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The Use of Complexon for the Increase of Regeneration Capacity in Some Fruit Trees after Hailstorm

S.K. Yeritsyan
H. Petrosyan Scientific Center of Soil Science, Melioration and Agrochemistry, ANAU Branch
D.A. Begetovskiy
Voskehat Educational and Research Center of Enology, ANAU Branch
S.A. Mamadjanyan, L.S. Yeritsyan
Armenian National Agrarian University
s_eritsyan@yahoo.com, beket.da.53@gmail.com, s.mamajanyan@gmail.com, lusineyeritsyan@yahoo.com

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ABSTRACT

Hailstorm causes huge damages to the orchards and vineyards in the Republic of Armenia. Particularly the yield, annual and perennial shoots, as well as the fruiting organs are badly damaged.

A fertilizer has been synthesized and applied by our research group, by means of which the artificially simulated injuries on the shoots or those caused by the hailstorm are recovered with noticeable intensity.

According to the experimental data the artificially simulated wounds on the shoots of "Victoria" plum tree have been well recovered, the index of which makes 35-45 % in the control variant, while in the variant where Complexon-3 has been twice administered it has amounted to 95-99 % with slight differences.

Introduction

Hail is a type of atmospheric precipitation which is formed out of the frozen water drops with various shapes and sizes. Hail mainly falls during the daytime (Soviet Armenian Encyclopedia, 1979, Gayvoronskiy, 1976, Margaryan and Simonyan, 2014).

Hailstorm damages or destroys the plants (crops). The hailstorm in Armenia often occurs with such intensity, that it damages the yield of orchards and vineyards, annual and perennial shoots, as well as fruiting organs (Margaryan and Simonyan, 2014). The growth and fruiting of such plants slow down and the possibility of getting infected with diseases and pests grows up. According to the studies conducted by different researchers, regeneration of the plants often lasts several years depending on the hailstorm intensity (Grigoryan, et al., 2014, Dinevich, 1990, Jackson, 2013, Mazin, 1972, www.asprus.ru).

In order to facilitate the process of viability recovery in the hail-damaged plants, different agro-technical events and materials are developed and implemented, such as pruning, growth stimulants, fertilizers, toxins, etc. (Startsev, 2018, Taov, 2000). There are different ways for hail fighting, such as hail cloud dissipation, dispersion of silver containing compounds through shells and planes, or shooting at the hail clouds through the device named "Zenit" (Agricultural Encyclopedia, 2015). The latter, however, is not efficient. Application of anti-hail nets is a more efficient method, but they are rather expensive and hence, not available for most farmers yet.

Considering the circumstance that almost every year hailstorm causes huge damages to horticulture and viticulture in the Republic of Armenia, we have recommended a water-soluble complex fertilizer, the application of which recovers the hail-stricken trees and vines and enhances their viability with remarkable intensity (within the same vegetation period). Thus, it was also planned to search for scientific evidences on the positive effects observed in the mentioned fertilizer.

Materials and methods

The aim of the research is to disclose the effect of applying the combined water-soluble fertilizer (Complexon-3) synthesized by our research group on the recovery process of the damage (hailstorm) simulated on the biennial shoots of the fruit trees.

The field experiments have been conducted in the orchards of the Zovashen community in the Ararat region (3 farm households) on the "Victoria" and "Italian Vengerka" plum tree (7-year-old), "Lodz" peach tree (6-year-old) and "Shaqarkeni" apple tree (30-year-old) varieties.

In the plum orchards the experiments have been conducted on the background of $N_{90}P_{60}K_{45}$ fertilization (April 5, 2020). The experiments in peach orchards have been set up on the background of $N_{90}P_{90}K_{60}$ fertilization, while the apple trees haven't been fertilized at all.

