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ROSE CULTIVATION IN CYPRUS UNDER TWO IRRIGATION REGIMES USING LOCAL SUBSTRATES

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SUMMARY- A joint programme between the Agricultural University of Athens – Greece and the Agricultural Research Institute of Nicosia – Cyprus (2001-2004), aimed at studying the development and photosynthetic activity of roses cultivated in four different substrates and two irrigation regimes.
Roses cv "Eurored" were cultivated on four different substrates in a heated greenhouse at the ARI using local materials i.e. perlite 100%, mixtures of perlite 50% with pomace 50%, perlite 50% with almond shells 50% and almond shells 50% with pine bark 50%. The two irrigation regimes applied, were 800ml (6 times/day x 2 min) and 530ml (4 times/day x 2 min). The photosynthetic rate, stomatal conductance, CO_2 concentration and transpiration rate of the rose plants grown in the four substrates and under the two irrigation regimes were measured as well as the total productivity and quality characteristics (stem length, fresh weight) of the roses produced.
Results showed that concerning the interaction between substrate and irrigation level, higher production was recorded with the roses growing in the substrate pine bark 50% and almond shells 50% irrigated with the reduced irrigation level and the substrate of perlite 50% and pomace 50% irrespective of irrigation level. The quality characteristics of the roses produced under all treatments were marketable with mean stem length between 75-85cm. No significant differences were observed concerning the photosynthetic rate, the stomatal conductance, the CO_2 concentration and the transpiration rate under the four substrates and the two level of irrigation. It seems that the lower irrigation level did not create conditions of water stress and did not affect negatively the physiological activities of the rose plants.

Key words: Irrigation regimes, substrates, roses, photosynthetic rate, stomatal conductance, productivity,

INTRODUCTION

Based on International studies, the increase in distribution of cut flowers at the International Market is estimated at about 5% per year. Roses are estimated to hold for decades the 24% of the total market; "new species of cut flowers" are estimated to hold the 50% of the market, while traditional species like carnation (15%) and chrysanthemum (9.5%) etc are continuously declining (International Trade Center, 1997).

Much research has been conducted on the effects of various scion-rootstock combinations, harvesting procedures, growth regulators and environmental factors on rose production. Recently, research on roses, has been focused on the physiology of flowering and the developmental stages from the axillary bud break until the full formation of the floral part of the rose (Marcelis-van Acker 1994, Chimonidou 2000, 2003). Critical stages of rose development have been found from the stage of petal until stamens formation in relation to water availability. At those stages, a drought stress might cause malformations and up to 70% reduction at the total productivity (Chimonidou 1999, 2001, 2004).

The problem of water deficiency in the Mediterranean countries constitutes of two components, quantitative and qualitative and represents one of the major restrictive factors in development of various cultivars. Rose cultivation is one of the most intensive cultivation per surface unit and water volume. For these reasons, today's trend is the cultivation of roses in hydroponics. These systems allow the total control of plants nutrition and in addition the total control of greenhouses environmental conditions. All these enable intensification and production scheduling of cultivation, leading to yield's increase, quality improvement together with decrease of cost production.

Results based on previous experiments at the Agricultural Research Institute have shown that the usage of wholly grainy or fibrous substrates does not comprise the best solution for perennial crops like roses. In an attempt to create the most suitable substrate for rose cultivation using local agricultural by-products, which are found in excess and are low cost, in this specific study almond shells, pine bark and pomace were used in mixtures with perlite. Previous experiments have shown that substrate from pomace appear to be of high porosity (85-95%), low size density (0,2-0,3 g/cm3) and pH between 6,7-7 (Inbar et al., 1986). It also contains high levels of P and K and it can maintain high percentage of air (59% v/v) but low percentage of easily water supply (1,2% v/v) (Reis et al., 2001). The aim of the present experiment was to study the development and photosynthetic rate of roses using different substrates (local agricultural by-products) under two irrigation-straining regimes.

MATERIALS AND METHODS

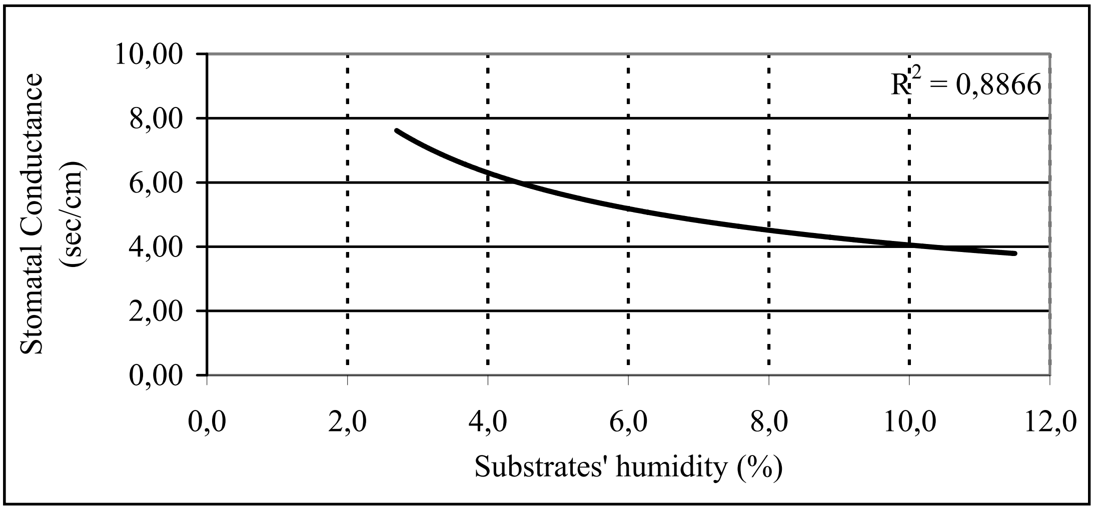
The experiment was conducted at the Agricultural Research Institute's location (2002-2004), in an automatic greenhouse of 250 square meters, fully covered with plastic polyethylene sheet. Four different substrate combinations were used: perlite 100%, mixtures of perlite 50% with pomace 50%, perlite 50% with almond shells 50% and almond shells 50% with pine bark 50%. For each combination of substrate and irrigation regime, six (8) plants were used under four replications. The plants were planted in two independent units consistent of 8 plants in 8 elevated polystyrene flowerbeds, with dimensions of 1m length, 40cm wide and 60cm height.

