

## 25. EFFECT OF DIFFERENT COMPOUNDS BIOCHIKOL 020 PC, CALCIUM NITRATE, TYTANIT AND POMONIT ON THE HEALTHINESS AND THE YIELD OF CHINESE CABBAGE

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### 1. Introduction

The Chinese cabbage (*Brassica rapa L. ssp. pekinensis* (Lour.) Hanelt) as the vegetable is cultivated all over the world with increasing popularity. It gives the crop 100 t·ha<sup>-1</sup> (sometimes more) for 2 - 3 months cultivation [1, 2]. Rapid growth of this plant makes it very sensitive to tipburn injures, which are physiological disorders connected with calcium and water deficiency [3 - 7]. Tipburn is the main cause of destroying the whole marketable yield of Chinese cabbage. The disorder concerns also other leaves vegetables [7]. Cultivars of Chinese cabbage differ in susceptibility of tipburn [8, 9]. It seems to be connected with the susceptibility to stress caused by high temperature promoted rapid growth, transpiration and water deficit [7], because cultivars did not differ in calcium concentration in leaves [10]. Chitosan as an elicitor, increased the plant resistance to different diseases [11 - 14]. Experiments were carried out to determine whether chitosan or other preparations can increase the resistance of Chinese cabbage on tipburn similarly as calcium nitrate.

### 2. Material and methods

Seeds of Chinese cabbage Bilko F<sub>1</sub> cultivar sensitive to tipburn [10] was sown in multipots in the warm glasshouse in April 14<sup>th</sup> 2004. High temperature was applied to prevent seedlings of Chinese cabbage grown in temperature lower than 18 °C, starting the generative development with lack of heads yield [15, 16]. On May 7<sup>th</sup> seedlings were transplanted to 5 liter in 11 replications pots filled with peat substrate. It contained in following mineral nutrition: 1 dm<sup>3</sup> 622 mg N-NO<sub>3</sub>, 142 mg P, 1218 mg K, 698 mg Mg and 6328 mg Ca. The salinity of the substrate was 6,05 g NaCl·dm<sup>-3</sup> and pH was 6.5.

Spraying with 2.5% Biochikol 020 PC were carried out 3 times: on May 11<sup>th</sup>, 19<sup>th</sup> and on June 9<sup>th</sup>. The preparation was made by Gumitex Poli-Farm in Łowicz. Biochikol 020 PC in concentration 2.5% was used instead of 0.1% chitosan calculated on dry mass. This preparation was diluted with distilled water to avoid the influence on plants by tap water (pH 7.5). Calcium nitrate fertilizer in concentration 1.5% and 0.02%, foliar fertilizer Tytanit (0.85% of Ti) produced by Intermag Company in Osiek near Olkusz were used 3 times (Table 1). Sprays with Pomonit contained KNAA (potassium salt of naphthene acetic acid) was done on June 14<sup>th</sup>. Its successful influence in controlling tipburn of internal leaves in lettuce [17]. The observations of tipburn incidences were carried out from half of June and there the scale 0-4 was used:

0 - healthy leaves

0.5 - slight symptoms of tipburn on edges on the 1-2 leaves

1 - symptoms of tipburn on edges of some leaves

2 - distinct symptoms of tipburn on numerous leaves

3 - almost all leaves in the head are affected less or more with tipburn, easy rotting. The picture of the stage of disorder was presented in journal Ochrona Roślin [9].

4 - the plant of Chinese cabbage is as strong affected by tipburn, that the head had not been formed and plant is predominantly rotten. This stage appeared rarely and is presented in Acta Hort. [4].

Chinese cabbage plants in pots grew at strong solar irradiation (southern side of the glasshouse), where the temperature at sunny midday was 5-10 °C higher than on the open area. During the warm days plants were watered 2 or 3 times with tap water. Plant heads were harvested on July 7<sup>th</sup>.

Similar growing scheme of experiments were carried out in 2005 with the same cv. Bilko F<sub>1</sub>. On April 4<sup>th</sup> seeds were sown to multipots (3 x 3 cm). On April 22<sup>th</sup> seedlings were transplanted to bigger multipots (6 x 6 cm). In 2004 and in 2005 in order to control insects cabbage fly (*Hylemya brassicae*), wivil betels (*Ceutorrhynchus quadridens* and *Ceutorrhynchus sp*) 0.1% solution of insecticide Grott 20 EC (diazinon) was applied 2 times by watering.

