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Studies Regarding the Variety and Planting Density Influence upon the Growth, Development and Yield of Chinese Cabbage (*Brassica campestris* var. *pekinensis* (Lour.) Olson)

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Abstract. Chinese cabbage is a less known vegetable in our country, it wasn't grown on large areas, but it can be cultivated with good results especially in Transylvanian Tableland specific conditions.This research had as main purpose the study of the variety and planting density upon the growth, development and yield of headed Chinese cabbage (*Brassica campestris* var. *pekinensis* (Lour.) Olson).The research took place on the experimental field which belongs to the Vegetable Growing Department from the Faculty of Horticulture from the University of Agricultural Sciences and Veterinary Medicine from Cluj-Napoca, from August to December, in 2011. In the experiences two cultivars were used, both of them planted at three planting densities (100 thousand plants/ha, 80 thousand plants/ha and 66.67 thousand plants/ha)Higher yields were obtained at low planting densities at both of the cultivars. Taking into account the influence of the both studied factors, the highest yield (69.67 t/ha) was obtained at Granat variety, where planting was made at a density of 66.67 plants/ha. From the two cultivars the plants and cabbage heads from Granat variety had higher values from the height, diameter, number of leaves and weight point of view.Chinese cabbage can be cultivated with success in Transylvanian Tableland specific conditions, but there are necessary more studies regarding the planting technology.

Keywords: Chinese cabbage, development, growth, yield, planting density.

INTRODUCTION

Chinese cabbage is cultivated for the cabbage heads or the leaves, depending on the botanical variety and hybrid, which are used raw in different salads or cooked (Poşta, 2008). Although var. *pekinensis* is grown exclusively to be commercialized as cabbage heads, it can be harvested in rosette stage, or as young leaves, semi maturated heads, and even the flowers or flower stalks can be consumed (Larkcom, 2008).

The high content in minerals and vitamins define Chinese cabbage as a valuable vegetable from alimentary point of view (Butnariu *et al*., 1992).

Studies of Krezel and Kolota (2003) shoved that in spring cultures the highest yield was 66.17 t/ha, while in the autumn culture the yield reached a value of 72.46 t/ha. In spring crop a high bolting tendency was registered, and the determinations showed that at plants harvested in spring, there was a higher content in sugars and vitamin C, while at those harvested in autumn there was a higher nitrate content. Yields up to 7 kg/m2 were obtained by Staugaitis and Starkute (1999), the cabbage heads weighted between 0.7 and 1.3 kg. Other studies concluded that with planting period delaying the yields have increased, because with the earlier planting a greater number of plants bolted before harvest, due to the low temperatures Gajc-Wolska *et al*. (1996), and the cabbage heads were heavier in autumn than in spring (Vavrina *et al*. 1993).

For reducing the risk of bolting, the planting stress (which is caused by the high temperatures, lack of water) have to be as low as possible, so even if the planting is made with seedlings, and not by direct seeding, this point has to be taken into account (Daly and Tomkins, 1997; Myers *et al*., 1998).

The planting density of Chinese cabbage is a very studied subject by the specialists in the field of Vegetable growing in the last few years. In a research effectuated in Transylvanian Tableland specific conditions, the authors found that the optimal planting density is 80 thousand plants/ha (Laczi *et al*., 2012). But not always a high number of plants can be recommended, because even if the number of plants on an area is higher, the heads weight is lower, causing a low total yield (Chirasantchai and Sidathani, 1994).

MATERIALS AND METHODS

The research took place on the experimental field which belongs to the Vegetable Growing Department from the Faculty of Horticulture, University of Agricultural Sciences and Veterinary Medicine from Cluj-Napoca, from August to December, in 2011.

The main purpose of the research was the study of the variety and planting density upon the growth, development and yield of headed Chinese cabbage (*Brassica campestris* var. *pekinensis* (Lour.) Olson) and the possibilities of growing this vegetable in Transylvanian Tableland specific conditions.

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

Factor A: variety

- Granat
- Vitimo F1

Factor B: planting density:

- 100 thousand plants/ha
- 80 thousand plants/ha
- 66.67 thousand plants/ha

By the factors combination six experimental variants were obtained. Each of them were placed into three repetitions, the surface of an experimental plot being $3m^2$. In the experiences two cultivars were used, both of them planted at three planting densities (100 thousand plants/ha, 80 thousand plants/ha and 66.67 thousand plants/ha).

