Influence of Manganese Fertilizer on Efficiency of Grapes on Sandy Soils of the Chechen Republic

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Abstract: According to Department of wine growing of the Ministry of Agriculture of Chechen Republic, the total area of vineyards exceeds 2200 hectares, from which 1193 hectares are a young vineyard. Wine-growers expect to collect 1400 tons of solar berries during 2014 season. The average productivity of grapes is 1970 kg/hectare. In comparison with 2013 the gain makes about 25%. Wine-growers of the republic plan to deliver the received crop for counters of grocery shops, markets of the republic. The wine growing and production of its processing are highly profitable, intensive and budget forming branch of agro-industrial complex of the republic. Development of new ways of productivity is actual purpose for scientific research with very high industrial applicability. Using of different kinds of manganese fertilizers is very promising method for Chechen Republic soils productivity improving. The new data has been obtained on manganese influence of grapes plantations productivity on sandy soils of the Chechen Republic as a result of the research. Manganese feeding is effective agricultural technique promoting the growth, development, increase of frost resistance and productivity of grapes plants. Manganese fertilizing of soils by 4 kg active ingredient per 1 ha against the background of nitrogen 90 kg/ha, phosphorus 90 kg/ha and potassium 90 kg/ha into a phase of grape sap flow promotes acceleration of damaged vineyards restoration by frosts, improves development of reproductive organs, allows to increase productivity. Application of this agricultural technique promotes increase in the content of sugar in grapes berries at essential decrease in acidity of juice.

Key words: Grapes • Soil • Mineral Nutrition • Manganese • Productivity

INTRODUCTION

Grape is not only the most beautiful but also the most nutritious, delicious and health product. Viticulture can not be conducted without taking into account the ecological potential of the region, soil and climatic conditions, the level of productive forces and production relations, technological advances, the requirements of nature protection, ensuring economic effect.

There has been recently began producing of vineyards bookmarks on the sands, both abroad and in our country and many questions of mineral nutrition have to be developed for each region. It has been required to take a study of agrochemical properties of different types of sandy soils, content of macro-and micronutrients and their impact on the grape harvest [1].

Grape plants need a manganese throughout all vegetation period. The form of manganese intake in grapes plants is ions Mn²⁺. The average of manganese content in the shoots of grapes on sandy soils is 9-11mg/kg of dry mass according to our data. The forms of manganese content in grapes plants are Mn²⁺, Mn³⁺, Mn⁴⁺ [2, 3].

The role of manganese in the metabolism of plants is similar with magnesium and iron functions. This compound activates the numerous ferments, especially during the process of phosphorylation. The manganese participates in various redox chemical reactions, being a part of redox ferments involved in the processes of respiration, photosynthesis and carbohydrate and nitrogen metabolism of plants, due to the ability to transfer electrons by changing the valence [4, 3].

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Manganese is involved in photosynthesis and Vitamin C synthesis. Manganese is involved in water photolysis and it is necessary for maintaining the structure of chloroplasts. It activates ferments involved in the oxidation of the plant hormones-indoleacetic acid (IAA), which is essential for the hormonal regulation of plant growth [5, 6].

The average manganese removal with the grapes harvest is nearly 1.2-1.5 kg/ha. The manganese deficiency affects many metabolic processes, in particular for the synthesis of hydrocarbons and proteins, since activates ferments in the plant [7].

Signs of manganese deficiency in plants are mostly observed in carbonate soil, in strongly limed and some peaty and sandy soils at pH above 6.5 [8]. Manganese deficiency in plants is exacerbated at low temperature and high humidity [9].

Manganese deficiency becomes noticeable firstly on young leaves by a lighter green color or discoloration (chlorosis) [10]. Also, very soon appear brown necrotic spots. The leaves die faster than at iron deficiency besides [4]. The known sign of manganese lack is brown spotting, especially in demanding to manganese by Euro-Amur grape hybrids [11].

Results of patent searches and generalization of published data show that studies were conducted on the influence on the yield and quality of grapes and level of security manganese plants in sandy soils [12]. Such studies are not only of great practical but also of the theoretical value.

