Volumen 30, Nº 2. Páginas 11-18
IDESIA (Chile) Mayo-Agosto, 2012

Agronomic performance of cultivars of organic onion in two harvest times

Desempeño agronómico de cultivares de cebolla orgánica en dos épocas del año

Marcelle Michelloti Bettoni[1], *Átila Francisco Mógor*[1], *Volnei Pauletti*[2],
Vitor Cezar Pacheco da Silva[1], *Renata Koyama*[1], *Lury Yibel Forero Peñuela*[1]

ABSTRACT

The growing demand for organic products and the need to plant onions (*Allium cepa* L.) in the town of Pinhais, Brazil at different times of the year generated this study in the Organic Horticulture Experimental Station of Canguiri-Federal University of Parana, Pinhais, Brazil. The objective was to evaluate the agronomic performance of seven cultivars of open-pollinated onion in an organic system in two planting seasons (January and September) different than traditional times (April and June). The experimental design was completely randomized in a 7x2 factorial scheme with three replicates: Franciscana IPA-10, Vale Ouro IPA-11, Brisa IPA-12, Alfa São Francisco (Cycle VIII), Alfa São Francisco -RT (*Thrips tabaci*-resistant genotype assessment - Embrapa Semi-arid) and BR-29. The results were evaluated for homogeneity by Bartlett's test and treatment means were compared by Tukey's test at a significance level of 5%. The variables assessed at the start of bulb formation and harvest were stem height, fresh and dry leaf weight, leaf number and scape diameter. At harvest we measured dry and fresh mass of the bulb, bulb type according to the diameter and productivity. The cultivars Alfa São Francisco and Alfa São Francisco-RT produced higher values of dry mass and productivity in January.

Key words: *Allium cepa* L., climate adaptation, productivity, harvest.

RESUMEN

*La necesidad de abastecer la creciente demanda de productos orgánicos y permitir la plantación de cebolla (*Allium cepa *L.) en el municipio de Pinhais, Brasil en épocas diferentes a las tradicionales, llevó a realizar un estudio en el Área Experimental de Horticultura Orgánica de la Estación del Canguiri-Universidad Federal de Paraná, municipio de Pinhais, Brasil. El objetivo fue evaluar el desempeño agronómico de siete cultivares de cebolla de polinización abierta, en un sistema orgánico, en dos épocas de siembra (enero y septiembre) diferentes a las épocas tradicionales (abril y junio). El diseño experimental fue completamente al azar, en un esquema factorial 7x2, con tres repeticiones: Franciscana IPA-10 (roja), Vale Ouro IPA-11 y Brisa IPA-12 de la Empresa Pernambucana de Investigación Agropecuaria-IPA, Alfa Tropical de Embrapa Hortalizas, Alfa San Francisco (ciclo VIII), Alfa San Francisco-RT (resistente al* Thrips tabaci *–genotipo en evaluación– Embrapa Semiárido) y BR-29 de Topseed-Agristar. Los resultados fueron evaluados en cuanto a homogeneidad por el Test de Bartlett y las medias de los tratamientos fueron comparadas por el Test de Tukey al nivel de significancia del 5% de probabilidad. Las variables evaluadas al inicio de la bulbificación y al final del ciclo fueron: altura del vástago, masa fresca y seca de hojas, número de hojas y diámetro del pseudotallo. En el momento de la cosecha se cuantificó la masa seca y fresca del bulbo, clase de bulbos de acuerdo al diámetro y la productividad. Los cultivares de Alfa San Francisco y Alfa San Francisco-RT obtuvieron altos valores de masa seca y productividad en enero.*

Palabras claves*:* Allium cepa *L., adaptación climática, productividad, época de colecta.*

Introduction

Onion (*Allium cepa* L.) is one of the most widely grown plants in the world; in 2009 72.3 million t were produced with a mean productivity of 19.6 t ha^{-1} (FAO, 2010). The greatest production is in China, India, USA, Pakistan and Turkey, which together produce 54% of the world total. Brazil is ninth in world production; onions third among agricultural crops in Brazil; the state of Parana is sixth in national production. Harvest is concentrated in the second half of the year; in some

1 Universidade Federal do Paraná - Departamento de Fitotecnia e Fitossanitarismo - Rua dos Funcionários, 1540, CEP 80035-050, Curitiba-PR, Brasil. Email: m2bettoni@gmail.com, atila.mogor@ufpr.br, vitorcezar@gmail.com, emykoyama@hotmail.com
2 Universidade Federal do Paraná - Departamento de Solos e Engenharia Agrícola - Rua dos Funcionários, 1540, CEP 80035-050, Curitiba-PR, Brasil. Email: vpauletti@ufpr.br

Fecha de Recepción: 23 Marzo, 2012.
Fecha de Aceptación: 8 Mayo, 2012.

seasons onions are imported from other states and countries (IBGE, 2010).

