Bulletin UASVM Horticulture, 68(1)/2011
Print ISSN 1843-5254; Electronic ISSN 1843-5394

The Influence of Planting Period and Seedling Age upon the Plants Development and Yield of Chinese Cabbage (*Brassica campestris* var. *pekinensis* Lour., Olson) in Autumn Cultures from Polyethylene Tunnels in Transylvanian Tableland Specific Conditions

Enikő LACZI, Alexandru Silviu APAHIDEAN, Jolán VARGA, Alexandru Ioan APAHIDEAN

University of Agricultural Sciences and Veterinary Medicine, Faculty of Horticulture, 3-5 Mănăştur Street, Cluj-Napoca, 400372, Romania; eniko.laczi@yahoo.com

Abstract. Chinese cabbage is a less known vegetable, not only in Transylvania, but all over our country, although it appears more and more often in the markets. In the present research, which took place in 2010 from September to December, the behavior of Chinese cabbage in Transylvanian area specific conditions was studied, in order to establish optimal planting period in autumn cultures. The experiment was realized in polyethylene tunnel and one of the objectives was to obtain a high yield of good quality.

Keywords: *Brassica campestris*, autumn culture, planting period, seedling age

INTRODUCTION

Chinese cabbage, *Brassica campestris* var. *pekinensis* (syn *Brassica rapa* var. *pekinensis*) is a less known vegetable in our country, but lately has appeared more and more frequently in the markets.

The development of this species, in China, was parallel with the European cabbages in Europe. Both belong to the same genus, *Brassica*, both evolved by cultivation from wild ancestors, both have been important foods since the remote past, and both now exist in numerous varieties which can be bought almost all year round (Davidson and Tom, 2006).

The headed types of Chinese cabbage form a barrel-shaped, rounded or tall cylindrical head of closely folded leaves, usually creamy to light green in color, with a crinkled texture, prominent white veining and white midribs broadening out at the base. The tall cylindrical types are generally later and slower-maturing. Another one group of Chinese cabbage exist, called loose or semi-headed type, which are used more like cut-and-come-again crops at the seedling and semi-mature stages, but they can be harvested at maturity too.

These plants are amongst the fastest growing of all leafy vegetables, in good conditions heads can be cut ten weeks after sowing loose-headed types two to three weeks sooner, while seedlings four to five weeks after sowing (Larcom, 2003).

MATERIALS AND METHODS

The research took place in the polyethylene tunnel from Vegetable Growing Department of University of Agricultural Sciences and Veterinary Medicine Cluj-Napoca, in the autumn of 2010.

It was used a single Chinese cabbage variety, which is commercialized by Agrosel Company, called Granat. This variety has a short vegetation period (approximately 70 days)

and forms a loose, cylindrical shaped head, which can reach a weight of 1.5 – 2 kg. The inner leaves are light green, while the outer ones are darker. It can be consumed raw in salads or cooked in different ways (soups, stuffed cabbage). The flavor is very delicate, and recalls the aroma of chicory, turnip and common white headed cabbage.

This research had as main purpose the establishment of the influence of planting period and seedling age upon the yield of Chinese cabbage, in autumn cultures effectuated in polyethylene tunnels in Transylvanian Tableland area.

To achieve the objectives of this experiment a bifactorial experiment was organized, which involved the following factors:

- Factor A: planting period, with 3 graduations:
  - a_1: - October I - first decade of October
  - a_2: - October II - second decade of October
  - a_3: - October III - third decade of October
- Factor B: seedlings age at planting, with 2 graduations:
  - b_1: - age I: 34 days
  - b_2: - age II: 24 days

By these factors combination six experimental variants were obtained, which are presented in table 1.

Tab. 1

Experimental variants

Nr. of variant	Planting period (month and decade)	Seedlings age (days)
1.	October I	Age I – 34 days
2.	October I	Age II – 24 days
3.	October II	Age I – 34 days
4.	October II	Age II – 24 days
5.	October III	Age I – 34 days
6.	October III	Age II – 24 days

Each experimental variant was placed into two repetitions, the surface of an experimental plot being 3 m^2.

To obtain seedlings with different ages, for the several planting periods, the sowing was made from 10 to 10 days, started from 30th of August. The seeds were sown, one by one, in small nutrient pots and were transplanted in bigger pots in stage of 3-4 true leaves. Planting was realized when the seedlings reached approximately 24, respective 34 days.

During growing season observations were made regarding plants growth and development (at planting time, at one month after planting and at harvesting) and on obtained production too.

