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INFLUENCE OF MANGANESE FERTILIZER ON GRAPES EFFICIENCY ON SANDY SOILS OF THE SOUTH RUSSIA

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ABSTRACT

As a result of the studies, there has been obtained a new information about manganese influence on productivity of grape plantations on sandy soils of the South Russia. Manganese fertilizing of 4 kg active ingredient per 1 ha on the background addition of nitrogen 90 kg ha^{-1}, phosphorus 90 kg ha^{-1} and potassium 90 kg ha^{-1} into a phase of grape sap flow contributes to higher yields and increase the sugar content of the berries with a significant decrease in juice acidity as compared with other variants. On determining the average weight of the fruit mass there has been found that manganese stimulates growth of berries significantly increasing their weight. The greatest effect of manganese fertilizer insertion is achieved on introducing it into the phase of sap flow at a dose of 4 kg ha^{-1} on the background of N90, K90, P90. In order to expedite the recovery of vineyards damaged by frosts to enhance the development of reproductive organs 4 kg ha^{-1} manganese into the phase of sap flow must be introduced on sandy soils.

Keywords: *grapes, soil, mineral nutrition, manganese, productivity.*

INTRODUCTION

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 (Benito et al., 2013; Pinskii et al., 2014). The average manganese uptake by the grapes harvest is nearly 1.2-1.5 kg ha^{-1}. The manganese deficiency affects many metabolic processes, in particular for the synthesis of hydrocarbons and proteins, since activates ferments in the plant (Romic et al., 2012). Signs of manganese deficiency in plants is mostly observed in carbonate soil, in strongly limed and some peaty and sandy soils at pH above 6.5 (Bell et al., 2013). Manganese deficiency becomes noticeable firstly on young leaves by a lighter green color or discoloration (chlorosis). Results of patent

searches and generalization of published data show the studies were conducted in the are of manganese effect on grape plants growth in sandy soils (Saleh et al., 2013). 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 Platovsky grapes.

MATERIALS AND METHODS

The studies were carried out on Terek-Kumskiy sands of vine producing farm "Burun" of Shelkovskoy District in the Chechen Republic. Soil and plant samples were collected simultaneously for the determination of macro and microelements by atomic absorption method. Sampling was carried out according state standard methods (GOST, 2008); general requirements for conducting soil analyzes. Sugar content of the berries and titratable acidity were determined according to according state standard methods. Statistics of results were determined by Statistica 11.0. 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 the field experiment was as follows: control (kg ha^{-1}: $N90+P_2O_590$ +Mn 0 kg ha^{-1}), the Mn spikes level to soil were 2, 4, 6 and 8 kg Mn per ha^{-1}. The field experiment was carried out in 2011, 2012 and 2013 years. In the work were used different fertilizers: sulphate manganese, ammonium silitra, super phosphate, potassium salt. Fertilizers were added into the soil during the phases of sap flow, or into the flowering phase, 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. The Platovsky type grapes were planting upon to 3 x 1.0 m scheme. Variants of experience were laid in four variants four plants per every replication. 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 up to 8.8. The phosphorus content in the 0-20 cm soil layer was 14.3 mg kg^{-1}, in the 20-40 cm soil layer - 10 mg kg^{-1}, and in the 60-150 cm soil layer – 13.0 mg kg^{-1}. The average of potassium total amount at all soil profile varied from 121 to 143 mg kg^{-1}. The total carbonates content in studied soils is 2.1-2.3% (Batukaev et al., 2014). The content of nitrogen in the sandy loam soil was observed in a very small amount 0.02-0.04%. The average content of total manganese in studied soils varied in the test area from 8.5 to 24.3 mg kg^{-1} (Table 1, Table 2).

Table 1. Nutrients content at different depths of sandy soil farm Burunny of Shelkovskoy District in the Chechen Republic (status 2012)

Soil depth (cm)	pH	Humus %	Nutrients in dry soil (kg ha^{-1})		Content of microelements (mg kg^{-1})				
			P_2O_5	K_2O	Zn	Cu	Mn	B	
0-20	8.8	0.7	14.3	143	0.8	1.9	16.8	0.4	0.53
20-40	8.8	0.7	10.0	121	0.7	1.3	14.4	0.5	
40-60	8.8	0.7	12.0	143	0.7	0.8	24.3	0.4	0.12
60-150	8.8	1.0	13.0	132	0.5	0.3	8.5	0.8	0.12

The share of firmly bound compounds more than 90% accounts for the major part of the total manganese content in the soil. Results of geobotanical research of field experiment in 2011, 2012 and 2013 showed that adding of manganese fertilizer had positive effect on plants growth (Table 2). The average length of shoots on the control variant without fertilizer was 154.6±36.4 cm in 2011. In the variant with the adding of manganese into the phase of sap flow at the dose of 4 kg ha^{-1} the average length of shoots was 180±37.4 cm. It has been considerably reduced the growth on insertion of manganese into the flowering phase, 164.4±26.4 cm, respectively, and even less growth was in the growth phase and in the beginning of berries ripening - 149.4±22.1 cm.