According to the Brazilian Ministerio de Agricultura Pecuaria y de Abastecimiento (MAPA, 2008), the world annual market for organics is about US$ 23.5 billion, and is expected to increase by 20% annually. From 2006 to 2008 Brazil exported 37 mill t in organic products. According to Baier *et al*. (2009), onion cultivation in Paraná is one of the main activities of a large number of small producers, classifying it as a family crop; socio-economically it is very important. The Instituto Biodinámico (IBD) in 2004 verified that nearly 80% of the organic producers in the state of Paraná are family producers in areas of less than 3 ha, which establishes a strong correlation between this type of property and the type of system used.

There is a lack of organic onions available in some seasons. Camargo Filho and Alves (2005), analyzing the productive chain of this species, reported that all the supply in the first semester comes from reserves of late onions (with cycles of 6-8 months and a photoperiod greater than 13 hours) produced in southern Brazil, which fulfills the demand in the January-April period. However, beginning in March onions from Argentina enter the national market and continue until July, since the production in Paraná is not sufficient to supply the local demand. According to Vilela *et al.* (2005), when there is external competition, market needs should be met by simulating and maintaining production by local producers.

Oliveira *et al*. (2004) indicated that photoperiod and temperature are the climatic factors which control the adaptation and consequently the recommendable onion cultivars; they consider that the use of cultivars not adapted to the growing conditions (place and time) generates low productivity and/or poor bulb quality. Detecting the needs for new alternatives in sustainable production in economic, social environmental aspects for family farmers, the lack of onions between harvests may be corrected, filling the growing demand for organic products.

We evaluated the performance of seven open-pollinated onion cultivars from national improvement programs, originally developed in the south of the country and later selected for the 12-hour photoperiod used in organic culture, in order to identify the cultivars with greatest productive potential in local photoperiod and temperature conditions which will allow harvests at other times of the year and therefore satisfy the demand in the time between traditional harvests.

Materials and Methods

The experiment was performed from January to December, 2009, in the area of Organic Vegetables of the Centro de Estaciones Experimentales del Canguiri of the Universidad Federal del Paraná, in the Municipio de Pinhais, Estado de Paraná, Brazil. It is located in the physiographic region called first paranaense plateau, located at 25º25' S, y 49°08' W, elevation 930m. According to the classification of Köeppen the climate is temperate Cfb with marked seasons. Mean monthly precipitation from January-December, 2009 was 135.2; 160.6; 118.4; 13.4; 41.6; 70.2; 265.6; 102.0; 272.4; 163.6; 213.8; 233.4 mm, respectively. Mean monthly temperatures for this period were 19.0º; 19.0º; 19.1º; 16.0º; 14.0º; 10.2º; 10.9º; 12.9º; 13.9º; 15.9º; 21.4º y 20.2 ºC, respectively (Simepar, 2010). The mean photoperiods of the area were: 13:30h/January, 12:56h/February, 12: 13h/March, 11:28h/April, 10:52h/May, 10:34h/June, 10:43h/July, 11:15h/August, 11:57h/September, 12:42h/October, 13:21h/November and 13:41h/December (Observatorio Nacional, 2009).

The soil is a Latosol red-yellow alico with clay texture and gentle rolling hills (EMBRAPA, 2006), whose chemical analysis in a 0-15 cm soil profile in the first cycle indicated: pH ($CaCl_2$) = 6.1; pH SMP = 6.4; Al^{+3} = 0; H+Al = 3.7 $Cmol_c$ dm^{-3}; Ca^{2+} = 7.2 $Cmol_c$ dm^{-3}; Mg^{2+}= 3.4 $Cmol_c$ dm^{-3}; K^+ = 1.44 $Cmol_c$ dm^{-3}; P = 158.4 mg dm^{-3}; C = 37.4 g dm^{-3}; Boron = 0.98 mg dm^{-3}; V% = 76 y CTC= 15.74 $Cmol_c$ dm^{-3}. For the second cycle the means were: pH ($CaCl_2$) = 5.1; pH SMP= 5.9; Al^{+3} = 0; H+Al = 5.4 $Cmol_c$ dm^{-3}; Ca^{2+} = 5.2 $Cmol_c$ dm^{-3}; Mg^{2+} = 3.0 $Cmol_c$ dm^{-3}; K^+ = 1.17 $Cmol_c$ dm^{-3}; P = 61.20 mg dm^{-3}; C = 27.4 g dm^{-3}; Boron = 0.96 mg dm^{-3}; V% = 63 and CTC= 14.77 $Cmol_c$ dm^{-3}.

