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# EFFECTS OF THE SUBSTRATE ON YIELD AND QUALITY OF TWO GERBERA VARIETIES GROWN UNDER PROTECTION

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**Abstract :** *Gerbera jamesonii* (cv. Cyprus and Heart Breaker) was cultivated on hydroponic system involving three substrates (zeolite, perlite and 1:1 zeolite:perlite) and yield and quality of flowers was recorded during a one year growing cycle. Significant differences in yield, flower quality and photosynthetic rate were noticeable in plant grown in the mixture 1:1 perlite to zeolite medium. Cv. Cyprus had the higher yield and quality in all treatments compared to Heat Breaker.

## INTRODUCTION

Gerbera will be endowed with a splendid future if the varieties and the growing techniques are well adapted to the economical and ecological conditions prevailing at the Mediterranean areas. Thus, there is an increasing interest in the physiological and productive responses of gerbera in protected soilless culture (Romero-Aranda and Martinez, 1991). Physical and chemical properties of the substrate, nutrient supply, water availability, and the particular plant characteristics contribute to the optimum productivity in intensive culture methods (Stern et al., 1974). The properties of different materials used as growing substrates exhibit direct and indirect effects on plant physiology and production (Verdonck et al, 1981). The selection of a particular material depends on its availability, cost, and local experience of its use (Klougart., 1983; Verdonck et al., 1981; Verdonck et al., 1983). For example, perlite is physically stable and chemically inert, providing a low buffering capacity. Water is retained on the granular surface or in the pore space between the aggregates (Maloupa et al, 1992) and released at relatively low moisture tension (Jackson, 1980). Perlite is used in mixtures to ensure good drainage and to increase air capacity to the substrates. In high percentages, however, it decreases the available water, which has also been observed for polystyrene (D'Angelo and Titone, 1988). Zeolite is characterized by its positive performance in cation exchange capacity (CEC), storage and availability of nutrients, and the possibility of an improved water management (Maloupa et al, 1992). Air and soil temperatures are the most important factors limiting the winter production of gerbera, as the yield and quality of flowers decline under low temperature regimes (Berninger, 1979).

The objectives of this work is to examine the effect of three substrates perlite, zeolite, and their mixture on flower yield quality and photosynthetic rate of two gerbera varieties.

## MATERIALS AND METHODS

Micropropagated plant material of *Gerbera jamesonii* H. Bolus, cvs. Cyprus, and Heart Breaker, were planted, on July 20th, into white polyethylene bags (2m in length and 30 cm in diameter) containing 80 L of substrate (10 L per plant, 8 plants per bag): perlite (particle size of 3-5 mm), zeolite (particle size of 0.8-2mm) and their 1:1 mixture. The bags were covered with coextruded black and white polyethylene film for protection from sun rays and were supported to 50 cm height. A total of 48 bags, (16 bags per substrate type, 4 plots of 4 bags) at plant density 3.15 plants/$m^2$ were used.

The experiment was installed in a greenhouse located at Thermi-Thessaloniki, Greece, covered with a 0. 18mm PE film, an additional inside thin (0.06mm) IRPE film as well as white-black plastic mulch to eliminate the evaporation effect of the ground level, avoid substrate contamination, prevent growth of weeds, and improve light reflection. The greenhouse was heated from December 1st to end of April by warm water circulation in a pipe network placed at the ground level. The greenhouse was shaded from the middle of May until September, using a black net of 40% transmittance.

Fertigation was applied 8-16 times daily for 60sec using drippers of 2 l/hr capacity. Nutrient solution, prepared in a 1m$^3$ tank, was applied through the irrigation system at the vegetative stage and contained the following concentration of nutrients: $N0_3^-$=11.5 mmol/l; $H_2PO_4^-$=1.5 mmol/l; $SO_4^{-2}$=1 mmol/l; $NH_4^+$=0.5 mmol/l; $K^+$ =11.5 mmol/l; $Ca^{2+}$=3.25 mmol/l; $Mg^{2+}$=l mmol/l; Fe=25 μmol/l; Mn=5 μmol/l; Zn=35 μmol/l; B=20 μmol/l; Cu=0.75 μmol/l; Mo=0.5 μmol/l. $K^+$ concentration during the flowering stage was 23 mmol/l. The electrical conductivity (EC) of the nutrient solution was 2 mmhos/cm and the pH was maintained at 5.5 to 6 by nitric acid.

