Turkish Journal of Agricultural and Natural Sciences
Special Issue: 1, 2014

TÜRK
TARIM ve DOĞA BİLİMLERİ
DERGİSİ

TURKISH
JOURNAL of AGRICULTURAL
and NATURAL SCIENCES

www.turkjans.com

Secondary Broccoli Production Depending On Sowing And Planting Dates

Desislava TODOROVA
Institute of Agriculture, Kyustendil, 2500, Bulgaria
Corresponding author: desi_todorovaiz@abv.bg

Abstract

The investigation was carried out during the period of 2009-2011 at the Institute of Agriculture – Kyustendil, located in the Southwest Bulgaria. Four broccoli (*Brassica oleracea* var. *italica* Plenck) hybrids were grown by the technology of late field production with different sowing and planting dates. The aim of the research was to establish a relationship between planting time and secondary yield of broccoli. Some morphological characteristics and production traits of an additional yield of broccoli side shoots were studied. Different variants and hybrids formed from 395.0 to 1038.5 kg/da additional production during the years of the experiment. Fiesta F1 has the highest number of secondary flower heads per a plant (4.9), average for the period. The largest lateral flower heads formed hybrid Marathon F1 – 0.092 kg. The secondary yield ranges from 18.6 to 33.1 % of total broccoli yield and can compensate the low yields obtained from primary head production.

Keywords: Broccoli, hybrids, sowing and planting dates, lateral flower heads, yield

Introduction

Over the last decade the consumption of broccoli (*Brassica oleracea* var. *italica* Plenck) is highly recommended on the basis of the information contained therein plant metabolites with health protective effects on the human body. It contains all the essential vitamins A, B, C, E and K, calcium, iron, magnesium, zinc, iodine, copper, cobalt, lutein and antioxidant sulforaphane. Broccoli contains flavonoids, phenolic acids and soluble dietary fiber, disaccharides, beta carotene and amino acids (including a high content of lysine) too and it has antioxidant and anticancer activity (Podsędek, 2007). Broccoli is a culture easygoing to soil and climatic conditions. Its important advantage is the ability after cutting central consumptive part to form additional small side branches heads of which generate additional production. Some varieties have a large central head and few side heads. They picked up for a short period. Others have smaller central head but have many side heads and harvested for a long period. Secondary flower heads are harvested in stages by the end of the growing season and in many varieties side shoot development will continue for several weeks after the harvest of the main head. Depending on the weather during harvest can be made 3 to 5 day interval harvests for a period of 2 to 3 weeks.

Lateral flower heads vary in size and weight depending on the hybrid, but they generally are significantly smaller than the central flower head. The weight of the lateral flower heads in broccoli reaches 8.90-30.82 g, and their number is 2.65-35.50 per plant (Acikgoz, 2007). Environmental factors such as light, temperature and precipitation play an important role in the growth and yield of broccoli. In an experiment in Pakistan has been found that drilling on May 5 provides the largest number of side flower heads of the plant - 16 (Ahmed and Siddique, 2004). The production of additional heads is affected by hybrid, density and manner of planting in the field (Apahidean, Apahidean, SA, 2010). In testing the broccoli breeding lines Antonova (2002) found that different genotypes formed from 2.1 to 3.0 number of lateral flower heads with a mass of 0.045 to 0.090 kg and a diameter of 2.1 to 5.0 cm. In other studies it was found that the productive potential of the formation of additional section is from 2.3 to 7.8 with a weight of 0.017 to 0.073 kg, it forms additional yield is within 103-710

kg/da (Antonova, 2003). In an experiment in Turkey has been found that while the central flower heads yield was 20-25%, the yield of the additional is above 75-80% (Sari et al., 2000).

The majority of investigations have focused on research and analysis of indicators related to central flower head. The purpose of this study was to determine the influence of the timing of planting to obtain additional yield of broccoli.

Materials and Methods

The study was conducted in the Institute of Agriculture, Kyustendil, Bulgaria during the period 2009-2011. The investigation includes four broccoli hybrids: Fiesta F1 and Coronado F1 (Bejo Zaden, Netherland), Marathon F1and Parthenon F1 (Sakata seeds, Japan) and 30 days old healthy seedlings, transplanted in the field at 15 days intervals as follows:

I - Early- sowing on June 1st and planting July 1st

II – Medium – sowing June 15th and planting July 15th

III – Late – sowing June 30th and planting July 30th

Normal growing system of cruciferous plants was followed in the nursery till transplanting times. The test plants in 12 treatment combinations were planted in the Randomized Block Design with four replications and 20 plants in each replication. The soil is *Chromic Luvisols*, medium to heavy sandy loam with low soil acidity. Recommended doses of fertilizers were incorporated. Furrow irrigation was applied. Plants were grown in technology for late field production with planting scheme 80/50 cm, providing 2.500 plants per hectare. Broccoli plants were subjected to the normal agricultural program of growing cruciferous plants in which irrigation, fertilization as well as safe disease and pest control systems were followed.