The experimental design was completely randomized in a 7 X 2 factorial design with three replicates; one factor was the seven open-pollinated onion cultivars: Franciscana IPA-10 (red), Vale Ouro IPA-11and Brisa IPA-12, (Empresa Pernambucana de Investigación Agropecuaria-IPA), Alfa Tropical (Embrapa Hortalizas), Alfa San Francisco (ciclo VIII Embrapa) and Alfa San Francisco-RT (resistant to thrips- genotype under study - Embrapa Semi-árido) and BR-29 (Topseed- Agristar). The second factor was sowing time or cycle; cycle one was sown in January and collected in August and cycle two was sown in September and collected in December. Seedlings were produced from seeds using the method of Ferreira (2000).

Soil was prepared two weeks before seedling transplant, according to the recommendation of Raij *et al*. (1996), and consisted of 200 kg ha^{-1} magnesium thermophosphate (YOORIN MASTER 1, with 17% P_2O_5) and 8 t ha^{-1} of organic compounds for the two cycles, whose analysis yielded for cycle one: N = 14.4 g kg^{-1}; P = 10.6 g kg^{-1}; K = 11.3 g kg^{-1}; Ca = 31.7 g kg^{-1}; Mg = 6.8 g kg^{-1}; C = 384 g kg^{-1}; pH = 7.1; C/N = 27.6; and for cycle two: N = 15.6 g kg^{-1}; P = 11.1 g kg^{-1}; K = 13.2 g kg^{-1}; Ca = 30;2 g kg^{-1}; Mg = 6.4 g kg^{-1}; C = 374 g kg^{-1}; pH = 7.1; C/N = 27.6.

Four rows were used per plot, with 30 cm spacing between rows and 15 cm between plants; plots of 4.86m (4.05 m x 1.20 m) with 104 plants, equivalent to 270,000 plants ha^{-1}. Seedlings were transplanted when they reached a height of 18-20 cm (Ferreira, 2000). 30-40 days after transplant in cycle one we applied 80 kg potassium sulfate per ha (50% K_2O and 17% S, both water soluble) and 40 Kg in cycle two.

Evaluations were performed at the beginning of bulbing in each cycle and at the end of each cycle. Productivity was calculated after about 75% of the aerial parts of the plants had fallen. The first evaluation was made with four central plants per plot at 50 days after transplant (DAT) for the first cycle and at 35 DAT for the second cycle. We measured plant height (from the scape to the highest leaf, fresh and dry leaf weight, number of leaves and scape diameter (measured with a manual pachymeter). Leaf area was measured in a WinRhizo Version 4.1c image analyzing system (Régent Instruments, 1999). Leaves were placed lengthwise and flattened to obtain better precision. Since leaves are cylindrical, the area was multiplied by two.

At harvest, 99 DAT for cycle 1 and 58 DAT for cycle 2, we evaluated bulb dry and fresh weight and bulb class according to the recommendation of the Ministerio de Agricultura y de Abastecimiento (portería 529, 18 August 1995), which established 5 classes of the greatest transverse diameter of the bulb: 1 (< 35mm), 2 (35-50mm), 3 (50-70mm), 4 (79-90mm) and 5 (> 90mm) (Luengo *et al*., 1999). Mean productivity was estimated by measuring the fresh weight of 20 bulbs and multiplying by 270,000.

Homogeneity of variance was evaluated with Bartlett's test; *a posteriori* comparisons of means used Tukey's test with $\alpha = 0.05$. Data were processed with the M-STAT program, version 2.11 (Michigan State University, 1989).

Results and Discussion

In cycle one the plants adapted better to the photoperiods and temperatures to which they were exposed; in cycle two the longer photoperiod and higher temperatures produced bulbing earlier, shortening the cycle.

Cycle one was superior to cycle two in plant height, leaf area, fresh and dry leaf weight and bulb diameter, both at bulbing and at harvest. This is explained by the adaptation of the cultivars to the photoperiods and temperatures. In cycle one, established in January, bulbing occurred at 58 DAT; in this cycle the vegetative period was longer since temperatures and photoperiod decreased, prolonging the cycle. Cycle two, established in September, bulbed at 35 DAT; the increasing photoperiod and temperature shortened the cycle, resulting in smaller bulbs (Oliveira *et al*., 2004).