On May 2<sup>nd</sup> plants of Chinese cabbage were planted to 5 liter pots in 11 replications and grown outdoor under the same conditions as in 2004. The substrate contained following concentration of fertilizers: in 1 dm<sup>3</sup> 370 mg N-NO<sub>3</sub>, 113 mg P, 570 mg K, 355mg Mg and 4566mg Ca, pH was 6.8 and salinity 4.7g NaCl-dm<sup>-3</sup>. Sprays with 2,5% Biochikol 020 PC were done 5 times: May 6<sup>th</sup>, 24<sup>th</sup>, June 8<sup>th</sup>, 20<sup>th</sup>, and 25<sup>th</sup>. Other treatments were done in similar shedule as in table 2. One spray with Pomonit contained KNAA (potassium salt of naphthalene acetic acid) and was carried out on June 10<sup>th</sup>. During plants cultivation ammonium nitrate (8 g per pot) in solution was applied 2 times. Observations of tipburn appearance started on June 10<sup>th</sup> with harvest time on July 7<sup>th</sup>.

Each plant head was weighted and then two leaves of each plant were collected for mineral nutrition analysis. The results were evaluated statistically by  $X^2$  (Chi<sup>2</sup>) test at

**Table 1.** Effect of Biochikol 020 PC, Pomonit, calcium nitrogen and Tytanit on the healthiness and yield of Chinese cabbage in 2004.

Preparations	Number of treatments	Observations of tipburn incidence in scale 0-4				% rotten plants 2)	Fresh matter of 1 plant, kg	% Ca in dry matter of leaves
		June 16th	June 22th	June 29th	July 6th			
Control	-	0.64	1.09	2.45	3.40	64	1.19 b	2.65
Biochikol 020 PC 2.5% 1)	3	0.23	0.45	1.73	2.59 <sup>xx</sup>	36	1.32 ab	2.30
Pomonit (25 ppm NAA) 1)	1	0.32	0.55	1.68 <sup>x</sup>	2.41 <sup>xx</sup>	82	1.41 a	2.87
Ca(NO <sub>3</sub> ) <sub>2</sub> 1.5% 1)	3	0.0 <sup>xx</sup>	0.36 <sup>x</sup>	1.68 <sup>x</sup>	2.68 <sup>xx</sup>	64	1.35 ab	3.02
Tytanit 0.02% 1)	3	0.23	0.73	1.68 <sup>x</sup>	2.68 <sup>xx</sup>	45	1.41 a	2.74

1) - spraying

2) - It is the first stage of rotting

x, xx Differences significant in comparison to underlined treatment calculated with criterion Chi<sup>2</sup> at  $\alpha = 0.05$  or 0.01 respectively. Average fresh matter was calculated with the analysis of variance using Newman Keuls test.

Tipburn scale 0-4: 0 – healthy plant, 0.5 – plant a little injured 4 – cabbage head completely destroyed.

$\alpha = 0.05$  or  $0.01$  to tipburn injury scale and Newman - Keuls test at  $\alpha = 0.05$  for fresh matter.

### **3. Results and discussion**

The lowest level of tipburn incidences was found in treatments: Pomonit (NAA), Biochikol 020 PC, calcium nitrate and Tytanit (Table 1). In this treatments the yield was markedly higher than in control, although not all differences were statistically significant. It was found, that after spraying with calcium nitrate tipburn injures are smaller and the calcium content in leaves increased because calcium make more stiff cells membranes [7, 18, 19].

Biochikol 020 PC also decreased tipburn injures, but in the some time the calcium content was the lowest. It confirms that tipburn injures are dependent not only from calcium content but also on plant resistance on stress (high temperature, wated shortage) as has been shown by Saure [7]. The experiments with tomato in glasshouse showed the influence of chitosan on the enzymes activity in tomato leaves [12]. Similar mechanism may be expected in Chinese cabbage giving the effect on tipburn appearance. Plants treated with Biochikol 020 PC were less affected with bacterial rotting than other. It confirms the data of Maćkowiak and Pośpieszny [20].

As was found earlier for lettuce cv. Ilanka and Marcia [17] Pomonit (KNAA) decreased significantly tipburn injuries in Chinese cabbage. However per cent of rotten plants was the highest (Table 1). Pomonit decreased also strongly the level of phenolic compounds in these plants [17]. It is interesting if Biochikol 020 PC or Tytanit had similar effect on phenolic compounds level in Chinese cabbage. High level of these compounds probably are connected with tipburn appearance. Spraying with Tytanit solution decreased the tipburn injures and increased the yield similarly to Pomonit treatment, and also lowered per cent of rotten heads. It is the similar result to earlier described favorable influence of titanium on plant growth and stress resistance [21, 22].