RESULTS AND DISCUSSION

The evolution of plants height. In figure 1 it can be observed, that at planting, the variant with higher plants was the first one, where plants reached an average height of 22.67 cm, followed by 3rd and 5th variant. At all of these variants the planting was realized with 34 days old seedlings.

The measurements made one month after planting shoved that the 34 days old seedlings, planted in second decade of October reached an average of 38.33 cm, while at the

last variant (24 days old seedlings planted in the last decade of October) was recorded the lowest average height, only 22.17 cm.

At harvest, plants height was again measured. At this point, the highest plants (43.17 cm) were also those from the 2nd variant, followed closely by the 1st variant (42.50 cm), planted in the first decade of October, which was set up in the same decade, but with older seedlings.

Also in this figure can be observed that at variants 3, 4 and 6 the average height of plants is higher at one month after planting, than at harvest, which is caused by the participation of leaves in head formation.

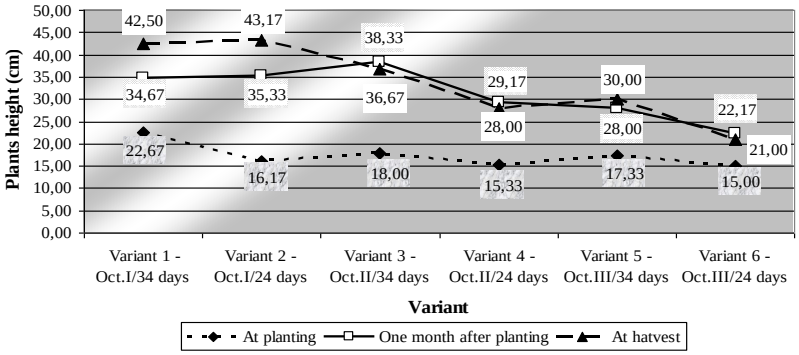

Fig. 1. The evolution of plants height

The evolution of plants diameter. At planting, the plants diameter varied between 15.33 cm (at 4th variant, 24 days old seedlings planted in second decade of October) and 29.67 cm (at 1st variant, 34 days old seedlings planted in first decade of the same month).

After a month the largest diameter (53.33 cm) was registered at 3rd variant (34 days old seedlings planted in second decade of October), while at the last variant plants reached an average diameter of only 36.17 cm.

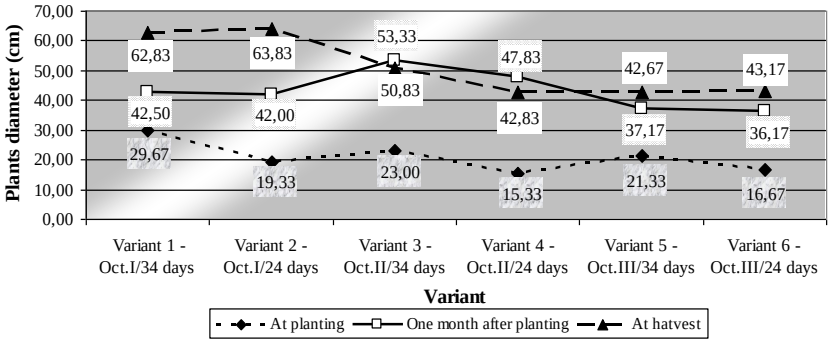

Fig. 2. The evolution of plants diameter

At harvest, the variants which were established first gave plants with larger diameter, so at 1st variant was recorded an average diameter of 62.83 cm, while at 2nd variant 63.83 cm. Although variants 3 and 4 revealed high diameters at one month after planting, at harvest they recorded lower values, 50.83 cm at variant 3 and 42.83 cm at variant 4. The plants from the last two variants reached average diameters of 37.17 cm and 36.17 cm.

The evolution of leaves number. Before planting, the recorded average number of leaves varied between 6.33 and 6.67 at 34 days old seedlings and between 5.33 and 5.67 in case of the youngest seedlings.

In figure 3 can be observed that in a month the plants have doubled their leaves number. The highest number of leaves (14.50) was recorded at variant 3, which for 34 days old plants were planted in the second decade of October, while plants from the last variant formed, in average, only 9.83 leaves.

At harvest, the plants which were planted in first decade of October reached an average maximum number of leaves of 22.50, respective 22.67.

Unfortunately with the dropping of the temperatures, plants from the last established variants have not enough time to develop a high number of leaves, so the average number of leaves from these variants was only 14.33 and 12.50.

