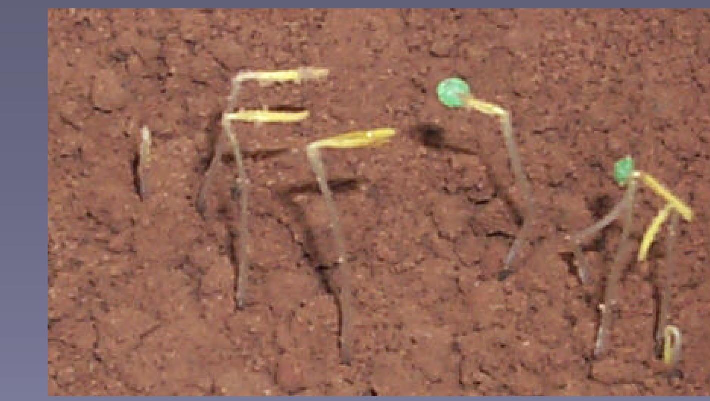
# Germination and Emergence Synchronization and Stand Establishment in Processing Carrots

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## Introduction

Sporadic germination, a common problem in process carrots, leads to poor crop stand and root uniformity, resulting in low yield, recovery, increasing wastage or production of less economical products. This results in low profits to the producers and processors. Low soil temperature and moisture availability may result in sporadic germination and poor vigor of seedlings. 80°F or 26°C is optimal for carrot seed germination. However, field-sown carrot seeds experience a soil temperature of 5-8°C. Further, the seeds are often exposed to water stress due to vagaries of rain, as processing carrots are grown rainfed. Low temperature and moisture availability hinder imbibition and thereby the physiological processes associated with seed germination due to a lag in synthesis of phytohormones. Temperatures below 20°C reduce germination of carrot seeds. Carrot seed germination is completely prevented at 2°C. The critical temperature threshold has been found out to be 5°C (1). DHBA and ASA seed treatment hastened germination significantly even at 5°C (1). In addition to low temperature that limit germination, moisture availability also plays a critical role in seed germination. However, there is no information on the effects of moisture content of the media on germination of carrot seeds available. The critical threshold moisture content for obtaining ideal emergence is also not known. A series of experiments were conducted to identify the effects of moisture regimes on carrot seed emergence and to see whether emergence can be promoted at limiting moisture conditions using various antistress, antioxidants.

## Project Objectives

1. To understand the germination dynamics as influenced by low temperature and moisture regimes
2. To synchronize emergence and enhance vigor under low temperature and low moisture regimes using osmoprotectants, antistress and thermogenic compounds.
3. Field evaluate the response

## Emergence as influenced by various moisture regimes

### Materials and Methods

Carrot seeds (*Daucus carota var sativus*) cv. Oranza obtained from Bejo Seed Co. (NY, USA) were used for this study. One litre plastic containers with lids were filled with 1kg of dried sandy type field soil. The soil was saturated with 250 ml of water and left to stand for 24 hours until the excess water had drained off. The weight of each pot was taken and this was recorded as the field capacity (FC) of the soil. The pots were left to dry down in an incubator set at 22°C ± 1° until they reached a field capacity of 100%, 80%, 40%, 35%, 30%, 25%, or 20%. Twenty five seeds per pot were planted ½" deep when the soil reached the desired FC. The lids were placed on the pots in order to stop water loss and maintain the soil moisture. The pots remained in the incubator and emergence was recorded daily for 28 days. Each treatment was replicated four times.

All data was analyzed using the GLM procedure (SAS Institute Inc. Cary NC, USA). A Duncan's multiple range test was used to separate the differences between means at a significance level of $p = 0.05$

### Results

The results indicate that carrot seed germination is sensitive to available moisture content of the medium. Lowering moisture content of the medium significantly reduced seedling emergence. Optimal moisture content was found out to be 40%FC (Fig 1). Seedling emergence can be inhibited *in toto* at a moisture content of 20%FC. Interestingly, seedling emergence was also limited by 100%FC.

