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EFFECTIVENESS OF THE APPLICATION OF VESICULAR ARBUSCULAR MYCORRHYZAL FUNGI AND PHOSPHORUS IN TISSUE CULTURE TECHNOLOGY OF GROWING BERHEE DATE PALM SEEDLINGS

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In vegetal experiments, carried out in 2008-2009, the effectiveness of colonization of vesicular arbuscular mycorrhizal fungi in tissue culture technology of growing Berhee date-palm seedlings has been studied. It has been found out that importing those fungi into rhizosphere increases significantly (by 2,5 times) overground growth of the plants, increases the leaf surface by four times as well as activates the absorption of phosphorus from the soil by date-palm seedlings.

Micorrhizal fungi – soil substratum – tissue culture – date-palm – phosphorus absorption

Իրանի Խուզիստան նահանգում 2008-2009թթ. իրականացված վեգետացիոն փորձերում ուսումնասիրվել է Բերիի արմավենու հյուսվածքային կուլտուրայով տնկիների աճեցման տեխնոլոգիայում վեզիկուլյար արբուսկուլյար միկորիզային սնկերի բնակեցման արդյունավետությունը: Պարզվել է, որ այդ սնկերի ներմուծումը ռիզոսֆերա զգալիորեն (2,5 անգամ) ուժեղացնում է բույսերի վերգետնյա աճը, 4 անամ ավելացնում տերևային մակերեսը, ակտիվացնում հողից ֆոսֆորի կլանումը արմավենու տնկիների կողմից:

Միկորիզային սնկեր - հողային սուբստրատ - հյուսվածքային կուլտուրա - արմավենի - ֆոսֆորի կլանում

За 2008-2009гг. В Иранской области Хузистан проведены вегетационные опыты по изучению эффективности колонизации везикулярно-арбускулярных микоризных грибов в технологии выращивания саженцев финиковой пальмы с использованием тканевой культуры. Установлено, что внесение грибов в ризосферу значительно (в 2,5 раза) усиливает прирост надземной части растения, и в 4 раза увеличивает листовую поверхность, активизирует поглощение фосфора саженцами пальмы из почвы.

Микоризные грибы – почвенный субстрат – тканевая культура – финиковая пальма – поглощение фосфора

Mycorrhizal fungi are widely spread in natural phytocenoses and agrocenoses. They play a great role especially in unfavourable soil-climate conditions and provide the plants with necessary nutrients and humidity [6, 8]. The effectiveness of mycorrhiza lies not only in the fact that the fungi play the role of a mediator between the soil and the plant, but also that, being spread in a great volume of soil substratum, they make the usage of that resource more effective [7, 8]. It has been found out that in ecologically extre-

mal conditions mycorrhizal fungi activate the absorption of a number of macro- and microelements by the plant and secure their normal growth [5, 7, 9, 10, 11]. The minerals during the first stage of the nutritional process get absorbed by mycorrhizal fungi, after which they are being transferred to the host-plant in more accessible forms.

A number of researches have confirmed that the mycorrhizal fungi imported into the rhizosphere increase the illness-resistance of crops, as well as their withering and rotting-resistance [1, 12, 14].

In desert and semi-desert soils of Iran Berhee date-palm gives high yield, but during the foundation of the plantation the take of seedlings is rather low, which is explained by dryness and poverty of the soil. One of the most effective biological measures to solve that problem is the colonization of mycorrhizal fungi in the rhizospheric layer. This enables the increase in take of the seedlings by 20-25% and favours the growth intensity of the trees [4, 7]. Importing mycorrhizal fungi into the rhizospheric layer has activated phosphorus absorption as well. As a result of combined usage of fungi and phosphoric fertilizers the leaf surface of the date-palm and the total biomass of the plants have grown, and their resistance to anthracnosis has increased significantly [2, 3, 6].

Materials and methods. Our investigations were carried out in 2008-2009 in the Khuzistan province of Iran. The goal of the experiments was to obtain high quality seedlings of Berhee date-palm from tissue culture, which would secure high take of seedlings in field conditions, luxuriant growth, as well as high resistance to insufficient humidity of air and soil. Vegetal experiments have been carried out in greenhouse conditions, where it is possible to grow thousands of seedlings in vessels containing 5 kg of soil with intensive method and to transport them to the field.