At 10 plants from each replication were recorded: number of side flower heads, average diameter (cm); average mass (kg) of the lateral flower heads. Additional yield from lateral flower heads of broccoli has been calculated in kg/da and the percentage of additional of the total yield too. The measurements were made on fully formed lateral flower heads in a single harvest.

The data of some indicators were processed statistically by QBasic LSD (Maneva, 2007) and the significance of the difference between the results was determined at levels of p=0.05%; 0.01% and 0.001%. As a standard was used Marathon F1 hybrid in view of its part in about 40% of World broccoli production.

Table 1. Effect of planting time on number of lateral flower heads

Traits	Year	July 01	July 15	July 30	Mean
Fiesta F1	2009	4.2	4.8	3.0	4.0
	2010	6.3	4.9	3.2	4.8
	2011	3.5	5.1	3.2	3.9
	Pooled	4.7	4.9	3.1	4.2
Maratho n F1	2009	3.5	3.3	3.5	3.4
	2010	3.0	3.5	3.1	3.2
	2011	3.7	2.8	3.2	3.2
	Pooled	3.4	3.2	3.3	3.3
Coronad o F1	2009	4.4	4.0	3.1	3.8
	2010	4.3	4.3	3.2	3.9
	2011	5.1	4.1	3.1	4.1
	Pooled	4.6	4.1	3.1	3.9
Partheno n F1	2009	3.3	4.0	3.5	3.6
	2010	3.4	3.7	3.4	3.5
	2011	2.9	3.6	3.6	3.4
	Pooled	3.2	3.8	3.5	3.5

Results

Majority of the plants of investigated hybrids form about 3-4, rarely 5 lateral flower heads. On its side branches broccoli formed from 2.8 to 5.1 lateral flower heads (Table 1). With the highest number of lateral head features hybrid Fiesta F1- 4.9 average for studied period. Single plants of Fiesta F1 formed 10 -12 side shoots. Japanese hybrids Marathon F1 and Parthenon F1 as a whole form smaller number compared to hybrids Netherland origin. Analyzing

the number of lateral heads formed, two of the hybrids (Marathon F1 and Coronado F) showed the best results in early sowing and planting date and for the remaining two - the most favorable sowing is June 15. When plants are transplanted in the field at late planting date number of lateral flower heads is in range from 3.1 to 3.5.

The mass of the lateral heads ranges from 0.042 to 0.103 kg with various hybrids from the years of the study (Table 2). The smallest are side shoots in Coronado F1 – 0.054 kg on average for three years and the biggest - in Marathon F1 – 0.092 kg. Single plants Marathon F1 form lateral flower heads with large, close to the average size of a central flower head in some hybrids. For example, in one of the plants of the hybrid grown as early variant of sowing and planting in 2009, measured 4 side heads weighing respectively 0.515, 0.220, 0.390 and 0.540 kg. Plants that do not form a central, only 3 side heads were observed too. The reason for this is most often interrupted vegetation top (apex) during planting, hoeing or attack by pests.

The diameter of lateral flower heads ranges from 4.1 to 5.6 cm (Table 2). It was least influenced by the planting time. For Fiesta F1 the largest are lateral heads, formed from plants transplanted at early planting date. Marathon F1 best achievement was on middle sowing and planting date. When transplant Coronado F1 and Parthenon F1 at the end of July (late variant), the lateral flower heads diameter was 4.8 and 5.0 cm respectively.

Table 2. Morphological characteristics of broccoli side shoots – number, mass, diameter and yield

