



Environmentally Friendly and
Safe Technologies for Quality
of Fruits and Vegetables

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Authors are responsible for content and accuracy of their papers.

Proceedings of the International Conference “Environmentally friendly and safe technologies for quality of fruit and vegetables”, held in Universidade do Algarve, Faro, Portugal, on January 14-16, 2009. This Conference was a joint activity with COST Action 924.

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SECTION 2. PRE-HARVEST FACTORS AFFECTING
POSTHARVEST QUALITY AND SAFETY

13. EFFECTS OF NITROGEN FERTILIZATION ON FRUIT QUALITY DURING STORAGE OF SPANISH 'PIEL DE SAPO' MELON

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Abstract

The aim of the work is the evaluation of the effect of nitrogen fertilization on fruit quality during postharvest conservation at low temperatures. Melon cultivation was fulfilled at open air with a plastic mulch and drip irrigation (100% of crop evapotranspiration). Nitrogen fertilization was applied at 0, 50, 100 and 150 kg N ha⁻¹. Melon fruits were harvested at 48-50 d (days) after fruit set, and stored at 9±1 °C and 85 % RH during 10, 20 and 30 d. After each period of conservation colour, firmness, soluble solids, vitamin C and total nitrogen contents from pulp tissue were analysed. The % fruit weight loss was determined too. No influence from the level of nitrogen fertilization on the quality parameters analysed has been detected. As expected, only total nitrogen content in fruit was affected by the different fertilization treatments. During conservation fruit firmness gradually diminished, % weight loss gradually augmented and at the end of storage vitamin C content decreased. The whole set of results showed that melon plant cultivation could be carried out with low levels of nitrogen fertilization without negatively affecting quality during postharvest, but a compromise must be found in order to avoid a negative effect on fruit production.

Keywords: conservation, fertilization, fruit quality, melon fruit

Introduction

Melon is one of the most demanded and consumed fruits in the developed countries. Spain is the main European producer of melon, with 46% of the total European production and a high level of exports. It produces more than one million tonnes per year, generating an income higher than 6 billion euros (FAOSTAT 2006). The largest areas dedicated to melon crops are concentrated in the southern half of Spain and more than 13,000 ha (33% of the national area) are found in Castilla – La Mancha region, with a total production of 365,000 t (MAPA2006).

Melon quality is defined by several parameters, in particular by those referred to pulp tissue such as colour, firmness, sweetness, although the fruit size and shape are important too. Another important quality parameter is one related to compounds that contribute to human health such as vitamin C (Odet 1991; Lester 1996). Fruit quality must be accomplished during growth and ripening on the vine because after harvest, during postharvest life, the quality can only be preserved. Quality parameters mainly depend on genotype but environmental factors such as cultivation conditions play an important role too. Among the latter ones management of fertirrigation is crucial for assuring fruit yield and quality. Irrigation and nitrogen fertilization are two important preharvest factors influencing melon production and quality (Lester *et al.* 1994; Yasuo *et al.* 2000). This crop has critical periods of growth when irrigation is necessary for optimal yield and quality (Hartz 1997) and, as in other horticultural crops; nitrogen is a dominant nutrient in growth development, productivity and longevity (Huett 1996). In particular the effect of nitrogen fertilization on melon quality has been scarcely studied until very recently (Ferrante *et al.* 2008).

The aim of this work has been evaluating the effect of nitrogen fertilization at 0, 50, 100 and 150 kg N ha⁻¹ dose on melon quality during the storage of fruits at low temperatures after harvest. The interest of this objective is the optimal management of nitrogen fertilization in order to obtain the best postharvest fruit quality and at the same time avoiding environmental contamination by excessive doses of application of nitrogen to the fields.

Material & Methods

Plant Material and Experimental Design

This conservation assay was performed with Spanish 'Piel de Sapo' melon (*Cucumis melo* L., var. *saccharinus* cv. 'Sancho'). Melon plants were grown during spring and summer seasons of 2007 in the Spanish province of Ciudad Real, in the Agronomic Experimental Station 'Entresierra' (3° 56' W – 39° 0' N, 640 m altitude).

The cultivation design of the plantation was fulfilled in randomized split-plots with four replications, where the nitrogen fertilization was the only factor of variation. This fertilization was accomplished with four treatments: 0, 50, 100 and 150 fertilization units (FU, kg N ha⁻¹). Each elemental plot (126 m²) included 7 planting rows with 8 plants per row placed 1.5 m apart, with a distance of 1.5 m between plants. The irrigation system consisted of one drip line per crop row and emitters of 2.0 l h⁻¹, 0.5 m apart. Irrigation water treatment was 100% of the crop evapotranspiration (Ribas *et al.* 1995). The cultivation was performed with transparent plastic mulch. As nitrogen source ammonium nitrate was applied at 34.5 % with the irrigation water from 13th June until 31st August, with 120 kg P₂O₅ as phosphoric acid.

