



# Synchronizing Emergence of Carrots Using Chemoembryoconditioning Agents



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## Introduction

Establishing uniform crop stand is a major problem in carrot production. Low temperature and moisture availability during germination and emergence results in sporadic germination and emergence of processing carrots. This leads to reduced crop stand and quality.

There are three stages of germination. The first is imbibition during which the seed absorbs water. The second is true germination or activation. The third is the growth stage in which the radicle elongates. Emergence occurs when the seedling has pushed through the soil.

Carrot seeds experience an average temperature of between 5 - 8°C when sown. The optimum temperature for germination and emergence is 25°C and the critical limiting temperature ( $GT_{50}$ ) is 5°C. The optimum moisture for carrot germination and emergence is 40% and the limiting moisture is 25%. Below the temperature and moisture limits the seed is under stress and a decrease is seen in germination, emergence, and yield.

Gibberellic acid (GA) has been found to increase emergence and the speed of emergence of carrots. DHBA (2, 6-dihydroxybenzoic acid) along with GA hastens and increases germination at 5°C in carrots. Glycinebetaine (GB) that accumulates in carrots and in several species under drought and salinity enhances the ability of plants to tolerate high and low temperatures also. It has been found to increase germination in processing carrots under limiting moisture conditions. AMBIOL, a derivative of 5-hydroxybenzimidazole, also increases germination in field grown carrots under limiting moisture conditions.

It is hypothesized that chemoembryoconditioning using various antioxidant, thermogenic, antistress compounds and PGRs promote germination and emergence under both limiting temperature and moisture conditions. Little or no information is available on this.

## Objective

The objective is to synchronize and enhance germination and emergence under limiting low temperature and moisture conditions using various antioxidant, antistress compounds.

## Materials & Methods

Carrot (*Daucus carota* L. var. Sativus) CV. Oranza was used. Ten grams of seeds were pre-treated with AMBIOL (0.1 mgL<sup>-1</sup>), GB (100 mgL<sup>-1</sup>) and DHBA and GA (1 µgL<sup>-1</sup> and 100 µgL<sup>-1</sup>), respectively. The water treated and untreated seeds served as controls. Seeds were sown at a depth of one half inch at 25 seeds per pot. A total of 96 pots were used. The pots were placed under one of four conditions of 25°C 40% moisture, 25°C 25% moisture, 5°C 40% moisture, or 5°C 25% moisture. Each treatment was replicated three times. Pots were checked daily at the same time for emergence. Emergence rate, cumulative emergence, and vigor value were assessed. This study adopted a randomized complete block design. The data was analysed using a General Linear Models Procedure (GLM) was conducted using SAS.

## Results

The results indicate that temperature is a critical factor compared to moisture regimes (Fig 1). Vigor value remained higher under 40% FC compared to 25%FC. At low temperature, irrespective of any moisture regimes, the seedlings did not emerge and remained significantly low. Ambiol treatment invigorated the seedlings significantly at low moisture which was nearly 5 folds higher than the untreated control. Water pretreatment also showed an increase in vigor compared to the untreated control. DHBA+GA and GB failed to invigorate seedlings at low moisture and low temperature regimes