Flowers were harvested weekly for 11 months (from November to September) when the third circle of stamens of the bisexual disc florets was ripe and assessed for the marketable quality (scape length, and capitulum diameter). Yield is expressed in number of flowers per plant and marketable quality in two grades based on scape length and flower diameter: A (scape length >40cm and capitulum diameter 7cm) and B (scape length <40cm and/or capitulum diameter <7cm). Photosynthetic rate (Pn) was measured once a month on a sunny day at 10:00 am, with a portable photosynthesis device (LI-Cor Model LI-6200).

The analysis of variance was performed by a SAS package. The Duncan's multiple range test and LSD were applied to compare means.

## RESULTS AND DISCUSSION

The average seasonal yield of Cyprus and Heart Break gerberas grown in perlite under lower heating was 51 and 35 flowers/plant white the number of A grade-quality flowers was 30 and 22, respectively (Table 1). Plants produced about 2 flowers/plant/month in November through January, increased thereafter to a peak of 10 and 6 flowers/plant/month in June (for the Cyprus and Heart Break, respectively) then decreased again to about 1 flower/plant/month (Fig. 1). The photosynthetic activity of both cultivars also increased from about 5.5 μmol $m^{-2}$ $s^{-1}$ to 7-8 μmol $C0_2$ $m^{-2}s^{-1}$ in January, decreasing thereafter to lower than the initial values in September (Fig 2). Perlite has been shown very good performance when is used as a substrate media in hydroponic cultures, since it provides high water use efficiency and economy upon reusing for more than one growing cycle crop (Hall et al., 1988). Gerberas grown in perlite culture give acceptable yield depending on the cultivated variety (Fakhri et al. 1995).

However, Cyprus and HeartBreak gerberas grown in zeolite had 4WO lower yield and A grade flower compared to perlite (Table 1). The seasonal production of flowers over time had a similar pattern with that of plants grown in perlite at also significantly lower rates; the highest yield was recorded in May amounting to 6 and 3 flowers/plant/month for the Cyprus and Heart Break, respectively (Fig. 1). Similarly the photosynthetic rate for the Cyprus and Heart Break grown in zeolite was lower by 15-20% (Fig. 2). Zeolite is also characterized by high cation exchange capacity (CEC), allowing storage and availability of nutrients as wen as an improved water management. Tsitsishvili (1988) reported that the high ion exchange and retention ability of natural sedimentary zeolites (in particular, clinoptilolites) and also their large adsorptive affinity for water contribute to their successful applications in plant growing. Moreover, clinoptilolite (zeolite type used in our experiment) posses high adsorption capacity for molecular nitrogen which interacts with adsorption sites in zeolite more intensively.

The inferior performance of plants grown on zeolite, compared to perlite can be presumably attributed to the small size of granules used (0-2mm) leading to compaction and affecting air and water availability at the root zone. Such conditions limit root respiration and nutrient or water absorption (Bunt 1983). Warmenhoven (1990) reported that gerberas grown in non- aerated solution had markedly reduced nutrient content in leaf except for Mg and Na.

**Table 1. Yearly average plant yield and flower quality of cv. Cyprus and Heart Breaker grown in a hydroponic system on three substrates**

| Substrate | *Cyprus* | | | *Heart Breaker* | | |
|---|---|---|---|---|---|---|
| | Perlite | Zeolite | Mixture* | Perlite | Zeolite | Mixture |
| Yield (average/plant/year) | 50.5 ef | 30.5 a | 56.9 f | 32.9 a | 18.6 b | 40.5 acd |
| Quality A >> | 29.8 de | 17.0 a | 37.7 f | 21.0 b | 15.0 a | 31.8 ef |
| Quality B >> | 20.7 c | 13.5 a | 19.2 ac | 11.9 b | 3.6 b | 8.8 b |

Means in the same row with the same letter are not significantly different at P = 0.05%.
* Perlite to Zeolite 1:1

Cultivation of Cyprus and Heart Break gerberas in a mixture of 1:1 perlite/zeolite resulted in a net increase in total yield and A grade flowers by 5 % compared to perlite (Table 1). This increase was especially evident from April to June for Cyprus and March to July in Heart Breaker (Fig.1). However, photosynthetic rates were higher during growth of both varieties from November to May (Fig.2). Such an increase in quantity or quality may be attributed in the combined good aeration conditions for the root system due to the presence of perlite as well as to the storage and availability of nutrients due to zeolite cation exchange capacity. In addition, the good performance of the mixture was more pronounced in the period between Feb.-Mar. when the flower prices are the highest (Table 1). A similar optimization of the performance of gerbera soilless cultivation has been reported for combinations of perlite with peat (Fahkri et al., 1995). The cation exchange capacity, which plays an important role to the availability of the nutrients to the plant (Verdonck et al., 1981), is for zeolite 130-150 meq/100g far exceeding that of perlite.