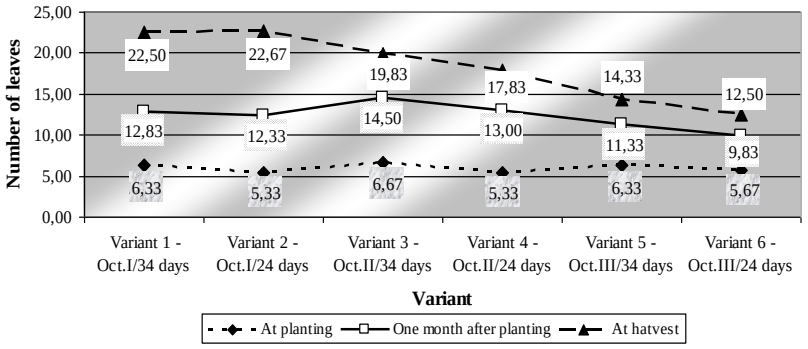

Fig. 3. The evolution of leaves number

Comparison between rosette and head diameter at harvest. In figure 5 is presented the rosette and plant diameter at the moment of harvest. It can be seen that those plants which were planted first have developed larger rosettes and also larger heads than the last planted ones. At 2nd variant (24 days seedlings planted in first planting period) was registered an average plant diameter of 63.83 cm, while at 1st one (34 days seedlings planted in the same decade) cabbage heads reached an average diameter of 41.83 cm.

The 5th variant, which was set up in the third decade of October, with 34 days old seedlings had the smallest values of rosettes and heads diameter, which were only 42.67 cm and 24.50 cm.

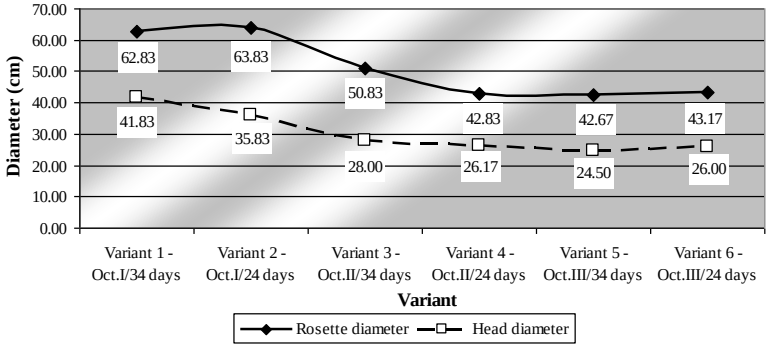

Fig. 4. Comparison between rosette and head diameter at harvest

Leaves distribution at harvest. Regarding the distribution of leaves at harvest, in the next figure it can be observed that plants had between 3.33 and 4.17 leaves in their rosette, while the heads are formed in average from 22-23 leaves in the first planting period (October I), 14-16 leaves in the second planting period (October II) and 9-11 leaves in the last planting period (October III).

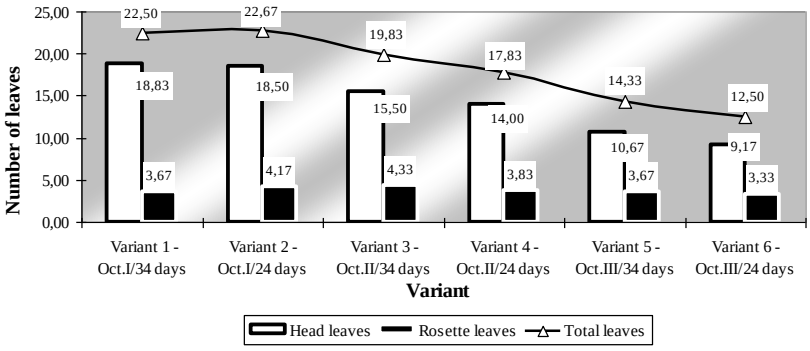

Fig. 5. Leaves distribution at harvest

Comparison between plant and head weight. At harvest the whole plants were measured, after that the outer, so called rosette leaves were removed, and the obtained "cabbage heads" were measured again. By processing the obtained data was obtained the next figure.

