Fact Sheet

Processing Carrot Research Program Fact Sheet

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Water Requirement and Irrigation Management for Optimizing Carrot Yield and Quality

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Carrots in Atlantic Canada are predominantly grown under rain-fed conditions. As such, they are subject to frequent periods of water deficit throughout their growth cycle. Prolonged water deficit reduces plant growth and lowers yield due to the resulting physiological dysfunction. As more frequent years of drought have been observed in this part of the globe, process carrot production has been threatened. Since water is the most essential factor for the cellular physiological and metabolic functions, nutrient uptake, translocation of essential factors that will enable optimal growth and development, sufficient amount of water is required every minute of plant growth and development. In order to obtain optimal yields and a high quality

Unirrigated carrots (left) vs. irrigated to maintain -60 Cbar soil moisture tension (right)

PCRP Publication 2004-03
January 2004

(marketable recovery) product, optimal soil moisture is required, either supplied through precipitation or irrigation. When supplemental irrigation is warranted, fields should be irrigated efficiently - making the most of both water and energy. Appropriate levels of irrigation during the critical stages of growth and development will enhance yield and quality.

Critical Plant Growth Stages

It is generally believed, due to their extensive root system, carrots are more tolerant to drought compared to other vegetable crops. Experiments conducted by the PCRP indicate that permanent wilting can occur when the soil moisture drops below -33 cbars (more negative),which can occur within 7 days (lighter soils) to 10-12 days in heavier soils. Each crop has critical stages when they are most sensitive to water deficits. For fruit vegetables, it is during the flower formation, flower set and fruit development stages and optimal moisture needs to be maintained. Our research indicates, for root crops such as carrots, there are at least 3 critical plant growth stages in terms of moisture demand:

- Germination and Emergence
- Initiation of Root Bulking
- Active Root Bulking

It is essential to ensure sufficient moisture during germination and emergence in order to ensure a good crop stand. A good crop stand will produce higher yields and uniform grades. Sporadic emergence will result in a crop with very low yields and of poor root recovery of marketable grades. Young carrot seedlings are also very vulnerable to physiological damage if their moisture requirements are not met. The soil moisture should not be allowed to fall below -40 cbars during this initial growth stage.

Wilted carrot tops as a result of severe drought

Following crop establishment, carrots can tolerate moderate water deficit which will in fact increase it's ability to cope with occasional periods of soil moisture deficit. Elevated water stress will cause decreases in shoot fresh weight, but will also result in a significant increase in root growth. This will often result in fibrous roots, corky or woody roots, poor tops which would impede mechanical harvesting. Decreasing soil moisture will force the plants to invest in root extension growth for water harnessing rather than storage root development. This will result in a reduction in root yield and recovery especially in diced carrots where a larger (girth) root is required.

Initiation of root bulking tends to occur in the Maritime region 10-12 weeks after emergence or about the first week of July. If soil moisture is below the critical threshold (-60 cbar) during this period yield and quality will suffer significantly.

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Soil Moisture Monitoring

Water flow from the soil into the plants occurs towards higher negative potential gradients. It is the moisture potential difference between soil-plant-environment continuum that drives water flow into the plants. Thus, it is critical to monitor the soil moisture at all times in carrot growth and development to ensure optimal soil moisture is available and to take decisions as regards when to irrigate. Methods of testing the soil vary from feeling the soil by hand to using satellite remote sensing. The recommended method for maritime carrot production is using electrical resistance blocks. They are relatively inexpensive and can be inserted into the soil quickly and removed before harvest. A simple hand-held reader is easily connected to the electrical contacts on the moisture block and an instantaneous measurement of soil moisture is given. Soil moisture should be measured at 1/3 of the root zone depth, approximately 6 inches for carrots. Readings should be taken weekly under normal conditions and at least twice weekly during drier periods.

Electrical resistance block soil moisture probe with hand-held reader

The above soil moisture meter provides readings in -cbars. It is recommended that the soil moisture be maintained at a minimum of -60 cbars (preferably in the range of -40 to -50 cbars) for optimal yield and root recovery.