The damage to the trees was simulated artificially on the biennial shoots with a priori assumption that the area of hail damage on the trees makes averagely 1 cm^2. Based on the fact that depending on the hailstorm intensity the injuries (slight wounds) can be of different degrees, 3 mimicked injuries of different degrees on the same biennial shoot have been simulated: a - only the bark has been damaged, b – the bark and phloem, c – the bark, phloem and xylem or the upper layer of cambium have been damaged.

So, 3 different wounds have been simulated on the same biennial shoot. For the experiments 5 trees have been selected, i.e., the trials have been conducted with 15 repetitions. One tree has been taken as a control option.

Immediately after wound simulation (16.05.2020), the first foliar nutrition with water solution (40g per 10L water) of Complexon-3 was implemented. The second foliar nutrition was applied on May 19, 2020 only in plum tree experiments.

The impact of Complexon-3 on the healing process of the mimicked wounds of the biennial shoots was tracked on May 31, June 28 and October 18, 2020. It should be noted that the time of inducing artificial damages in the trees is adjusted to the time period of natural hailstorms occurred in the terrain.

The first two observation periods coincide with the trees intensive growing period, while the third observation period coincides with the eve of winter dormancy.

To examine the experimental plots, soil samples from the orchard sites have been taken and their chemical analyses have been conducted through the accepted methods in the Republic of Armenia (Yagodin, 1987).

The reliability of the study results have been justified through the dispersion analysis. The experimental error (Ex%) and the least significant difference (LSD) between the discussed options has been estimated (Dospekhov, 1979).

Results and discussions

The experiments have been carried out on the light brown carbonate soils, the description of which is presented in Table 1. According to the table data the humus content at the depth of 0-30 cm in the experimental plots of plum trees makes 3.48-3.96 %, the soil mechanical composition is clay and sandy of medium texture, the reaction (pH) is 7.5-7.6, the content of carbonates makes 4.96-5.1 %, the dissolved salts content in water is 0.046-0.051 %, the ratio of Ca-Mg fluctuates within the range of 0.68-0.083.

According to the data of Table 1, the soil mechanical composition, the content of water dissolved salts and carbonates are quite favorable for the growth of fruit tree varieties. The ratio of Ca-Mg in the soil solution is distorted at the price of calcium, which was regulated through the application of double superphosphate.

The experimental plots are poorly provided with affordable nitrogen and phosphorus and averagely provided with potassium.

Table 1. The chemical and mechanical properties of the experimental plots*

Soil type, crop	Light brown, Plum tree	Light brown, Peach tree
Depth, cm	0-30 30-60	0-30 30-60
Mechanical composition	Clay and sandy, medium	Clay and sandy, medium
Humus, %	3.48/1.56	3.96/1.44
pH	7.6/7.8	7.5/7.8
Content of carbonates, %	5.17/6.84	4.96/6.76
Content of dissolved salts, %	0.046/0.038	0.051/0.048
In water solution mg/eq in100g soil, Ca^{2+}	1.3/1.8	1.5/1.6
In water solution mg/eq in100 g soil, Mg^{2+}	1.9/2.5	1.8/2.0
Plants affordable nutrients, mg in 100 g soil, N	4.14/3.01	5.12/3.38
Plants affordable nutrients, mg in 100 g soil, P_2O_5	2.28/1.84	2.81/2.06
Plants affordable nutrients, mg in 100 g soil, K_2O	31.61/28.74	25.45/21.36

Table 2. The effect of Complexon-3 on the regeneration property of the plum tree after simulated hailstorm*

