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Davarynejad G.H., Rashed M.H., Alizadeh A., Nasiry M.

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A method for plantation and establishment of pistachio trees under rainfed conditions

G.H. Davarynejad, M.H. Rashed, A. Alizadeh and M. Nasiry
Ferdowsi University, College of Agriculture, P.O. Box: 991775 – 1163, Mashhad, Iran

SUMMARY – Extreme temperature and low annual rainfall limit the extension of pistachio plantation in some parts of Iran. However, there are some endemic varieties of *P. mutica* and *P. khinjuk* which can be seen in some parts of the country. The objective of this study was to assess plantation and establishment of pistachio seedlings under semiarid conditions, when annual rainfall is below 250 mm. The experiment was conducted in 1994-1999 at Faizabad (central part of Khorasan) Iran. The seeds of *P. mutica*, *P. khinjuk* and *P. vera* (Saracksi and Sephid cvs) were planted in the centre, of the micro-catchment insuch a way that the water was conducted toward the base of the plants via different treatments. There were significant differences between treatments and cultivars. The results indicated that Sephid and Saracksi cultivars could emerge and be established whereas of *P. mutica* and *P. khinjuk* well germinated with soil moisture and died by the middle of the growing season. The result of germination and establishment of the plants and situation of roots and shoots for each treatment is investigated and discussed.

Key words: Rainfed condition, *Pistacia* cultivars, pistachio.

RESUME – *"Une méthode pour la plantation et l'établissement de pistachiers en conditions non irriguées". Les températures extrêmes et une faible pluviométrie annuelle limitent l'étendue des plantations de pistachiers dans certaines contrées de l'Iran. Cependant il y a des variétés endémiques de* P. mutica *et* P. khinjuk *que l'on peut voir dans certaines parties du pays. L'objectif de cette étude était d'évaluer la plantation et l'établissement de plants de pistachier en conditions semi-arides, lorsque la pluviométrie annuelle est en dessous de 250 mm. L'expérience a été menée en 1994-1999 à Faizabad (partie centrale du Khorasan), Iran. Les semences de* P. mutica*,* P. khinjuk *et* P. vera *(cultivars Saracksi et Sephid) ont été plantées au centre du micro-bassin de façon à ce que l'eau soit conduite vers la base des plants par différents processus. Il y a eu des différences significatives entre les traitements et les cultivars. Les résultats ont indiqué que les cultivars Sephid et Saracksi pouvaient émerger et s'établir tandis que* P. mutica *et* P. khinjuk *qui germaient bien avec l'humidité du sol, mouraient vers la moitié de la saison de croissance. Les résultats de germination et d'établissement des plants et la situation des racines et des rameaux pour chaque traitement sont investigués et discutés.*

Mots-clés : *Conditions non irriguées, cultivars de* Pistacia*, pistachier.*

Introduction

Northeastern part of Iran is one of the important region for growing pistachio. The climate of this area is arid to semi-arid (Davarynejad *et al.*, 1995). Annual amount of rainfall is usually less than 200 mm which is almost concentrated in March and April. Since the rainfall are torrential, it cause erosion and flood. Almost 80% of the rainfall is directly evaporated. Sepaskhah *et al.* (1988) stated that runoff can be harvested around the trees. They believe that this kind of harvesting is more useful than conventional terracing.

Water holding capacity, physical and chemical characteristics of the soil as well as the climate have considerable influences on the growth of pistachio trees. Studies of the effect of soil moisture and water stress on the growth and root development of pistachio trees, under rainfed condition will determine the drought resistance of this tree. However, plant varieties are affected by genetical characteristics of the plant. Root development, number of secondary roots, extension of root pattern, weight of roots and the canopy of the tree are therefore genetical characters. Sepaskhah and Maftoun (1981) demonstrated that pistachio has wide genotypic variability for water stress and salt tolerance. Spiegel *et al.* (1977) found remarkable drought resistance in pistachio trees under run-off farming. The effect of irrigation regime and pistachio cultivation on rainfed conditions has been recently studied (Goldhamer *et al.*, 1985; Spiegel, 1985; Enthoven, 1987; Khanjani, 1988; Sheibani, 1990; Haj-Ebrahim, 1995; Kafkas, 1995), but only few published report are available regarding the new orchard plantation under rainfed conditions. The present study was initiated to evaluate the ability of *Pistacia* varieties under rainfed conditions.