The influence of vesicular arbuscular fungi (Glomus intraradices) and 5 different dosages of phosphorus on the growth and development of the seedlings has been studied (the chart is on Table 1). The experiments have been carried out in 4 repetitions. In the vessels superphosphate was used, and the mycorrhizal fungi were imported into the soil in the form of a concentrate. The obtained data were worked out with SPSS 16, SAS and Minitab programs. In all variants the measure of the average mistake in the obtained data has been compared with Duncan criteria on the probability level of (a,b,c,d,e) $P < 0,05$ (5%) [13].

Results and Discussion. In Khuzistan province the total amount of precipitation according to perennial average data makes up 250-300 mm annually, air temperature is never below zero, average temperature and relative humidity are 25°C and 30%, respectively.

For vegetal experiments the soil has been taken from the outskirts of the town Ahvaz from the layer of 0-30 cm depth. The soil is of semi-desert brown type, which in some areas has weakly-expressed reddish-yellow tint and well-expressed skeletal structure, medium loamy mechanical structure (sand (> 0,01mm) was of 18%, clay (< 0,001mm) 43%, slime (0,005 – 0,0005mm) 39%). The soil contains carbonates in significant quantities ($CaCO_3$ – 29%) and has alkaline reaction (pH – 7,8), it is poor in organic substances and humus (according to carbon 0,15-1,0%), as well as nitrogen (N total - 0,088%) and available combinations of phosphorus and potassium which comprise 1,69 and 15,5 mg in 100g of soil, respectively. In the soil the contents of mobile forms of several microelements, which are important for plant nutrition, is also very low (Cu – 1,4; Mn – 8,9; Zn – 1,7; Fe – 8,9 mg/kg), and the degree of saturation with alkalis (SP) is 46%. The analysis of the chemical composition of the soil shows that in those areas it is very difficult without agrotechnical and agrochemical measures to secure high results even in date-palm plantations.

It has been found out from investigations performed in vegetal vessels, that the combined Importing mycorrhizal fungi and phosphorus into the soil reinforces significantly the growth of date-palm seedlings (Table 1).

The height of plant stem oscillated between 21-23, total length of roots – between 169-187 cm, and leaf surface – between 911-1147 mm^2, moreover, the highest result has been stated when P_2O_5 in the dosage of 15 mg/kg was imported. In total mass of the plants the quantity of dry substance according to variants of P_2O_5 didn't show significant oscillation either in case of mycorrhiza importing or without (9,6-12,5g). As to overground and root masses of the plants, there is an interesting contradiction here – if the combined imported amount of mycorrhizal fungi and phosphorus increased the overground mass by about 2-3 times (0,08-0,22 kg) as compared with the variants without fungi (0,02-0,07 kg), the weight of root mass was greater in the first 5 variants without mycorrhizal fungi (0,18-0,26 kg). The significant decrease in the root mass in the cases of importing mycorrhizal fungi is likely to be connected with the activity of mycorrhiza.

Table 1. The effect of vesicular arbuscular mycorrhizal fungi and dosages of phosphorus on the growth and development of date-palm seedlings

Variants		For one plant					
Mycorrhiza	P_2O_5, mg/kg soil	Length of stem, cm	Total length of roots, cm	Total leaf surface, mm^2	Fresh weight of overground mass, kg	Fresh weight of root mass, kg	Total quantity of dry substance, g
without mycorrhiza fungus (M-)	0	8,3–c	152,5-abc	268-d	0,02-b	0,18-a	9,6-a
	5	13,2-b	126,8-bc	451-d	0,04-b	0,24-a	12,3-a
	10	14,3-b	106,0-c	558-dc	0,06-b	0,23-a	11,9-a
	15	14,4-b	122,8-bc	503-dc	0,06-b	0,26-a	11,3-a
	20	19,5-a	151,1-ab	779-bc	0,07-b	0,20-a	12,5-a
with mycorrhiza fungus (M+)	0	21,4-a	169,1-abc	983-ab	0,08-ab	0,17-a	11,4-a
	5	22,3-a	187,0-a	1141-a	0,10-ab	0,16-a	11,0-a
	10	21,6-a	153,0-abc	911-ab	0,22-a	0,22-a	11,4-a
	15	23,1-a	180,0-a	1147-ab	0,09-ab	0,17-a	11,1-a
	20	22,9-a	180,0-a	912-ab	0,08-ab	0,15-a	10,7-a