Options	Plum tree varieties					
	Victoria (Jane Prune)			Italian Vengerka (Chernosliv)		
	The study periods for 2020					
	First 31.05	Second 28.06	Third 18.10	First 31.05	Second 28.06	Third 18.10
Control (without spraying)						
shoot 1	37	40	45	44	50	65
shoot 2	30	35	40	45	50	65
shoot 3	25	30	35	42	55	60
The 1st sprayed tree						
shoot1	70	95	97	70	80	80
shoot2	50	90	95	80	90	95
shoot3	40	85	95	70	90	95
The 2nd tree						
shoot 1	45	55	98	35	40	40
shoot 2	45	50	99	30	35	40
shoot 3	35	40	97	25	30	40
The 3rd tree						
shoot 1	45	50	55	67	80	82
shoot 2	35	40	45	65	80	83
shoot 3	25	35	65	55	70	75
The 4th tree						
shoot 1	40	85	98	70	90	95
shoot 2	45	80	99	55	70	97
shoot 3	46	75	95	40	65	99
The 5th tree						
shoot 1	60	90	98	35	40	45
shoot 2	55	85	99	30	35	50
shoot 3	40	80	99	25	30	45

Note: *the data of the Table 2 and 3 are retrieved by averaging results on the repair process of wounds of different degrees simulated on the same shoot.*

*Composed by the authors.

Table 3. The effect of Complexon-3 on the regeneration properties of peach and apple trees after simulated hailstorm*

Options	"Lodz sliced" peach variety			"Shaqarkeni" apple variety		
	The study periods for 2020					
	First 31.05	Second 28.06	Third 18.10	First 31.05	Second 28.06	Third 18.10
Control (without spraying)						
shoot 1	25	50	50	40	40	50
shoot 2	20	45	65	45	45	50
shoot 3	15	40	65	35	35	70
The 1st sprayed tree						
shoot1	35	90	92	40	40	95
shoot2	33	80	91	33	35	97
shoot3	25	70	90	20	30	97
The 2nd sprayed tree						
shoot 1	72	90	90	40	80	99
shoot 2	50	80	95	33	60	85
shoot 3	32	70	95	20	55	95
The 3rd sprayed tree						
shoot 1	25	50	55	27	50	85
shoot 2	33	40	45	20	45	90
shoot 3	40	40	60	15	35	95
The 4th sprayed tree						
shoot 1	60	70	70	10	70	95
shoot 2	50	65	70	15	95	96
shoot 3	30	50	85	17	65	96
The 5th sprayed tree						
shoot 1	33	50	60	15	50	60
shoot 2	27	50	60	17	45	65
shoot 3	20	40	55	18	40	70

*Composed by the authors.

The data of Tables 2 and 3 indicate the effect of Complexon-3 on the recovery process of artificial damages simulated on the biennial shoots of the experimented trees. It is noteworthy that per our observations wound healing process (barking) takes place through the following phases:

1. Discoloration of the damaged surface from milky to the brown color,
2. Formation of cuticular hillocks out of the stomatal pores from the both sides of the damaged surface,
3. Hillocks growth, their approximation and gradual recovery of the phloem wound,
4. Wound repair with the resin layer coating,
5. Wound repair with the bark layer coating.

The data introduced in the Tables 2 and 3 testify that the application of Complexon-3 exerts a significant impact on the wound repair process (barking). Moreover, this process is more intensive after the second nutrition with the solution of Complexon-3, particularly in case of "Victoria" plum trees.

The data of Table 3 show that the barking process (bark regeneration) on the shoots of peach tree occurred much slower, yet going on throughout the whole vegetation period, while the wound repair process in apple trees went on up to June 19, 2020 and then was almost interrupted.

We believe that the abovementioned is related to the fact that the crops foliar nutrition with Complexon-3

was implemented only once (May 16, 2020), where the biological peculiarities of the plants also played a key role.

The course of such process in the apple trees is also related to the age of tree (30-year-old), due to which the biological processes considerably slow down, while in peach trees the damage recovery is related both to the age and peculiarities of the plant species.

Conclusion

According to the results of the experiments, Complexon-3 can be used to recover the crop injury caused by the hailstorm within the same vegetation period.

Wound repair process, upon the use of Complexon-3, takes more intensive course in the actively growing period of the trees.

The course of wound repair is also related to the tree variety (species) and the frequency of Complexon-3 application. In case of only single foliar nutrition the wound healing process in the plants is much slower and less complete as compared to that of recorded in case of double or triple foliar nutrition.

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