Table 2. Time and dose effect of manganese fertilizer adding on growth, and productivity of Platovsky grapes plants

Impact of manganese fertilization (kg Mn ha^{-1}: 0, 2,4, 6 and 8) added by control (kg ha^{-1}: N90 + P_2O_5 90 + K_2O 90) on status of Platovsky grape plants: length of shoots (LS), diameter of shoots (DS), yield (Y: t ha^{-1}) and sugar contents of the berres (SCB: g/dm^3)												
	The 2011 growing season				**The 2012** growing season				**The 2013** growing season			
Mn	LS	DS	Y	SCB	LS	DS	Y	SCB	LS	DS	Y	SCB
	cm	mm			cm	mm			cm	mm		
	Manganese (kg Mn ha^{-1}) adding into the phase of sap flow											
0	154.6	5.6	69.9	174.0	133.8	5.1	68.7	182.0	146.2	5.1	19.9	176.4
2	172.4	5.8	71.6	176.2	146.9	5.4	72.4	183.1	156.8	5.3	21.9	185.4
4	180.0	6.0	74.6	185.6	167.9	5.8	75.7	190.3	171.8	5.9	24.5	198.4
6	171.4	5.9	73.3	183.8	150.0	5.6	74.3	186.4	162.4	5.5	23.3	184.5
8	160.5	5.9	70.5	176.4	145.6	5.8	70.7	184.5	143.6	5.4	20.7	179.1
	Manganese (kg Mn ha^{-1}) adding into the flowering stage											
0	153.9	5.4	69.9	174.0	127.8	5.1	68.7	181.4	133.7	5.4	19.6	175.6
2	160.3	5.5	71.0	174.3	141.7	5.7	72.1	181.0	142.1	5.7	21.7	181.5
4	164.4	5.7	73.0	176.8	150.0	5.7	75.8	186.6	156.9	5.8	24.8	186.0
6	161.5	5.6	72.3	175.5	142.8	5.6	74.7	183.3	147.7	5.4	23.9	183.1
8	161.0	5.5	70.0	173.8	134.9	5.6	70.7	182.7	135.6	5.5	20.9	182.5
	Manganese (kg Mn ha^{-1}) adding in growth and beginning of grapes ripening											
0	140.0	5.1	69.9	174.0	125.8	5.1	68.7	182.2	132.8	5.2	19.7	177.2
2	141.6	5.1	70.1	171.0	129.9	5.2	72.1	182.6	130.8	5.3	21.6	182.0
4	149.4	5.2	71.6	173.5	145.9	5.5	73.6	186.8	149.5	5.6	22.6	186.2
6	140.6	5.1	71.0	172.0	130.0	5.2	71.5	185.9	138.6	5.2	21.1	185.1
8	139.4	5.0	71.0	172.0	127.0	5.2	70.3	184.1	135.4	5.2	20.0	184.8

The maximum value of shoots length in the variant 4 kg ha^{-1} Mn added into the phase of sap flow. Using the low and high doses of Mn reduced its effectiveness on grapes morphometric characteristics (Table 3). The rate of accumulation of dry biomass aboveground organs of plants is the criteria of photosynthesis efficiency.

Table 3. Influence of manganese fertilizer on root development of Platovsky grapes in stage of sap flow

Impact of manganese fertilization (kg Mn ha^{-1}: 0, 2,4, 6 and 8) added by control (kg ha^{-1}: N90 + P_2O_5 90 + K_2O 90) on status of Platovsky grape plants in stage of sap flow: air-dry weight of root and number of skeletal roots (NSR)						
Mn	**The 2011** growing season		**The 2012** growing season		**The 2013** growing season	
	Root weight (kg 10^{-3})	NSR	Root weight (kg 10^{-3})	NSR	Root weight (kg 10^{-3})	NSR
0	385	400	379	387	368	397
2	398	422	386	421	385	435
4	426	462	432	479	435	462
6	419	451	417	452	429	451
8	416	453	434	437	427	453

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. The increase in sugar content of berries was up to 1.8 g/dm^3. The highest rates in growth and productivity of grapes were obtained by manganese insertion into the phase of sap flow in the amount of 4 kg ha^{-1}. The most intensive restoration of Platovsky grapes roots after Mn addition in the phase of sap flow at a dose of 4 kg ha^{-1} (Table 3). The addition of Mn into the phase of sap flow increased the average length of shoots on the control compare to control up to 167.9±35.4 cm in 2012. Adding the higher amount of Mn (6 kg $ha^{-1}$and 8 kg ha^{-1}) increased the growth of shoots.

CONCLUSIONS

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, hardiness and productivity of grape plants in Shelkovskoy District of Chechen Republic. The most effectiveness цфы manganese fertilizфешщт by adding active manganese into the phase of sap flow at a dose of 4 kg ha^{-1} on the background of N90, K90, P90.

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