Plant height at bulbing varied from 52.78-70 cm in cycle one and from 31.93-38.90 cm in cycle two. In both cycles, the cultivars EMBRAPA, Alfa Tropical, Alfa San Francisco nd Alfa San Francisco-RT had the greatest plant heights (Table 1).

Plant height at harvest in the first cycle varied from 66.89-73.33 cm with little difference among cultivars, which may be explained by the reduction in height of the cultivars at the end of the cycle, concurring with the results of Santos *et al.* (2007), who observed a significant reduction in the cultivar Alfa San Francisco grown in Sao Francisco, Bahia. The mean heights at harvest in cycle two were from 36.96-45.92 cm, considerably less than the first cycle. Cultivars BR-29 and IPA-10 were shorter at bulbing (Table 1). In the Guarapuava region (Estado de Paraná, Brasil), with a crop established at the traditional time, Resende *et al.* (2007) reported heights of 46.37-49.97 cm at 100 DAT for cultivars Red Creole, Bola Precoce and Baia Periforme, similar to the values we found for the Embrapa cultivars in cycle two.

Leaf area at bulbing varied from 352.82 cm^2 to 792.39 cm^2; it was greater in Embrapa

Table 1. Plant (leaf) height and leaf area at the beginning of bulbing and harvest in different onion cultivars, municipality of Pinhais, Paraná, Brazil, 2010.

Cultivars*	Leaf height (cm)				Leaf area (cm²)			
	Bulbing		Harvest		Bulbing		Harvest	
	Cycle 1**	Cycle 2**	Cycle 1	Cycle 2	Cycle 1	Cycle 2	Cycle 1	Cycle 2
IPA-10	52.78eA	31.83bB	66.89bA	37.19cdB	352.82fA	152.17aB	417.20eA	182.86dB
IPA-11	63.89bcA	33.25bB	71.78abA	40.00cdB	586.56cA	130.90aB	548.69cA	226.12cB
PA-12	59.56cdA	35.43abB	71.50abA	37.74cdB	479.53dA	132.19aB	615.00bA	230.06cB
A. Trop.	65.89abA	38.90aB	67.22bA	42.85abB	628.21bcA	126.61aB	509.27dA	287.15bB
ASF VIII	70.00aA	38.42aB	67.56bA	42.07abcB	792.39aA	147.76aB	404.72eA	307.34bB
ASF –RT	66.56abA	38.49aB	70.11abA	45.92aB	678.07bA	137.04aB	598.31bA	372.51aB
BR-29	56.83deA	32.34bB	73.33aA	36.96dB	413.12eA	100.50aB	717.76aA	210.30cB
CV***(%)	3.59		3.49		6.13		13.37	

*Cultivars: Franciscana IPA-10 (IPA-10), Vale Ouro IPA-11 (IPA-11), Brisa IPA-12 (IPA-12), Alfa Tropical (A. Trop.), Alfa San Francisco –Ciclo VIII (ASF VIII), Alfa San Francisco – RT (resistent to thrips) (ASF RT) and BR-29 (BR-29); **Cycle 1: Established in January; Cycle 2: Established in September; CV: Coefficient of variation; Means followed by the same lower case letter in columns and upper case leters for rows were not significantly different (Tukey $p > 0.05$).

cultivars and lower in IPA-10 in cycle 1. In cycle two values ranged from 100.50-152.17 cm, differences among cultivars were not significant (Table 1). Enrique *et al.* (2005) suggested that greater leaf areas reflect greater dry weight since they indicate a greater photosynthetic rate and consequently greater productivity; comparing leaf area and productivity, this was true in the present study in both cycles.

Leaf area at harvest varied from 404.72 to 717.76 cm^2 in the first cycle, showing an inversion in cultivar performance, since BR-29 had the greatest value; the same result was found in cycle two, with areas from 182.86-372.51 cm^2.

Fresh and dry weight at bulbing varied between the cycles (Table 2). Cultivars Alfa San Francisco and ASF-RT had greater fresh weight in cycle one.

Fresh leaf weight at harvest ranged from 60.27-98.46 g in cycle one and from 14.34 to 31.70 g in cycle two (Table 2); cultivar BR.29 had the greatest weight in both cycles, and also the greatest leaf dry weight. This suggests that there was no translocation of photosynthates from the leaves to the bulbs (Soares *et al.* 2004), since the productivity of bulbs was not greater (Table 4).

