

# **Grower Summary**

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## **FV 430**

Reducing wastage in stored  
winter cabbage and swede

Annual 2015

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**Project Number:** FV 430

**Project Title:** Reducing wastage in stored winter cabbage and swede

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## **GROWER SUMMARY**

### **Headline**

Calcium spray programmes on cabbage increase the weight of harvested heads; increased head size can lead to cabbages with softer centres.

Calcium spray programmes on swede increase calcium content in roots and reduce the rate of tissue browning.

### **Background**

Significant losses in winter cabbage and swedes occur after harvest with up to 30-40% wastage during storage, due to fungal decay and physiological breakdown. Strategies that control physiological breakdown and the incidence of post-harvest disease require further investigation.

A number of post-harvest strategies that combine treatments to improve crop health and reduce fungal load will help reduce wastage. Pre-harvest nutrient sprays containing calcium and boron have been shown to improve firmness, reduce the rate of senescence and delay the onset of disease of harvested crops.

Additional treatments during storage such as ethylene removal and ozone treatments are also beneficial in reducing water loss, and thereby improving the financial return on the saleable crop coming out of store. The amount of ethylene removal required to provide significant effect on the quality of cabbage needs to be determined to provide threshold levels which growers can try and achieve in commercial stores. The use of ozone has been trialed on a range of crops to reduce the incidence of disease and lower moisture loss in a range of crops. Identifying an effective dose of ozone that both lowers disease and water loss of both crops without discolouring cut surfaces has yet to be determined.

Alternative disease control techniques including advances in the development of bio-control agents such as Serenade give the possibility of lowering the disease spread during storage caused by *Botrytis*. The combination of calcium sprays and post-harvest dipping with biological control agents may provide a viable alternative to current post-harvest fungicide application.

## Summary

A series of trials were initiated to investigate the effect of pre-harvest calcium/nutrient trials and post-harvest treatments to reduce the onset of disease.

For white winter cabbage (*Brassica oleracea*), a field site was kindly provided by Naylor Farms, Fosdyke, Lincolnshire, and for Swede (*Brassica napus var. napobrassica*) A W Mortier, Cedar Farm, Alderton, Woodbridge, Suffolk provided a field site. A randomised plot trial design was created using four replicate plots per treatment.

The four treatments were as follows: Untreated control, InCa (Plant Impact) – 1L/ha, Brassitrel Pro (Yara) – 4L/ha and Carnival (Headland) – 5L/ha. All sprays applied in 200L/ha water with 02F110 nozzles using a 2m spray boom.

A total of eight sprays were applied at 2 weekly intervals by the Allium and Brassica Agronomy Limited starting in July and finishing in mid-October. Cabbages were hand harvested on the 5/6th November 2014 and swedes were hand harvested on 23<sup>rd</sup> October 2014. Cabbages and swedes were immediately transported to the Produce Quality Centre at East Malling Research where they were placed in 1°C to remove field heat. Cabbages were transferred to nets and placed into four 500 kg CA chambers. Controlled atmospheres were established by N<sub>2</sub> flushing and the addition of CO<sub>2</sub> to achieve a CA atmosphere of 5% CO<sub>2</sub>, 3% O<sub>2</sub> (1°C).

### Post-harvest treatments

#### Cabbages: Disease control

Cabbages were dipped in 200 L of solution in the following treatments; water, Serenade (Bayer) 30 mL L<sup>-1</sup>, BASF9747 (BASF) 1 g L<sup>-1</sup>, + Bond sticker (1 mL L<sup>-1</sup>) and Rovral WG (BASF) 0.67g L<sup>-1</sup> /SL567A 0.104 mL L<sup>-1</sup>. Bins were transferred to a 1°C store.

#### Cabbages: Ethylene - trial

To determine the effect of background ethylene on the storage potential of white cabbages, trials were conducted on 4-5 kg cabbages placed in 500 kg storage containers with a constant flow of air (1 L kg<sup>-1</sup> h<sup>-1</sup>) amended with 0, 50, 100 or 150 ppb ethylene (BOC, UK).

