



New Technological Solutions for the Production of Planting Material of Grapes

Abuzar Batukaev¹, Grigoriy Malih², Andi Magomadov^{2,3}, Abdulmalik Batukaev³, Olga Seget²

¹Chechen Research Institute of Agriculture, Grozny, Russia

²All-Russian Research Institute for Viticulture and Winemaking named after Ya.I. Potapenko", Novocherkassk, Russia

³Chechen State University, Grozny, Russia

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Abstract

In order to develop new technological solutions, experimental facilities for accelerated reproduction of grapes and other crops have been created. In microtelco installation in a single technological cycle is the stratification, cultivation, thermotherapy. In addition, the plant can saturate the cultivation of vaccinations and seedlings with the necessary nutrients. The support of polymer materials for the cultivation of seedlings in the bottom, planting them in a permanent place, placement and retention of the sleeves and the growth in the plane of the trellis. The new method combines previously separated elements of the technology of their production from the cultivation of planting material to the operation of fruit-bearing plants in a single technological cycle, in order to exclude a number of operations for the care of plants, protecting them from adverse weather factors, pests and diseases, mechanical damage.

Keywords: grafted seedlings, substrates, graviatational stimulation application, experimental setup for growing seedlings

1 Introduction

One of the most important reserves of saving labor and money resources in viticulture is the development of mechanization and automation equipment to create an optimal regime for growing quality seedlings, as well as the methods of production and planting of vineyards. They should help increase labor productivity and reduce a number of agro-practices of caring for plantations.

The technology of carrying out stratification of vaccinations, treatment of planting material from diseases and pests, maintenance of optimal automatic regimes in the cultivation of seedlings in Russian and foreign practice is still very poorly developed (1,2,7,17). A serial electrostatic plant ESU-2M is known, where grafting is carried out with a heating wire of the brand POSHP-1-1. When stratified, the grafted cuttings are placed in boxes and interlaid with wet sawdust. From above, a moisture-heating element is laid in a box in the form of a rug 700 x 900 mm, the edges of which are folded along the box for 10-12 cm. To monitor the temperature maintenance, a thermometer is installed in one of the 72 boxes, connected to one installation. Sawdust before use is well sieved, steamed with superheated steam (130°C) for 30 minutes, adjusted to optimum moisture and used in warm state (25-30°C) to interlace grafted cuttings. The described installation allows only stratification of vaccinations, while some of the vaccinations being molded and with bud damping-out. When using this type of equipment at the end of the stratification, when the grafts begin to germinate in poorly illuminated conditions, the shoots are rapidly stretched, and a

large amount of nutrients is consumed, depleting the grafts. Vaccinations planted in the crop of saplings have a low survival rate.

At present, the technology of open stratification in the environment of intensively humidified air has been developed. Stratification chambers are usually heated by water heating, and the necessary humidity in the chambers is maintained by evaporation of water from special baths. For additional moistening and removal of mold on grafted cuttings, they are periodically poured with water from special nozzles, and also ventilated with special fans. The disadvantage of this technology is in the complexity of its implementation, the mold is intensely formed with such stratification, which is difficult to combat. After grafts' treatment with pesticides it is not possible to monitor the passage of the grafts' stratification (5,15,18,24). When using this type of equipment at the end of the stratification, when the grafts begin to germinate in poorly illuminated conditions, the shoots are rapidly stretched, and a large amount of nutrients is consumed, depleting the grafts. With such stratification, it is not possible to create different regimens in the apexes and bases of the same grafts, which sharply reduces the yield of grafts with circular callus. Not one of these plants does not provide proper control of pests and diseases by heat treatment of plants (25,22). We were not able to find the studies of technology for stratifying vaccinations and growing vegetative seedlings in the same technological regime in literary sources. Planting seedlings are not actual for our country, one of the main reasons is that there are no

Corresponding author: Abuzar Batukaev, Chechen Research Institute of Agriculture, Grozny, Russia.

equipment and developed, scientifically justified technologies for their production.