Scape diameter at bulbing varied from 1.17 to 1.82 mm and from 0.67-0.86 mm in cycles one and two, respectively, and at harvest varied from 1.68-1.99 in cycle one and from 0.88-1.36 mm in cycle two (Table 3). The greater height, leaf area and leaf mass in cycle one were reflected in greater scape diameter compared to cycle two. Similar results were obtained by Resende *et al.* (2007), who reported scape values of 1.64- 2.03 mm at 100 DAT for cultivars Baia Periforme, Red Creole, Bola Precoce and the hybrid Bucanner grown in Guarapuava (Paraná, Brazil).

Bulb fresh weight was greater in cycle one for all cultivars except IPA-11. Cycle one means ranged from 22.34-66-82 g; Embrapa cultivars had the greatest fresh weight, and also had the greatest dry weight, which varied from 1.97 to 5.30 g in cycle one (Table 4).The behavior of bulb fresh weight and dry weight for the majority of the cultivars in cycle one may be explained by the longer time the plants remained in the field and by their good adaptation to the conditions of photoperiod and temperature in this period, which allowed more vegetative growth, as seen in plant height and leaf

Table 2. Leaf fresh weight and dry weight at the beginning of bulbing and harvest in different onion cultivars, municipality of Pinhais, Paraná, Brazil, 2010.

Cultivars*	Fresh leaf weight (g)				Dry leaf weight (g)			
	Bulbing		Harvest		Bulbing		Harvest	
	Cycle 1**	Cycle 2**	Cycle 1	Cycle 2	Cycle 1	Cycle 2	Cycle 1	Cycle 2
IPA-10	29.25 fA	8.04 aB	60.27 dA	14.34 bB	1.89 fA	0.30 aB	4.02 fA	1.19 dB
IPA-11	56.59 Ca	6.41 aB	92.00 abA	19.55 bB	4.22 bA	0.21 aB	5.77 cA	1.64 cB
PA-12	41.33 eA	7.90 aB	81.28 cA	17.04 bB	2.90 dA	0.47 aB	4.90 eA	1.52 cB
A. Trop.	50.72 dA	10.41 aB	98.03 aA	20.14 BB	3.73 cA	0.42 aB	6.25 bA	2.06 bB
ASF VIII	70.62 AA	8.69 aB	83.96 bcA	23.23 abB	5.18 aA	0.35 aB	6.14 bA	2.00 bB
ASF –RT	63.02 bA	8.72 aB	87.28 bcA	31.70 aB	4.88 aA	0.32 aB	5.43 dA	2.65 aB
BR-29	31.76 fA	6.79 aB	98.46 aA	17.81 bB	2.46 aA	0.24 aB	6.56 aA	1.39 cbB
CV*** (%)	6.12		7.41		6.66		2.95	

*Cultivars: Franciscana IPA-10 (IPA-10), Vale Ouro IPA-11 (IPA-11), Brisa IPA-12 (IPA-12), Alfa Tropical (A. Trop.), Alfa San Francisco –Ciclo VIII (ASF VIII), Alfa San Francisco – RT (resistent to thrips) (ASF RT) and BR-29 (BR-29); **Cycle 1: Established in January; Cycle 2: Established in September; CV: Coefficient of variation; Means followed by the same lower case letter in columns and upper case leters for rows were not significantly different (Tukey p > 0.05).

area, leading to a greater storage of photosynthates which were translocated to the bulbs (Nasreen *et al.* 2003). Cycle two was transplanted in conditions of lengthening photoperiod and increasing temperature which reduced the length of the cycle, altering the source-sink relations (Harder *et al.* 2005) and giving the plants less time for vegetative growth and development.

Productivity in cycle one ranged from 6.03 to 18.04 t ha^{-1}, and was greater in the Embrapa cultivars. In cycle two the productivity varied from 3.43-7.75 t ha^{-1}; the greatest values were produced by the Embrapa cultivars and by IPA-12 (Table 4). The productivity in cycle one was greater than in cycle two for all cultivars. The best results were obtained in January, possibly due to the better adaptation of the onion to the favorable temperatures, which lengthened the critical photoperiod and allowed a longer development time for the plant, producing greater productivity (Resende and Costa, 2008).

