BOLTING OF CHINESE CABBAGE INFLUENCED BY FERTILIZATION AND CULTIVATION PLACE

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Abstract. The main aim of the experiment was to study the behavior of several hybrids of Chinese cabbage cultivated in protected places and open field when different types of manures were applied. The research took place in Poieni, a small village near Cluj Napoca, in a polyethylene tunnel, respectively in open field, and involved three hybrids: Golden Wa-Wa, Vitimo and Hybrid Super. Cattle and horse manure was applied before planting and in the vegetative period. Results showed that bolting of Chinese cabbage was influenced by cultivation place - best results (1.41% of bolted plants) were registered in the case of protected crops; by fertilization - a higher number of plants bolted (3.39%) when no fertilizers were added and by planting material – a lower bolting ratio (1.31%) was registered at Hybrid Super. It can be concluded that bolting of Chinese cabbage can be reduced by choosing the right planting material combined with an improved cultivation technology.

Keywords: bolting, Brassicas, open field crops, manure, protected cultures, vegetables.

INTRODUCTION

As the name implies, Chinese cabbage (Brassica campestris L. var. pekinensis (Lour.) Olson) is native to eastern Asia and possibly Japan. The plant is mentioned in Chinese literature from the 5th century A.D., but was used much earlier than that (Dixon, 2007; Toxopeus and Baas, 2004).

The parts used from Chinese cabbage are: the head or the rosette of leaves, according to botanical variety, to prepare different kind of food or are used raw in salads. At maturity the outer foliage and wrapper leaves are characteristically pale green, whereas the inner leaves are blanched a creamy color (Ciofu et al., 2003; Dixon, 2007). It is commonly consumed in Asian countries and in Asian communities from Western countries.

Even if in Transylvania the cultivation of Chinese cabbage is not very popular, it had increased significantly lately. Unfortunately, under certain conditions a number of oriental brassicas have a tendency to bolt – to produce flowers and run to seed rather to form a good leafy head. The causes of this physiologically disorder are mainly: low temperatures in the early stages of growth, genetic factors, and also various kinds of “stress” such as: lack of water or even overwatering, nutritional deficiencies or excesses (Larkcom, 2003; Larkcom, 2008). The main aim of the present research was to study the behavior of growth, development and bolting of this vegetable, in order to eliminate some of the bolting factors, being well known that the initial stage of starting a large-scale cultivation of vegetables from other parts of the world is to check their response to the target soil or climatic conditions, which are often different from the originating regions (Siomos, 1999; Kalisz, 2011).
MATERIALS AND METHODS

A polifactorial experiment (following randomized complete block design, with four replications) was organized in Poieni village from Cluj county, Transylvania, Romania in 2013 and 2014. The location of the experimental site is 46°55’11’’ N latitude and 22°51’55’’ E longitude. By position, the experimental site falls into the moderate continental climate which is characteristic of western and north western region of the country.

The studied factors involved: different fertilization treatments (fertilization with cattle and horse manure), two cultivation places (in order to obtain an open field and a protected culture) and three Chinese cabbage hybrids. The combination of the factors and their graduations gave 18 experimental variants as seen in Table 1. The manures were obtained from an animal farm from the village; the protected crop was done in a polyethylene tunnel. The biological material consisted of three Chinese cabbage hybrids, with a vegetation period of 65-80 days, all of them being adequate for fresh consumption and medium-term storage.

Table 1

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<tbody>
<tr>
<td>1</td>
<td>a1</td>
<td>7</td>
<td>a2</td>
<td>13</td>
<td>a3</td>
<td>b1 – open field</td>
<td>c1 – Golden Wa-Wa</td>
</tr>
<tr>
<td>2</td>
<td>8</td>
<td>14</td>
<td></td>
<td></td>
<td></td>
<td>c2 – Vitimo</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>a1 – unfertilized</td>
<td>9</td>
<td>a2 – cattle manure</td>
<td>15</td>
<td>a3 – horse manure</td>
<td>b2 – polyethylene tunnel</td>
<td>c3 – Hybrid Super</td>
</tr>
<tr>
<td>4</td>
<td>10</td>
<td>16</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>5</td>
<td>11</td>
<td>17</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>c1 – Golden Wa-Wa</td>
</tr>
<tr>
<td>6</td>
<td>12</td>
<td>18</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>c2 – Vitimo</td>
</tr>
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</table>

Sowing was done in greenhouse in different times due to planting sites in the middle of March for protected culture and in the middle of April for the open field. The soil preparation started with plowing in autumn of preceding years. One month before establishing the trial, air dried cattle and horse manure (20 t/ha) was incorporated into the soil. Planting took place in second decade of April, for protected crops, respectively in May in open field. During vegetation period intercultural practices were done as per requirements. For supplementary fertilization fresh cattle, respectively horse manure were macerated in water, in proportion of 1:10, for 10 days. The obtained maceration was applied to the plants after 30 days from planting.

Before harvest was registered the number of bolted plants on each experimental plot. The average data were statistically analyzed to find out the significance difference of fertilizations, place and time of the culture and hybrid on the bolting of Chinese cabbage. The significance of the differences among the treatment combinations means was estimated by the Duncan’s multiple range test at 5% level of probability and linear correlation coefficients were calculated between bolting and other characteristics at 99% of probability (Ardelean et al., 2007).

RESULTS AND DISCUSSIONS

Figure 1 presents the bolting ratio of all variants, which varied between 0.00% and 5.62%. There were four experimental variants at which there were no bolted plants: at Hybrid Super cultivated in polyethylene tunnel and fertilized with cattle and horse manure.
manures, at the same hybrid grown in open field fertilized with horse manure, respectively at Vitimo hybrid, fertilized with horse manure and grown in protected area. These results are considered satisfactory taking into account past studies from the same area where even 100% of plants had bolted in an open field crop (Laczi et al., 2011).