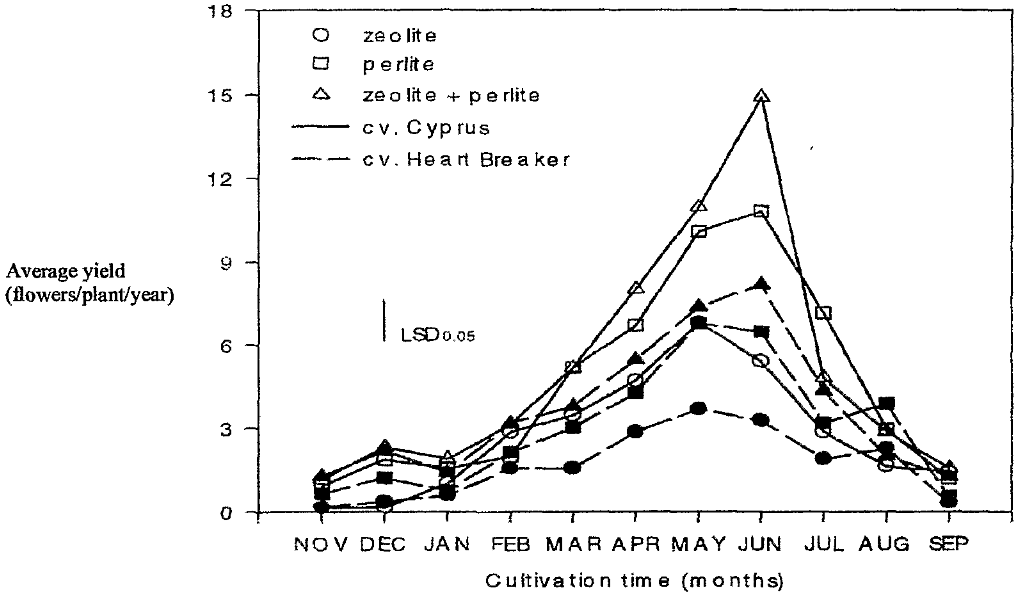


**Fig. 1. Average monthly yield of cv. Cyprus and Heart Breaker gerberas grown in a soilless system on three substrates. Each point is an average of 32 replications.**

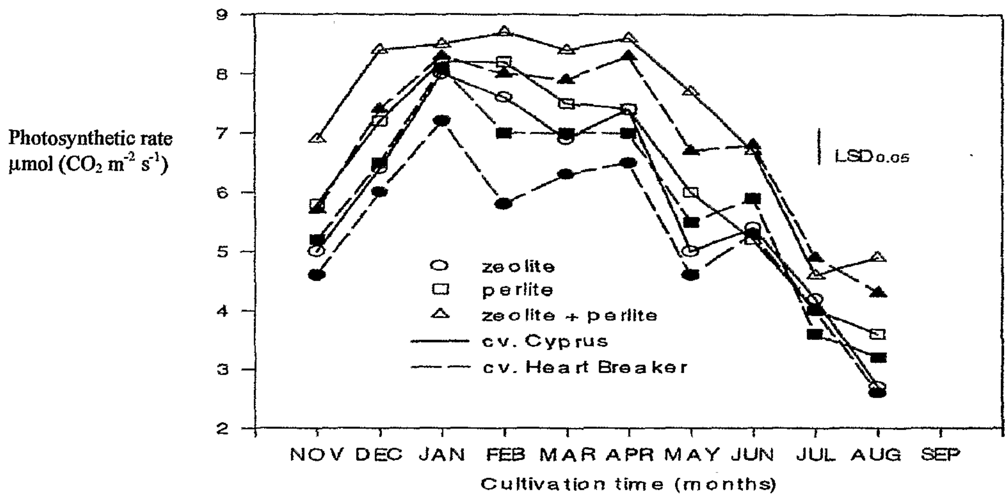


**Fig. 2. Photosynthetic rate of cv. Cyprus and Heart Breaker gerberas grown in a soilless system on three substrates. Each point is an average of 32 replications.**

## CONCLUSIONS

While perlite performed as expected, zeolite showed the worst performance. This was strongly related to the granule size of zeolite used in the experiment (0-2mm). The promising results of cultivation of gerbera on the 1:1 perlite to zeolite mixture obtained could be attributed to the physical and properties of both zeolite and perlite. Thus, the physical properties of zeolite combined with those of perlite improved the effectiveness of their mixture. Further work should be carried out to investigate the performance of granular zeolite and other mixtures of zeolite and perlite.

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