Baier *et al.* (2009) suggested that the classification of bulbs by size is another indicator of the realized productivity. In the first cycle, classes 1 and 2 were the most frequent. In the two cycles, except for the Embrapa cultivars, there were high percentages of rejected bulbs. There were no bulbs of class 5 (Table 5). There were significantly more bulbs of class 3 in the second cycle (range 62%-79.8%) than in cycle one (range 21.2%-52.8%); the differences among cultivars were small, except for IPA-10, which had a lower percentage (Table 5). Cultivars Alfa San Francisco-RT and Alfa Tropical had the highest percentages in cycle one, while in cycle two cultivars IPA-10, IPA-11 and San Francisco had the highest percentages.

According to Souza and Resende (2002), the national consumer market prefers medium-sized bulbs, with transverse diameter between 40 and 80 mm. In the first cycle the greater plant heights were associated with greater leaf area, and as a consequence produced greater fresh and dry bulb weights, as well as a greater number of class 3 bulbs in the Embrapa cultivars. This produced a greater productivity for these cultivars, demonstrating their adaptability to the period in which the plants were established.

In cycle two the fresh and dry bulb weights were similar among cultivars, resulting in homogenous

Table 3. Diameter of the scape at the beginning of bulbing and harvest in different onion cultivars, municipality of Pinhais, Paraná, Brazil, 2010.

Cultivars*	Diameter of scape (cm)			
	Bulbing		Harvest	
	Cycle 1**	Cycle 2**	Cycle 1	Cycle 2
IPA-10	1.17 cA	0.86 aB	1.69 bA	0.88 cB
IPA-11	1.71 aA	0.77 abcB	1.98 aA	1.12 abcB
PA-12	1.49 bA	0.83 abB	1.74 abA	1.01 bcB
A. Trop.	1.51 bA	0.81 abB	1.99 aA	1.23 abB
ASF VIII	1.71 aA	0.73 abcB	1.73 abA	1.18 abB
ASF –RT	1.72 aA	0.71 bcB	1.68 bA	1.36 aB
BR-29	1.29 cA	0.67 cB	1.93 abA	1.12 abcB
CV*** (%)	4.76		7.03	

*Cultivars: Franciscana IPA-10 (IPA-10), Vale Ouro IPA-11 (IPA-11), Brisa IPA-12 (IPA-12), Alfa Tropical (A. Trop.), Alfa San Francisco –Ciclo VIII (ASF VIII), Alfa San Francisco – RT (resistent to thrips) (ASF RT) and BR-29 (BR-29); **Cycle 1: Established in January; Cycle 2: Established in September; CV: Coefficient of variation; Means followed by the same lower case letter in columns and upper case leters for rows were not significantly different (Tukey $p > 0.05$).

Table 4. Fresh weight and dry weight of bulbs at harvest in different seasons and cultivars of onion, municipality of Pinhais, Paraná, Brazil, 2010.

Cultivars*	Fresh bulb weight		Dry bulb weight		Mean productivity	
	g bulb^{-1}				t ha–¹	
	Cycle 1**	Cycle 2**	Cycle 1	Cycle 2	Cycle 1	Cycle 2
IPA-10	22.34 dA	17.13 cdB	2,.2 dA	2.01 bcA	6.03 eA	4.63 cdB
IPA-11	40.,36 cA	16.18 cdB	3.61 cA	1.70 cdB	10.90 dA	4.37 cdB
PA-12	23.13 dA	23.00 bA	2.02 dB	2.35 bA	6.25 eA	6.21 bA
A. Trop.	50.91 bA	18.13 bcB	4.82 bA	1.67 cdB	13.75 cA	4.89 bcB
ASF VIII	57.25 aA	21.06 bcB	5.30 aA	2.02 bcB	15.46 bA	5.69 bcB
ASF –RT	66.82 aA	28.72 aB	5.10 abA	3.03 aB	18.04 aA	7.75 aB
BR-29	23.66 dA	12.69 dB	1.97 dA	1.38 dB	6.39 eA	3.43 dB
CV*** (%)	7.74		5.78		6.90	

*Cultivars: Franciscana IPA-10 (IPA-10), Vale Ouro IPA-11 (IPA-11), Brisa IPA-12 (IPA-12), Alfa Tropical (A. Trop.), Alfa San Francisco –Ciclo VIII (ASF VIII), Alfa San Francisco – RT (resistent to thrips) (ASF RT) and BR-29 (BR-29); **Cycle 1: Established in January; Cycle 2: Established in September; CV: Coefficient of variation; Means followed by the same lower case letter in columns and upper case leters for rows were not significantly different (Tukey $p > 0.05$).

productivity values except for cultivars IPA-19 and B-29, which had a large number of bulbs of classes 1 and 2.