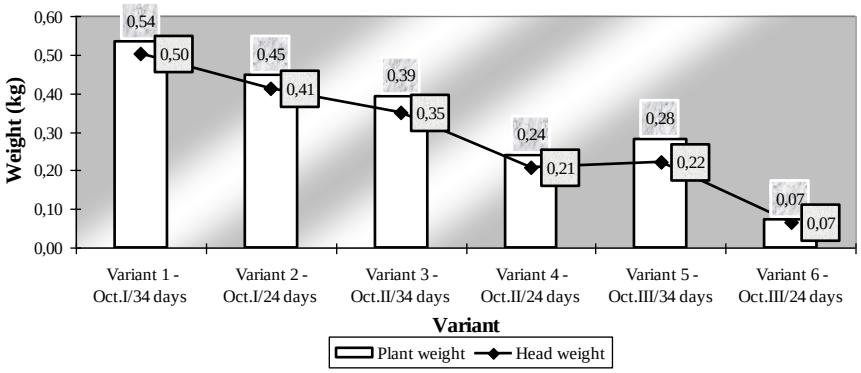

Fig. 6. Comparison between plant and head weight

Because the setting up of the culture was effectuated to late, the last variants couldn't benefit of optimum growing conditions. Although high temperatures were replaced with lower ones, plants reached 70 g at last variant, while at 4th and 5th variant plants average weight was between 240-280 g, and head weight between 210-220 g.

The heaviest plants, respective heads were those which were first planted with older seedlings.

Correlations between characters of head at Chinese cabbage. In figure 7 it can be observed that a very strong and positive correlation exists between head weight and total leaves number, head length and head diameter. The correlation coefficient was very significant between heads weight and total leaves number (r=0.93) and between heads weight and head length (r=0.98) while between head weight and head diameter (r=0.86) it was significant.

The conclusion is that as heavier the cabbage head is the total leaves number, head length and diameter had all higher values, but also if the cabbage has a higher number of leaves, a greater length or diameter its weight is higher.

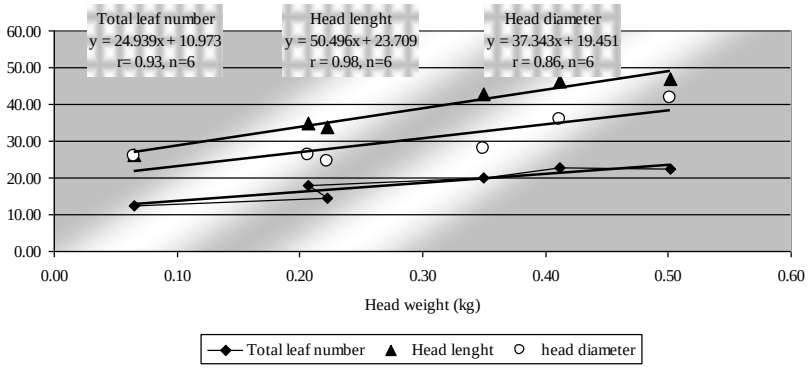

Fig. 7. Correlation between head weight and total leaf number, head length and head diameter

The influence of planting period upon the yield. The planting period had a strong influence upon the obtained production. In table 2 it can be observed that in the second and third decades of October lower productions were obtained in comparison with the first planting period, the differences being very significant negatives. In these cases the production was lower with 7.91 t/ha respectively with 17.91 t/ha than in case of first variant.

If we took the average, as control variant, the first planting period (October I), where the production was 30.45 t/ha, with 8.61 t/ha more than the average yield, recorded a very significant positive difference, while the third planting period (October III) registered a very significant negative difference with a production of 12.54 t/ha.

Tab. 2

The influence of planting period upon the yield

Variant Planting period	Yield (t/ha)	Yield (%)	Diff. (t/ha)	Signif.	Yield (%)	Diff. (t/ha)	Signif.
October I	30.45	100	0.00	-	139.43	+8.61	***
October II	22.54	74.0	-7.91	ooo	103.21	+0.70	-
October III	12.54	41.2	-17.91	ooo	57.42	-9.3	Ooo
Average	21.84	-	-	-	100	0.00	-

LSD (p 5%)=1.64, LSD (p1%)=2.72, LSD (p 0.1%)=5.08;

The influence of seedling age upon the yield. In the table 3 is presented the influence of seedling age upon the yield of Chinese cabbage. It can be noticed that higher production was obtained when older, respectively 34 days old, seedlings were used instead of 24 days old ones. In the first case the yield was 28.16 t/ha, while when age II seedlings were used, the production was lower with 12.64 t/ha, the difference being very significant negative.

Taking the average yield as control variant, the 34 days old seedlings recorded a very significant positive difference, with an extra yield of 6.32 t/ha, while the 24 days old ones a very significant negative difference with a lower production (with 6.32 t/ha).

Tab. 3

The influence of seedling age upon the yield

Variant Seedlings age	Yield (t/ha)	Yield (%)	Diff. (t/ha)	Signif.	Yield (%)	Diff. (t/ha)	Signif.
Age I - 34 days	28.16	100	0.00	-	128.94	+6.32	***
Age II – 24 days	15.52	55.11	-12.64	ooo	71.06	-6.32	Ooo
Average	21.84	-	-	-	100	0.00	-

LSD (p 5%)=1.87, LSD (p1%)=2.83, LSD (p 0.1%)=4.54;

Combined influence of seedling age and planting period. A distinct negative difference (6 t/ha) was recorded at variant where 24 days old seedlings were planted in first decade of October if the control variant was taken the age I and the first planting period.

