Acta Universitatis Sapientiae
Agriculture and Environment, **3**, (2011) 144–151

Establishment of Planting Period for Chinese Cabbage (*Brassica campestris* var. *pekinensis* (Lour.) Olson) Early Crops in Open Field, in Transylvanian Tableland Specific Conditions

Enikő LACZI
email: eniko.laczi@yahoo.com

Alexandru Silviu APAHIDEAN

Jolán VARGA

University of Agricultural Sciences and Veterinary Medicine, Faculty of Horticulture, Cluj-Napoca, Romania

Manuscript received April 2011; revised July 2011, accepted July 2011

Abstract. In the spring of 2010 was organized a research in the experimental field of Vegetable Growing Department, from Horticulture Faculty of University of Agricultural Sciences and Veterinary Medicine Cluj - Napoca. The main subject of this experiment was the cultivation of Chinese cabbage (Brassica campestris var. pekinensis (Lour.) Olson) in Transylvanian Tableland specific conditions.

The results allowed establishing the optimum planting period for this species, so the achieved production to be adequate from the point of view of plants growth and development, the quality and quantity of obtained yield, and obtaining a low bolting percentage.

From the results can be concluded that to avoid the Chinese cabbage bolting and allow the head formation, the seeds have to be seeded in the second decade of March, and the 36 days old seedlings have to be planted in the third decade of April.

Keywords: bolting, planting period, seedlings age

1 Introduction

Chinese cabbage (*Brassica campestris* var. *pekinensis*) is a least known and used vegetable in Romanian gastronomy, but lately has begun to appear more frequently on the shelves of the markets in our country to.

This plant has its origin in Eastern Asia and Japan, and it was taken in culture since the eighteenth century [1].

Chinese cabbage has a very delicate taste and flavor. Some varieties tend to sweetness, others are starchier, some are more watery than others. Plants from this variety need only a light cooking or else their particular flavor is destroyed.

Although the *pekinensis* variety is almost exclusively grown for mature heads, it can be harvested in seedling stage, young plants or semi-mature heads, for leaves or for flowering steams and branches, which have a sweet taste and can be consume.

There is only a little waste with Chinese cabbage: the outer wrapper leaves of a mature head may have to be discarded if they are tattered and weather-beaten, but of the rest, the leaf blade, the midrib and the white leaf bases are all very tender and edible [2].

2 Materials and methods

The culture of Chinese cabbage, which had as main purpose the determination of planting period of this species, in early spring crops, took place from February to June, in 2010. The place of this experiment was the experimental filed of Vegetable Growing Department, which belongs to Horticulture Faculty from the University of Agricultural Sciences and Veterinary Medicine Cluj - Napoca.

In this culture it was used Granat variety, commercialized by Agrosel Company.

This variety has a vegetation period of approximately 70 days. The cabbage heads have a dark green color and a long and cylindrical shape. The heads can reach a weight of 1.5-2 kg. The leaves have a delicate flavor, which recalls the aroma of chicory, turnip and cabbage. The heads can be consumed raw in salads or cooked in different ways. Harvesting takes place from 2 to 3 months after sowing.

To establish the Chinese cabbage optimum planting period in open field culture, in Transylvanian Tableland specific conditions, it was realized a bi-factorial experiment which involved the following factors:

- Factor A: planting period, with 4 graduations:
  - a1: - second decade of April
  - a2: - third decade of April
  - a3: - first decade of May
  - a4: - second decade of May
- Factor B: seedlings age at planting, with 2 graduations:
  - b1: - age I: 46 days
  - b2: - age II: 36 days

By combination of this factors 8 variants resulted, which are presented in the next table (table 1).

Each variant was placed into three repetitions; the surface of one experimental plot was 2.25 m^2.