#### Cabbages/Swede: Ozone trial

In year 1, the effectiveness of ozone to disinfest swede and cabbage was determined. Cabbages and swedes were exposed to ozone for 30 or 90 minutes. Untreated cabbages and swedes were included as controls. Treatments were repeated after 2 and 4 months of storage.

### Swedes: Hydrogen peroxide trial

Swedes were treated with hydrogen peroxides solution (~100 mL/t (x1) and ~200 ml/t (x2) of (hydrogen peroxide solution (10% H<sub>2</sub>O<sub>2</sub>) Treatments were repeated every 6 weeks, water control and untreated roots were included as controls.

### Harvest Quality Assessments: Spray Trial.

Leaf colour of cabbages and the rate of discolouration of cut swedes were recorded using a Minolta colour meter. Sugar and mineral content and dry matter analysis were taken from a V shape sections removed from cabbages and a from an equatorial section removed from.. Firmness measurements of cabbage were taken on the cut surface, two in the centre of the cabbage either side of the stalk and two towards the outer circumference (Figure 1), using an 8 mm probe attached to a penetrometer (Llyod Instruments). The firmness and elasticity of swedes was measured using a wedge fracture technique, a 1 cm<sup>3</sup> sections of root

## **Results**

### Cabbage

Bassitrel Pro and Carnival significantly increased the size of cabbages compared to the control. However, InCa was the only product to significantly increase the amount of calcium present in cabbage. The firmness profiles of cabbages from all three calcium spray programmes showed a reduction in firmness in the tissue around the base of the stalk (Heart) compared to the controls. The outer leaves (Figure 1) of InCA and Carnival treated cabbages were firmer than the control.

All three calcium spray products are formulated with incorporation of nitrogen. Bassitrel Pro (6.9 % w/w) and Carnival (14.9 % w/w) have a larger nitrogen component in the formulation than InCa (4.5% w/v) the combination of calcium and nitrogen increased the size of cabbages, however, the central heart tissue was less firm. The increase in calcium present in the outer leaves of cabbage treated with InCA and Carnival suggests a localised incorporation of calcium in the outer leaves. Calcium spray treatments had no effect on the dry matter accumulation. In general, application of calcium/nutrient sprays reduced the amount of weight loss in CA stored cabbage from 3 % in the control to ~2% in the treated cabbage after 3 months storage. There was no evidence from initial inspections that calcium spray application reduced rotting. Only once destructive analysis is complete at the end of the trial (June) will it be possible to determine the overall impact of calcium on diseases spread. Assessments of leaf quality and incidence of disease on ozone and ethylene treated cabbage is underway.

## Swede

All calcium sprays increased the calcium content of roots. Whether the resultant increase in calcium was the movement of calcium from leaves to roots is unknown. An alternative and more likely scenario is that calcium application to leaves has encouraged leaf canopy development and increased transpiration allowing for greater accumulation of calcium in the roots. In addition to calcium, Brassitrel Pro increased iron, phosphate and manganese; Inca application increased potassium and phosphate and Carnival led to raised iron content in the roots. While none of the formulations contained potassium, phosphate or iron, the presence of increased calcium content can stimulate the uptake of other minerals from the rhizosphere. Interestingly, no increase in boron was observed in swedes even though Brassitrel Pro and Carnival are formulated with boron as a minor element.

No effect on dry matter content or yield or size distributions were observed between treatments and no increase in nitrogen content in roots was observed indicating foliar applied nitrogen had not moved into the root. Application of Carnival increased resistance to splitting/crack formation after harvest when tested using a wedge fracture test.

All calcium treatments reduced the rate of tissue browning in swedes cut after harvest. Additional testing will be conducted at the end of the trial (April). Initial experiments with hydrogen peroxide and ozone treatments showed no reduction in stem or root rotting.

The incidence of rotting was most obvious on the leaves and petioles of the leaves infected with *Botrytis spp*, with a large amount of visible sporulation on the surface of leaves, the disease migrated onto the stem and in some severe cases infection progressed to the main root. Disease of the root not associated with the direct ingress from the stem was observed, but less frequently. Root diseases were associated with *Botrytis* sporulating on leaf debris stuck to the side of roots, cross infection from adjacent swedes or where infection had developed around a lesion or wound. There was no effect of calcium sprays controlling disease spread on leaves and the low frequency of direct root infections meant no significant treatment effects were observed.