The aim of the research is to determine the content of manganese in soils of Tersky sands and to identify the physiological reaction to manganese fertilizer of Platovskiy grapes. To determine the effect of root feeding time and doses to productivity of vineyards.

MATERIALS AND METHODS

Studies were carried out on fruiting vines Terek-Kumskiy sands of vine producing farm "Burun" of Shelkovskoy District of the Chechen Republic. The methods of agrobiological counts (the number of buds, shoots, buds on the bushes, accounting harvest berries from the bush and 1 hectare and the average mass of clusters) were performed on establishing the vineyards on industrial scale [13].

Soil and plant samples were collected simultaneously for the determination of nitrogen, phosphorus, potassium, calcium, magnesium and boron microelements, cobalt, manganese, molybdenum, zinc by atomic absorption method. Selection of soil samples was carried out according state standard methods [14]; general requirements for conducting soil analyzes [15]; nitrate nitrogen in the soil [16]; exchange ammonium in the soil [17]; mobile forms of phosphorus and potassium in the soil by the Machigin exchange method [18].

Sugar content of the berries [19] and titratable acidity [20] were determined according to according state standard methods. Statistics of results were determined by Statistica 7.0.

The purpose of field experiment is investigation of different doses and timing effects of manganese fertilizer on growth, development and productivity of plantations.

The scheme of field experiment:

- Variant: control (without micronutrients N\textsubscript{0}, P\textsubscript{0}, K\textsubscript{0} Background).
- Variant: background + Manganese (2 kg/ha).
- Variant: background + Manganese (4 kg/ha).
- Variant: background + Manganese (6 kg/ha).
- Variant: background + Manganese (8 kg/ha).

In the work were used different fertilizers; sulphate manganese, ammonium silitra, super phosphate, potas-sium salt. Fertilizers were injected into the soil during the phases of sap flow, or the flowering stage, or the phase growth and the beginning of the ripening berries by the hydro drills method at the distance of 80 cm from the bush, to a depth of 30 cm per year. There were totally 16 wells in performed by hydro drills in each experimental variant. The Platovskiy type grapes were planting upon to 3 x 1.0 m scheme. Variants of experience were laid in four replicates four plants in each. Forming of vineyards is long sleeved, unsheltered.

RESULTS AND DISCUSSION

The content of humus in the 0-20 cm soil layer of studied sandy soils is 0.67%, in the 20-40 cm soil layer-0.66% and in the 60-150 cm soil layer-0.95% pH ranges from 8.5 to 8.8. The phosphorus content in the 0-20 cm soil layer is 14.3 mg/kg, in the 20-40 cm soil layer-10 mg/kg and in the 60-150 cm soil layer-13.0 mg/kg of dry substance.

The average of potassium total amount at all soil profile depth varied from 121 to 143 mg/kg. The total carbonate content in studied soils is 2.1-2.3%. The content of nitrogen in the sandy loam soil is observed only in total analysis in a very small amount 0.02-0.04%.
Table 1: Nutrients content at different depths of sandy soil state farm Burunny of Shelkovskoy District in the Chechen Republic, 2012

| Selection depth, cm | pH  | Humus, % | P_2O_5 | K_2O | Content of microelements, mg/kg |
|---------------------|-----|----------|--------|------|--------------------------------|
| 0-20                | 8.8 | 0.7      | 14.3   | 143  | 0.8  1.9  16.8  0.42          |
| 0-40                | 8.8 | 0.7      | 10.0   | 121  | 0.7  1.3  14.4  0.54          |
| 0-60                | 8.8 | 0.7      | 12.0   | 143  | 0.7  0.8  24.3  0.46          |
| 0-150               | 8.8 | 1.0      | 13.0   | 132  | 0.5  0.3  8.5   0.8           |

Table 2: Influence of manganese fertilizer on root development of Platovsky grades in phase of sap flow (2011)

| Variant of field experiment | Air-dry weight of roots | Number of skeletal roots |
|-----------------------------|-------------------------|-------------------------|
| I. Control (without micronutrients N_2O, P_2O_5, K_2O background) | 385 | 400 |
| II. Background + Mn (2 kg/ha) | 398 | 422 |
| III. Background + Mn (4 kg/ha) | 426 | 462 |
| IV. Background + Mn (6 kg/ha) | 419 | 451 |
| V. Background + Mn (8 kg/ha) | 416 | 453 |

The average content of total manganese in studied soils employed in the test area is from 8.5 to 24.3 mg/kg (Table 1, Table 2). The content of water-soluble manganese in studied soils on the average is 5.7 mg/kg or about 1.2% of the total amount (Table 1).