The research began when the seeds were sown, which took place from 10 to 10 days (first sowing was realized in 27 February), and ended with harvesting, in June. The sowing was made in cells, plants raised in approximately 2 to 4 days, after 15 days there were transplanted in pots of 10×10 cm. The seedlings were planted when they had 36, respectively 46 days.

Table 1: Experimental variants

Variant	**Planting period**	**Seedling age**
1.	Second decade of April (April II)	Age I
2.	Second decade of April (April II)	Age II
3.	Third decade of April (April III)	Age I
4.	Third decade of April (April III)	Age II
5.	First decade of May (May I)	Age I
6.	First decade of May (May I)	Age II
7.	Second decade of May (May II)	Age I
8.	Second decade of May (May II)	Age II

The main purpose of the research was the determination of planting period so that the production to be high and of best quality. During growing season observations were made regarding plants growth and development (these were made at planting, at one month after planting and at harvesting), but on obtained production to.

3 Results and discussions

Before planting, 10 seedlings from each variant were analyzed and measurements were made upon the following characteristics:

- Seedlings height
- Seedlings diameter
- Leaves weight
- Roots weight
- Total weight

Table 2 contains the obtained average dates.

Table 2: Measurements made at planting

Variant	Planting period	Seedling age	Height (cm)	Rosette diameter (cm)	Number of leaves	Weight (g)		
						leaves	roots	total
1	April II	Age I	32.83	35.33	12.67	41.00	3.67	44.67
2	April II	Age II	27.17	29.33	10.00	21.67	2.30	23.97
3	April III	Age I	23.83	37.00	11.00	31.33	3.00	34.33
4	April III	Age II	20.83	33.00	9.67	19.33	1.70	21.03
5	May I	Age I	23.00	37.00	12.00	36.67	3.00	39.67
6	May I	Age II	19.67	35.00	11.00	30.33	2.30	32.63
7	May II	Age I	25.33	37.33	12.67	36.00	3.00	39.00
8	May II	Age II	24.67	32.00	11.33	30.00	2.00	32.00

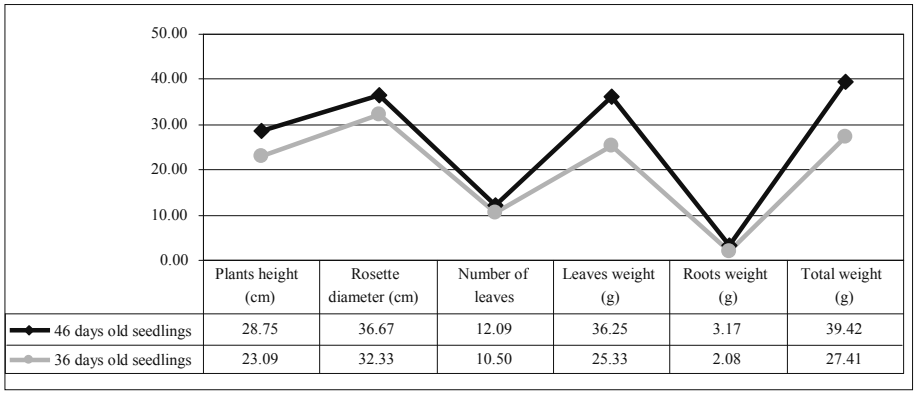
Regarding the average plants height, the highest (32.83 cm) were those from first variant, while at variant 6 were registered those with lowest average height (19.67 cm).

From point of view of rosette diameter, the plants from variant 7 were the most developed (with a diameter of 37.33 cm), while the least developed (with a diameter of 29.33 cm) the plants from variant 2.

Most leaves were formed at seedlings from the first and sixth variant, an average of 12.67 leaves, while at variant 4, were registered only 9.67 leaves.

To analyze plant weight, were measured both: leaves and roots weight, the sum of them gave the total weight. Leaves average weight varied between 19.33 g at variant 4 and 41 g at first variant, while roots weight between 1.70 g at variant 4 and 3.67 g also at variant 1.