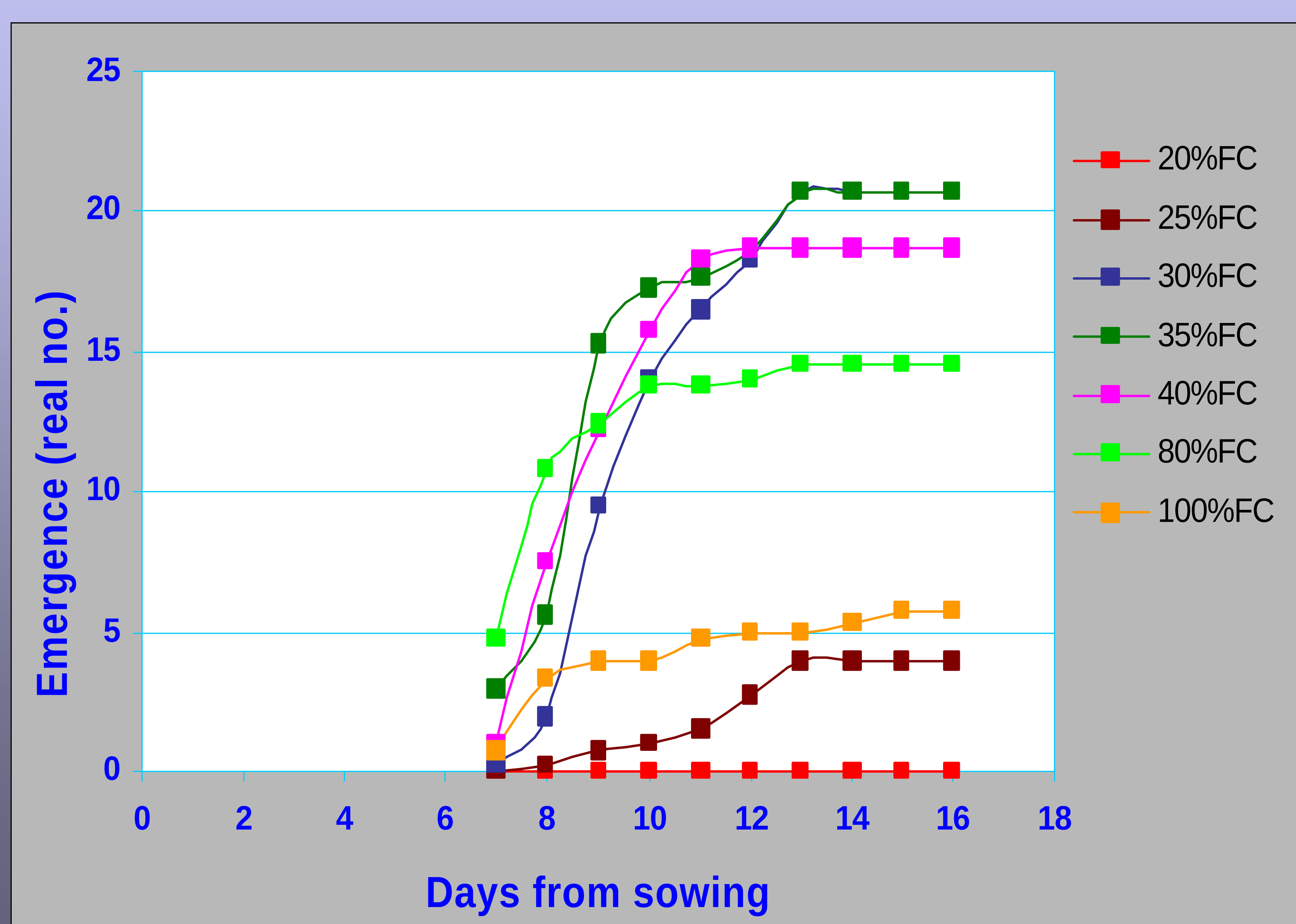


**Fig 1.** Effect of various soil moisture regimes on emergence of carrot seedlings.

## Effect of Various Antistress, Antioxidants on Emergence of Carrot Seedlings

### Materials and Methods

Carrot seeds (*Daucus carota var sativus*) cv. Oranza obtained from Bejo Seed Co. (NY, USA) were used for this study. The seeds were preconditioned using AMBIOL (0.1 $mgL^{-1}$), and Glycinebetaine (100 $mgL^{-1}$). All the solutions were prepared using distilled water. There were two control sets of seeds, untreated and water treated using distilled water. Seeds were weighed out and placed in flasks with the solutions at a ratio of 1g:10 ml. The flasks were sealed with parafilm and then placed in an incubator shaker set at 25°C and 147 rpm for 24 hours. The seeds were then strained, rinsed with distilled water, and spread out to air dry at room temperature.