We conclude that harvesting outside of the traditional period is possible in the region studied. Cultivars Alfa San Francisco-RT and Alfa San Francisco – Ciclo VIII were confirmed as the material with best productive potential and response to the photoperiod and temperature; the best results were obtained in January.

Table 5. Percentage of bulbs in the different size classes defined by the Ministerio de la Agricultura y del Abastecimiento Brasilero (Portaria 529, of 18 August 1995) at harvest, in different seasons and different cultivars of onion. Municipality of Pinhais, Paraná, Brazil, 2010.

Cultivars*	Bulb classes (%)							
	1 (< 35 mm)		2 (35-50 mm)		3 (50-70 mm)		4 (70-90 mm)	
	Cycle 1**	Cycle 2**	Cycle 1	Cycle 2	Cycle 1	Cycle 2	Cycle 1	Cycle 2
IPA-10	36.5 bA	9.8 aB	39.6 abA	28.3 aB	23.9 cB	62.0 cA	0.0 dA	0.0 eA
IPA-11	22.9 cA	3.6 bB	37.2 bA	13.6 cB	39.8 bB	76.1 abA	0.0 dB	6.6 dA
PA-12	50.6 aA	2.1bcB	26.0 cA	14.9 cB	21.2 cB	72.1 bA	2.3 cB	10.9 cA
A. Trop.	10.0 dA	0.0 cB	23.7 cdA	11.1 dB	49.5 aB	79.8 aA	16.8 bA	9.2 cB
ASF VIII	9.6 dA	0.0 cB	21.4 deA	6.7 eB	52.8 aB	72.8 bA	16.2 bB	20.4 aA
ASF –RT	12.8 dA	2.9 bcB	20.5 eA	4.2 fB	46.6 aB	78.2 aA	20.5 aA	14.8 bB
BR-29	38.5 bA	3.8 bB	41.3 aA	18.8 bB	20.2 cB	76.4 abA	0.0 dA	1.0 eA
CV*** (%)	8.63		5.30		3.56		9.47	

*Cultivars: Franciscana IPA-10 (IPA-10), Vale Ouro IPA-11 (IPA-11), Brisa IPA-12 (IPA-12), Alfa Tropical (A. Trop.), Alfa San Francisco –Ciclo VIII (ASF VIII), Alfa San Francisco – RT (resistent to thrips) (ASF RT) and BR-29 (BR-29); **Cycle 1: Established in January; Cycle 2: Established in September; CV: Coefficient of variation; Means followed by the same lower case letter in columns and upper case leters for rows were not significantly different (Tukey p > 0.05).

Conclusions

Collection outside of the traditional period in the region allowed the identification of materials with greater productive potential and a better response to the photoperiod and temperature of the area. The best results were obtained in the month of January, for the cultivars Alpha San Francisco-RT and Alpha San Francisco – Cycle VIII.

Literature Cited

Baier, J.E; De Resende, J.T.V.; Galvão, A.G.; Battistelli, G.M.; Machado, M.M.; Faria, M.V.
2009 Produtividade e rendimento comercial de bulbos de cebola em função da densidade de cultivo. *Ciência e Agrotecnologia*, Lavras 33: 2.

Brasil. Ministério da Ciência e Tecnologia (Org.).
2009 Observatório Nacional. Disponible en: <http://www.on.br/>. Acceso en: 18/1/2009.

Camargo Filho, W.P.; Alves, H.S.
2005 Produção de cebola no Mercosul: Aspectos Tecnológicos e Integração de Mercado no Brasil e na Argentina. *Informações Econômicas*, São Paulo, 35: 5.

EMBRAPA – Empresa Brasileira de Pesquisa Agropecuária.
2006 Centro Nacional e Pesquisa em Solos. Sistema Brasileiro de Classificação de Solos. Brasília: Embrapa-SPI; Rio de Janeiro: Embrapa-Solos, 306 p.

FAO - Food and Agriculture Organization.
2010 Disponible en:<http://faostat.fao.org/site/567/default.aspx#ancor>. Acceso en 01/09/10.

Ferreira, M.D.
2000 Cultura da cebola: recomendações técnicas. Campinas: Asgrow Vegetable Seeds, SVS do Brasil Sementes Ltda, s.n., 36 p.

Harder, W.C.; Zarate, N.A.H.; Vieira, M.C.
2005 Produção e renda bruta de rúcula (*Eruca sativa* Mill.) 'Cultivada' e de almeirão (*Cichorium intybus* L.) 'Amarelo', em cultivo solteiro e consorciado. *Ciência e Agrotecnologia*, Lavras, 29: 4, 775-785.