In Fig. 1 it can be observed that the older seedlings, which had 46 days, compared to the youngest, the 36 days old ones, had higher values at all measured characteristics. Thereby, the age I seedlings average height was higher with 5.66 cm, their diameter was higher with 4.34 cm, and they had more leaves to. Age difference was observed best when the plants weight was analyzed. Thus, even if the differences between the roots weight were not very significant, the leaves and total weight of the older seedlings were much higher in case of the older ones.



	Plants height (cm)	Rosette diameter (cm)	Number of leaves	Leaves weight (g)	Roots weight (g)	Total weight (g)
46 days old seedlings	28.75	36.67	12.09	36.25	3.17	39.42
36 days old seedlings	23.09	32.33	10.50	25.33	2.08	27.41

Figure 1: Measured characteristics comparison at planting, from the two categories of seedlings

One month after planting were conducted again a series of measurements, which included the following features:

- Plants height
- Rosette diameter
- Number of leaves

The measurements were made at 10 plants of each repetition of the eight variants, after that were calculated the averages, which are presented in table 3.

Regarding plants height at one month after planting, the highest values were recorded at variant 2 (35.55 cm), followed by variant 6 (35 cm), both variants were established with 36 days old seedlings. These variants registered higher values, than the first and fifth ones, where the planting was made at the same planting period, but with older seedlings.

Table 3: Measurements made at one month after planting

Variant	Planting period	Seedling age	Height (cm)	Rosette diameter (cm)	Number of leaves
1	April II	Age I	34.33	50.67	21.33
2	April II	Age II	35.55	50.00	19.67
3	April III	Age I	34.17	53.00	22.17
4	April III	Age II	32.33	51.67	20.00
5	May I	Age I	33.00	43.83	20.67
6	May I	Age II	35.00	41.33	20.33
7	May II	Age I	27.33	33.17	23.17
8	May II	Age II	24.83	35.17	16.33

The lowest average height was measured at last variant, where the 36 days old seedlings were planted in the last planting period. In this case the plants average height was only 24.83 cm.

The rosettes diameter varied from 33.17 cm (at variant 7) to 53 cm (at variant 3).

An other very important characteristic is the number of leaves, because plants with a higher number of leaves can form a bigger head, respectively have a higher weight. From this point of view, plants belonging to variant 3 formed in average 22.17 leaves, while on opposite pole is the last variant, with only 16.33 leaves.

Although at measurements made at planting there were significant differences at all analyzed characteristics, in favor of older seedlings, this has changed a month after planting. Data registered in this period showed that the differences between the two seedling ages have been reduced. The average height of plants was higher at 46 days old seedlings with only 0.34 cm, the rosette diameter with 0.63 cm and they have more leaves formed, in average with 2.67 (Fig. 2).

At one month after planting some of the plants started to emit flower stems, to bolt, before passing through the stage of head formation. The main elements which can cause this physiological diseases are: low temperatures during seedling production, day lengthiness, different genetic elements, in addition there can be some stress factors like: the shock of transplantation, water shortages, excess humidity or sudden temperature changes [2]. Until harvest a large part of plants flowered, which couldn't be harvested or valued as headed cabbages. It is known that between head formation and flower buds differen-

tiation there isn't a certain relationship, so the differentiation can start before or after the start of head formation [3].

