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Determining Growth of Caper (*Capparis ovata* Desf.) Plantations with Eleven Different Provenances on an Erosion Control Area in Turkey

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Abstract: Caper is an important plant because of its high adaptation ability to marginal agriculture fields that are not suitable for agricultural crops. In addition, different parts of Caper such as roots, fruits, flowers and unopened buds can be used to increase the inhabitants' income level. It is also used with other plant species for controlling erosion in rocky and steep landscapes of many countries. This study has been carried on an erosion control area in Artvin-Yusufeli region (Latitude: 40°46' 23'' N, Longitude: 41°49' 07'' E, h: 1010 m) of Turkey. Study area was established with 1-year-old and potted caper seedlings that propagated from 11 different origins of caper seeds that collected from natural growing zone ranging from 300 to 1200 m through the Çoruh Watershed. The experimental design was a randomised complete block with three replications for each provenance where 30 pots were used in each replication and it was researched growth of the seedlings. At the end of the third growing period, among all caper origins, the highest survival rate of 52.2% for origin-5, the average shoot growth of 40.9 cm for origin-1 and coverage of 2397.7 cm^2 for origin-7 were determined.

Key words: Caper, *Capparis ovata* Desf., plantation, coverage area, erosion, provenance

INTRODUCTION

Capparis ovata, a prostrate shrub and *C. spinosa* found in most arid zones of Mediterranean countries are called capers in the literature (Barbera, 1991; Pugnaire and Esteban, 1991; Tanslı, 1999). They are well adapted and profited in countries such as Greece, Cyprus and Turkey and also cultivated commercially in Morocco, Spain, Italy (Pascual *et al*., 2004) and they have wide natural distribution in Turkey (Davis, 1965). In general, while *C. spinosa*'s native growing zone is between 200 and 300 m in altitude, *C. ovata* has a much wider growing zone ranging from 250 to 1600 m, especially in the Northeastern region of Turkey (Davis, 1965).

Caper shows the characteristics of a plant adapted to poor soils, where water and nutrients are major limiting factors (Neyişçi, 1987; Pugnaire and Esteban, 1991). Barbera and Lorenzo (1982) mentioned that caper is a xerophyte plant and tolerant to drought and also it grows up in places where annual rainfall is about 350 mm (Barbera, 1991; Söyler and Arslan, 2000). It has a deep root system (up to 40 m; Kara *et al*., 1996) and short stem from which the branches grow. Caper is a kind of perennial, shrubby and prickly plant which grows spontaneously in cracks and crevies of rocks and is used for soil erosion prevention in slopy areas (Barbera, 1991; Söyler and Arslan, 2000). A study on *C. decidua* showed that this species is best when used for stabilising the dunes and controlling wind erosion (Gupta *et al*., 1989; Sharma and Gupta, 1989). A *C. ovata* individual can achieve 1 m in height and occupy an area of 15 m^2, with a canopy of 4 to 6 radial branches from which many secondary branches grow. According to Üçler *et al*. (2002) capers were distributed more on the southern slopes than on the northern slopes. The mature plants in the group of 0-25% sloped areas have the largest area (3.242 m^2) covered.

The objective of this study was to determine average shoot growth, coverage area and survival rate of caper shrubs with 11 different origins and to define suitable origin or origins of caper according to these variables. On the other hand, since a part of the natural range of capers will be covered by dam lakes being built in the Çoruh watershed, this study may serve as an *ex situ* conservation area for caper origins used in the study.

MATERIALS AND METHODS

This study has been carried on an erosion control area in Yusufeli-Artvin region (Latitude: 40°46' 23'' N, Longitude: 41°49' 07'' E, h: 1010 m) of Turkey. Average slope, exposure and soil pH of the research area were 15%, southeastern and 7.95, respectively. The region where the sample plots were established is a semi-arid

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Table 1: Locations of eleven different provenances of caper seeds