The purpose of the work is to study the mechanization and automation tools that we have created for optimal conditions of growing seedlings in a single technological cycle, to restore plants from phytopathogenic infection, to saturate cuttings of rootstocks with nutrients for better callus formation, and to increase the yield of seedlings. It was necessary to combine stratification, cultivation on the basis of new substrates. To develop a new type of trellis to connect disparate elements of the grapes production technology from growing seedlings by the pot method cultivation to the exploitation of fruit-bearing plantations in a single technological cycle. And also, the exclusion of a number of operations to care for plantations, protecting them from adverse factors, pests, diseases and mechanical damage. Eliminate such a labor-intensive operation as cutting of outer roots and a number of other operations in the vineyards.

2 Methods of research

1. Agrobiological surveys and observations were carried out according to "Agrobiological research on the creation of intensive vine plantations on an industrial basis" (edited by B.A. Muzychenko, 1978);
2. Phenological observations of the growth and development of grape plants were carried out according to the method of M.A. Lazarevsky;
3. Determination of the leaf-area duration was established according to the method of A.S. Melnik and V.I. Shcheglovsky;
4. Absorption method for the determination of toxic elements GOST-30178-96. R. Soil selection - GOST - 28168-89; general requirements for the analysis - GOST-29269-91; Nitrate nitrogen in the soil - GOST-26951-86; ammonium exchange in soil - GOST-26489-85; mobile forms of phosphorus and exchangeable potassium in soil by the method of B.P. Machigin - GOST 26205-91;
5. Determination of the developed techniques for the organ-embryonic fruitfulness of the central buds of the eyes and the content of trace elements in the leaves and berries according to the methodology set forth in the manual "Agrotechnical research on the creation of intensive vine plantations on an industrial basis" (Novocherkassk, 1978);
6. The consumption of electricity per one seedling was taken into account when using new plants;
7. Output of commodity grapes, pcs., number of berries in bunches, pcs., bunch weight, berry weight, g., effort to detach berries, crush berries according to the method of N.N. Prostoserodov;
8. Determination of the quality of the crop - the mass concentration of sugars in the juice was carried out by the hydrometer during the period of reaching the technical maturity of the crop (GOST 27198-87);
9. Determination of titratable acidity in the juice of berries was carried out by titration with 0.1 N NaOH solution during the technical maturity of the crop (GOST 51434-99);
10. Samples of wine materials were obtained by the method of micro winemaking according to N.N. Prostoserodov (1963);
11. The physio-chemical analysis of wine materials was carried out according to the following methods: sugar content - according to the method of Bertrand (1947); titrated acidity - titrated 0.1 N. solution of NaOH, organoleptic analysis - according to the 10 point assessment system by the taste panel of the All-Russian Research Institute for Viticulture and Winemaking named after Ya.I. Potapenko.

The research was carried out at the All-Russian Institute of Viticulture and Wine making named after Ya.I. Potapenko and OOO Loza in the Semikarakorsk district of the Rostov region.

3 Results and discussion

The test of the setup, that we designed, when growing grafted seedlings, showed that the cost of electricity per seedling is reduced by a factor of 1.4 - 2. In average, the yield of grafted seedlings increases by 10 - 25%. Installations can be available to any farmer who starts to produce healthy seedlings but does not have his own material base (grifting complex with a computer room, stratification chambers, greenhouses, etc.). As shown by the practitioner, it is possible to use the setup in rooms that are not used for these purposes. Good results were obtained in the cultivation of grafted vegetative seedlings by farmers in the premises that were not used for these purposes. At the same time, anybody can temporarily do without creating new nursery facilities. This setup can be used even in empty abandoned buildings and film heifers, providing optimal conditions during stratification of grafts, growth and development of seedlings (23, 26). The block diagram shows the installation of one of the setup we offer.

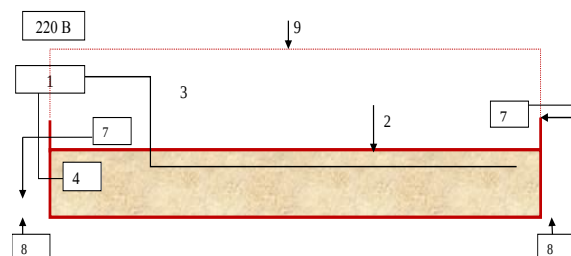


Figure 1: Block diagram of the first setup installation. (1) Control unit; (2) Heated surface; (3) Heating element; (4) Sand temperature sensor; (5) Micro-hull housing; (6) Sifted sand; (7) Humidity sensors; (8) Steam generators; (9) Pipe for steam supply.