The seeds of the two cultivars were seeded at 10^{th} of August, in small nutrient plots, and the first plants risen four days later. The seedlings were planted, when each of them had 3-4 true leaves, in 8/8 cm pots in 25^{th} of the same month. The planting was made in 15^{th} of September. To obtain the mentioned planting densities, the following planting distances were used: 0.50 m between rows and the distances between rows were: 0.20 m for 100 thousand plants/ha, 0.25 m for 80 thousand plants/ha and 0.30 m for 100 thousand plants/ha. At Granat variety the harvest started at 25^{th} of November, while at Vitimo hybrid, in 29^{th} of the same month. Measurements were made at one month after planting, and at harvest, the data being processed.

RESULTS AND DISCUSSIONS

At one month after planting the highest plants, with an average height of 31.83 cm, were recorded at Vitimo hybrid, planted at a density of 100 thousand plants/ha. The same hybrid registered the highest diameter (54.50 cm). The leaves number varied between 11.50 and 12.83. The lowest values were registered at Granat variety (average plants height

23.17cm, average diameter 40.00 cm and average leaf number 11.50), at a density of 80 thousand plants/ha (Tab. 1).

Tab. 1

Development degree af plants one month after planting, Cluj-Napoca, 2011

Variant			Plant height (cm)	Plant diameter (cm)	Number of leaves
No.	Variaty / Hybrid	Density (plants/ha)			
1	Granat	100 000	30.17	45.17	12.83
2	Granat	80 000	23.17	40.00	11.50
3	Granat	66 667	26.50	43.00	12.17
4	Vitimo F_1	100 000	31.83	52.33	11.83
5	Vitimo F_1	80 000	31.33	54.00	12.17
6	Vitimo F_1	66 667	26.33	54.50	12.33
Average			28.22	48.17	12.14

The plants height varied between 28.00 cm, at Vitimo hybrid, planted at a density of 66.67 and 50.83 cm, at Granat variety, at a density of 80 thousand plants/ha. The diameter was between 42.00 cm (at Vitimo hybrid at 80 and 66.67 thousand plants/ha) and 60.67 cm (at Granat variety, at the lowest planting density). The average number of leaves was 41.36, a higher number of leaves being noted at Vitimo hybrid. Regarding the weight of the plants, the easiest heads were registered at Vitimo hybrid, at the highest planting density (0.58 kg), while the heaviest ones at Granat variety, at the lowest density (1.12 kg) (Tab. 2).

Tab. 2

Development degree af plants at maturity, Cluj-Napoca, 2011

Variant			Plant			
No.	Variaty / Hybrid	Density (plants/ha)	Height (cm)	Diameter (cm)	Number of leaves	Weight (g)
1	Granat	100 000	50.33	53.83	38.67	0.89
2	Granat	80 000	50.83	56.50	35.33	0.93
3	Granat	66 667	49.33	60.67	44.00	1.12
4	Vitimo F_1	100 000	33.33	47.33	46.67	0.79
5	Vitimo F_1	80 000	39.00	42.00	38.50	0.58
6	Vitimo F_1	66 667	28.00	42.00	45.00	0.85
Average			41.81	50.39	41.36	0.86

Analyzing the cabbage heads, in Tab. 3 can be observed, that at Granat variety the height was between 51.83 cm and 56.50 cm, while at Vitimo hybrid, between 25.83 cm and 26.00 cm. Like the height, the diameter had lower values at Vitimo hybrid (between 13.17 cm and 14.67 cm) and higher values at Granat variety (between 24.83 cm and 26.67 cm). On the other hand, the number of leaves was higher at Vitimo hybrid, and lover at Granat variety, the average leaf number being 35.50. The lowest weight of the cabbage heads were registered at Vitimo hybrid, when planting was effectuated at a density of 80 thousand plants/ha, while the highest weight at Granat variety, at the variant where the plants were planted at the lowest density.

Tab. 3.

