The Influence of Plant Spacing on Yield and Fruit Nitrate Concentration of Greenhouse Cucumber (Cucumis sativus L.)

Samih Abubaker¹, Yasin Al-Zu’bi¹ and Azmi Aburayan²

ABSTRACT

Cucumber (Cucumis sativus L.) cv. F1 -189 hybrid was examined at Princess Tesneem Bent Gazi Research Station at Al-Balqa’ Applied University. The study was conducted under plastic house conditions during 2007-2008 growing season. The objective of this study was to evaluate nitrate accumulation in fruits at three-size stages as affected by different plant spacings (15, 20, 25, 30, 35, 40 and 45 cm) within row and 45 cm between rows around the drip irrigation line. Total yield was significantly the highest (P < 0.001) under 30×45 plant spacing. However, fruit number was significantly higher (P < 0.001) at narrower spacing. Generally, small size fruits (less than 7 cm length) accumulated 2.0 and 1.3 folds of nitrates of those of big size (above 15 cm length) and medium size (from 7-15cm length) fruits, respectively.

Keywords: Jordan Valley, Cucumber, Plant spacing, Nitrate accumulation, Cucumis sativus L.

INTRODUCTION

Cucumber (Cucumis sativus L.) is one of the most important crops grown in Jordan (Amr and Hadidi, 2001). Consequently, the estimation of cucumber fruits’ nitrate content reflects the proportion of the nitrate problem contribution in the Jordanian diet of fresh cucumber all around the year.

Panhwar (2000) reported that nitrate in food may cause diseases including cancers and infants’ blue blood. Nitrate is the major precursor of nitrite in the human body (Cassens, 1997; Hansen et al., 2002).

Increment in plant population resulted in higher yield of bean and cucumber (Gebologlu and Saglam, 2000), cucumber (Kasrawi, 1989) and lettuce (Abu-Rayyan et al., 2004). Schleicher (2003) indicated that shading, cool and cloudy weathers coupled with high plant populations are among the factors increasing nitrate accumulation in cucumber plants. Cantliffe (1972) found that nitrate concentration in spinach was inversely proportional to light intensity.

Yield and fruit length of cucumber were affected by plant density (Gebologlu and Saglam, 2000). Plant density influences the nitrate accumulation in plants positively (Schleicher, 2003). There is no information available about the effect of density on fruit nitrate content in cucumber. Therefore, the aim of this research was to determine the optimum cucumber plant population in synchronization with the minimum nitrate content in fruits.

MATERIALS AND METHODS

This study was conducted during 2007-2008 growing season at Princess Tesneem Bent Gazi Research Station in Al-Humra area at Al-Balqa’ Applied University. Soil
texture was sandy loam. Solarization of the plastic house soil (9 x 25 m) was applied (Abu-Irmaileh, 1991). Seedlings of the most cultivated cucumber by farmers in the Jordan Valley "F1 -189 hybrid" were planted in raised beds (0.9 x 2 m) covered with black plastic mulch. Seven planting distances (15, 20, 25, 30, 35, 40 and 45 cm) within row and 45 cm between rows were used in a Randomized Complete Block Design (RCBD) with three replications. Plants were drip irrigated whenever it was considered necessary. Compound soluble fertilizer (NPK/20:20:20) was fertigated at a rate of 30 kg/ha/week for the first 3 weeks after transplanting. Thereafter, urea (N=46%) was applied at a rate of 50 kg/ha/ week till the end of the harvest season. Weeds were manually controlled, while other pests were kept under control by pesticides at both preventive and curative levels. Harvesting of the cucumber fruits was subdivided into early (the 1st 10 harvesting times from 13/12/07 to 17/1/08), medium (the 2nd 10 harvesting times from 20/1/08 to 16/3/08) and late (the last 9 harvesting times from 23/3/08 to 24/4/08). For nitrate determination, fruits were divided into 3 categories with regard to length: small fruits of less than 7 cm, medium fruits of 7-15 cm and big ones of greater than 15 cm (Amr and Abu-Rayyan, 2007). A representative sample of 20 fruits per category was taken from each plot. Nitrate analysis was conducted according to Cataldo and Haroon (1975). In addition to yield, fruit number, diameter and length were measured. Obtained data were statistically analyzed according to SAS (1998) as for the (RCBD) outlined by Steel and Torrie (1980).