3.1 The operating principle of the setup

The block diagram (Fig. 1) shows the installation device. When the voltage supply is applied to the control unit 1 and the set temperature is controlled by the temperature sensor 4, the sand layer is heated by the heating element 3. The steam generator qualitatively provides the necessary parameters for not only the temperature and humidity of the air, but also the substrate, ensuring high yield of grafted seedlings. Developed, the setup can be recommended for use in production in the study of thermotherapy, as a method of treatment against fungal, viral diseases and a number of pests of grapes. On the basis of this installation, we developed an ecologically clean method for decontaminating grape seedlings during their cultivation from gray rot. For example, gray rot is an infectious disease. This micro fungus develops well on the dead parts of plants and is considered saprophyte. Gray rot spreads through conidia. Conidia penetrates the nodes' tissues of the shoots through the antennae, the leaf or the stem of the grapes and lead to tissue death. On the vineyard plantations or on the mother solution in rainy cool weather, the number of conidia in the air increases and, as a rule, their billionth mass, the "smoke" and spraying is released from the surface of the diseased bunches. Gray rot is dangerous because the outbreak of its development occurs during the ripening of grapes, when the use of chemicals in vineyards is not allowed. It can settle

on the surface of the bud scale, at its base and on the wounds left after the fall of leaves (6,8).

When preparing grafts in November-December, especially with mild and rainy weather, the hyphae of gray rot penetrate deeply into the living tissue, resulting in the main and replacement buds die during storage of grafts, spots appear on the bark of shoots with dead tissues. It often happens that from a healthy-looking bud in the process of stratification of grafted cuttings, the shoot that develops from the bud is already affected by gray rot. From what has been said, it follows that it is necessary to destroy conidia by chemical treatment in vineyards, just before harvesting the grafts and re-laying them for storage. In Germany, Chinosol (Chinosol W) consisting of 67% 8-hydroxyquinoline sulfate + 30% potassium sulfate is used to treat the grafts. In Hungary, Solvokhin extra (Chinoiin, Budapest) 70% 8 hydroxyquinoline, 14% potassium sulfate, 15% ethylenedialin-tetraacetic acid, 1% neutral fatty sulfate are used. For disinfection, the bundles of rootstock and scion grafts are completely soaked in a 0.5% solution of quinazole. The duration of soaking depends on the water temperature: at 5°C it lasts for 5 hours, 10°C for 3 hours, and 20°C for 2 hours. Soaking the cuttings in quinozole is carried out after they are soaked in water. Excess concentration of the disinfectant inside the grafts and on their surface adversely affects the formation of callus and roots, the development of the buds and sharply reduces the yield of seedlings.

All these chemical control measures are ineffective and dangerous for the health of workers involved in growing seedlings. The currently used complex of agrochemical and chemical measures for combating gray rot cannot solve the problem of protection against gray rot, especially when growing seedlings of grapes. The task of the proposed method is to increase the yield of grafted seedlings by destroying *Botrytis cinerea* before stratification of the rootstock, which drastically reduces bud damping-out and the cost of seedlings. It has been established that steam with a temperature of 20-25 °C and an air humidity of 90-95% is used to provoke the development of the fungus, and the full germination of conidia *Botrytis cinerea* is formed by the formation of a green cone from the bud of a stock with a height of 1.5-2 cm, and continuously the *t* of the the steam rises to 45-50 °C. Such a high *t* of the steam is kept for 10 minutes, being a critical boundary, after which the death of gray rot occurs. This method provides not only the death of gray rot with minimal outlays of labor and resources, but also the yield of standard seedlings, their survival on the plantation, which will speed up the laying of new vineyards.

Table 1: Influence of grafts' saturation by Albit on the quality and development of annual grape plants (Kristall variety, Kober rootstock 5 BB)