			Locality				
Provenance No.	Exposure	Altitude steps (m)	Region	District	Village	Latitude	Longitude
1^{-}	South	300-400	Artvin	Merkez	Berta	41°13' 17'' N	42°00' 29'' E
2^{+}	South	500-600	Artvin	Merkez	Sakalar-1	41°12' 15'' N	41°59' 45'' E
$3^{-,+}$	South	400-500	Artvin	Merkez	Sakalar-2	41°12' 05'' N	41°59' 40'' E
4^{-}	South-west	300-400	Artvin	Yusufeli	Yağcılar	40°56' 58'' N	41°45' 39'' E
5^{-}	South-west	400-500	Artvin	Yusufeli	Kolik	40°50' 33'' N	41°40' 35'' E
6^{-}	South-east	500-600	Artvin	Yusufeli	Merkez	40°48' 44'' N	41°38' 32'' E
7^{-}	South	600-700	Artvin	Yusufeli	İşhan	40°46' 36'' N	41°42' 18'' E
$8^{-,+}$	South	700-800	Artvin	Yusufeli	Pamukçular	40°45' 51'' N	41°46' 29'' E
9^{+}	South-east	800-900	Erzurum	Oltu	Taşlıköy	40°45' 10'' N	41°53' 12'' E
10^{+}	South	900-1000	Erzurum	Olur	Coşkunlar	40°46' 02'' N	41°59' 60'' E
11^{+}	South	1000-1200	Erzurum	Oltu	Ayvalı	40°45' 39'' N	42°10' 43'' E

- : Origins will be under lake water because of the dams, +: Origins will not be under lake water of the dams

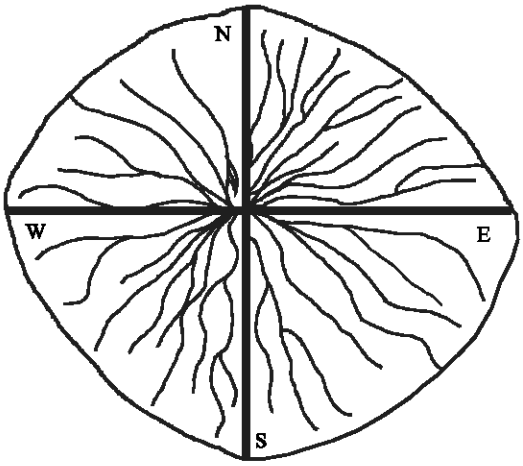

Fig. 1: Uniform and compact growth form of a caper plant

and arid place with Mediterranean Climate characteristics (Akman, 1999). The annual precipitation in the research area and its close environment is 295 mm and the mean temperature is 15°C (Anonymous, 1984).

Sample plots were established in November 2000 with 1-year old and potted caper seedlings that propagated from 11 different provenances of caper seeds that collected from natural growing zone ranging from 300 to 1200 m through Çoruh Valley in September 1999 (Table 1). The seeds were separated from the fruit material, rinsed in tap water, dried in the shade and kept at room temperature in linen sacks. Cold stratification pretreatment for 60 days, suggested by Olmez *et al.* (2004a), was applied on the seeds and they were sown in polyethylene pots under open field conditions at the nursery in Ardanuç, in the spring (March) of 2000. Three seeds were sown in each pot to obtain high seedling percentages. Polyethylene pots were filled with growing medium composed of forest soil, creek sand and manure (1:1:1).

Caper seedlings were planted with 2×2 m spacing. The experimental design was a randomised complete block with three replications for each origin where 30 pots were used in each replication. At the end of the third growing

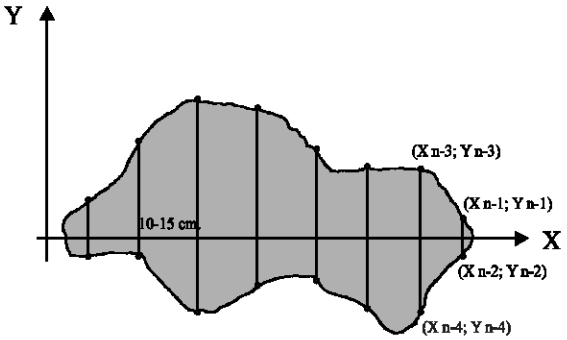

Fig. 2: Measuring of spreading caper sample (Üçler *et al.*, 2002)

period the highest survival rate, average shoot growth and coverage area of the caper plants were determined.

Coverage area of each individual of caper plant was calculated with the following procedures:

For the plants which were uniform and compact growth form as well as having conspicuous centre of main stem like in Fig. 1, lengths of shoots were measured from the center of the plant to outwards on eight different directions and these values were scaled down to 1/5 and transferred on to a millimetric paper to calculate the coverage area of a plant.