Note: Average values of 4 repetitions, which are marked by the same letters (a, b, c, d), differ significantly from the level equivalent to 5%, while the values marked by 2 or 3 letters (ab, bc, abc) at the level $P < 0,05$ show no essential difference in comparison with Duncan criteria.

This means that the fungi in the soil, constantly securing the accessible nutrient storage, hamper the root growth and weaken their diffusion in the soil profile, in other words the chemotaxis activity of the roots is increased. This phenomenon attests to the fact, that in field conditions the colonization of mycorrhizal fungi on the trunk surface of the tree can secure full growth, development and yield of the plant.

Differentiating the effects of optimal quantities of mycorrhizal fungi and phosphorus (15-20 mg/kg) on the growth and development of date-palm seedlings, it is not difficult to note, that the influence of mycorrhiza without phosphorus is higher than the influence of phosphorus without mycorrhiza. Mycorrhizal fungi increase the length of the stems of date-palm seedlings, the weight of overground mass and leaf surface by 2-4 times as compared with the control (Fig. 1-4). Differentiated influence of vesicular arbuscular mycorrhizal fungi and optimal dosages of phosphorus on growth and development of date-palm (Fig. 1-4).

Nevertheless, figures 1-4 show that the greatest indices were stated in the variants with combined application of high dosages of phosphorus and mycorrhizal fungi.

By summarizing the results of the research and taking into consideration the existence of vast limy soil areas containing harmful salts for the plants in the southern provinces of Iran, it can be concluded that it is necessary to apply widely biological measures, one of which is the colonization of mycorrhizal fungi in the rizosphere of the plant.

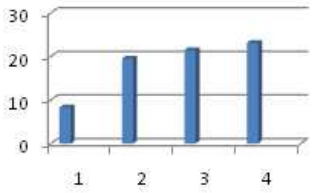

Fig. 1. The length of green stem of the plant, cm
1. Without mycorrhiza and phosphorus (control)
2. Phosphorus – 20mg/kg
3. Mycorrhiza 4. Mycorrhiza+$P_{15mg/kg}$

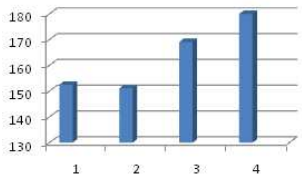

Fig. 2. The length of green stem of the plant, cm
(*see* Fig.1)

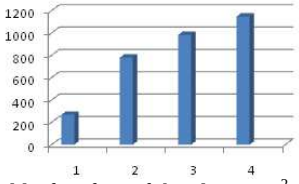

Fig. 3. Total leaf surface of the plant, mm^2
1. Without mycorrhiza and phosphorus (control)
2. Phosphorus – 20mg/kg
3. Mycorrhiza
4. Mycorrhiza+P15mg/kg
(*see* Fig.1)

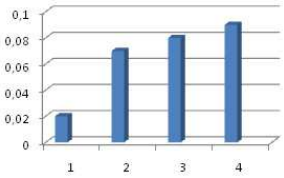

Fig. 4. Fresh weight of overground mass of the plant, kg
1. Without mycorrhiza and phosphorus (control)
2. Phosphorus – 20mg/kg, 3. Mycorrhiza
4. Mycorrhiza+P15mg/kg
(*see* Fig.1)

Photo 1. The process of growing date-palm seedlings in a greenhouse.

Parallel to the vegetal experiments, it is necessary to enlarge field researches in the direction of combined application of organic-mineral fertilizers (NPK) and mycorrhizal fungi, which is an important guarantee of the protection of the environment.

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