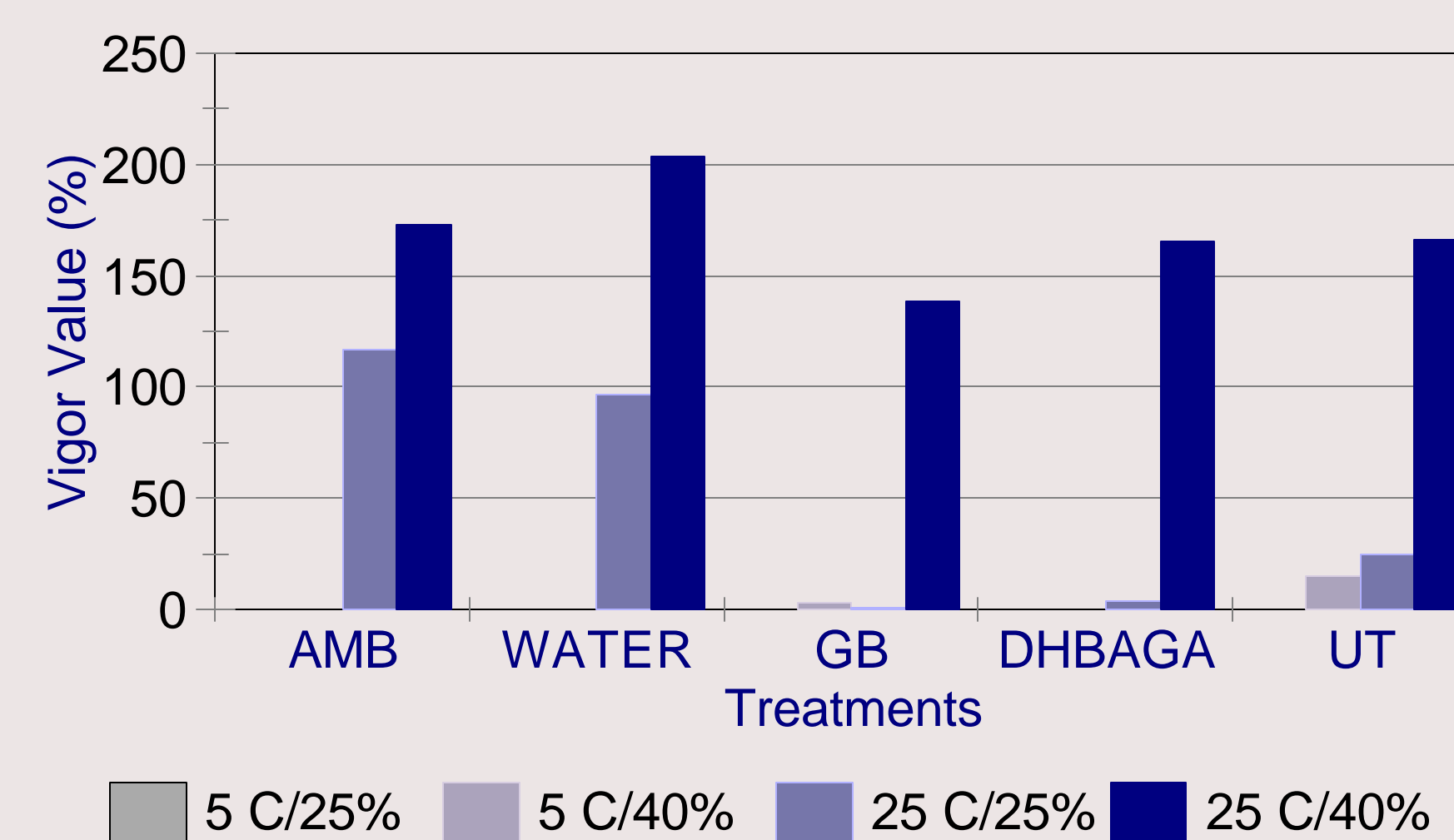


Figure 1: Vigor value as influenced by various chemoembryoconditioning agents at various temperature and moisture regimes

Low temperature delayed the speed and number of seedlings emerged significantly (Figure 2). Ambiol accelerated the emergence significantly on day 7 which proceeded until day 15. The enhancement in emergence due to Ambiol treatment was nearly 3 fold higher compared to untreated control. Water pretreatment also enhanced the emergence significantly higher than the untreated control. However, the initial speed of emergence was higher with Ambiol than with water treatment. Both, DHBA+GA and GB failed to enhance emergence at low temperatures.