The share of firmly bound compounds more than 90% accounts for the major part of the total manganese content in the soil. Firmly bound compounds of manganese are included in the primary and secondary minerals of silicate (clay minerals) and non-silicate origin (oxides, manganese hydroxides, salts). Firmly bound in the organic wastes manganese and compounds of its transformation (including humic substances) have less effect at the total level of manganese in the soil due to the relatively low share and significantly lower stability compared to mineral manganese matrixes [21].

It should be noted that weather conditions were varied during the research that allowed examining their effects on grapes plants. Average monthly spring and summer temperatures of 2011 were higher than historical averages (from 1.0°C in April to 4.2°C in July). The summer was hot and the maximum temperature recorded +39.6°C 28 of July. Maximum soil surface temperature on that day was 50°C. In summer months, the air temperature was above perennial indicators (1.8, 4.2 and 1.6°C, respectively). The sum of active air temperatures during these months exceeded the long-term data on the 237.7°C. Winter in 2011-2012 was snowless, with frequent thaws.

Snow cover was low and quite unstable. In the northern part of the country (Shelkovskoj district) had increased wind activity. It was 30 days with strong winds in 2011 with maximum speed reached 15 m/s. The annual rainfall was 341.4 mm.

The coldest month of 2012 was January. The minimum winter temperature was observed to minus 35.7°C in January. In February the air temperature dropped to minus 34.8°C. Shift through the average decade temperature +10°C was in early April.

Multiple slices on vines wood showed the presence of frost damages on bushes heads, sleeves and grapevines. Temperature at a depth of 30 cm of soil in the state farm "Burunny" briefly dropped to minus 10-14°C. As a result, the root system of the hybrids with the Amur grapes has been damaged on this depth. Live roots was preserved, starting at the depth of 35 cm.

Results of geobotanical research of grapes plants of field experiment in 2011 and 2012 showed that adding of manganese fertilizer had positive effect on plants growth (Table 3, 4). The average length of shoots on the control variant without fertilizer was 154.6 cm in 2011 (Table 3). In the variant with the adding of manganese into the phase of sap flow at the dose of 4 kg/ha the average length of shoots was 180 cm. It has been considerably reduced the growth on insertion of manganese into the flowering phase, 164.4 cm, respectively and even less growth was in the growth phase and in the beginning of berries ripening-149.4 cm.

The maximum value of average length of shoots reached in the variant with fertilization by 4 kg/ha Mn into the phase of sap flow. Using the lower and higher doses of manganese sulphate reduced its effectiveness on grapes morpho biometrics characteristics (Table 3).

The rate of accumulation of dry biomass above-ground organs of plants is the criterion of photosynthesis efficiency. Their level is determined by the synthesis of organic substances and spending them...
on the process of breathing. The data show that with increasing doses of manganese sulphate to a certain limit (4 kg/ha) in the phase of sap flow the diameter of shoots amounted to 6.0 mm, in the blooming phase-5.7 mm, in the growth phase and in the early fruit ripening-5.2 mm (Table 4) [11].

The study of the nature of the leaf surface Platovsky grapes showed that the number of leaves on the bush, the area of the leaf blade, as well as the total area of leaves on one bush and 1 ha, changed depending on the dose and timing of manganese fertilizing. Climatic conditions in 2011 were favorable for overwintering and growing of grapes during the growing season. When determining the average weight of fruits found that man-ganese stimulates berries significantly increasing their weight [7].