Fruits were tagged at the moment of fruit set and harvested when they reached the commercial ripening stage, 48-50 d after fruit set. Immediately after harvest, fruits were transported to the research centre CEBAS-CSIC, located in Murcia, and subjected to low temperature storage. The conservation conditions were 9±1 °C of temperature and 85% of relative humidity. After 10, 20 and 30 d of conservation samples were collected for their analysis. Also samples at day of harvest (day 0) were previewed. Samples were made of 3 fruits per each level of nitrogen fertilization, and pulp tissue was collected of each fruit for analytical determinations of fruit quality and total nitrogen content.

Fruit weight was measured at harvest and at the end of the experiment in order to assess weight loss. The following quality parameters were determined: colour, total soluble solids (TSS) content and firmness, according to methods described by Flores *et al.* (2007). Colour was expressed as L (luminosity), C (chroma or colour purity) and Hue angle (tone or true colour) parameters. Firmness and TSS results were expressed in Newtons (N) and °Brix respectively. Ascorbic acid (ASC) was determined according to Wimalasiri & Wills (1983) with the modifications introduced by Egea *et al.* (2007). For the extraction 10.0 g of frozen pulp was dissolved into 10.0 mL 5% metaphosphoric acid. The results of total ASC content were expressed as mg 100 g⁻¹ FW.

The experimental results are shown as the mean of determinations made for each sample. A factorial analysis of the variance (ANOVA) was applied to the results and when significance was revealed a test of Tukey was applied (p≤0.05).

Results

No significant differences has been observed with regard to the evolution of colour parameters and TSS content in relation to nitrogen level in fertilization treatments and period of conservation of the fruits. The colour parameters values were around 66±0.69 for L, 12.34±0.82 for C and 108.3±0.58 for Hue angle for every sample, and for TSS the average value of all samples was 11.6±0.75 °Brix.

Total nitrogen content in pulp tissue gradually increased as nitrogen level in fertilization became higher, with significant differences among every level of nitrogen fertilization assayed (Fig 1A). The period of storage of fruits at low temperature seemed to have a negligible influence on the evolution of this parameter (Table 1). Total ASC content was not affected by nitrogen level of fertilization, but period of storage did

have an influence, since it significantly decreased after 30 days (d) of storage of the fruits (Fig 1B, Table 1). Also no significant influence of nitrogen level of fertilization has been observed on pulp firmness (Table 1).

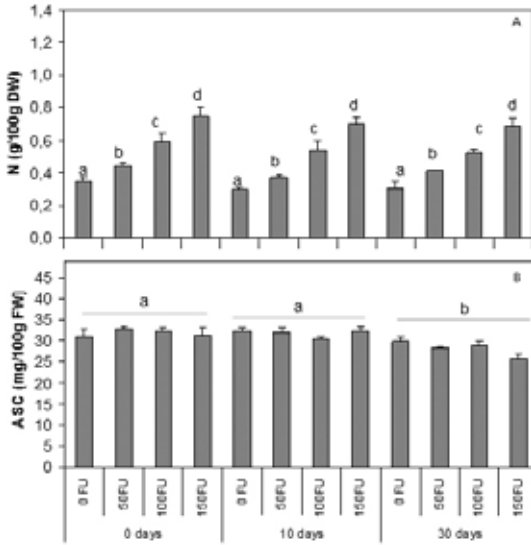


Fig 1. Total nitrogen (N) and ascorbic acid (ASC) contents in pulp tissue from 'Piel de Sapo' melon fruit in function of nitrogen fertilization treatment of plants and period of storage at 9 °C of fruits.

Table 1. Statistical F and p-value of ANOVA test performed on total nitrogen (N) and ascorbic acid (ASC) contents, and firmness in pulp tissue, and fruit weight loss, in function of period of storage (days), applied fertilization units (FU), and the interaction between both factors (D*FU).

| | Total N | | ASC | | Firmness | | Weight Loss | |
|------|---------|----------|------|----------|----------|----------|-------------|----------|
| | F | p-value* | F | p-value* | F | p-value* | F | p-value* |
| Days | 1.60 | 0.22 | 5.15 | 0.02* | 22.33 | 0.00* | 110.00 | 0.00* |
| FU | 37.39 | 0.00* | 0.30 | 0.83 | 0.99 | 0.61 | 2.59 | 0.60 |
| D*FU | 0.06 | 0.99 | 0.49 | 0.81 | 1.86 | 0.99 | 1.39 | 0.21 |

*p-values lower than 0.05 mean significant differences.