RESULTS AND DISCUSSION

Different cucumber plant spacings resulted in significant differences in fruit diameter and length. The two widest spacings gave the highest fruit diameter and lowest length (Figure 1).

Variations in plant spacing introduced (Figure 2) high significant differences among early, medium, late and total fruits’ number. Highest total number of fruits was recorded at 15 x 45 cm spacing which was not statistically different from what was obtained by 20 cm as space between plants. However, medium plant spaces of 25 cm and 30 cm showed statistically similar fruit numbers.

Total yield recorded in Figure 3 varied significantly between 65 T/ha for the plants spaced at the largest distance of 45 cm to 84.9 T/ha for plants spaced at 30 cm. However, lowest spacings of 15 and 20 cm, as well as the highest one of 45 cm gave statistically the lowest total production of 65.3 and 66.4 T/ha, respectively. On the other hand, medium and late yield demonstrated almost similar trends to total yield. However, spacings of 15, 20, 25 and 30 cm did not statistically vary in the yield of early stage. The recorded results were 25.9, 25.4, 25.4 and 27.1 T/ha, respectively. This could be related to high number of plants per square meter, which in turn enhanced early yield (Kasrawi, 1989; Gebologlu and Saglam, 2000). Results recorded in Figure 4 showed significant superiority of cucumber nitrate accumulation in small fruits followed by medium fruits, while big fruits tended to contain the lowest nitrate levels. This result agreed with Amr and Abu-Rayyan (2007) who found that cucumber fruit aging reduced sharply nitrate accumulation. This might be related to the fact that nitrate content was diluted in greater quantity of dry matter presented in big fruits (Reinink et al., 1987; Esawy et al., 2009). On the other hand, results indicated that the higher the plant population the more the nitrate accumulation with significant differences in either small, medium or big fruits (Figure 4). High NO₃ content in lower-spaced plants could be attributed to the high shading and less building up of amino-acids and proteins consequenced with more nitrate accumulation (Schleicher, 2003; Abu-baker et al., 2007).
Results demonstrated in Figure 4 indicated that plant spacing affected significantly (P ≤ 0.001) the nitrate residues in the soil. The highest content of 21.3 ppm was recorded in the soil of wider plant spacings (40 and 45 cm), while the narrowest spacings of 15 and 20 cm showed the lowest nitrate accumulation (14.3 and 15 ppm, respectively). Moreover, soil of 30 and 35 cm plant spacings recorded moderate levels of nitrate content, with 17.7 and 19.3 ppm, respectively. This result could be due to the fact that higher plant populations of 15 and 20 cm spacings absorbed more nitrate from the unit area compared to those under lower plant populations. This coincided with the findings of (Cantliffe, 1972; Schleicher, 2003).

**ACKNOWLEDGEMENT**

This research was funded by the Deanship of Scientific Research at Al-Balqa’ Applied University, Al-Salt, Jordan.

---

**Figure 1. Effect of plant spacing on fruits’ quality of cucumber under plastic house conditions.**

Within each line, counts labeled with the same letter are not significantly different at p > 0.05.
Figure 2. Effect of plant spacing on fruit number of cucumber under plastic house conditions.

Within each line, counts labeled with the same letter are not significantly different at p > 0.05.

Figure 3. Effect of plant spacing on yield (T/ha) of cucumber under plastic house conditions.

Within each line, counts labeled with the same letter are not significantly different at p > 0.05.
The Influence of Plant…                                                                     Samih Abubaker, Yasin Al-Zu’bi and Azmi Aburayan

Figure 4. Effect of plant spacing on nitrate accumulation (ppm) in soil and cucumber under plastic house conditions.

Within each line, counts labeled with the same letter are not significantly different at p > 0.05.

REFERENCES


(Cucumis sativus L.)

الفصل الثاني: تأثير نبات الثمار في التطور والتكوين على نبات غازيل التثقيف

تؤثر ثمار الغازيل كثيفة التثقيف على نباتات الغازيل (Cucumis sativus L.) في التطور والتكوين. تثبت النتائج أن ثمار الغازيل كثيفة التثقيف تؤثر على نباتات الغازيل في التطور والتكوين بنسب عالية. 

لمزيد من التفاصيل، يرجى قراءة المنشور الأصلي.