Development degree af cabbage heads at harvest, Cluj-Napoca, 2011

Variant			Cabage head			
No.	Variaty / Hybrid	Density (plants/ha)	Height (cm)	Diameter (cm)	Number of leaves	Weight (g)
1	Granat	100 000	56.50	24.83	33.17	0.70
2	Granat	80 000	51.83	26.67	30.00	0.64
3	Granat	66 667	55.50	25.17	37.83	0.86
4	Vitimo F_1	100 000	26.00	13.67	41.00	0.57
5	Vitimo F_1	80 000	26.17	13.17	31.67	0.54
6	Vitimo F_1	66 667	25.83	14.67	39.33	0.63
Average			40.31	19.69	35.50	0.66

The differences between total plant weight and head weight varied between 50 g, at Vitimo hybrid, planted at 80 thousand plants/ha and 290 g, at Granat variety, and the same density. Overall, the differences between the two characters was smaller at Vitimo hybrid (in average 146 g), and higher at Granat variety (in average 248 g) (Fig. 1).

The value of the correlation coefficient between the total weight and cabbage weight was 0.91, so it can be concluded that between the two characters exists a strong relationship, which is significant positive from statistical point of view (Fig. 2).

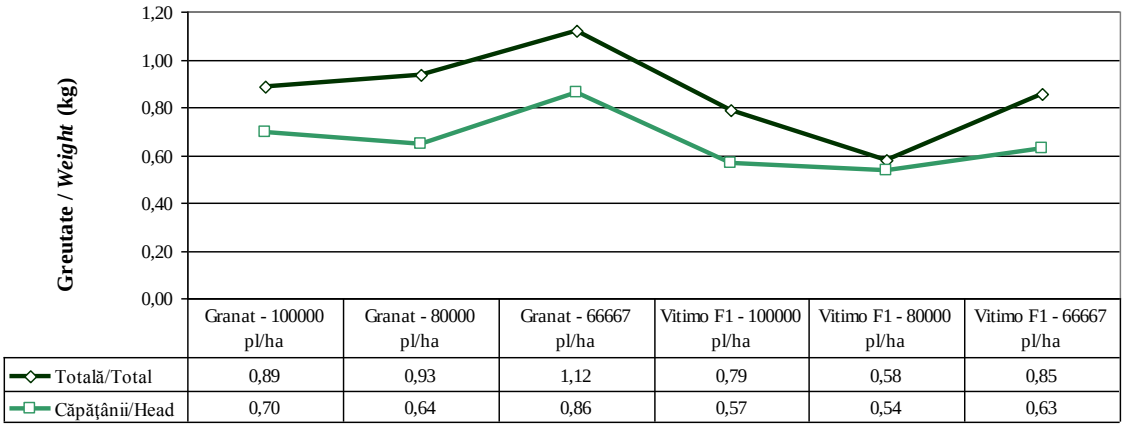

Fig. 1. Comparison between total plant and head weight

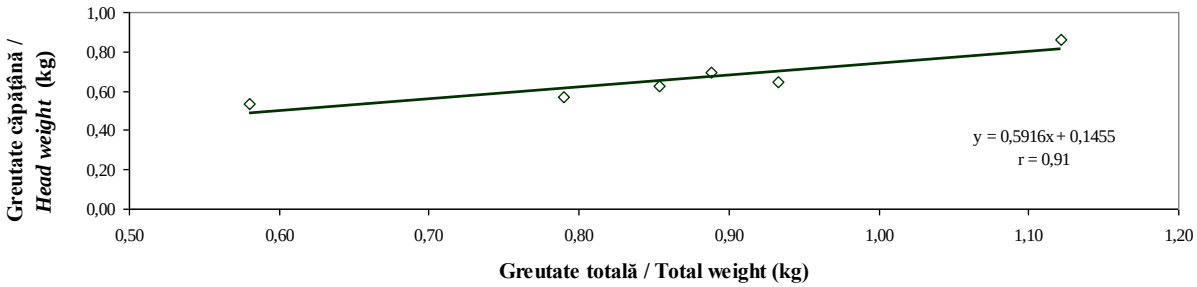

Fig. 2. Relationship between total and head weight
(n=6, p (5%)=0,81, p (5%)=0,92)

The average bolting percentage at one month after planting was 1.39%, while at harvest more than 3% of the plants emitted flower stalks. While at Vitimo hybrid no plant has bolted, at Granat variety, planted at a density of 100 thousand plants/ha, more than 10% of plants flourished (Fig. 3).