In 2005 experiments the best results in the tipburn control were received in objects treated with 3 preparations: 1.5% calcium nitrate and 2.5% Biochikol 020 PC, calcium nitrate and Tytanit or with calcium nitrate alone (Table 2). It is interesting that tipburn incidences on plants treated with 3 preparations together: Biochikol 020 PC, calcium nitrate and Tytanit were similar as in control. The mechanisms of action of Biochikol and Tytanit are different [12]. For that reason it seems to be rather some kind of antagonistic effect between this preparations than expected additive one.

Not significant differences between treatments in the cabbage yield were observed (Table 2). The lowest per cent of rotting plants was in objects treated with Biochikol 020 PC (similarly as in 2004), calcium nitrate alone, calcium nitrate with Biochikol 020 PC and Tytanit with Biochikol 020 PC. In 2004 Biochikol 020 PC decreased calcium level in Chinese cabbage leaves. It is interesting, that chitosan is able also decrease the calcium level in animal cells [23]. Similarly as in 2004 spraying with calcium nitrate

**Table 2.** Effect of preparations Biochikol 020 PC and Pomonit and fertilizers calcium nitrate and Tytanit on the healthiness and yield of Chinese cabbage in 2005.

Objects	Number of sprays	Observations of tipburn incidences in scale 0 – 4							% rotten plants 1)	Weight of one head and leaves a), kg	% Ca in dry matter of leaves
		June		July							
		21th	27th	4th	7th	7th					
Control	-	1.32	1.50	1.73	1.91	1.91	1.91	36	1.19	2.24	
2.5% Biochikol 020 PC	5	1.18	1.36	1.36	1.36 <sup>xx</sup>	1.36 <sup>xx</sup>	1.36 <sup>xx</sup>	9	1.21	2.40	
1.5% calcium nitrate	4	0.91 <sup>x</sup>	0.95	1.09 <sup>x</sup>	1.14 <sup>xx</sup>	1.14 <sup>xx</sup>	1.14 <sup>xx</sup>	9	1.26	2.75	
0.02% Tytanit	5	1.14	1.27	1.64	1.82	1.82	1.82	45	1.19	2.38	
2.5% Biochikol and 1.5% calcium nitrate	5+4	0.82 <sup>x</sup>	0.82 <sup>xx</sup>	0.91 <sup>x</sup>	0.91 <sup>xx</sup>	0.91 <sup>xx</sup>	0.91 <sup>xx</sup>	9	1.11	2.78	
1.5% calcium nitrate and 0.02% Tytanit	4+5	0.64 <sup>xx</sup>	0.91 <sup>xx</sup>	1.05 <sup>x</sup>	1.05 <sup>xx</sup>	1.05 <sup>xx</sup>	1.05 <sup>xx</sup>	36	1.32	2.77	
Biochikol, calcium nitrate and Tytanit	5, 4, 5	1.14	1.32	1.64	1.86	1.86	1.86	45	1.16	2.76	
Pomonit (25 ppm NAA)	1	1.18	1.27	1.41	1.50	1.50	1.50	54	1.11	2.63	
1.5% calcium nitrate and Pomonit	4+1	0.73 <sup>xx</sup>	0.86 <sup>xx</sup>	1.00 <sup>x</sup>	1.14 <sup>xx</sup>	1.14 <sup>xx</sup>	1.14 <sup>xx</sup>	18	1.24	2.51	
0.02% Tytanit and Biochikol 020 PC	5	1.14	1.14	1.18 <sup>x</sup>	1.23 <sup>xx</sup>	1.23 <sup>xx</sup>	1.23 <sup>xx</sup>	9	1.22	2.33	

a) - Differences not significant by use Newman-Keuls test at  $\alpha = 0.05$

x,xx - Differences significant in comparison to underlined treatment calculated with criterion  $Chi^2$  at  $\alpha = 0.05$  or  $0.01$  respectively.

Tipburn 0-4 scale: 0 – healthy plant 0,5 – plant slightly injured 4 – cabbage head completely destroyed

1) It is the first stage of rotting.

increased markedly the content of calcium in Chinese cabbage leaves. Biochikol 020 PC did not increased calcium content in leaves, but decreased tipburn symptoms. Spraying with calcium nitrate and Tytanit gave also similar effect.

#### 4. Conclusions

Results of pot investigations carried out in 2004 - 2005 showed that calcium nitrate or Biochikol 020 PC spraying decreased tipburn incidence on Chinese cabbage. The treatments with calcium nitrate and Biochikol 20 PC together gave the best effect, because strong decreased tipburn incidentes and decreased per cent of rotten plants. Spraying with calcium nitrate and Tytanit gave better results than calcium nitrate alone or Tytanit alone. The treatment with combination of 3 components (calcium nitrate, Biochikol 020 PC and Tytanit) used together is not usefull because there the effect would be similar as in control.

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