One litre plastic containers with lids were filled with 1kg of sandy type field soil. The soil was first dried in a 55°C oven for a week to minimize variations in initial soil moisture between pots. The soil was saturated with 250 ml of water and left to stand for 24 hours until the excess water had drained off. The weight of each pot was taken and this was recorded as the field capacity (FC) of the soil. The pots were left to dry down in an incubator set at 22°C ± 1° until they reached a field capacity of 40% (control) or 25% (limiting moisture). Twenty five seeds per pot were planted ½" deep when the soil reached the desired FC. The lids were placed on the pots in order to stop water loss and maintain the soil moisture. The pots remained in the incubator and emergence was recorded daily for 28 days. Each treatment was replicated four times.

All data was analyzed using the GLM procedure (SAS Institute Inc. Cary NC, USA). A Duncan's multiple range test was used to separate the differences between means at a significance level of $p = 0.05$

### Results

At optimal soil moisture (40% FC), both Ambiol 0.1 $mgL^{-1}$ and Glycinebetaine 100 $mgL^{-1}$ significantly enhanced emergence compared to both the untreated and water treated controls (Fig 2). Ambiol 0.1 $mg^{-1}$ was also effective in increasing the rate and number of seedlings emerged in a limiting soil moisture (25%). Glycinebetaine, however, did not show a significant promoting effect at 25% field capacity.

