BOLTING OF CHINESE CABBAGE INFLUENCED BY VARIETY AND PLANTING TIME AND PLACE

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Abstract. Chinese cabbage is a least known vegetable in Transylvania, but lately its consumption has increased. Unfortunately the fresh product can be found only in super markets, where is brought from abroad. In order to be cultivated in this area is necessary an improved cultivation technology. The present research has as main purpose to study the bolting of this vegetable in Transylvanian Tableland specific conditions, and in the end to formulate recommendations regarding the planting period and place and to show those varieties which have a good behavior from bolting point of view. The result showed that best result were obtain in autumn protected culture, hybrid Vitimo F_1 having the lowest number of bolted plants.

Keywords: bolting, Chinese cabbage, hybrid, variety, protected crops

INTRODUCTION

Headed Chinese cabbage (*Brassica campestris* var. *pekinensis*) is a member of the cole crops, being an important fresh and processed vegetable, in special in Asian countries. Due to its good taste and high nutritional value the request for this vegetable is higher and higher (Larkcom, 2003). The cultivation of this vegetable is limmited by several factors, such as tempeture, light condition, humidity. Under certain conditions a number of the Oriental brassicas have a tendency to bolt – that is, to produce flowers and run to seed rather than form a good leafy head (Larkcom, 2008). Blossoming marks the transition between vegetative and generative (reproductive) phase. It is therefore a crucial event in the life cycle of plants, especially in terms of seed production. Initiation of flowers takes place either before or after the heads formation according to the temperature and / or photoperiod during the growing season (Opeňa et al., 1988).

The causes of bolting are complex and interrelated. To a greater or lesser extent the following factors all play a part: low temperatures in early stages of growth or even in the germination period; day length: bolting occurring in special in long days conditions, with more than 12-14 hours of daylight, being known that in the northern hemisphere the bolting risk is therefore highest in spring and early summer; genetic factors (some types of brassica are inherently less prone to bolting than others) and stress factors such as: shock of transplanting, lack of water, overwatering or sudden temperature changes (Guttormsen, 1981; Larckom, 2008). Zhang et al. (2008) demonstrated that the floriferous steams will appear faster if the low temperature treatment is longer. Chinese cabbage sensibility to vernalization stars at germination and continues with the increasing of plants age (Opeňa et al., 1988).

Studies made by Pressman and Shaked (1988) showed that with the decreasing of the supplementary light intensity the length of flower stalks and flowering intensity was also decreased, while by supplying the natural light until 16 hours of light/day the bolting of plants was delayed.

A research effectuated in Transylvanian Tableland specific conditions showed that even 100% of plants can bolt, if planting if made in an inappropriate period (Laczi et al., 2011). If there is no adequate cultivation technology available for this species in a certain location the risk of failure is very high, so more studies are mandatory to obtain an improved technology.

MATERIAL AND METHODS

The research took place in the experimental field which belongs to the Vegetable Growing Department from the University of Agricultural Sciences and Veterinary Medicine Cluj - Napoca, during 2011. The purpose of this experiment was to study the bolting of several Chinese cabbage varieties during one year of cultivation in protected and open field crops in Transylvanian Tableland specific conditions.

To achieve the objectives of this study five experiments were set up in several times of the year: in spring were organized three crops: the first one, as protected crop, in polyethylene tunnel, and other two in open field to obtain an early yield, respectively an later one. During the summer other two crops were set up, one in protected area, an other one in open field. Each crop involved a collection of varieties (Granat) and hybrids (Kingdom 80, Michihli, Nepa F_1 and Vitimo F_1) and each variety was placed into three repetitions.

Seeds were sown, one by one, in small nutrient pots (according to data presented in Table 1) and were transplanted (according to data presented in Table 1) in bigger pots in stage of 3-4 true leaves. Planting was effectuated manually (according to data presented in Table 1) after a carefully preparation of the soil. During the vegetation period, there were not necessary any treatments or fertilizations. Observations were made regarding plants growth and development (at planting, one month after planting and at harvesting), a high attention was given to the number of the bolted plants.

Table 1

Calendar date of the most important practices

Planting date and place	Sowing	Transplanting	Planting	Harvest start date	Harvest end date
Spring protected crop	25th February	21st March	30th of March	18th of May	15th June
Spring early open field crop	25th February	25th March	4th April	1st June	25th June
Spring late open field crop	22nd March	7th April	15th April	27th May	5th July
Late protected crop	10th August	25th August	15th September	25th November	9th December
Late open field crop	20th July	8th August	20th August	20th September	25th November

In order to minimize the risk of bolting several measures were taken (according to existing possibilities): seedlings for early crops were grown in protected and heated spaces, to avoid plants suffering by low temperatures, seeds were sown individually in small nutrient pots and transplanted in pots to enable a good root system developing and to minimize the shock when the plants are transplanted into their permanent positions. Germination of the seeds was realized at temperature which varied between 18-20^{o}C, when plants formed 3-4 leaves the temperature was decreased to 15-16^{o}C. When low

temperatures occurred in open field, plants were given extra protection by covering them with plastic film. Beside these measurements the varieties and hybrid were chosen from local markets (Granat, Vitimo F_1these were grown in the past in this area), but also were brought from abroad (Michihli, Kingdom 80, Nepa F_1), in order to compare their growth and development capacity, as well as their bolting tendency throughout an agricultural year.

RESULTS AND DISCUSSIONS

One month after planting the average bolting percentage was 16.67%. The influence of the planting period and place on bolting (Table 2) showed that the lowest number of flowered plants (4.17%) was found in protected crops, both in spring and autumn cultures. The highest bolting ratio was registered in the late spring crop, which is probably due to the higher temperatures recorded in open field.

