INTERNATIONAL JOURNAL OF AGRICULTURE & BIOLOGY
ISSN Print: 1560–8530; ISSN Online: 1814–9596
11–674/ZIP/2012/14–4–641–644
http://www.fspublishers.org

Full Length Article

Sowing Date and Plant Population Effects on Seed Yield of *Cucurbita pepo*

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ABSTRACT

Effects of sowing date and plant population on seed yield of *Cucurbita pepo* L. were investigated. The experimental treatments included plant population at three levels (0.6, 1.3 & 2.2 plant m^{-2}) as the main plot and sowing date at three levels (April 18, 29 & May 9) as the sub-plot. Seed yield per unit area, the number of seeds per fruit, fruits per plant, flowers per plant and auxiliary branches per plant were recorded. The highest seed yield was recorded in plots having 2.2 plant m^{-2} sown on April 18. Thus, present results revealed that suitable plant density cannot improve yield and yield components of pumpkin if sowing date was delayed.

Key Words: *Cucurbita pepo* L.; Population; Sowing date; Yield

INTRODUCTION

The produce of a medicinal plant is economical when its secondary metabolites are at acceptable level. The most favorable yield can be obtained by selecting appropriate environment, variety and cultivation conditions (Omidbeigi, 2004; Ameri *et al*., 2007). *Cucurbita pepo* L. var. Styriaca is an annual herb that belongs to family Cucurbitaceae. Its main ingredients include phytosterol, flavonoids, fatty acids, vitamin E and minerals (zinc-rich) (Omidbeigi, 2004).

Plants need suitable space and environment (light, moisture, nutrients) for their growth and development. The population and sowing date of varieties differ with climate and physical and chemical characteristics of soil. Increased population decreases yield and influences the number of flowers per plant and yield per unit area because of light deficiency and competition for the uptake of nutrients (Sangoi, 2000). The maximum yield can be obtained by selecting proper environmental parameters, appropriate cultivar and on time sowing. Also, the quality and quantity of ingredients of medicinal plants varies with the growth stage. On the other hand, determination of sound time for planting plays an important role in improving the quality and quantity of secondary metabolites. The best sowing date of *Cucurbita pepo* L. is early-April and early-May in Iran (Omidbeigi, 2004).

Plant density is an important parameter affecting yield, too. As a principle, inter-species competition always decreases yield at excessive high populations. However, environmental parameters including light, space, water and soil are not optimally used at excessively low populations and so, the yield decreases (Cormark & Smith, 1998; Rassam *et al.,* 2007). Plants compete on the resources of atmosphere and soil. As canopy develops, the adjacent leaves overlap and competition for light commences. Therefore, attention must be paid to the competition for light when population and plant arrangement is to be selected (Yazdi & Poostini, 1994). Optimum plant density depends on different factors such as: the attributes of the plant, growth period, sowing date and method, soil fertility, plant size, available moisture, solar radiation, planting pattern and weeds (Ameri *et al*., 2007). As a consequence of the impact of environmental parameters on physiological stages, the optimum sowing date of a crop varies with region and genetic differences of cultivars (Seghat Al-Eslami & Mousavi, 2008).

Choice of appropriate sowing date is important, because of the necessity of maximal usage of natural resources during growing season. Early sowing plants are weakly established in spring due to the low soil temperature and the damages of frost. Also, the delay in sowing adversely influences the growth and development of the plants because of shortened growth period and the likelihood of the coincidence of flowering with high temperature (Robert & Korkmaz, 1998).

The sowing date of giant pumpkin in spring is when the soil temperature is 15°C at the depth of 10 cm (Ebadi *et al.,* 2008). Plants need suitable space and conditions (light, moisture & nutrients) for growth and development, their sowing date and plant density varies with climate, soil physical and chemical characteristics, soil fertility and cultivar (Evans & Davis, 1998). This paper describes the effect of sowing date and plant population on seed yield of *Cucurbita pepo* L. var. Styriaca in Rasht, Iran climate.

To cite this paper: Latifi, M., A. Barimavandi, S. Sedaghathoor and S.R. Lipayi, 2012. Sowing date and plant population effects on seed yield of *Cucurbita pepo*. *Int. J. Agric. Biol*., 14: 641–644

MATERIALS AND METHODS

In order to study the effect of sowing date and population on seed yield of medicinal pumpkin *Cucurbita pepo* L., an experiment was conducted in Rasht, Iran (Lat:37°10′ 5.5"N, Long: 45°33′12.6″ E., Alt. 73 m). Province of Guilan has a very humid climate with mean annual temperature of 15°C, precipitation of 1348 mm. 40 t ha^{-1} manure was applied to the field during late-August. During mid-April, N (urea), P (triple super phosphate) and K (potassium sulfate) were applied. Then, the field was divided into 27 plots, each 5 × 5 m^2. The plots were 0.5 m apart and the blocks were 1 m apart. Some physical and chemical properties of experimental field were measured. The pH and EC were 6.33 and 0.59 mmhos/cm. the texture of soil was clay with 0.7% organic matter, 84 ppm K, 7 ppm P and 0.3% N.

