tamerlan Maratovich Gokoyev[6]

[1]Federal state budgetary educational institution of Gorsky State Agrarian University, Republic of North Ossetia-Alania, 362040, Vladikavkaz, 37 Kirov Street. E-mail: prorektor_uvr@gorskigau.com

[2]Federal state budgetary educational institution Gorsky state agrarian university, Republic of North Ossetia-Alania, 362040, Vladikavkaz, 37 Kirov Street. E-mail: bekos37@mail.ru

[3]All-Russian Scientific Research Institute of Vegetable-Growing - a branch of the Federal State Budgetary Scientific Institution "Federal Scientific Center for Vegetable-Growing", 140153, Moscow Region, Ramensky District, Vereya, p.500, E-mail: **vniioh@yandex.ru**

4Federal state budgetary educational institution of Gorsky State Agrarian University, Republic of North Ossetia-Alania, 362040, Vladikavkaz, 37 Kirov Street. E-mail: esenov1949esenov@yandex.ru

[5]Federal state budgetary educational institution of Gorsky State Agrarian University, Republic of North Ossetia-Alania, 362040, Vladikavkaz, 37 Kirov Street. E-mail: pro-ggau@mail.ru

[6]Federal state budgetary educational institution of Gorsky State Agrarian University, Republic of North Ossetia-Alania, 362040, Vladikavkaz, 37 Kirov Street. E-mail: Tamerlan.g@mail.ru

Abstract:

The energy method of soil disinfection of greenhouses from pests and pathogens of vegetable crops has been studied and proposed in Gorsky State Agrarian University. As a coolant, it is recommended to use ionized water steam, pretreating the soil with a cutter with a diameter of 25…30 mm lumps or cells with a diameter of 16…20 mm. High quality of disinfection is ensured, when using water ionized steam as a coolant, the time of soil heating is reduced by on average of 1,5 times, the steam consumption reduces by 35...40%, the heat utilization coefficient is increased by 1,3 times compared with the use of non-ionized steam as a coolant.

***Key words**: decontamination of soil, pests and pathogens, bioindicators, coolant, ionized steam, the thermal conductivity, the heating of the soil, the steam condensation front, rotary hoe, cutter.*

Corresponding author:

Taymuraz Khambievich Kabaloev,

Federal state budgetary educational institution of Gorsky State Agrarian University, Republic of North Ossetia-Alania, 362040, Vladikavkaz, 37 Kirov Street. E-mail: prorektor_uvr@gorskigau.com

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INTRODUCTION:

A long period of vegetable crops vegetation and optimal microclimate in the protected soil structures creates favorable conditions for obtaining high yields, but at the same time pests and pathogens of these crops develop and multiply in the soil. In greenhouses crop losses from disease up to 40...60%, in connection with which the soil should be periodically decontaminated. The quality of soil heating is determined by the biological requirements for the disinfection process. For example, one female Gallic nematode by the end of the growing season gives 10^{20}…10^{30} of their own kind.

Nowadays, soil disinfection is carried out by the so-called "tent" method in almost all large farms of the country, it is when water steam is supplied directly under the cover laid on the soil surface. The steam in contact with the cold soil condenses, releasing a large amount of latent heat, and the condensate causes the heat of sorption, which leads to an increase of the soil temperature. The more steam in the heating medium, the greater the rate of moisture sorption is and faster heating occurs. Ionized steam or a steam-air mixture with a higher concentration of low temperature steam (105…115 ° C) are more advisable to use as a coolant [1-7].

METHOD:

The research was carried out in 2017-2018 at the Department of Electrical Equipment and Electrical Engineering in the agroindustrial complex of FSBEI of Higher Education of Gorsky State Agrarian University and in the research laboratory of protected soil of All-Russian Research Institute of Vegetable Growing.

The permanent use of soils in greenhouses, a long period of vegetation of vegetable crops, high temperature and humidity contribute to the development of pests and pathogens. The most widespread diseases in the protected ground buildings are the Sclerotia (white mold), Anthracnose (leaf and stem shape), Fusarium and root-knot nematode pest. The method of determining the decontamination re-presses was as follows. "Hot junction" thermocouples were placed into the bioindicators, representing gauze bags with a size of 10 × 10 × 3 mm, with those leaders of fungal diseases who live in the soil (Fussarium oxysporum Schl. Emend Scierotinia sclerotiorum D.By) or persisting in it (Scl. sclerotiorum) and on plant residues (Ascochyta cucumeris Fautr. Et Roum), as well as the antagonist of soil fungi Trichoderma liqno-rum, and laid them to a depth of 30 cm air-dry segments of the stem and cucumber leaves, affected by ascochitosis, sclerosis of the causative agent of white rot, the culture of the fungus F. Oxysporum (dried and propagated culture of the fungus on rice), as well as a biological product of the fungus-an antagonist of many soil pathogens Tr.lignorum (reproduced by culture of the fungus on peat 6 strain obtained by All-Russian Research Institute of Plant Protection) were used as bioindicators.