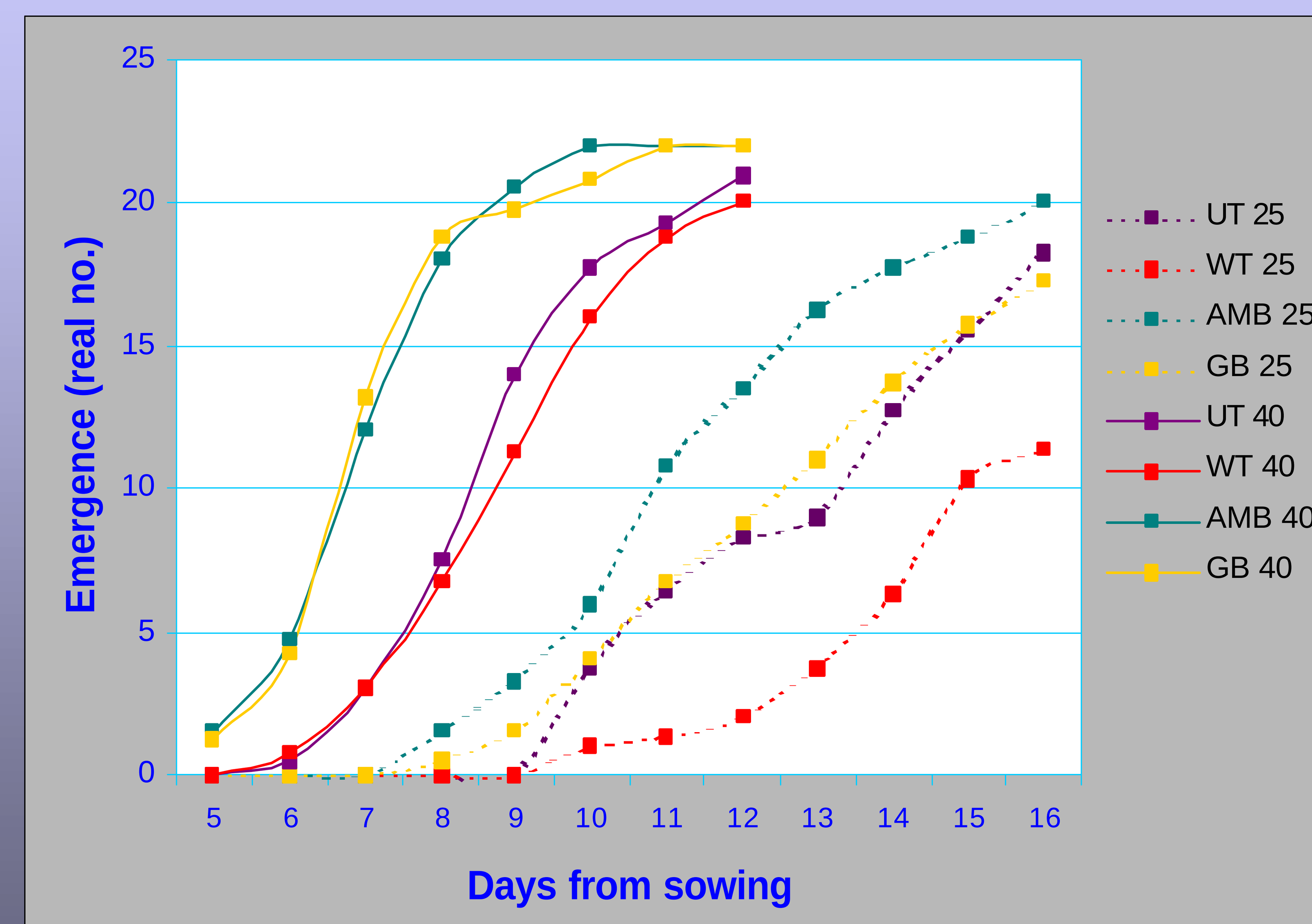


**Fig 2.** Effect of Various Ambiol and Gylcinebetaine on emergence of carrot seedlings at optimal and limiting moisture

## Role of $GA_3$ in Enhancing Germination at Low Temperature

### Objectives

Carrot seed germination is limited at temperatures below 20°C and can be totally inhibited at 2°C. DHBA and ASA promoted germination at a low temperature and has been postulated to be due either to their thermogenic activity or due to promoting GA synthesis. This experiment was conducted to test whether 1. GA is limiting under low temperature and 2. germination enhancement by DHBA and ASA at low temperature can be further enhanced by GA in the presence of DHBA and ASA.

### Materials and Methods

Carrot seeds (*Daucus carota var sativus*) cv. Oranza obtained from Bejo Seed Co. (NY, USA) were used for this study. One hundred seeds of uniform size (1.60 - 1.80 mm) were manually counted and placed in sterile petri dishes (100 x 15mm) on filter paper ( Munktell's No. 1 F). The seeds were supplied with 10 ml of acetylsalicylic acid (ASA) at 0, 100 $mgL^{-1}$, 2, 6 dihydroxybenzoic acid (DHBA) at 0, 1 $mgL^{-1}$ or gibberellic acid ($GA_3$) at 0, 1, 10, 100 $mgL^{-1}$ which were prepared using distilled water. DHBA was first dissolved in 1.6 ml of ethanol because of it's low solubility in water. Combinations of ASA 100 $mgL^{-1}$ and $GA_3$ (1, 10, 100 $mgL^{-1}$) as well as DHBA 1 $mgL^{-1}$ and $GA_3$ (1, 10, 100 $mgL^{-1}$) were also tested. Each treatment was replicated four times. The seeds were allowed to stand for 24 hours at room temperature (23°C ± 1°C) then the excess solution was decanted. The seeds were then placed in an incubator set at 5°C and were supplied with the respective solutions daily. The solutions were equilibrated to 5°C.

The number of seeds germinated was recorded daily for 21 days and percent germination was calculated. Germination was declared once the radicle had emerged through the seed coat.

The data was analyzed using the GLM procedure (SAS Institute Inc. Cary NC, USA). A Duncan's multiple range test was used to separate the differences between means at a significance level of $p = 0.05$

### Results

Germination of seeds was reduced at 5°C significantly with the untreated controls. Seed treatment with GA at 1mg/L alone or in the presence of DHBA (1 $mgL^{-1}$) or ASA (100 $mgL^{-1}$) promoted emergence significantly even at 5°C compared to the untreated controls (Fig 3). Emergence enhancement under GA treatment in the presence or in the absence of DHBA or ASA indicate that GA may the limiting factor under low temperature conditions and ASA or DHBA may have facilitated synthesis of GA by providing ideal environment for germination inside the seeds.