The bolting of Chinese cabbage was influenced by all three studied factors. As seen in Table 2 between different fertilization treatments were registered significant differences: highest bolting ratio was observed at unfertilized variants (3.39%), followed by cattle manure fertilization (2.92%) and horse manure fertilization (1.08%). Statistically supported differences were observed in case of biological material too: at hybrid Golden Wa-Wa was observed the highest number of bolted plants before harvest (3.30% from total number of plants). This hybrid was followed by Vitimo (2.78%) and Hybrid Super (1.31%). In another study made in Transylvania, hybrid Vitimo registered bolting ratio which varied between 0.00 and 8.33% depending on time and place of the crop (Laczi et al., 2014). The interaction of fertilization and hybrid revealed that only in case of Hybrid Super fertilized with horse manure were no flourished plants. Unfertilized plants of Golden Wa-Wa hybrid had the highest tendency to bolt.

Table 2

<table>
<thead>
<tr>
<th>Hybrid</th>
<th>Fertilization</th>
<th>Mean hybrid</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>unfertilized</td>
<td>cattle manure</td>
</tr>
<tr>
<td>Golden Wa-Wa</td>
<td>4.37 f</td>
<td>3.28 d</td>
</tr>
<tr>
<td>Vitimo</td>
<td>3.86 e</td>
<td>3.50 d</td>
</tr>
<tr>
<td>Hybrid Super</td>
<td>1.95 c</td>
<td>1.99 c</td>
</tr>
<tr>
<td>Mean fertilization</td>
<td>3.39 O</td>
<td>2.92 N</td>
</tr>
</tbody>
</table>

Note. Different letters within hybrids, fertilization, place of culture and different treatment combinations denote significant differences (Duncan test, p < 0.05).

Cultivation place and period had a great role regarding plants bolting (Table 3). As expected the plants cultivated in open field had a higher tendency to bolt, due to the uncontrolled cultivation factors, such as: soil and air humidity and temperature, fact demonstrated by Hernandez et al. (2004). In a similar experiment bolting of plants was reduced if planting was realized in summer in polyethylene tunnel (Laczi et al., 2014). In
case of the combination place of culture x hybrid, lowest number of bolted plants was observed at Hybrid Super in protected crops. In this case only 0.48 plants flourished earlier. On the other hand, Golden Wa-Wa hybrid, cultivated in open field, registered the highest bolting ratio (4.84%).

Table 3

<table>
<thead>
<tr>
<th>Hybrid</th>
<th>Place of the culture</th>
<th>Mean hybrid</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>open field</td>
<td>polyethylene tunnel</td>
</tr>
<tr>
<td>Golden Wa-Wa</td>
<td>4.84 e</td>
<td>1.76 b</td>
</tr>
<tr>
<td>Vitimo</td>
<td>3.56 d</td>
<td>2.01 bc</td>
</tr>
<tr>
<td>Hybrid Super</td>
<td>2.14 c</td>
<td>0.48 a</td>
</tr>
<tr>
<td>Mean place of culture</td>
<td>3.51 M</td>
<td>0.48 a</td>
</tr>
</tbody>
</table>

Note. Different letters within hybrids, fertilization, place of culture and different treatment combinations denote significant differences (Duncan test, \( p < 0.05 \)).

Pressman and Shaked (1988) demonstrated that flowering intensity was related to light conditions, which is different for the two studied places. Taking into consideration the combined influence of place of the culture and fertilization, best results were obtained in polyethylene tunnels, in special when fertilization was done using horse manure. Cattle manure application gave also good results regarding plants bolting in case of protected areas (Table 4).

Table 4

<table>
<thead>
<tr>
<th>Place of the culture</th>
<th>Fertilization</th>
<th>Mean place of the culture</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>unfertilized</td>
<td>cattle manure</td>
</tr>
<tr>
<td>Open field</td>
<td>4.08 e</td>
<td>4.65 f</td>
</tr>
<tr>
<td>Polyethylene tunnel</td>
<td>2.71 d</td>
<td>1.19 b</td>
</tr>
<tr>
<td>Mean fertilization</td>
<td>3.39 O</td>
<td>2.92 N</td>
</tr>
</tbody>
</table>

Note. Different letters within hybrids, fertilization, place of culture and different treatment combinations denote significant differences (Duncan test, \( p < 0.05 \)).

The Pearson correlation, which is -0.76, reveals that between the bolted plants ratio and total yield there is a significant negative correlation, which means that with the increasing of the bolted plants number the yield is decreasing. This fact is demonstrated by the regression line too, as seen in Figure 2.

Fig. 2. Relations between total yield and bolting ratio
CONCLUSIONS

Bolting of Chinese cabbage was influenced by cultivation place and period, hybrid and fertilization.

Lower number of bolted plants was recorded in polyethylene tunnel, which is due to better growing conditions, compared to open field. Using polyethylene row covers can constitute a low cost technique to obtain higher yields in case of open field crops.

Fertilization had a positive effect on crops; unfertilized plants had a higher tendency to bolt, while cattle and horse manure application had decreased the bolting ratio.

Hybrids had the highest influence on bolting, so the number of flourished plants can be decreased, in special, with a correct choose of the planting material. It is recommended to choose bolting resistant hybrids, which have genetically induced slow bolting capacity.

To increase yields is recommended to cultivate bolting resistant hybrids in protected spaces, application of different kind of manure being also essential.

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REFERENCES