Variant	Seedlings yield, %	Shoot length, cm	Shoot diameter, mm	Root system length, cm	Leaf-area duration, cm ²	Adaptation on the plantation, %	The content of macro- and microelements in the vine of annual plants						
							N, %	P, %	K, %	Zn, mg/kg	B, mg/kg	Co, mg/kg	Mn, mg/kg
1. Treatment of grafts with steam at 60 °C for an hour	8,8	25,9	4,5	18,6	110,5	12,6	-	-	-	-	-	-	-
2. Treatment of grafts with steam at 60 °C for half an hour	15,0	18,4	4,8	22,9	121,8	18,9	-	-	-	-	-	-	-
3. Treatment of grafts with steam at 45-50 °C for 10 minutes	80,6	173,3	6,5	89,0	2015,5	84,2	0,7	0,11	0,75	1,12	11,3	0,06	0,80
4. Grafts treated with a 0.1% solution of quinazole three times (control)	27,4	23,0	5,3	65,0	1752,3	63,4	0,6	0,09	0,63	0,95	9,6	0,05	0,68
HCP ₀₅	0,7					0,45	0,04	0,01	0,02	0,03	0,11	0,01	0,03

As can be seen from Table 1, during the treatment of grafting at t 60 °C for an hour, the conductive tissues of the rootstock cuttings were damaged, and the yield of the grafted seedlings of the Kristall variety was only 8.8%. Treatment with the same temperature for 30 minutes also resulted in the seedling tissues burns with the steam, but at the same time their yield increased significantly and amounted to 15%. The three-times spraying with a 0.1% solution of quinazole proved a low effectiveness: a large number of grafts was affected by gray rot, and the yield was only 27.4%, while in the proposed method the yield of vegetative seedlings was 80.6%.

The obtained experimental data shown that the best callus formation in grafts was noted with Albit application, as well as the most intensive growth of shoots. The leaf-area duration in the second variant is 75.6 cm², which is higher than the first variant by 20.7 cm² and higher by 55.1 cm² than in the third variant. The yield of grafts with circular callus in the second variant was 94.7%, which is 16.7% higher than in the first variant, and 82.7% higher than in the third variant. The yield of seedlings at the control was 50%, which is less by 31.2% than in the second variant and by 40.6% more than in the third variant. The average increase in shoots reached 10.6 cm in the first variant, 17.0 cm in the second variant, and 6.9 cm in the third one. The adaptation ability of the seedlings on the plantation was 87.4%, which is 6.2% higher than at the control. At the same time, the growth of shoots increased both in the apical and in the lateral meristem. In general, the quality of seedlings increased.

3.2 We offer a second setup for the production of seedlings

Figures 2 and 3 show its installation. In order to identify the optimal regime for growing seedlings and vegetative seedlings, we tested the heat shield developed by us. The heat shield consisted of 30 mm high density polyethylene pipes. To create the installation of the entire area of the greenhouses, river sand was applied with a layer of 8-10 cm, the heat shield tubes were laid according to the scheme of 40 × 40 cm each, forming a screen 160 cm wide, over which a sand layer of 3-5 cm was poured. Shelving units 180 cm wide, covered with a black plastic film with a thickness of 200 microns were installed along the heat shield. The established heat shield created a differentiated temperature regime: under the shelves in the root system 22-23 °C, and the air in the greenhouse about 14-16 °C, close to the optimum temperature. The temperature control was automated using the TRDK-3 thermal relay. In the blocks of greenhouses, five sections with aerosol irrigation were created. In the first variant, heating of greenhouses with pipes filled with hot water with a temperature of 50 - 80 °C was carried out from the boiler winery. The heat shield provides a higher yield of seedlings in comparison with the second block, where the heating of the greenhouses was carried out by heat generators. An important role in growing seedlings is played by substrates. However, for vegetative seedlings, such substrates were required, that would ensure not only good development of them in the greenhouse, but, above all, their high survival rate on the plantation.

We offer the production technology of growing seedlings on gravelly plates. On the basis of the greenhouse the first plate of gravelly is laid with a width of 50 cm, a length of 400 cm and a thickness of 12 cm. Then, grafts are placed on the gravelly, placing them at an angle of 30 ° to the horizontal surface and tightly to each other (3500-4000 grafts), with

apices in one direction. The grafts are placed in such a way that the upper bud does not reach the edge of the plate by 2-4 cm. The next gravelly plate is laid on top with the same width, length and thickness of 3-4 cm. Grafts are placed on it in exactly the same way as in the previous case.



Figure 2: The construction of a heat shield in polyethylene greenhouses (OOO Loza, Semikarakorsky District, Rostov Region)



Figure 3: Shelves, covered with polyethylene film for the installation of boxes with seedlings



Figure 4: Seedlings in a polyethylene greenhouse (OOO Loza, Semikarakorsky District, Rostov Region)



Figure 5: Vegetative seedlings in a polyethylene greenhouse (OOO Loza, Semikarakorsky District, Rostov Region)

The subsequent layers of grafts are transferred with the same gravelly plates. The total height of the plates reaches the height of the greenhouses.