However, the evolution of this parameter is greatly influenced by the period of conservation of fruits at low temperatures (Fig 2, Table 1). In this case, pulp firmness gradually decreases along the period of storage, with significant differences among each date of sampling ($p \leq 0.05$). The opposite occurred with fruit weight loss evolution, which significantly augmented with the period of conservation at 9 °C ($p \leq 0.05$) (Fig 3). Also it was observed that fruits from plants with higher degree of nitrogen fertilization showed lower weight loss, mainly in samples with longer periods of storage, but differences among different fertilization treatments were not significant ($p \leq 0.05$) (Table 1).

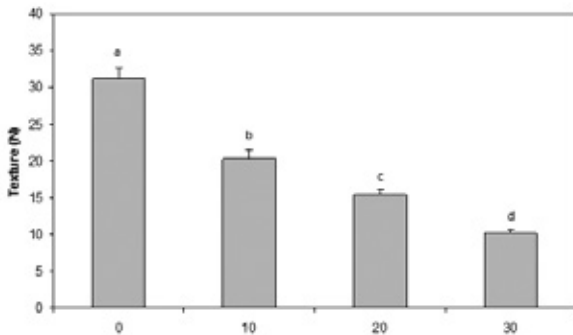


Fig 2. Pulp firmness evolution of 'Piel de Sapo' melon fruit during storage at 9 °C.

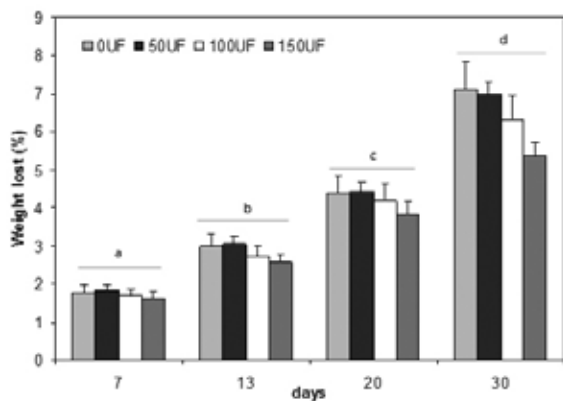


Fig 3. Percentage of fruit weight loss of 'Piel de Sapo' melon fruit during conservation at 9 °C in function of nitrogen fertilization treatment of plants and period of storage at 9 °C of fruits.

Discussion

Among quality attributes of 'Piel de Sapo' melon fruit, pulp colour, firmness and sugar content are the most important ones to determine the degree of acceptance of the fruit by consumers. The results from this experiment show that nitrogen fertilization did not affect pulp colour, contrary to results presented by Ferrante *et al.* (2008) in similar experiments with netted cantaloupe melons (*C. melo* L. var. *reticulatus*). These authors found that fruits from plants with the highest N fertilization dose showed an increase in lightness and yellowness. The minimum value of pulp firmness to be considered acceptable by consumers is 20 N. This parameter has not been found to be affected by nitrogen fertilization, although in other fruits it seems to be inversely correlated to the level of nitrogen applied in fertilization (Hernandez-Fuentes *et al.* 2003). However, storage strongly affected pulp firmness, as this parameter gradually and significantly decreased with longer periods of storage, already reaching values below 20 N from 20 d. Content of TSS did not vary with nitrogen dose in fertilization, a result in agreement with other authors. Kirnak *et al.* (2005) reported that nitrogen levels in fertilization of plants generally had little or no effect on TSS of fruits. Total nitrogen content in fruit increased with fertilization levels; these results support the hypothesis stated by Ferrante *et al.* (2008) who suggest that at high fertilization levels, the nitrogen content is not a growth limiting factor and therefore an accumulation dynamic situation takes place. Some studies have shown a negative correlation between nitrogen fertilization and ASC content (Lee & Kader 2000), while others found no effect of this first parameter on the latter one (Ferrante *et al.* 2008). In this study, ASC remained

steady among the different fertilization treatments applied. Also weight loss was not significantly affected by fertilization treatment, in spite of the fact that samples with longer periods of storage seems to suffer lower weight loss when plants were treated higher doses of nitrogen.

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