For the non-uniformly spreading plants, the coordinates (X; Y) of species crown were established horizontally (X) and vertically (Y) on the different points with 10-15 cm intervals (Fig. 2). The formula used for this procedure is given below (Üçler *et al.*, 2002);

$$CO = \sum [(Yn\text{-}1\text{-}Yn\text{-}2) + (Yn\text{-}3\text{-}Yn\text{-}4)/2] \times [(Xn\text{-}1\text{-}Xn\text{-}3) + (Xn\text{-}2\text{-}Xn\text{-}4)/2] \quad (1)$$

Data from the research was analyzed by the SPSS version 9.0 after using Arcsinus transformation only for survival rates of the seedling. The ANOVA and Newman Keuls tests were used to compare treatment groups as to whether or not they show any statistically significance differences which was set at $\alpha = 0.05$.

RESULTS AND DISCUSSION

In nursery period of this study, in general, high seedling percentages were determined from all origins of caper. The highest seedling percentage (91.0%) was obtained from seeds collected in Sakalar Village (origin-3) and the lowest seedling percentage was 76.2% for origin-8 (Fig. 3). Yahyaoğlu *et al.* (2002) reported that sowing three or more seeds caused an increase in seedling percentages of caper. In the nursery period of our study, sowing three seeds in each poliethylene pot was effective positively on getting high seedling percentages.

The caper seedlings propagated at the nursery were planted on the study area in the autumn (November) of 2000. At the end of the third growing period, the capers obtained from origin-1 resulted in significantly higher average shoot growth with 40.9 cm among other origins. However, the capers from origin-9 showed the lowest average shoot growth with 15.9 cm (Table 2 and Fig. 4). In another study, Olmez *et al.* (2004b) reported that an average shoot growth of 8.1 cm at the end of the second growth season for caper with single origin on the south-eastern exposure.

Table 2: Results of statistical analyses showing the relationship of the average shoot growth with different provenances (Means in column with the same letter are not significantly different at $\alpha = 0.05$)

Treatments	Origin No.	No. in sample	Average shoot growth (cm)	ANOVA (F ratio)	Newman Keuls test result
Average	9	19	15.9		a
shoot	10	36	18.6		ab
growth-	4	33	22.9	9.602*	abc
origins	8	13	23.7		abcd
	7	20	24.9		abcd
	6	26	26.7		abcd
	5	47	23.3		bcd
	2	27	32.6		cde
	11	31	35.1		de
	3	45	40.4		e
	1	40	40.9		e

*: Significant at 95% significance level

Table 3: Results of statistical analyses showing the relationship of the survival rate with different provenances (Means in column with the same letter are not significantly different at $\alpha = 0.05$)

Treatments	Origin No.	No. in sample (N)	Survival rate (%)	ANOVA (F ratio)	Newman Keuls test result
Survival	8	13	14.43		a
rate-origins	9	19	21.10		b
	7	20	22.20	42.411*	b
	6	26	28.86		c
	2	27	29.97		c
	11	31	34.43		cd
	4	33	36.67		d
	10	36	40.00		de
	1	40	44.43		e
	3	45	50.00		f
	5	47	52.20		f

*: significant at 95% significance level

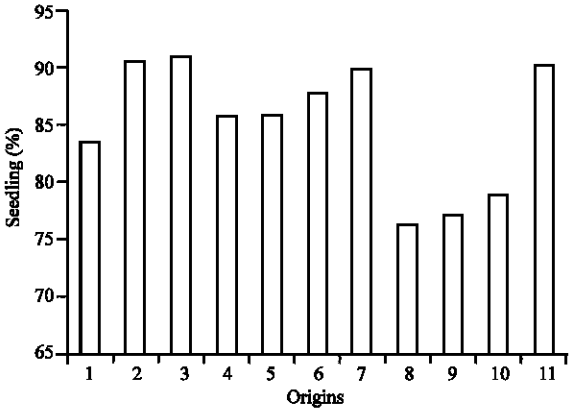

Fig. 3: Seedling percentages for each caper origin

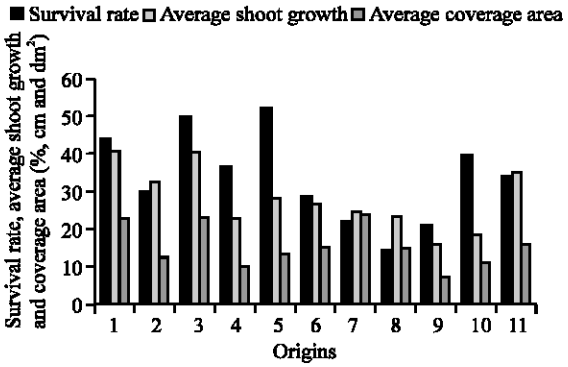

Fig. 4: Survival rate, average shoot growth and coverage area of caper plants with different provenances