Materials and methods

The experiment was conducted during 1994-1999 at the central part of Khorasan province (Faizabad valley of Mahvalat). The purpose of the study was to examine who a rainfed pistachio orchard can be established. This valley is located at southwest of Torbat-Hydariah with a longitude of 57 to 58 degree East and latitude of 34 to 35 degree West. The climate of the area is hot and dry with a desertic characteristics. Absolute annual max. and min. temperatures are 40, and –12 degree (°C), respectively. Annual rainfall average 175 mm which is mostly concentrated in winter and early spring. During the study years, the climate was rather different than normal, and the amount of rainfall was even less than average. The soil under investigation had an EC of 2 mmhos/cm in its saturated state extract. EC of the irrigating water was also 2 mmhos/cm. pH of the soil was 8 to 8.5. The soil was deep sandy clay. Physical and chemical characteristics of the soil is listed in Table 1.

Table 1. Physical and chemical properties of the soil

Soil depth (cm)	Particle size			Bulk density (g/cm^3)	EC (ds/m)	pH	N (%)	P (ppm)	K (ppm)
	S (%)	C (%)	Si (%)						
0-30	18	49	33	2.4	1.8	7.4	0.03	6.0	190
30-60	23	62	15	2.3	1.8	7.5	0.01	8.8	210
60-90	60	30	10	2.0	1.9	7.6	0.01	8.6	80
90-120	74	16	10	2.5	1.7	7.6	0.01	8.5	75

Since preparing the basin for harvested water, parkets and terraces was difficult by mechanical machinery, at this experiment the following method was adapted. A parcel of land 120 x 48 m was selected. The land was divided to 4 sub-plots that the width of each of them was 12 meter. These plots were graded such a way that a dike with 30 cm height and 80 cm width was remained at the center. The soil around the dike was then pushed away. So a land with a slope of 6% was created. The experimental design was a split plot with 3 replications, in which the treatments of the land area of the basins: (i) graded land covered with plastic; (ii) compacted land; (iii) compacted land plus plastic mulch with a 80 cm width around the trees; and (iv) control, irrigated every 12 days; used as main plots and varieties of *P. mutica*, *P. khinjuk*, in *P. vera* (Sephid and Saracksi) were sub-plots. After a heavy rain and harvested enough moisture, germinated seed of each varieties were planted in the pits, 3 meters apart. In order to conserve moisture, and preventing from frost, a piece of plastic was covered on the soil.

The amount of moisture at different depth were determined by gravimetric method in several time during the growing period. Finally, seedling characteristics, growth of canopy, length of main shoots as well as the secondary, length of roots and their development, time of leaf falling were measured and the results were statistically analysed. Since Faizabad is located at the center of Torbat-Hydariah, Kashmar, and Gonabad, the average of climatological data of these stations were used in this study.

Results and discussion

Total rainfall in the growing season was 117 mm at the first year of the experiment (1995), while it was 29 mm, 86 mm, 45 mm and 20 mm in other years (1996, 1997, 1998 and 1999), respectively. The drought condition in May and June were particularly sever. Under drought conditions of late spring the *P. mutica* and *P. khinjuk* varieties did not established even after a good germination, while *P. vera* (Sephid and Saracksi) had a good growth at the first year. These seedling (Sephid and Saracksi) remained alive and grew vigorously before the soil moisture was depleted. Skyes (1975) cited in Kanber *et al.* (1993) indicated that extreme temperatures both low and high and low annual rainfall are the low main constrains which limit the extension of pistachio plantation.

It seems the differences between varieties depend on the amount of stored materials in the cotyledons of embryos. The bigger seed produced a vigorous seedling with a better establishment of young plants before high temperature of June and soil moisture depletion. When new orchards or sensitive varieties are planted on dry soils, irrigation must be applied especially at first and second years.

However, pistachios could be cultivated in rainfed conditions and the results of this experiment showed that Sephid and Saracksi varieties were established properly without any irrigation which was mainly due to a better water conversation practices but varietal characteristics should be considered as well.