If the planting was done in the second decade of October, the younger plants realized a yield of 14.78 t/ha, lower with 15.52 t/ha than the yield of the older ones, the difference being very significant negative. If the control variant was the average of the yields, distinct significant differences were obtained: positive in case of the age I seedlings and negative in case of age II seedlings.

The third planting period reveals again some very significant differences, the 24 days old seedlings obtained a low production (4.33 t/ha) in comparison with the 34 days old ones, (20.74 t/ha), the differences being very significant negative. If considering the average yield (12.54 t/ha) as control, the age I seedlings recorded very significant yield increase (8.2 t/ha) while the younger seedlings recorded very significant yield decrease (8.21 t/ha) in comparison with control.

Tab. 4

Combined influence of seedling age and planting period

Variant		Yield (t/ha)	Yield (%)	Diff. (t/ha)	Signif.	Yield (%)	Diff. (t/ha)	Signif.
Seedlings age	Planting period							
Age I – 34 days	October I	33.45	100	0.00	-	109.45	+3.00	-
Age II – 24 days	October I	27.45	82.07	-6.00	oo	90.15	-3.00	-
Average (Mt.)		30,45	-	-	-	100	0.00	-
Age I – 34 days	October II	30.30	100	0.00	-	134.4	+7.76	**
Age II – 24 days	October II	14.78	48.78	-15.52	ooo	65.6	-7.76	Oo
Average		22,54	-	-	-	100	0.00	
Age I – 34 days	October III	20.74	100	0.00	-	165.39	+8.2	***
Age II – 24 days	October II	4.33	20.88	-16.41	ooo	34.52	-8.21	Ooo
Average		12,54	-	-	-	100	0.00	-

LSD (p 5%)=3.23, LSD (p1%)=4.89, LSD (p 0.1%)=7.86;

Combined influence of planting period and seedling age. If the 34 days old seedlings were used, a maximum average yield of 33.45 t/ha was obtained if planting was realized in the first decade of October. If this variant was considered as control, the yield obtained by planting in the second decade was lower with 3.15 t/ha, while the yield obtained by planting in the third decade was lower with 12.71 t/ha, the differences being significant negative and respectively very significant negative. The average yield when the older seedlings were planted was 28.16 t/ha. If this variant was taken as control, the first and the last planting periods recorded statistically supported yield differences, respectively distinct significant yield increase in case of the first planting period (5.29 t/ha) and very significant yield decrease in case of the third planting period (7.42 t/ha).

By using younger seedlings the yield varied between 4.33 t/ha (at planting in the third decade of October) and 27.45 t/ha (at planting in the first decade of October). At second and third planting periods were registered very significant negative yield differences in comparison with the yield obtained for planting in the first period. If the average yield was taken as control, the first planting period registered a very significant positive difference (the yield being higher with 11.93 t/ha) while the third one a very significant negative difference (the yield being lower with 11.19 t/ha).

Tab. 5

Combined influence of planting period and seedling age

Variant		Yield (t/ha)	Yield (%)	Diff. (t/ha)	Signif.	Yield (%)	Diff. (t/ha)	Signif.
Planting period	Seedlings age							
October I	Age I – 34 days	33.45	100	0.00	-	118.79	+5.29	**
October II	Age I – 34 days	30.30	90.6	-3.15	o	107.60	+2.14	-
October III	Age I – 34 days	20.74	62.0	-12.71	ooo	73.65	-7.42	Ooo
Average		28,16	-	-	-	100	0.00	-
October I	Age II – 24 days	27.45	100	0.00	-	176.87	+11.93	***
October II	Age II – 24 days	14.78	53.8	-12.67	ooo	95.23	-0.74	-
October III	Age II – 24 days	4.33	15.8	-23.12	ooo	27.90	-11.19	Ooo
Average		15.52	-	-	-	100	0.00	-

LSD (p 5%)=2.81, LSD (p1%)=4.38, LSD (p 0.1%)=7.42;

CONCLUSIONS

The optimum planting period for late autumn cultures, effectuated in polyethylene tunnels, is the first decade of October, or even a little earlier, because the plants need a few weeks to develop and to form their head.

To obtain a high production, it is recommended to use approximately 30-34 days old seedlings instead of younger ones.

Plants have developed better if they were planted earlier in the autumn.

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