### Table 3: Time and dose effect of manganese fertilizer adding on growth and productivity of Platovsky grapes plants (2011)

| Variant of field experiment | The average length of shoots, cm | The average diameter of the shoots, mm | Yield, t/ha | Sugar content of the berries, g/dm³ | Increase to control |
|----------------------------|---------------------------------|--------------------------------------|-------------|-----------------------------------|--------------------|
|                            |                                 |                                      |             |                                   |                     |
| Adding into the phase of sap flow |                                 |                                      |             |                                   |                     |
| I. Control (without micronutrients N, P, K background) | 154.6 | 5.6 | 69.9 | 174 | - |
| II. Background + Mn (2 kg/ha) | 172.4 | 5.8 | 71.6 | 176 | 1.7 |
| III. Background + Mn (4 kg/ha) | 180.0 | 6.0 | 74.6 | 195 | 4.7 |
| IV. Background + Mn (6 kg/ha) | 171.4 | 5.9 | 73.3 | 183 | 6 |
| V. Background + Mn (8 kg/ha) | 160.5 | 5.9 | 70.5 | 176 | 0.6 |
| Adding into the flowering phase |                                 |                                      |             |                                   |                     |
| I. Control (without micronutrients N, P, K background) | 153.9 | 5.4 | 69.8 | 170 | - |
| II. Background + Mn (2 kg/ha) | 160.3 | 5.5 | 71.0 | 174.3 | 1.2 |
| III. Background + Mn (4 kg/ha) | 164.4 | 5.7 | 73.0 | 176.8 | 3.2 |
| IV. Background + Mn (6 kg/ha) | 161.5 | 5.6 | 72.3 | 175.5 | 2.3 |
| V. Background + Mn (8 kg/ha) | 161.0 | 5.5 | 70.0 | 173.8 | 0.2 |
| Adding into the phase of growth and beginning of grapes ripening |                                 |                                      |             |                                   |                     |
| I. Control (without micronutrients N, P, K background) | 140.0 | 5.1 | 69.7 | 170.0 | - |
| II. Background + Mn (2 kg/ha) | 141.6 | 5.1 | 70.1 | 171.0 | 0.4 |
| III. Background + Mn (4 kg/ha) | 149.4 | 5.2 | 71.6 | 173.5 | 0.9 |
| IV. Background + Mn (6 kg/ha) | 140.6 | 5.1 | 71.0 | 172.0 | 0.3 |
| V. Background + Mn (8 kg/ha) | 139.4 | 5.0 | 71.0 | 172.0 | 0.3 |

### Table 4: Time and dose influence of manganese fertilizer adding on growth, development and productivity of grapes Platovsky plants (2012)

| Variant of field experiment | The average length of shoots, cm | The average diameter of the shoots, mm | Yield, t/ha | Sugar content of the berries, g/dm³ | Increase to control |
|----------------------------|---------------------------------|--------------------------------------|-------------|-----------------------------------|--------------------|
|                            |                                 |                                      |             |                                   |                     |
| Adding into the phase of sap flow |                                 |                                      |             |                                   |                     |
| I. Control (without micronutrients N, P, K background) | 133.8 | 5.1 | 19.9 | 181 | - |
| II. Background + Mn (2 kg/ha) | 146.9 | 5.4 | 21.9 | 183 | 2.0 |
| III. Background + Mn (4 kg/ha) | 167.9 | 5.8 | 24.5 | 190 | 4.6 |
| IV. Background + Mn (6 kg/ha) | 150.0 | 5.6 | 23.3 | 186 | 3.4 |
| V. Background + Mn (8 kg/ha) | 145.6 | 5.4 | 20.7 | 184 | 0.8 |
| Adding into the flowering phase |                                 |                                      |             |                                   |                     |
| I. Control (without micronutrients N, P, K background) | 127.8 | 5.1 | 19.9 | 180 | - |
| II. Background + Mn (2 kg/ha) | 141.7 | 5.7 | 21.7 | 181 | 1.8 |
| III. Background + Mn (4 kg/ha) | 150.0 | 5.7 | 24.8 | 186 | 4.9 |
| IV. Background + Mn (6 kg/ha) | 142.8 | 5.6 | 23.9 | 183 | 4.0 |
| V. Background + Mn (8 kg/ha) | 134.9 | 5.6 | 20.9 | 182 | 1.0 |
| Adding into the phase of growth and beginning of grapes ripening |                                 |                                      |             |                                   |                     |
| I. Control (without micronutrients N, P, K background) | 125.8 | 5.1 | 19.9 | 181 | - |
| II. Background + Mn (2 kg/ha) | 129.9 | 5.2 | 21.6 | 182 | 1.7 |
| III. Background + Mn (4 kg/ha) | 145.9 | 5.5 | 22.6 | 186 | 2.7 |
| IV. Background + Mn (6 kg/ha) | 130.0 | 5.2 | 21.1 | 185 | 1.2 |
| V. Background + Mn (8 kg/ha) | 127.0 | 5.2 | 20.0 | 184 | 0.1 |
Yield increased on a variant with the adding of N90R90K90+Manganese (2 kg/ha) compared to the control without manganese adding was 1.7 kg / ha. Also the increase in sugar content of berries was 2 g/dm$^3$. The differences on experience options of yield were significant.