Table 1. Mineral content of cabbages sprayed with InCa, Brassitrel Pro and Carnival

Minerals	Control	Inca	Brassitrel	Carnival	LSD <sub>0.05</sub>
mg/100g					
N	161.5	180.2	150.2	175.8	30.21
Ca	32.62	<b>38.12</b>	31.6	36.85	4.50
K	210.5	218.5	202.8	<b>234.8</b>	19.55
Mg	12.93	12.97	12.55	13.35	1.35
P	15.38	16.55	15.1	16.85	2.16
mg/kg					
B	1.218	<b>1.525</b>	1.222	<b>1.44</b>	0.15
% Dry Mat.	8.85	8.64	8.54	8.92	0.31
Ca/DM	3.68	<b>4.322</b>	3.572	<b>4.178</b>	0.41
K/Ca	6.53	<b>5.73</b>	6.43	6.38	0.75
K+Mg/Ca	6.92	<b>6.07</b>	6.83	6.75	0.77

Table 2: Weight and firmness of cabbages sprayed with calcium products InCa, Brassitrel Pro and Carnival

Treatment	Position	Control	Inca	Brassitrel	Carnival	LSD <sub>0.05</sub>	df
Weight (g)		3631.2	3763.5	<b>4382.2</b>	<b>4266.2</b>	215.2	78
Firmness (N)	Heart	101.1	<b>86.43</b>	<b>92.08</b>	<b>88.11</b>	3.723	32
Firmness (N)	Outer Cortex	94.8	<b>104.96</b>	<b>83.67</b>	<b>104.64</b>	3.723	32

Table 3. Weight loss and the incidence of disease in incidence of CA (5% CO<sub>2</sub>. 3% O<sub>2</sub>)

	Control	Inca	Brassitrel	Carnival	LSD
% Wt loss	3.05	2.69	<b>2.01</b>	<b>2.11</b>	0.542
% Botrytis	57.5	<b>73.8</b>	59.8	<b>85.9</b>	16.15
% Phytophthora	14	23.3	18.8	<b>32.1</b>	13.13

*N.B.* Results highlighted in bold are significantly different ( $P < 0.05$ ) from the control within the same row

Table 4. Mineral content of swedes sprayed with InCa, Brassitrel Pro and Carnival

Minerals	Control	Inca	Brassitrel-Pro	Carnival	LSD <sub>0.05</sub>
mg/100g					
N	88.80	111.20	104.50	102.80	31.57
Ca	36.25	<b>40.15</b>	<b>42.00</b>	<b>41.52</b>	3.65
K	261.00	<b>297.50</b>	287.50	272.80	31.28
Mg	8.88	9.60	9.80	9.00	1.05
P	41.88	<b>44.12</b>	<b>44.12</b>	38.67	1.87
mg/kg					
B	1.97	1.94	2.01	2.01	0.20
%Dry Mat.	11.29	10.96	11.21	11.34	0.92
Ca/DM	4.12	4.54	<b>4.76</b>	<b>4.71</b>	0.41
K/Ca	7.21	7.40	6.86	<b>6.57</b>	0.51
K+Mg/Ca	7.46	7.64	7.09	<b>6.79</b>	0.50

## Financial Benefits

Significant losses in winter cabbage and swedes occur after harvest with up to 30-40% wastage during storage, due to fungal decay and physiological breakdown. Any reduction in these losses will increase grower's financial margins.

## Action Points

- Pre-harvest sprays of calcium formulated with nitrogen increased the weight of cabbages
- Larger cabbages tended to have softer centres - managing head development will be important in determining the crispness of leaves
- Application of InCa and Carnival increased the firmness of cabbage outer leaves
- Biological control agents show some promise for control of Botrytis, in early assessments
- Calcium sprays increased calcium content of swedes and reduced the onset of tissue browning