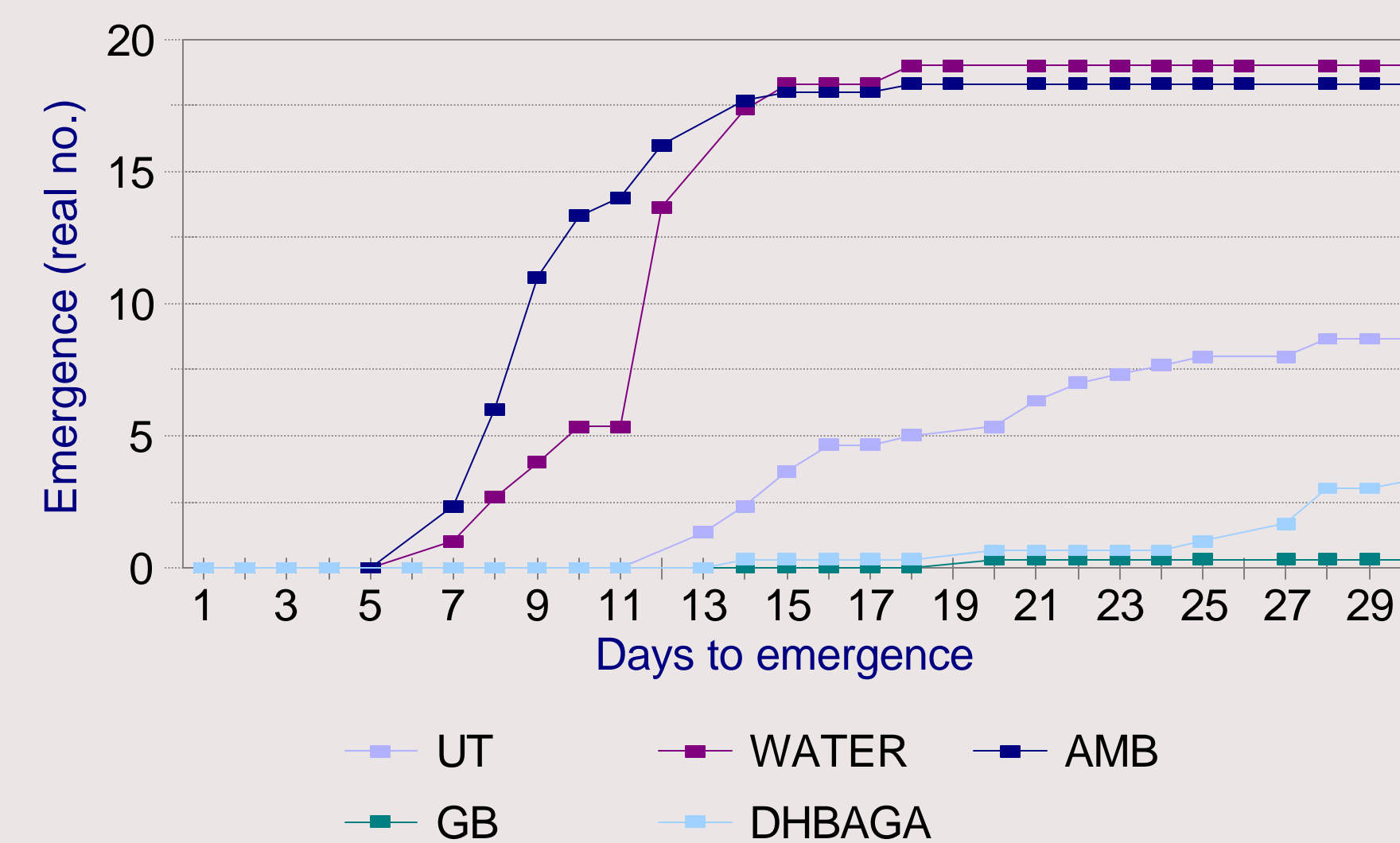


Figure 2: Carrot seedling germination and emergence as influenced by chemoembryoconditioning under limiting temperature (5°C) and optimal moisture (40%)

Under both optimal temperature and moisture regimes, GB registered early emergence on day 4. The speed of emergence was higher with both water and Ambiol preconditioning treatments which was significantly higher compared to the untreated control. Although both DHBA+GA and GB had a lag in emergence initially there were no significant differences after day nine (Figure 3).