At first, furrows were built 1.5 m apart. Then, the seeds were planted on them (3 seeds for each hill) on April 18 (first sowing date). Two weeks later, the superior plants were selected and the remaining ones were removed in order to have the densities of 1, 2 and 3 plant m^{-2}. The same was done for the next two sowing dates (i.e., April 29 & May 9). Hill planting method was used for sowing all the plots. The first sowing date was April 18. The plant spacing was considered as 30, 50 and 100 cm. Three seeds were sown on each hill. After emergence, all but one was removed. The same operation was carried out at sowing dates of April 29 and May 9.

Five plants were randomly selected from each plot to measure such traits as the number of flowers, fruits, seed per fruit and auxiliary branches per plant. Then, their fruits were removed and afterwards, the seeds were dried at the temperature of 45°C for 6 h. Then, they were weighed. In addition, the fruits of five plants were selected from each plot and were weighed. Fruit yield per unit area was calculated by the following equation:

$$\text{Fruit yield } m^{-2} = \text{fruit number } m^{-2} \times \text{single-plant fruit yield}$$

And seed yield per unit area was calculated by the following equation:

$$\text{Seed yield } m^{-2} = \text{plant number } m^{-2} \times \text{seed yield plant}^{-1}$$

This study was a factorial experiment based on a randomized complete block design with three replications at three levels of sowing date (April 18, April 29 & May 9) and three levels of population (0.6, 1.33 & 2.2 plant m^{-2}). It included 27 plots with the areas of 25 m^2. The studied traits included fruit yield per plant, fruit yield per m^2, seed yield per plant and yield per unit area, and the number of fruits per plant, seeds per fruit, auxiliary branches and flowers per plant. The data were analyzed by software SPSS and the means were compared by LSD test. Also, the graphs were drawn by software MS-Excel.

RESULTS AND DISCUSSION

Simple treatment of population influenced significantly all experimental traits, while sowing date and interaction of plant density and date did not have significant effect on traits (Table I). The effect of population was significant on seed yield per unit area ($p<5\%$), but the interaction between sowing date and population did not significantly affect it. The highest seed yield per unit area (1882.95 kg ha^{-1}) was obtained with the population of 2.2 plant m^{-2} and the first sowing date and the lowest one (851.48 kg ha^{-1}) was obtained with the population of 0.67 plant m^{-2} and the third sowing date (Fig. 1).

Elizabeth (2001) reported that the highest seed yield per unit area was obtained at in-row spacing of 150 cm and that single-plant yield decreased with the decrease in in-row spacing. Sajed *et al.* (2002) concluded that in-row spacing of 3.5 m and within row spacing of 1 m produced the highest yield per unit area.

The first sowing date with the population of 0.67 plant m^{-2} caused to produce the highest seed dry weight per fruit (70.11 g) and the third sowing date with the population of 2.2 plant m^{-2} gave the lowest one (Fig. 2). But the impact of sowing date on it was not significant. As the population was decreased, plants accessed more water and nutrients and so, seed dry weight per fruit increased. The results about the effect of population on seed dry weight per fruit are in agreement with the results of other studies. Bavec *et al.* (2002) reported the population of 1 plant m^{-2} and May 31 sowing date as the best treatments for pumpkin. Cushman *et al.* (2002) concluded that the population of 5000 plant ha^{-1} had the highest yield.

The population significantly affected the number of seeds per fruit ($p<0.05$), but the effect of sowing date was not significant (Table I). The highest number of seeds per plant (424.9 g/fruit) was obtained under the population of 0.67 plant m^{-2} and the first sowing date and the lowest one (301.6 g/fruit) was obtained with the population of 2.2 plant m^{-2} and the second sowing date. Population significantly impacted the number of fruits per plant, but the effect of sowing date was not significant. It can be said that the population of 0.67 plant m^{-2} at the first sowing date produced the greatest number of fruits per plant (2.51) and the population of 2.2 plant m^{-2} at the third sowing date produced the lowest one (1.44). The results of other studies confirm the effect of population on the number of fruits per plant. Lima *et al.* (2003) found that as the density was increased, the number of fruits and seeds per plant decreased, which was related to the decrease in light and nutrients. Cushman *et al.* (2002) studied the effect of population (5053, 3363, 2244, 1494 plants ha^{-1}) on fruit size and weight of pumpkin and concluded that the number of fruits per plant decreased with the increase in population, so that the highest number of fruits per plant (2.7) was obtained at the population of 1494 plants ha^{-1} (Cushman *et al.*, 2002).