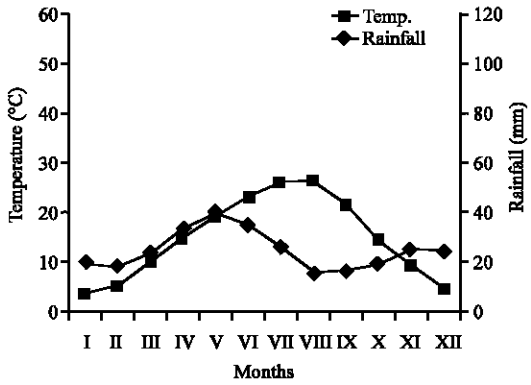

Fig. 5: Water budget of Yusufeli region according to Walter method

According to the statistical analyses the highest survival rates (52.2 and 50.0%, in the same homogeneous group) were obtained significantly from origin-5 and 3. The lowest survival rate (14.4%) was found in origin-8 (Table 3 and Fig. 4). Tetik and Yeşilkaya (2002) reported a mean survival rate of 40% for caper on the southern

Table 4: Results of statistical analyses showing the relationship of the mean coverage area with different provenances (Means in column with the same letter are not significantly different at $\alpha = 0.05$)

Treatments	Origin No.	No. in sample	Mean coverage area (cm^2)	ANOVA (F ratio)	Newman Keuls test result
Mean	9	19	769.7		a
coverage	4	33	1009.6		a
area-origins	10	36	1112.1	2.850*	a
	2	27	1239.0		ab
	5	47	1329.4		abc
	8	13	1499.2		abc
	6	26	1554.2		abc
	11	31	1612.8		abc
	1	40	2260.8		bc
	3	45	2319.2		bc
	7	20	2397.7		c

*: significant at 95% significance level

exposure. This finding was lower than our findings belonged to origins-1, 3 and 5 and higher than origins-2, 4, 6, 7, 8, 9 and 11.

In general, our study area is in a semi-arid region (annual rainfall: 295 mm) according to FAOs (1963). In addition, Fig. 5 shows that there is a water deficit in the study area and its close environment between May and October according to Walter Method. These may explain why, in general, the survival rates of capers for all origins were low (between 14.4 and 52.2%, Table 3). For that reason, can be said that replacement plantings using caper seedlings in the same origins are necessary to increase survival rate and to prevent erosion efficiently.

Analyses showed that at the end of the third growing season, while origins-7, 3, 1, 11, 6, 8 and 5 of caper gave similar results of coverage area, the highest mean coverage area of 0.24 m^2 was obtained from origin-7 (Table 4). Plants in our study were four years old and they did not have too large mean coverage area yet. Üçler *et al.* (2002) reported that the mature wild caper plants in the Çoruh Valley had coverage areas ranging from 0.56 to 3.78 m^2.

CONCLUSIONS

Overall, statistical analyses showed that the caper obtained from origin-3 was the most suitable among all origins (Table 2-4) when all variables (both seedling percentage in the nursery, and average shoot growth, coverage area and survival rate for the capers in the study area) were considered. In general, it can say that survival rates of all caper origins are low because of less annual rainfall and water deficit (Fig. 5) in the region.

Caper seeds were collected through the Çoruh watershed between 200 and 1200 m, in Artvin and Erzurum regions (Table 1). Recently, some dams have being constructed and will be built in near future in this watershed. When the erosion control efforts in the watershed are completed these erosion control and afforestation efforts will be beneficial for the economical usage and lifespan of the dams. But most of the caper plants in this watershed will be under the water that will reach upto altitude of 712 m high because of lake of dams. Since the study area was established at the altitude of 1010 m in Pamukçular village, in Yusufeli-Artvin, when the dam constructions are completed, our study area can serve as an *ex situ* conservation area for each caper origin.

Moreover, there are about 154000 ha degraded forest areas in Artvin, Turkey. It is necessary that afforestation and erosion control efforts should be done on these areas because of strong erosion in the Çoruh watershed (Göktürk *et al.*, 2004). Caper seedlings should be planted in these degraded areas with other suitable plant species in the valley to protect further loss of top soil by water erosion.

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