At the experiment two factorials design was implemented and the statistical analysis was based on the effect of substrates, of irrigation regimes and of their interaction. Two irrigation regimes were applied in an open hydroponics' system. At the first treatment, the plants under investigation were irrigated 6 times for 2 minutes twenty-four hours (6 x 133 ml=800ml) while at the second treatment the plants were irrigated 4 times/day for 2 min (4 X 133ml = 530 ml, 33% reduction), with dripper irrigation capacity of 41/h. The water quantity and frequency was based on previous studies on roses (Chimonidou, 1999). The drainage percentage ranged between 5-15% and the pH was fixed at 6,5 with the addition of HNO3. The electrical conductivity of the irrigation solution was 1,7 – 1,9 dS/m.

Temperature, light intensity and relative humidity in greenhouse environment were recorded daily. Daily measurements were conducted also for the leaf stomatal resistance/conductance by a porometer. For the measurement of the water content of the substrates tensiometers TDR type were used. Measurements on the quantity (total productivity of the roses) as well as quality characteristics (height and weight of the stems) were studied.

RESULTS AND DISCUSSION

Measurements of the porometers' and tensiometers' readings showed that the stomatal conductance of the leaves was conversely proportional to the substrates' humidity (Graph 1). When the percentage of the rhizospheres' humidity reached its lowest price (2,7%), the stomatal conductance of the leaves reached the value of 8 sec/cm, while when it reached its highest value (11,5%), the stomatal conductance value was reduced to 3,8 sec/cm.



Graph 1. Relation between the stomatal conductance of the leaves and the percentage of the ubstrate's humidity

The interaction between different substrates and irrigation regime, have shown that the greatest productivity was obtained from plants grew on the mixture of almond shells 50% with pine bark 50% irrigated with the reduced irrigation regime. Same results were obtained from plants grew on the mixture of perlite 50% with pomace 50%, regardless of the irrigation regime used. Both have shown to be statistically different from other treatments. There were not significant differences concerning the height and the weight of the flowering stems, which varied between 73-100 cm at the "extra" category.

Table 1. Effect of irrigation frequency in total production and quality of roses

Substrate	Irrigation Regime	Total Productivity	Height (cm) mean	Weight (g)mean
perlite 100%	stressed	58,5b	77,7a	60,6a
perlite 100%	normal	50,3b	78,1a	62,5a
Perlite 50%+ almond shells 50%	stressed	57,0b	75,4a	61,5a
Perlite 50%+ almond shells 50%	normal	50,3b	75,8a	64,1a
Pine bark 50%+ almond shells 50%	stressed	92,3a	97,4a	60,5a
Pine bark 50%+ almond shells 50%	normal	59,0b	74,4a	60,8a
Pomace 50%+ perlite 50%	stressed	73.5ab	83,8a	67,3a
Pomace 50%+ perlite 50%	normal	68,3ab	79,6a	65,8a
	SX	9,16	7,57	2,03
	CV	28,7	18,9	6,5

Statistical analysis on the total productivity and/or the quality of roses (height and weight of the stems), were not significantly different considering the irrigation regime irrespective of substrates. However, the substrates irrespective of irrigation had an effect on the quantity of the produced flowers. Significant differences were recorded and the best substrate appeared to be the mixture of pine bark 50% with almond shells 50%, followed by the mixture of pomace 50% with perlite 50%. This is in consistence with previous work that showed that softwood and hardwood bark are among the popular growing and rooting media, especially when a high level of AFP is required (e.g. for orchids, anthurium etc.), (D. Savvas and H. Passam, 2002). It is also widely used for trees and shrubs in nurseries, where growth in deep containers entails a high risk of anoxia at the bottom of the container.

Lemaire *et al.,* 1998*,* stated that composting, or even just growing plants in the park, increases its cation exchange capacity. The weight of the flowering stems of the roses cultivated in the substrate pomace 50% with perlite 50% was significantly higher compared to the roses grown in the other substrates.

Different substrates, irrigation regimes or their interaction, showed no significant differences on the parameters of chlorophyll concentration, photosynthetic ability of the leaves, stomatal density and anatomic observations (i.e. leaf thickness of spongy parenchyma). The measured parameter Fv/Fm appeared to be no statistically different regarding the different substrates and the different irrigation regime used. Taking into consideration the parameters' values it is evident that no glitch incurred at the photosynthetic centres or at the photosynthetic ability of the leaves.

Measurements were also conducted regarding the photosynthesis rate, the stomatal conductance, the transpiration rate and the CO_2 concentration at the intercellular space for both years of the cultivation for radiation intensity at PAR 500 mmol m^{-2} s^{-1} and for radiation intensity, PAR 75-90 mmol m^{-2} s^{-1}. Based on the conducted measurements there were not significant differences between the different substrates and the different irrigation regimes.

From all parameters evaluated, it can be concluded that the substrates used at the specific experiment could be used for roses cultivation in combination with the reduced irrigation regime too. It seems that the frequency of water application than the total reduced amount of water was sufficient for rose cultivation and no water distress conditions were created to affect neither the production nor the normal functions of rose plants.

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