Instituto Biodinâmico (IBD)
2010 Site Institucional. 2004. Disponible en: <www.ibd.com.br>. Acceso en: 20/06/2010.

IBGE - Instituto Brasileiro de Geografia e Estatística
2009 Produção Agrícola Municipal. Disponible en <http://www.sidra.ibge.gov.br>. Acceso en: 20/08/2010.

Luengo, R.F.A; Calbo, A.G.; Lana, M.M.; Moretti, C.L. Henz, G.P.
1999. Classificação de hortaliças. Brasília: Embrapa Hortaliças, 27-33.

Mapa - Ministério Da Agricultura, Pecuária E Abastecimento.
2008 Projeções do Agronegócio – Mundial e Brasil – 2006/07 a 2017/18. Disponible en: <http://www.agricultura.gov.br. Acceso en: 12 dez 2010.

Melão, I.B.; Mori, M.M.; Wirbiski, S.; Darolt, M.R.; Rodrigues, A.S.; Karam, K.F.
2007 O mercado de orgânicos no Paraná: caracterização e tendências. *Revista Brasileira de Agroecologia*, 2: 2, 70-74.

Michigan State University.
1989 Department of Agricultural Economics. Department of Crop and Soil Sciences. MSTAT-C: microcomputer statistical program. Version: 2.1.

Nasreen, S.; Haq, S.M.I.; Hossain, M.A.
2003 Sulphur effects on growth responses and yield of onion. *Asian Journal of Plant Sciences*, 2, 897-902.

Oliveira, V.R.; Mendonça, J.L.; Santos, C.A.F.
2004 Sistemas de Produção. Embrapa Hortaliças. Versão Eletrônica. Disponible en: <http://www.cnph.embrapa.br/sistprod/cebola/climal.htm>. Acceso en: 20/03/2009.

Raij, B.V.; Silva, N.M.; Bataglia, O.C.; Quaggio, J.A.; Hiroce, R.; Cantarella, H.; Bellizazzi Júnior, R.; Dechen, A.R.; Trani, P.E.
1996 Recomendações de adubação e calagem para o Estado de São Paulo. 2. ed. Campinas: Instituto Agronômico (IAC. Boletim Técnico, 100). 170 p.

Régent Instruments.
1999 Win/MacRHIZO V4.1c Reference. Régent Instruments Inc., Québec, Canada. 51p.

Resende, J.T.V. De; Pires, D.B.; Camargo, L.K.P.; Marchese, A.
2007 Desempenho produtivo de cultivares de cebola em Guarapuava, Paraná. *Ambiência*, 3: 2, 193-199.

Resende, G.M. De; Costa, N.D.
2008 Épocas de plantio e doses de nitrogênio e potássio na produtividade e armazenamento da cebola. *Pesquisa Agropecuária Brasileria*, Brasília, 43:2, 221-226.

Santos, E.E.F.; Fernandes, D.M.; Silva, D.J.; Bull, L.T.
2007 Acúmulo de macronutrientes por cultivares de cebola, em um vertissolo no médio São Francisco. In: Congresso Brasileiro de Ciência do Solo, 31. 2007, Gramado. Conquistas e desafios da ciência do solo brasileira: anais. Porto Alegre: SBCS, CD-ROM.

SEAB - Secretaria Da Agricultura e do Abastecimento
2010 Valor bruto da agropecuária paranaense. Disponible en: <http://www.pr.gov.br/seab/deral>. Acceso en: 15/02/2010.

Simepar – Sistema Meteorológico do Paraná
2010 Temperatura média, precipitação mensal e umidade relativa. Pinhais: SIMEPAR, (Arquivo Eletrônico Word for Windows).

Soares, V.L.F.; Finger, F.L.; Mosquim; P.R.
2004 Influência do genótipo e do estádio de maturação na colheita sobre a matéria fresca, qualidade e cura dos bulbos de cebola. *Horticultura Brasileira*, Brasília, 22: 1, 18-22.

Souza, R.J.; Resende, G.M.
2002 Cultura da cebola. Lavras: UFLA, 115 p. (Textos acadêmicos – olericultura, 21).

Vilela, N.J; Makishima, N.; Oliveira, V.R.; Costa, N.D.; Madaill, J.C.M.; Camargo Filho, W.P.; Boeing, G.; Melo, P.C.T.
2005 Desafios e oportunidades para o agronegócio da cebola no Brasil. *Horticultura Brasileira*, 23: 4, 1029-1033.