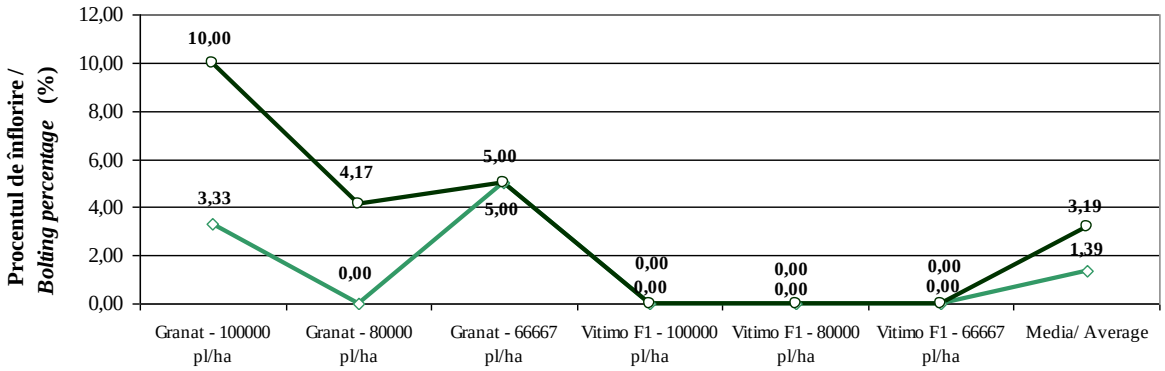

Fig. 3. Bolting percentage

Regarding the unilateral influence of the cultivar upon the Chinese cabbage yield, in Tab. 4. It can be observed that at Vitimo hybrid the yield was 49.91 t/ha, while at Granat variety 61.22 t/ha, the difference between the cultivars being distinct significant negative.

Tab. 4

Unilateral influence of cultivar upon the Chinese cabbage yield, Cluj-Napoca, 2011

Variant / Cultivar	Average yield (t/ha)	Relative yield (%)	Difference (t/ha)	Significance	Relative yield (%)	Difference (t/ha)	Significance
Granat	61.22	100.0	0.00	Mt.	110.2	5.65	*
Vitimo F_1	49.91	81.5	-11.31	oo	89.8	-5.65	o
Average	55.57	-	-	-	100.0	0.00	Mt.
LSD (p 5%)				5.49			5.49
LSD (p 1%)				8.12			8.12
LSD (p 0,1%)				12.11			12.11

The average yields varied between 50.07 and 66.08 t/ha, the average yield being 55.57 t/ha. If the lowest planting density is taken as witness variant, the other two densities registered very significant negative differences (at the density of 80 thousand plants/ha the yield was lower with 16.01 t/ha, and at the density of 100 thousand plants/ha was lower with 15.53 t/ha). If the average yield is considered as control variant, the lowest planting density registers a very significant positive difference, with a yield increase of 10.52 t/ha (Tab. 5).

At both hybrids the highest yield was recorded at the lowest planting density. The differences between the yields obtained at Granat variety, at the density of 100 thousand plants/ha and the other used densities were very significant negative, the yields being lower with more than 12 t/ha.

At Vitimo hybrid, the yields varied between 43.47 t/ha, at a density of 80 thousand plants/ha and 62.50 t/ha, at a density of 100 thousand plants/ha. Like at Granat variety, the differences registered at 80 thousand and 100 thousand plants/ha, were much smaller and very significant negative from statistically point of view.

Tab. 5.

Unilateral influence of planting density upon the Chinese cabbage yield, Cluj-Napoca, 2011

Variant Planting density (plants/ha)	Average yield (t/ha)	Relative yield (%)	Difference (t/ha)	Significance	Relative yield (%)	Difference (t/ha)	Significance
66 667	66.08	100.0	0.00	Mt.	118.9	10.52	***
80 000	50.07	75.8	-16.01	ooo	90.1	-5.50	o
100 000	50.55	76.5	-15.53	ooo	91.0	-5.01	o
Average	55.57	-	-	-	100.0	0.00	Mt.
LSD (p 5%)					3.69		3.69
LSD (p 1%)					5.75		5.75
LSD (p 0,1%)					8.63		8.63

If the average yields were taken as control variants, at both hybrids positive differences were recorded at the lowest planting densities. Thus, at Granat variety, the yield was higher with 13.8%, the difference of 8.43 t/ha being distinct significant positive, and at Vitimo hybrid, it was higher with 25.2%, the difference of 12.59 t/ha being very significant positive (Tab. 6).