Thus, in order to reduce labor costs and improve the quality of seedlings by eliminating the mechanical damage to seedlings during their growing and forming, cuttings or grafts are placed between plates stacked at a distance of 2-4 cm from the edge of the plate where they are stratified, and then grow and form seedlings with a bend to form a horizontal cordon on

the seedlings during stratification and growing in the greenhouse (11,14,16). In this case, the shoots can be formed at different angles with respect to the soil surface for various methods of planting. As shown by the experiments, shorter internodes on the shoots of the seedlings and the best intergrowth of the stock with the scion can occur when laying the grafts in the greenhouse at an angle of 30 ° to the horizontal surface. The highest yield of seedlings with circular callus was obtained with the location of grafts at an angle of 30 ° with respect to the horizontal surface of 80.4% or higher than in the vertical location of grafts by 4.1%.



Figure 6: Grafted seedlings in a shroud from a heat-shrinkable photocleavable sleeve, grown in gravelly plates



Figure 7: Grafted vegetative seedlings, grown on gravelly, ready for sale

3.3 Preparation of grafted cuttings and their planting in the greenhouse

For the cultivation of grafted seedlings, the graft is produced in February-March. It is best to conduct a bandage of grafts with F-535 photocleavable sleeves according to the technology developed by Malykh G.P. (3). For the bandage, the graft is placed in a 250 mm long sleeve with a melted upper part, 10-15 mm wider than the graft diameter, and then immersed in molten vaseline oil at a temperature of 150-200 °C for 1-2 seconds and immediately placed in cold water.

Due to the high shrinkage force, it tightly squeezes the joint of the stock with the graft. After the end of the specified service life (45 days), the photocleavable film decomposes in the light, and then finally is destroyed by microorganisms (19,20).

The use of gravelly as a substrate makes it possible to extend the growing period of seedlings in a greenhouse up to 60 days or more without reducing their yield. This contributes to the development of well-developed seedlings, when laying vineyards, they have a better survival rate and more powerful development of bushes (9,10,13,21).

Then, for acclimatization of plants and further flow of physiological and chemical processes taking place in the constituent parts of the grafts, they are set before planting on the plantation. To do this, the film from the greenhouses

should be removed, the heating of the soil and steam generators should be turned off. Setting is carried out for 9-10 days, every three days, there are moistening, watering sessions. Before planting the seedlings in the open ground, the substrate moisture in the covers is brought to the level of 85-90%.

3.4 Timing of planting

Vegetative seedlings should be planted in vineyards in the Rostov region, in the Chechen Republic from May 10 to June 10. The temperature and humidity regimes of soil and air have a great influence on the survival of vegetative seedlings. Dying-out after planting in early May can occur from recurrent frosts, which are often observed in many regions of Russia. It is mainly explained by the loss of the root system or a sustained recovery of growth: the soil during this period is too wet, because it is colder and less aerated. The highest survival rate is observed when planting in the first half of June, when conditions for the development of the root system are more favorable.

Planting seedlings in a permanent place should be done in pits with depth of 45-55 cm, depending on the region of growing grapes. The pits are made with digger KGK-60 or planting is made under hydro-drills with an extended tip. Planting pits are slightly deeper than the depth of planting. At the bottom of the pit a mellow earth hummock mixed with humus is placed (2-3 kg per bush and 100 grams of ammonium nitrate phosphate fertilizer).

When planting vegetative seedlings, the cover is raised to the top, freeing the roots from below. The cover is tied with twine above root system heel, and above, under the junction, as shown in Figure 8. Then, the vegetative seedling is set in center. The pit is covered at a half with the soil and watered at the rate of 10-15 liters of water. After water absorbing, the pit is completely covered. It is advisable to leave a seedbed around the seedlings, for the following watering. The location of the joint, in this case, for the grafted seedlings should be 5-6 cm above the soil surface. After 7-10 days, depending on the weather conditions, the second watering is carried out, and after 25-30 days the third one.