The temperature of the soil monitoring was carried out using the potentiometer of type PP 63 connected to the thermocouple HC, and laboratory elektrokontact thermometers, and time was measured by an electric stopwatch. The experiments were carried out with typical soil composition: peat – 60%, sawdust – 20%, manure – 10%, land (loam) – 10%.

The viability of pathogens after exposure was determined in the laboratory of plant protection of All-Russian Research Institute of Vegetable Growing by sowing the entire volume of infectious material on the agarized nutrient medium of Chapek-Dox. The repeatability of the experiment was adopted three times as for pathogens, pests, and to determine the survival of antagonist. Each Petri cup has 5 seeding points. The cups were placed in a thermostat for 8...10 days, after which the number of viable colonies of pathogens which have formed on the nutrient medium was calculated [9].

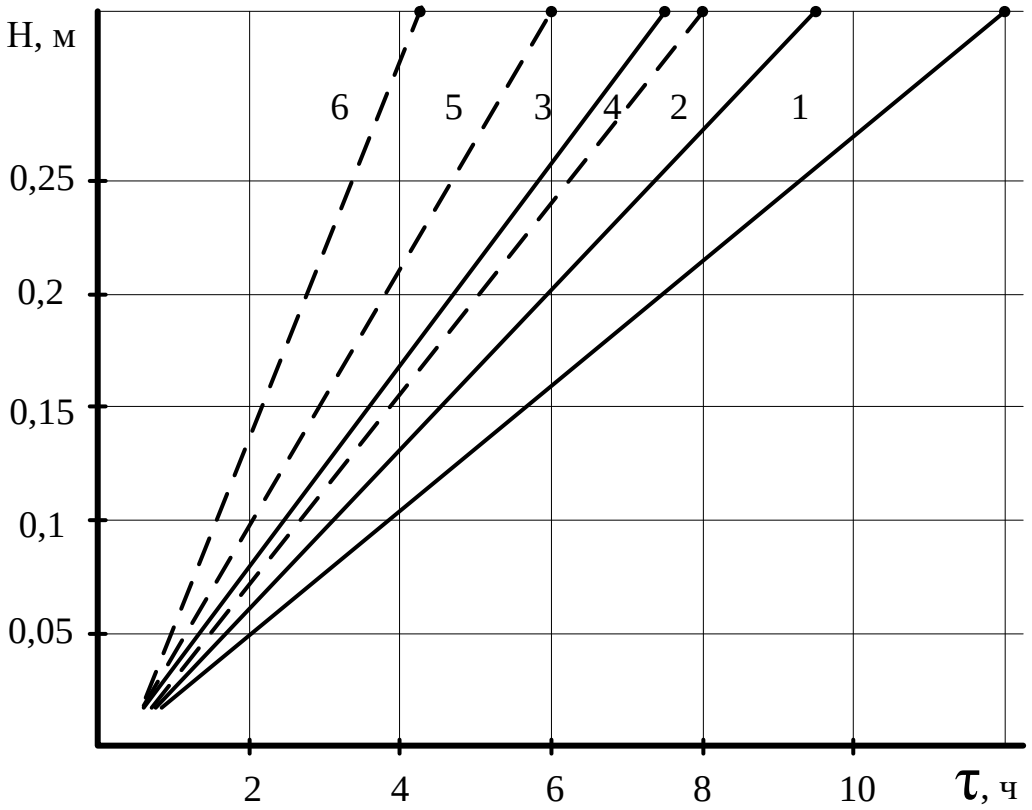
The experiments in greenhouses were carried out according to the scheme given in table 1. The efficiency of soil disinfection using ionized and non-ionized steam from the pressure of the supplied steam and the method of soil treatment was studied. The time of soil heating, the consumption of steam and the utilization of heat has also been determined.

THE RESEARCH RESULTS AND THEIR DISCUSSION:

The scientists of Gorsky State Agrarian University conducted studies on the process of soil heating by "tent" method, where non-ionized and ionized steam was used as a coolant. The process of soil disinfection by non-ionized steam is sufficiently fully investigated in works [6-9]. Decontamination of soil by ionized steam is of practical interest, but insufficiently investigated. Passing through the soil layers, ionized steam condenses faster than non-ionized steam, this is due to the fact that the steam ions are the centers of condensation and the heating process is more intense. In addition, the penetrating power of ionized steam in the soil is higher than that of non-ionized steam, since equally charged ions create an additional force of

thawing, which leads to a more uniform distribution of the steam-water mixture in the soil [8].

The results of experiments on heating the soil of greenhouses with non-ionized and ionized steam are presented in table 1 and picture 1.



Pic. 1. The Dependence of the Position of the Lethal Temperature Front on the Time in the Process of the Soil Decontamination by the Marquee Method (1,2,3 - unionized couples; 4,5,6 – ionized vapor; H is for the depth of processing; graphics 1, 4 – soil not treated; 2, 5 – soil processed "Ratepay"; 3, 6 – the soil processed by the mill).