Tab. 6.

Combined influence of planting density and cultivar upon the Chinese cabbage yield, Cluj-Napoca, 2011

Variant Planting density (plants/ha)	Cultivar	Average yield (t/ha)	Relative yield (%)	Difference (t/ha)	Significance	Relative yield (%)	Difference (t/ha)	Significance
66 667	Granat	69.67	100.0	0.00	Mt.	113.8	8.45	**
80 000	Granat	56.67	81.3	-13.0	ooo	92.6	-4.55	-
100 000	Granat	57.33	82.3	-12.34	ooo	93.6	-3.89	-
Average		61,22	-	-	-	100.0	0.00	Mt.
66 667	Vitimo F_1	62.50	100.0	0.00	Mt.	125.2	12.59	***
80 000	Vitimo F_1	43.47	69.6	-19.03	ooo	87.1	-6.45	o
100 000	Vitimo F_1	43.78	70.0	-18.72	ooo	87.7	-6.14	o
Average		49,91	-	-	-	100.0	0.00	Mt.
LSD (p 5%)					5.59			5.59
LSD (p 1%)					8.14			8.14
LSD (p 0,1%)					12.20			12.20

CONCLUSION

The highest values of the plants and cabbage heads height, diameter, weight and number of leaves were recorded at Granat variety. Even if at Vitimo hybrid the cabbage heads had a lower weight, the loss with the external leaves was lower. There exist a significant correlation between head and total weight of the plants. The unilateral and combined influence of the factors showed that higher yields were obtained when Granat hybrid and lower planting densities were used.

The main conclusion of this research is that Chinese cabbage can be cultivated with success in Transylvanian Tableland specific conditions, but there are necessary more studies regarding the planting technology.

REFERENCES

1. Butnariu, H., D. Indrea, C. Petrescu, P. Savitchi, Pelaghia Chilom, Ruxandra Ciofu, V. Popescu, G. Radu, N. Stan (1992). Legumicultură. EDP, Bucureşti.
2. Chirasantchai, D. and K. Sitadhani (1994). Effect of plant spacing on yield of Chinese cabbage in off season. Proceedings of the second symposium on vegetable and legume research, Kasetsart University, Research and Development Institute, Tropical vegetable research Center, Bangkok (Thailand). 142-146.
3. Daly, P. and B. Tomkins (1997). Production and postharvest handling of Chinese cabbage. Rural Industries Research and Development Corporation (RIRDC), Barton ACT, Australia, RIRDC Research Paper. 97/1.
4. Gajc-Wolska, J., S. Odziemkowski, H. Skapski (1996). Influence of cultivar and production time on the yield of Chinese Cabbage. Biuletyn Warzywniczy.44:5-14.
5. Krezel, J. and E. Kolota (2003). Yield evaluation of some Chinese cabbage cultivars in spring and autumn cultivation. Folia Horticulturae. 15(1):11-18.
6. Laczi Enikő, Al. S. Apahidean, Al. I Apahidean (2012). Research Regarding the Planting Density Influence upon the Growth, Development and Yield of Chinese Cabbage (Brassica campestris var. pekinensis (Lour.) Olson) in Early Protected Crops in Transylvanian Tableland Specific Conditions. Bulletin USAMV, serie Horticulture.1:189-197.
7. Myers Claudia, I. Fu, L. Valenzuela (1998). Specialty and minor crops handbook – second edition. University of California, Communication services Publications, United States of America.
8. Staugaitis, G. and R. Starkute (1999). Dependence of Chinese cabbage yield and its quality on growing season. Horticulture and vegetable growing, Scientific works. 18(3):58.
9. Vavrina, C. S., T. A. Obreza, J. Comell (1993). Response of Chinese cabbage to nitrogen rate and source in sequential plantings. HortScience. 28 (12):1164-1165.