Hybrid		2009				2010				2011				Average for the period			
		Number	Mass, kg	D, cm	Yield, kg/da	Number	Mass, kg	D, cm	Yield, kg/da	Number	Mass, kg	D, cm	Yield, kg/da	Number	Mass, kg	D, cm	Yield, kg/da
F	I	4,2	0,042	3,9	441,0	6,3	0,066	5,6	1038,5	3,5	0,100	7,4	875,0	4,7 ns	0,069	5,6	784,8
	II	4,8	0,061	4,2	732,0	4,9	0,058	4,3	710,5	5,1	0,055	3,8	701,0	4,9 ++	0,058	4,1	714,5
	III	3,0	0,054	4,4	395,0	3,2	0,060	3,7	480,0	3,2	0,058	4,2	455,0	3,1 ns	0,057	4,1	443,3
M	I	3,5	0,103	4,9	901,0	3,0	0,079	4,3	594,0	3,7	0,094	4,7	869,5	3,4	0,092	4,6	788,2
	II	3,3	0,062	5,3	511,5	3,5	0,066	5,1	577,5	2,8	0,074	4,8	518,0	3,2	0,067	5,1	535,7
	III	3,5	0,056	4,7	483,2	3,1	0,059	3,9	457,1	3,2	0,059	4,2	468,0	3,3	0,058	4,3	469,4
C	I	4,4	0,084	4,6	924,0	4,3	0,068	4,2	731,0	5,1	0,062	4,0	790,5	4,6 ns	0,071	4,3	815,2
	II	4,0	0,054	4,3	540,0	4,3	0,057	4,4	613,0	4,1	0,050	4,2	512,5	4,1 **++**	0,054	4,3	555,2
	III	3,1	0,062	5,3	484,6	3,2	0,066	4,2	520,4	3,1	0,069	5,0	535,6	3,1 ns	0,066	4,8	513,5
P	I	3,3	0,064	4,5	528,0	3,4	0,071	4,4	603,5	2,9	0,068	4,6	493,0	3,2 ns	0,068	4,5	541,5
	II	4,0	0,070	4,4	700,0	3,7	0,085	5,1	786,0	3,6	0,072	4,9	648,0	3,8 ns	0,076	4,8	711,3
	III	3,5	0,073	6,0	631,3	3,4	0,074	4,8	629,4	3,6	0,055	4,1	480,9	3,5 ns	0,067	5,0	580,5

F – Fiesta F1; M - Marathon F1; C – Coronado F1; P – Parthenon F1; D – Diameter, cm
LSD 0,05 = 0,82 0,01 = 1,241 0,001 = 1,994

Table 3. Additional and total yield broccoli, kg/da

Hybrid		2009		2010		2011		Average for the period	
		Add.	Total	Add.	Total	Add.	Total	Add.	Total
F	I	441	2653.5	1038.5	2621	875	2523	784.8	2599.2
	II	732	2424.5	710.5	2285.5	701	3067	714.5	2592.3
	III	395	2195	480	1536.3	455	1681.3	443.3	1804.2
M	I	901	2965	594	2371.5	869.5	2485.5	788.2	2607.3
	II	511.5	2549	577.5	2282.5	518	2130.5	535.7	2320.7
	III	483.2	2323.8	457.1	1768.4	468	2221.8	469.4	2104.7
C	I	924	2651.5	731	2291	790.5	2453.5	815.2	2465.3
	II	540	2775	613	1988	512.5	2850	555.2	2537.7
	III	484.6	2288.6	520.4	1864.8	535.6	2226.2	513.5	2126.5
P	I	528	2958	603.5	2611	493	3162	541.5	2910.3
	II	700	3730	786	3058.5	648	3708	711.3	3498.8
	III	631.3	3448.8	629.4	2455.7	480.9	2833.4	580.5	2912.6

The yield of the lateral flower heads to a certain extent can compensate for compromised yield of the central flower head. Individual hybrids and variants percentage of the additional yield ranged from 18.6 to 33.1 % compared to the total production average for the period of study (Fig. 1). These results are in contrast with the data reported by Sari et al. (2000). In soil and climatic conditions of Kyustendil area, Bulgaria, the main part of broccoli yield is formed by central flower head. From the obtained data it is clear that with a delay of sowing the additional yield decreases with the first three hybrids and increases with Parthenon F1. Data are unidirectional as in the years of the experiment, and the average three-year period. The largest yield of lateral flower heads was formed Fiesta F1 – 1038.5 kg/da in 2010, but the same hybrid option has the lowest value in the previous year – 395.0 kg/da (Table 3). This fact indicates that Fiesta F1 hybrid has a high biological production potential side flower heads, but this largely depends on the weather conditions during vegetation. The highest secondary head yield was obtained by the combined effect of the early planting date and Coronado F1. Average for the period Coronado F1 features 815.2 kg/da, which corresponds to 33.1 % of total yield. The lowest secondary yield was recorded by the interaction of late planting date and Fiesta F1. Other interaction treatments ranged between these two treatmentsThe least efficient in terms of lateral flower heads is Parthenon F1, wherein the secondary yield is from 18.6 to 20.3% of total yield respectively. The low value of its additional yield does not affect the overall yield, which is the highest among all hybrids. Secondary yield per plant recorded maximum at 1 July planting date. The every delay in sowing and transplanting after that date resulted in significant decrease in yield and its attributes, except hybrid Parthenon F1. The decrease in yield with the delay in sowing was also reported by Yoldas and Esiyok (2004) and Wlazo and Kunicki (2003).

Extraction of additional flower heads to a certain extent can compensate for the low yields obtained from primary production and generally the secondary yield of 18.6 to 33.1 % of total yield obtained from investigated broccoli plants (Fig. 1). Typical of first three hybrids is that late dates of sowing and planting decrease the percentage of the additional of total yield while hybrid Parthenon F1 dependence is reversed. The later sowing and planting of it influence positive on the formed additional yield, the increase was 1.7 % (medium planting) and 1.3 % (late planting). The most significant reduction in the later period of planting shows hybrid Coronado F1 - 11.2 % and 9.0 % respectively.