The highest rates in development and productivity of plants are obtained by manganese insertion into the phase of sap flow in the amount of 4 kg/ha. In this variants the yield was 74.6 t/ha or above 3 kg/ha, compared to the dose of manganese 2 kg/ha [21].

The most intensive restoration of root Platovsky grapes after a harsh winter in 2012 occurred with the introduction of manganese in the phase of sap flow at a dose of 4 kg/ha (Table 2). This is confirmed by an increase in the amount of skeletal roots at 40 pcs of grape plants in the variant with the adding of the manganese of 4 kg / ha. Adding manganese fertilizer at a dose of 4 kg / ha promotes the formation and growth of the root system that is interconnected with the life of the aerial plant organs.

The development of the root system provides increased absorption capacity of the roots and, as a consequence, increase the intensity of the growth of aerial organs. Improvements in these indicators affect the biomass accumulation and the formation of the leaf surface. According to a survey of the field experiment in 2012 found that Mn fertilizers had a positive effect on plant growth (Table 4).

Thus, on insertion in the phase of sap flow the average length of shoots on the control made without fertilizer was 133.8 cm, in option of manganese insertion in the dose of 4 kg/ha in this phase-167.9 cm-,150 cm in flowering phase, in a growth phase and early berries ripening was 145.9 in 2012. The most actively growing were plants with adding manganese fertilizer into the phase of sap flow [22].

The maximum value of this index reached in the variant with adding of fertilizers into the soil at a dose of 4 Mn kg per hectare, while using lower and higher doses of micronutrient its efficiency decreased [22]. The data shows that only one limited dose of manganese sulphate 4 kg / ha adding in the phase of sap flow increased the diameter of grapes plants up to 5.8 mm, at the flowering stage-up to 5.7 mm and in the growth phase and early fruit ripening-up to 5, 5 mm [8].

On insertion into the soil a higher amount thereof (6 kg/ha and 8 kg/ha) the growth of shoots and their diameter are increased. A similar effect occurs in the case of Mn appliance in doses of 2 kg/ha [23]. The data shows that manganese fertilizer at a dose of 4 kg / ha is enough for the activation of the grape production process (Table 4).

**CONCLUSION**

Manganese content in the soil profile studied soils varies greatly, ranging from 8 to 24.3 mg or 15 times less than in the alluvial soils of the Chechen Republic. Manganese fertilizer is effective farming techniques promoting the growth of development, hardness and productivity of grape plants in Shelkovskoy District of Chechen Republic.

The most effectiveness is manganese fertilizing by adding active manganese into the phase of sap flow at a dose of 4 kg/ha on the background of N90, K90, P90. It is recomended to add to the sandy soils of Chechen Republic of 4 kg of active ingredient per hectare manganese in the phase of sap flow in order to accelerate the recovery of vineyards damaged by frost, to enhance the development of reproductive organs.

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