The essence of the new method of planting seedlings, grown by us, is that they are planted with closed root system with ready graft horizontal cordon, having 10 rows formed in one direction and 10 rows in the other direction. This allows to reduce the age of the grafted plantations under the mechanized cover of the vine plantations and to increase their durability and productivity.



Figure 8. Prepared vegetative seedling with a cover for planting under a hydro-drill. Under the action of gravitational stimulation, a horizontal cordon was formed on the seedlings during the stratification and growth in the micro-greenhouse

We believe that this progressive, intensive and economical method of growing planting material in our country should be given much more attention. We have developed a highly effective way of growing vegetative seedlings, forming and growing grapes using plastic supports made in the form of rod elements made of elastic and durable synthetic heat-insulating material. The support of polymeric materials for fruit and berry crops is intended for growing seedlings in its lower part, planting them in a permanent place, as well as placing, retaining sleeves and crops in the trellis angle (4,12).

The new method of growing seedlings and laying down plantations of grapes unites previously disunited elements of their production technology from growing planting material to the exploitation of fruit-bearing plantations in a single technological cycle, with the goal of excluding a number of operations for planting, protecting them from unfavorable meteorological factors, pests, diseases, damage. The support of polymeric materials is mounted from separate cones 1 and support ring 2 (Figure 9). The cone consists of identical parts.

When conducting the grapes in the lower cone of the support, filled with a substrate, one graft or cuttings of 50-55 cm in length is planted.

The seedlings are grown according to the pot method cultivation. Cultivated seedlings are planted on a permanent place together with a cone. To do this, hydro-drill or digger are used to make a pit with a depth of 55-60 cm and a cone with seedlings set to the bottom. After filling the pits, a support ring is fixed, which gives the support greater stability.

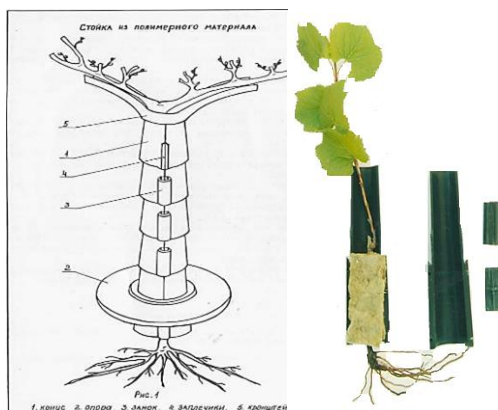


Figure 9: Polymer material support



Figure 10: Vineyards with polymeric support

As the bush grows, a new cone is set, and the stem is inserted into it. Thus, successively, installing cones on each

other, the support is assembled to the desired height. Suggested method:

- Provides protection of stem and sleeves of grape bushes from the impact of critical low temperatures;
- Allows the specialist to create a stable and straight stem of the desired height;
- Increases the productivity of vineyards by improving the conditions for plant development;
- Protects the stem of the sleeve from mechanical injuries, which allows to fully mechanize soil cultivation in rows and inter-rows at young vineyards;
- Eliminates the appearance of dew roots, which inhibits the spread and development of phylloxera;
- Excludes cutting of outer roots - one of the most laborious operations in viticulture;
- Allows to replace reinforced concrete or wooden supports with light plastic ones.
- The cost of implementing the proposed method of forming and growing vine bushes per unit of area is 2 times cheaper than existing ones. Supports, manufactured using the proposed technology, are used from 10 years till the renewal of vineyards. The construction of these supports is easier than the construction of reinforced concrete supports in 8 times.
- The complexity of care for the vineyard is reduced, compared to the traditional, by 27%. Equipment for the manufacture of supports for the formation of vine bushes is simple and does not require highly qualified specialists.
- The technical solution is patented in 13 countries.

4 Conclusion

The setup we created allows us to stratify and grow seedlings in a micro-greenhouse in a single technological cycle, which helps them to significantly improve the quality and yield. Studies on pest and disease control by steam with a temperature of 45-50 °C showed encouraging results. The steam generator qualitatively provides, in the right parameters, not only the temperature and humidity of the air and substrate, but the feeding regime of the seedlings. When studying thermotherapy, as a method of treatment from fungal, viral and a number of pests of grapes, the developed setup may well be used. Application of the developed technological methods for the production of planting material, improvement of the methods of planting and maintaining plantations in vineyards will improve the yield and quality of seedlings, survival rate, productivity of vineyards.

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