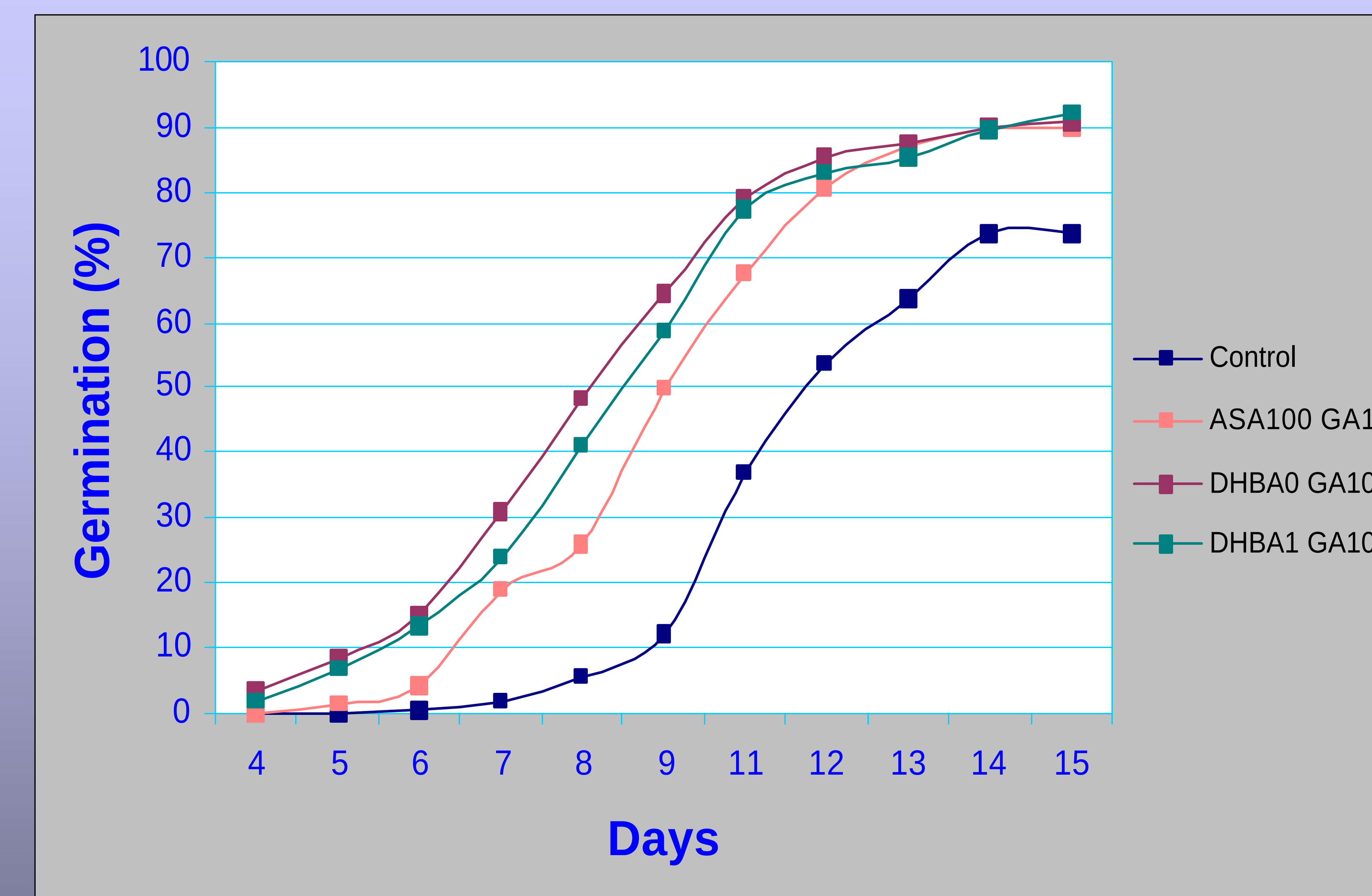


**Fig 3.** The effect of ASA + GA3 and DHBA + GA3 on emergence of carrot Seedlings at 5°C


*In proud partnership with:* Oxford Frozen Foods Ltd., Nova Scotia Department of Agriculture and Fisheries, and the Nova Scotia Agricultural College



Reference:

1. Rajasekaran LR, A. Stiles, C. Caldwell 2000. Can J of Plant Sci. (submitted)