Irrigation Scheduling

When and how much to irrigate can be easily calculated when soil moisture is monitored on a regular basis. Our research has identified the critical soil moisture potential to be -60 cbars for optimal yield and quality. It has also been revealed that the crop benefits tremendously when the soil moisture is maintained at this level during emergence, initiation of bulking (10-12 weeks after emergence) and during active bulking later in the season (15-16 weeks after emergence). To maintain the soil moisture at - 60 cbar may require as little as one irrigation event and up to possibly 3 or 4 events. Factors such as soil type, crop density, plant growth stage and natural precipitation would affect the number of irrigations required. The best way to decide on when to irrigate is to monitor the soil moisture frequently. However, if that is not possible, then the general recommendation is to provide 1 inch of water per 10 days through combined rainfall and supplemental irrigation.

The following graph shows the differences in yield (sum of all grades) and recovery of various grades as influenced by timing of irrigation. T1 - control (no irrigation), T2 - maintained at -60 cbar throughout season, T3 - maintained at -60 cbar during 4-6 weeks post emergence, T4 - maintained at -60 cbar during 10-12 weeks post emergence, T5 - maintained at -60 cbar during 15-16 weeks post emergence, T6 - maintained at -60 cbar during 4-6 and 10-12 weeks post emergence, T7 - maintained at -60 cbar during 4-6 and 15-16 weeks post

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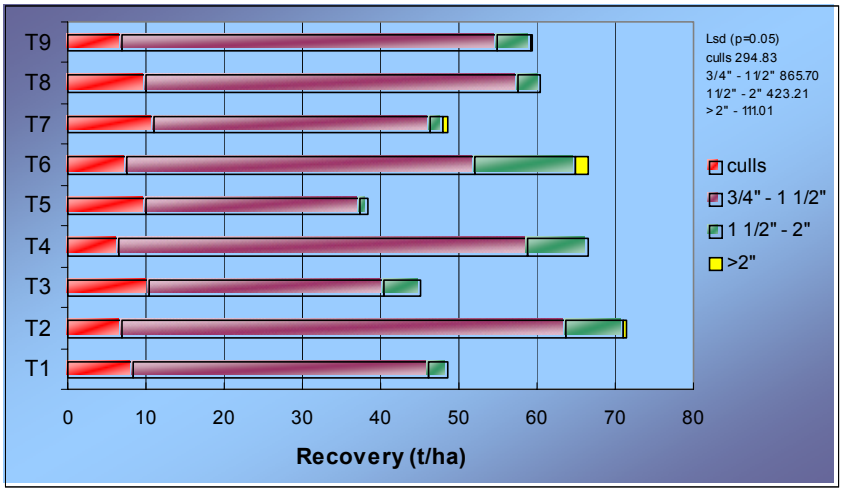
emergence, T8 - maintained at -60 cbar during 10-12 and 15-16 weeks post emergence, and T9 - maintained at -60 cbar during 4-6, 10-12 and 15-16 weeks *post emergence*



Irrigation Systems for Carrots

The most common and efficient method of supplemental irrigation for carrot production in the Maritimes is the sprinkler class of irrigation systems. Typically used are reel/traveling gun and to a lesser extent, center pivot systems. Reel systems require more labour to operate compared to center pivot, however they are suitable for use in irregular shaped fields. Center pivot systems are limited to circular, rectangular or square fields.

Microsprinkler irrigation system used for Irrigation Management trials conducted by the PCRP

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In proud Partnership with Oxford Frozen Foods Ltd, NSDAF & NSAC
Irrigation Management in Processing Carrots Project Funding Agency: Technology Development 2000
Cooperators: P. Hicklenton - AAFC Kentville, C. Caldwell,
A. Madani -NSAC; A. Ells, Bragg Lumber Company

PCRP Publication 2004-03
January 2004