Table I: Means comparison of the studied traits (based on Duncan Test)

Treatments	Seed yield ($kg.ha^{-1}$)	Seed dry weight (g/fruit)	Seed number per fruit	Fruit number per plant	Flower number per plant	Stem number per plant
S_1D_1	1164.14 c	70.11 a	424.92 a	2.51 a	8.86 a	3.07 a
S_1D_2	1882.95 a	64.66 b	406.66 a	2.19 cd	7.17 c	2.46 c
S_1D_3	1757.08 a	39.24 e	332.60 d	2.02 de	5.76 d	1.91 d
S_2D_1	1076.45 c	63.11 b	383.75 b	2.48 ab	8.22 b	2.83 b
S_2D_2	1549.50 b	54.87 c	345.09 cd	2.12 cde	6.05 d	2.46 c
S_2D_3	1564.92 b	36.93 ef	301.56 e	1.91 e	5.15 e	1.98 d
S_3D_1	851.48 d	56.35 c	365.64 bc	2.27 bc	5.86 d	2.40 c
S_3D_2	1072.36 c	48.52 d	341.71 d	1.65 f	4.84 e	1.88 d
S_3D_3	1094.01 c	34.12 f	311.45 e	1.44 f	3.94 f	1.65 e

S_1, S_2 and S_3 show the sowing dates of April 18, April 29 and May 9, respectively; and D_1, D_2 and D_3 show the populations of 0.67, 1.3 and 2.2 plant m^{-2}, respectively. Means sharing the similar letter in a column are statistically non-significant ($P > 0.05$)

Fig. 1: Seed yield ($kg\ ha^{-1}$) under trial planting density

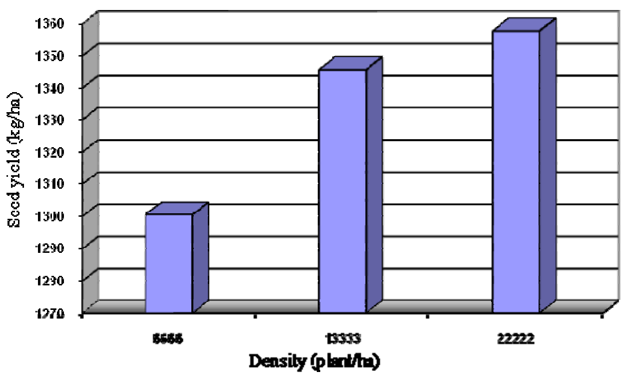
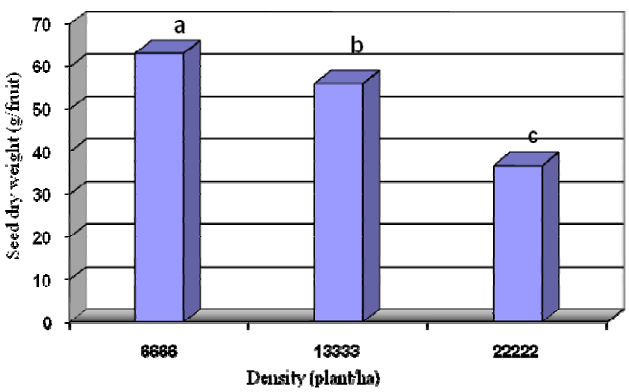


Fig. 2: Effect of plant population on seed dry weight per fruit (g/fruit)



The effect of population was significant on the number of flower per plant (Table I). The population of 0.67 plant m^{-2} and the first sowing date had the highest number of flower per plant (8.86) and it can be concluded that as the population was decreased, the competition between plants started to decrease and the availability of nutrients and light for each plant increased, which led to the increase in the number of flowers per plant. The population of 2.2 plant m^{-2} and the third sowing date had the lower number of flowers per plant (3.94) (Table I). This severe decrease in the number of flowers per plant can be related to the deficiency of nutrients and light at higher populations and it can be concluded that high population and delayed sowing can lead to the reduction of the number of flowers per plant. In a study on the effect of plant spacing (10, 20, 30, 40 & 50 cm) on the flower yield of summer squash, Hafidh (2001) observed that the spacing of 50 cm had the maximum number of flowers and the spacing of 10 cm had the minimum one. The population of 0.67 plant m^{-2} and the first sowing date produced the most branches per plant (3.07) and the population of 2.2 plant m^{-2} and the third sowing date gave the least branches per plant (1.65).

CONCLUSION

Simple effect of early sowing date and low plant population caused to yield increasing in pumpkin, but these factors interaction did not have significant effect on the yield. The highest seed yield was obtained with the population of 2.2 plant m^{-2} and sowing on April 18. Thus, suitable plant density could not improve yield and yield components of pumpkin if sowing date was delayed.

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(Received 28 November 2011; Accepted 21 February 2012)