The analysis of the experimental data shows that with the use of ionized steam as a coolant, the time of contamination and the steam consumption are reduced and the heat utilization coefficient is increased compared to these indicators for non-ionized steam.

In all variants of experiments, the steam pressure under the "tent" at first decreases sharply due to the intense condensation of steam on the surface of the soil and on the tent cover, with the heating of the array and the cover, the condensation intensity decreases markedly, and the pressure under the "tent" increases. In 0,5…1,8 hours the tent was filled with steam and began to rise, the pressure under the "tent" has increased, then gradually decreased due to the increase of the steam losses due because of its infiltration into the environment around the perimeter of the "tent." Steam consumption in all experiments was constant.

The dependence of the condensation front position on time in the experiments is close to linear; this is explained by the fact that the main type of heat transfer during steaming is the coolant filtration, and also by the fact that the steam pressure under the "tent" continuously increases.

Due to the high pressure under the "tent" and the flow of steam at the beginning of heating during disinfection with both non-ionized steam and ionized steam, the rate of movement of the steam condensation front is variable – at first it is high, then it decreases, as the pores and capillaries of the soil are clogged with condensate, which prevents the filtration of steam, and the pressure under the "tent" almost does not increase.

An important factor that determines the effectiveness of the process of disinfection of the soil of greenhouses with the "tent" method as the preliminary treatment of the soil.

The steam pressure under the cover in the "tent" method of disinfection is 20...100 PA, that is why, the depth of penetration of steam into the soil is insignificant and depends on its porosity. If you imagine the lumps of the soil in the form of balls, the porosity is determined by the nature of their packing. It would seem that the rate of heating of the soil layer, caused mainly by the thermal power of the internal heat source (steam and condensate), does not depend on the size of the lump, however, as the experiments have shown, the size of the lumps significantly affects the duration of heating. With a small diameter of lumps, their total surface is higher in comparison with the surface of lumps of larger diameter (with the same laying). This ratio, for example, lumps with a diameter of 25...30 mm (the soil is about to develop cutter) and 150mm (soil processed by "Rotaspa" or plow) is equal to 5. Thus, in the first case, the amount of condensed steam is 5 times greater. Accordingly, at the first moment the power of the internal heat source during fine-grained tillage is higher. The pore size in this case is less, therefore, due to the rapid filling with condensate, the aerodynamic resistance sharply increases, and practically no steam enters the soil depth [9].

The conductive heating of each lump (lumps) can be noticed separately because of the large clumps, which can occur with the soil treatment by the rotary hoe "Rotaspa" or a plow before disinfection, i.e. the heating of the ball of greater diameter at a constant temperature can be approximately seen on the surface of the soil. Steam is spent almost only to maintain the surface temperature of the soil lumps.

We conducted experiments in the conditions of production, the aim was to determine the dependence of the soil temperature on the steaming time and depth of the massif, the specific steam consumption, the heating time depending on the steam pressure supplied under the "tent" and the heating temperature at a depth of 30 cm from the soil surface, presented in table 1.

Table 1. The Results of the Soil Heating by the "Tent" Method.

№ p/p	Indicator	Not Processed		Processed by ‘’Rataspa’’		Milling Cutter Treatment	
		non-ionized steam	ionized steam	non-ionized steam	ionized steam	non-ionized steam	ionized steam
1	Steam Pressure, PA	28-30	28-30	28-30	28-30	28-30	28-30
2	Heating time up to 80^0C to a depth of 0,3 m	12,0	8,0	9,8	6,0	7,5	4,3
3	Steam consumption, kg/m^3	86,8	66,4	78,2	55,3	71,3	48,6
4	Heat using factor, %	18,2	25,0	19,9	28,8	22,7	32,5

The analysis of the soil temperature dependence on the heating time and the depth of the massif, when the soil is milled and not milled, showed that the heating time of the milled soil is from 1,4 to 1,6 times less in comparison with that of the unmilled, steam consumption is reduced by 28...56%, the coefficient of the heat use increases. According to our research, the most effective is the soil processing by mill, and with regard to recommendations [8] treatment of cells with a diameter of 16…20 mm lumps in quantity of 140 units per a square meter.

Based on the results of the research, it is recommended to treat the soil before steaming, as a result of which the steam consumption reduces. The heating time also significantly reduces and depends not only on the type of processing, but also on the pressure of the supplied steam, humidity and thermal characteristics of the soil.

CONCLUSION:

Thus, the use of ionized steam to heat the soil in greenhouses ensures high quality of disinfection, reduces the duration of the technological process by on average of 1,5 times, the coolant consumption by on average of 1,4 times, the heat utilization coefficient increases by 1,24...1,36 times, and the electricity consumption for steam ionization is 2,2...2,6% of the total energy consumption for heating the soil. Before disinfection it is recommended to process the soil with a cutter, or cells with a diameter of lumps of 25...30 mm or the cells with a diameter of lumps 16...20 mm, which further reduce the heating time, the flow rate of the coolant and prevent overheating of the soil, which causes

ammoniac and manganese poisoning of the greenhouse soil.

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