Table 2

The influence of the planting period and place on Chinese cabbage bolting one month after planting

Planting date and place	Bolting ratio (%)	Significance
Spring protected crop	4.17	^{A}
Spring early open field crop	6.67	^{B}
Spring late open field crop	7.50	^{B}
Late protected crop	4.17	^{A}
Late open field crop	5.83	^{AB}

One month after planting two hybrids (Kingdom 80 and Vitimo F1) showed no bolted plants, while at Michihli hybrid more than 13% of plants emitted already flower stalks (Table 3).

Table 3

The influence of the cultivar on Chinese cabbage bolting one month after planting

Variety/Hybrid	Bolting ratio (%)	Significance
Michihli	13.33	^{C}
Kingdom 80	0.00	^{A}
Granat	8.33	^{B}
Nepa F_1	6.67	^{B}
Vitimo F_1	0.00	^{A}

The combined influence of the two experimental factors revealed that one month after planting 29.17% from total number of plants already bolted at Michihli hybrid when it was cultivated is late open field conditions. It has to be noted that in this experiment it was the only hybrid which registered bolted plants in this moment, so from this stage of the study was clear that this is an inappropriate hybrid for late crops, in special for unprotected ones. The second highest bolting ratio was noted at Granat variety, where 16.67% plants bolted in late spring crop conditions due to higher temperatures which were registered at the beginning of the summer (Table 4).

Table 4

The influence of the variety/hybrid and planting period and place on Chinese cabbage bolting one month after planting

Planting date and place / Variety/Hybrid	Spring protected crop	Spring early open field crop	Spring late open field crop	Late protected crop	Late open field crop
Michihli	8.33^{AB}	8.33^{AB}	12.50^{BC}	8.33^{AB}	29.17^{D}
Kingdom 80	0.00^{A}	0.00^{A}	0.00^{A}	0.00^{A}	0.00^{A}
Granat	4.17^{A}	12.50^{BC}	16.67^{C}	8.33^{AB}	0.00^{A}
Nepa F_1	8.33^{AB}	12.50^{BC}	8.33^{AB}	4.17^{A}	0.00^{A}
Vitimo F_1	0.00^{A}	0.00^{A}	0.00^{A}	0.00^{A}	0.00^{A}

As seen in Table 5, the bolting ratio was highly influence by the planting period and place, so lowest number of bolted plants (10.00%) occurred in the protected crop from autumn, while the highest bolting percentage (21.17%) was recorded in the protected crop from spring. These results confirm that low temperatures from early stages of growth can induce bolting of plants. The highest number of bolted plants was registered at experience where the seedlings production started earlier in the year. High bolting percentages were registered in open field crops to, in special at those which were in field during summer months, long day conditions having an impact on this process to.

Table 5

The influence of the planting period and place on Chinese cabbage bolting at harvest

Planting date and place	Bolting ratio (%)	Significance
Spring protected crop	21.17^{B}	
Spring early open field crop	18.83^{AB}	
Spring late open field crop	15.83^{AB}	
Late protected crop	10.00^{A}	
Late open field crop	18.05^{AB}	

As mentioned earlier, the genetically background of the planting material had high influence on bolting. Therefore in Table 6 it can be seen that hybrid Michihli (28.67%) had the higher tendency to bolt, followed closely by Granat (23.89%) variety and Nepa F_1 hybrid (20.67%). Low bolting ratios were observed at Vitimo F_1 hybrid, where only 1.67% of the plants emitted flower stalks before head formation and at Kingdom 80 hybrid, where 8.61% of plants bolted.

Table 6

The influence of the cultivar on Chinese cabbage bolting at harvest

Variety/Hybrid	Bolting ratio (%)	Significance
Michihli	28.67^{D}	
Kingdom 80	8.61^{B}	
Granat	23.89^{CD}	
Nepa F_1	20.56^{C}	
Vitimo F_1	1.67^{A}	

The combined influence of the two factors revealed that only at Vitimo F_1 hybrid there were no bolted plants in several planting places and periods (Table 7). Low values were recorded at Kingdom 80 hybrid in both protected cultures and at Vitimo F_1 hybrid in spring early open field crop. Highest bolting percentage (41.67%) was observed at Michihli hybrid in late open field crop, followed by the same hybrid (30.17%) and variety Granat (37.50%) in spring protected crop.

Table 7

The influence of the variety/hybrid and planting period and place on Chinese cabbage bolting at harvest

Planting date and place / Variety/Hybrid	Spring protected crop	Spring early open field crop	Spring late open field crop	Late protected crop	Late open field crop
Michihli	39.17^{GH}	20.83^{CDE}	25.00^{DEF}	16.67^{BCDE}	41.67^{H}
Kingdom 80	4.17^{AB}	12.50^{ABCD}	12.50^{ABCD}	4.17^{AB}	9.72^{ABC}
Granat	37.50^{FGH}	29.17^{EFGH}	29.17^{EFGH}	12.50^{ABCD}	11.11^{ABC}
Nepa F_1	25.00^{DEF}	20.83^{CDE}	12.50^{ABCD}	16.67^{BCDE}	27.78^{EFG}
Vitimo F_1	0.00^{A}	8.33^{ABC}	0.00^{A}	0.00^{A}	0.00^{A}

CONCLUSIONS

To reduce the bolting of Chinese cabbage the seedlings should be produced in heated spaces in spring or in open spaces in summer, seeds should be sown in individual pots in order to obtain vigorous roots. The best place to cultivate this species, to avoid early flowering, is in polyethylene tunnel, in an autumn culture. There should be given a high attention to the variety, bolting depending on the genetically background to; hybrid Vitimo F_1 and Kingdom 80 are therefore highly recommended to be taken in culture in Transylvanian Tableland.

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