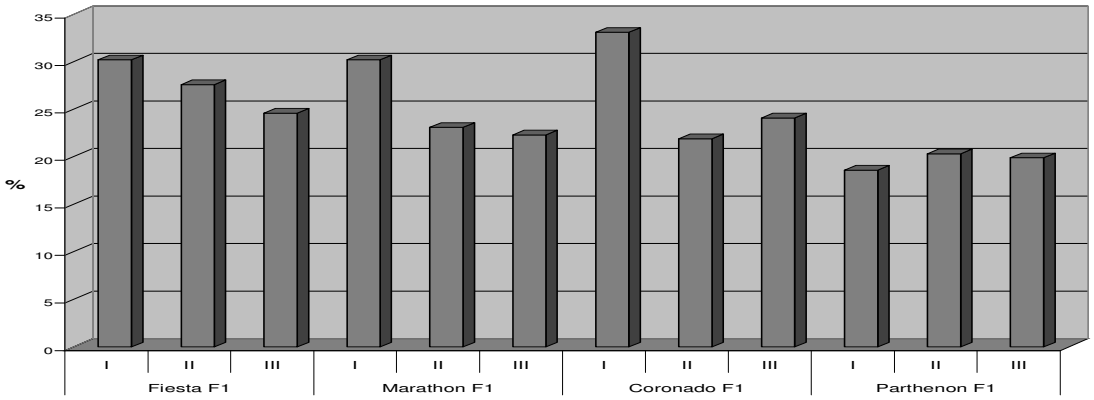

Figure 1. Share of the yield of lateral flower heads against the total yield, average for the period, %

The delayed planting markedly reduced the secondary yield, except Parthenon F1.

No statistical results confirmed but there are clearly discernible trends for the different indicators. About number of lateral flower heads data are statistically proven for medium planting of Fiesta F1 and Coronado F1 at LSD 0.01.

Conclusions

Coronado F1 hybrid showed highest biological production potential of side flower heads with secondary yield of 815.2 kg/da.

The yield of additional flower heads can compensate lower yields derived from primary production. Its size is from 18.6 to 33.1% of the total yield.

It was established that the delay of sowing and planting by 15 days in the majority of the tested hybrids leads to reduced formation of secondary to the total production from 0.8 to 11.2%.

Harvesting the production of lateral flower heads can provide additional yield from 395.0 to 1038.5 kg/da, which is a solid stock compensate for low yields obtained from major central flower head.

References

Antonova, G., 2002. Morphological characteristics of broccoli breeding lines. Scientific Session of Jubilee 2002 – Sadovo, Volume II, 245-248.

Antonova, G., 2003. Influence of variation factors on the expression of some characters for productivity in broccoli breeding lines, Scientific conference with international participation - Stara Zagora 2003, Volume I. Agricultural Sciences, Part 1. Plants, 236-239.

Acikgoz, FE., 2007. The effect of different sowing times on development and efficiency of some broccoli varieties grown in Corlu conditions. Pak J Biol Sci. 2007 Sep 15;10(18):3234-6.

Apahidean, A. I., Apahidean, S. A., 2010. Secondary broccoli sprouts influence upon broccoli yields. Bulletin of University of Agricultural Sciences and Veterinary Medicine Cluj-Napoca. Horticulture 2010, Vol. 67, No. 1, pp. 501.

Ahmed MJ, Siddique W, 2004. Effect of sowing dates on growth and yield of broccoli (*brassica oleracea* l.) under Rawalakot conditions. Asian J. Plant Sci 198.170.104.138.

Dev, H., 2012. Standardization of planting time and spacing in broccoli cv Green Head for lower hills of Northern India. *International Journal of Farm Sciences* 2(1) : 36-42.

Maneva, S., 2007. Mathematical methods in plant protection. PhD Thesis, p. 201.

Sari, N., Yildiz Dasgan, H. and Abak, K. 2000. Effects of sowing times on yield and head size of broccoli grown in the Gap area, Turkey. Acta Hort. (ISHS) 533:299-306.

Podsędek, A., 2007. Natural antioxidants and antioxidant capacity of Brassica vegetables: A review, LWT - Food Science and Technology, Volume 40, Issue 1, January 2007, Pages 1–11.

Wlazo A and Kunicki E., 2003. The effect of transplant age and planting time on yield and quality of autumn broccoli. Folia Horticulturae 15(2): 33-40.

Yoldas F and Esiyok D 2004. Effects of seedling age and plant spacing on yield and quality of broccoli (*Brassica oleracea* var. *italica*) varieties in plateau conditions. Anadolu 14(2): 81-104.