The soil moisture profile under different treatments are presented. The drought symptoms appeared in late July and by early August. Following the stress period, a new rainfall can immediately accelerate shoot growth rate. For example, at the second half of may 1997, after the seedlings being stressed, 12 mm rainfall in mulched caused shoot length increase by 10 cm but in non mulched treatments the observed shoot length increase with the same amount of rainfall was only 3 cm. It can be concluded that the plastic covered treatments created better conditions for water run-off and more water harvesting.

It is reported that the abscission of pistachio leaves occurs as a result of prolonged periods of water stress during dry years when rainfall is below 400 mm. But under summer drought conditions of this experiment the leaves of young trees remained green until the normal leaf fall and no differences were found in term of leaf fall in any years.

The skeletal root of pistachio trees were strong, well developed, penetrated near the trunk and developed a few number of ramifications. Shoot and root length of two pistachio cultivars were affected by soil moisture level which are shown in Table 2. Shoot length decreased with decreasing of soil moisture while root length of pistachio cultivars increased with decreasing of soil moisture. This finding is in agreement with the result reported by Kanber *et al.* (1993). Root length of *P. vera* (Saracksi cv.) were longer than *P. vera* (Sephid cv.). According to our observations, under the poor water conditions, the upper layer of the soil dried out in the second half of growing period but with a high variation (Table 2).

Table 2. Soil moisture in different depth of treatments (percentage on mass basin) (1995)

	Depth	After a heavy rain	April	May	June	July	August	Sept.
Compacted micro-catchment + mulching around the trees	0-30	35	27	25	20	14	12	10
	30-60	33	27	23	20	16	15	14
	60-90	31	25	22	18	16	15	14
	90-120	29	25	22	19	16	16	15
Plastic mulching the micro-catchment	0-30	32	27	19	15	9	8	8
	30-60	31	28	20	16	14	13	13
	60-90	30	26	20	16	15	14	14
	90-120	28	26	20	17	15	15	15
Compacted the micro-catchment	0-30	34	25	17	14	8	8	8
	30-60	32	26	19	15	13	12	12
	60-90	31	26	20	17	14	13	12
	90-120	30	26	20	17	14	13	12

Soil moisture level depended on precipitation conditions and its in turn had an adverse effect on the shallow horizontal development of roots in first years after plantation. As a result root system of irrigated trees were shallow and the length of their main root were smaller as compared with stressed treatments (Table 3).

According to Spiegel *et al.* (1977) the pistachio root may go as deep as 2.5 m in search of soil moisture, while in this experiment the deepest roots of Saracksi variety was found to penetrate less than 135 cm. However, the difference between cultivars was not significant (Table 3). The significant increase in root length was found only in the compacted micro-catchment treatment with the lowest water harvesting capacity. At the end of fifth year the irrigated treatment produced larger trunk diameter and tree height as compared to those in non irrigated treatments. Plastic mulch around the trees led to a higher crown diameter compared to non-mulched treatments and a significant differences were observed between cultivars with a higher diameter in Sephid cultivar. By the end July 1999 the trees in irrigated treatments had greater trunk diameters than the other treatments. While, no. of lateral roots was not significantly changed between treatments, no. of branches showed the same trend as was observed for shoot length (Table 3).

Table 3. Mean values of various trails and varieties of pistachio[†] (fifth years after planting)

Treatments	Cvs	Shoot length (cm)	Root length (cm)	No. of branches	No. of lateral roots	Crown diameter (cm)
Control (irrigated)	Sephid	225 a	85 d	7.3 a	4.2 a	7.5 a
	Saracksi	195 ab	91 cd	6 bc	4.0 a	5.0 bc
Compacted micro-catchment	Sephid	175 bc	98 bcd	6.6 ab	3.5 a	6.0 b
+ mulching around the tree	Saracksi	160 cd	94 bcd	6 bc	4.0 a	3.1 de
Plastic mulching the micro-	Sephid	130 de	90 cd	6.5 bc	4.5 a	5.5 b
catchment	Saracksi	101 e	115 abc	4.2 d	4.0 a	3.0 de
Compacted micro-catchment	Sephid	110 e	120 ab	5.2 cd	3.3 a	4.0 cd
	Saracksi	100 e	135 a	4.2 d	3.0 a	2.0 e

[†]Analysis of variance were done based on new Duncan multiple range test p > %5.
[a,b,c,d,e]Numbers with the same letter are not significantly different.

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