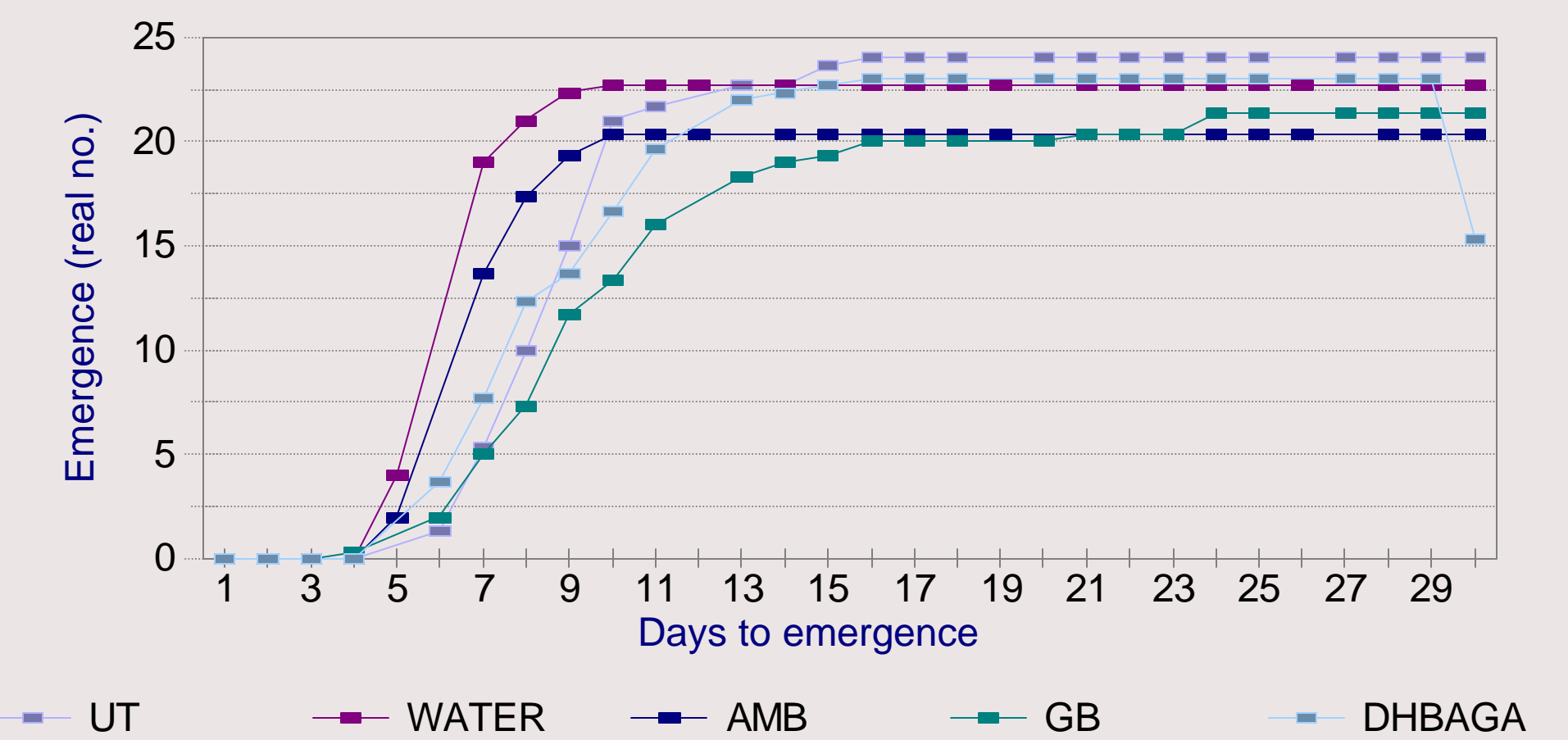


Figure 3: Carrot seedling germination and emergence as influenced by various chemoembryoconditioning agents under optimal temperature (25°C) and optimal moisture (40%)

## Discussion

The results showed that the temperature is a critical factor rather than moisture regimes for the emergence of carrot seedlings which indicates that the cell division and cell elongation processes are sensitive to low temperature of 5°C. None of the embryoconditioning agents could invigorate the seedlings to emerge at low temperature. However, embryoconditioning with Ambiol promoted seedling vigor despite low moisture content of the medium. Low moisture content of the medium could inhibit or delay the phase I and II of the germination processes. Increased vigor value due to Ambiol treatment suggests that Ambiol may enhance vigor due perhaps be to their structural activity that resemble that of cytokinins. Cytokinins are responsible for cell division and shoot development. In line with Ambiol, water treated control also registered high vigor value compared to the untreated control which may perhaps be due to the reason that there could be a compound similar to Ambiol may be released out of the seeds, stimulating emergence. The absence of emergence under DHBA+GA treatment indicates that the embryonic seedling would have been deprived of C reserves as they would have been used up during thermogenesis.

## Conclusion

Carrot seedling emergence is highly sensitive to low temperature rather than low moisture conditions. None of the chemoembryoconditioning agents promoted seedling emergence under low temperature. However, Ambiol was the most effective in promoting seedling emergence under low moisture regime of 25%FC. Chemoembryoconditioning using Ambiol at 0.1 mg/L may promote seedling emergence and vigor at low moisture conditions.