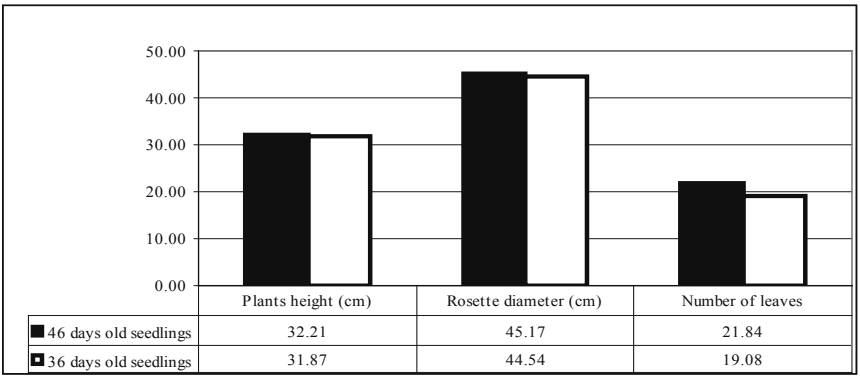


Figure 2: Measured characteristics comparison at one month after planting, from the two categories of seedlings

Fig. 3 presents the percentage of bolted plants from the total planted ones. It can be observed that in case of variants 1, 2 and 8, all the plants have flourished, while at variant 6 the bolting percentage was only 20%.

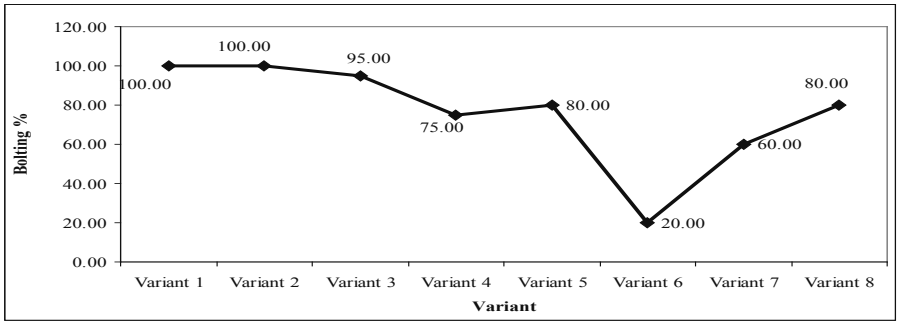


Figure 3: Bolted plants percentage

At variants, in which all the plants have formed flowering stems, the harvesting couldn't be realized, and measurements couldn't be done.

Best variant regarding the plants height, total weight, heads weight and number of leaves in rosette is variant 4 (table 4). The average plants height in this case was 58.30 cm, the average total weight of plants was 1.21 kg and the average heads weight was 0.93 kg, while the plants had in average 13.17 leaves. The third variant pointed the highest rosette diameter (an average of 63 cm), and the longest heads (an average of 60 cm). The highest head

diameter (32.33 cm) and highest number of leaves in heads (in average 20.83 leaves) were registered at variant 6.

The lowest values of analyzed characteristics were measured at variant 7.

Table 4: Measurements made at harvest

Var.	Planting period	Seedling age	Plants height (cm)	Rosette diameter (cm)	Total weight (kg)	Number of leaves in rosette	Head			
							Length (cm)	Diameter (cm)	Weight (kg)	Number of leaves
1.	April II	Age II	-	-	-	-	-	-	-	-
2.	April II	Age II	-	-	-	-	-	-	-	-
3.	April III	Age I	58	63.00	0.8	12	60	30.00	0.62	20.00
4.	April III	Age II	58.30	58.50	1.21	13.17	55.17	29.00	0.93	18.67
5.	May I	Age I	42.00	57.00	0.48	8.25	38.50	23.00	0.40	20.00
6.	May I	Age II	39.33	50.33	0.57	7.33	37.50	32.33	0.49	20.83
7.	May II	Age I	38.00	46.75	0.45	4.75	40.75	32.25	0.39	18.00
8.	May II	Age II	-	-	-	-	-	-	-	-

4 Conclusions

For setting up a Chinese cabbage culture it is recommended to sow in the second decade of March, and the seedlings at planting should be approximately 36 days old.

The optimal planting period of Chinese cabbage culture is the third decade of April, with seedlings which are produced in greenhouses since the middle of March.

It is recommended to avoid sowing to early or planting to late, because of high risk of plants bolting, or using bolting resistant varieties or hybrids.

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