Maturity, Yield and Quality Modeling

R.Lada[1], A. Stiles[1], M. Surette[1], S. Kyei-Boahen[1], A. Ells[3], C. Caldwell[1], G Atlin[2]

[1]Dept. Of Plant and Animal Sciences, NSAC [2]IRRI, Manila, The Philippines [3]Bragg Lumber Company, Collingwood, N.S

Objectives

The long-term goal of this project is to understand the maturity dynamics of slicer and dicer varieties as influenced by environmental parameters and to correlate to understand the environmental controlling factor(s) and to develop root maturity and quality models.

Materials and Methods

Four high performing varieties of both slicer and dicer carrots were chosen for this study. Slicers included Oranza, Bergen, Nantindo and Stylus. Dicers varieties consisted of RCC Carson, Cascade and Fontana. Seeds were obtained from Bejo Seeds (New York, USA) and Harris Moran Seed Co. (USA). Fields were sown with a commercial pneumatic seeder in approximately 1 acre plots. Slicers were seeded at a rate of 33 seeds 30^{-1}cm on hills spaced at 2 feet. Dicers were sown on flats spaced at 2 feet at a rate of 16 seeds 30^{-1} cm. A standard nutrient and pest management program was implemented by the grower. There were 4 sites within 2 separate locations; Debert/Londonderry and Centreville/Canning. In location 1, slicers were seeded on May 22 followed by the dicers on May 26. Dicers were sown on May 8 in location 2 and slicers followed on June 1.

Sampling began approximately 6-8 weeks after sowing and continued bi-weekly until harvest. Seven random 1 meter samples were manually harvested and measurements on gross yield, number of roots per meter, root girth, root length, root color, leaf fresh and dry weight, leaf number, sugar and beta-carotene content as well as leaf area index were recorded. In addition soil moisture was monitored and soil samples (0-6") were taken at each harvest. Weather stations were placed in the fields to record a number of parameters including air temperature, soil temperature, rainfall, solar radiation/sun hours, wind speed and direction, from which cumulative degree days and evaporation was calculated. Cumulative data was compiled for all of the weather parameters measured to coincide with the sampling dates (Table 1)

Table 1. Sampling dates and corresponding cumulative weather data

Location 1 Debert/Lomdonderry

Sampling Date	Cumulative Solar Radiation (Wat/m^2)	Cumulative Rainfall (mm)	Cumulative Max Temp. (ºC)	Cumulative Min Temp. (ºC)
July 9	116705.9	51.1	470.7	240.5
July 30	250012.5	89.3	978.8	453.2
August 14	339018.3	89.8	1381.8	653.5
August 27	403583.0	101.8	1704.4	801.6
September 11	478371.5	124.2	2057.3	936.3
October 11	600595.2	261.7	2653.7	2847.1
October 23	633924.9	332.6	2847.1	1156.6

	Cumulative Max Soil Temp. (ºC)	Cumulative Min Soil Temp. (ºC)	Degree Days	Cumulative Evaporation (mm)
July 9	538.9	297.4	152.0	-98.7
July 30	1124.3	579.4	307.1	-229.8
August 14	1554.9	843.4	460.9	-338.6
August 27	1884.1	1046.3	569.8	-418.0
September11	2236.6	1252.8	673.9	-490.3
October 11	2793.3	1559.9	800.4	-512.5
October 23	2961.2	1649.6	828.1	-490.9

Location 2 Canning/Centreville

Sampling Date	Cumulative Sun Hours (hr)	Cumulative Rainfall (mm)	Cumulative Max Temp. (ºC)	Cumulative Min Temp. (ºC)
July 19	345.2	107.4	1173.6	623.4
August 7	533.3	108.0	1711.6	897.5
August 20	622.8	110.0	2074.1	1102.4
September 4	740.6	170.1	2446.1	1284.1
September 18	865.9	170.9	2774.2	1416.1
September 20	886.0	170.9	2817.0	1431.1

	Cumulative Max Soil Temp. (ºC)	Cumulative Min Soil Temp. (ºC)	Degree Days	Cumulative Evaporation (mm)
July 19	N/A	N/A	408.85	-209.7
August 7	N/A	N/A	624.95	-341.2
August 20	N/A	N/A	778.70	-414.2
September 4	N/A	N/A	905.65	-483.3
September 18	N/A	N/A	995.60	-546.1
September 20	N/A	N/A	1004.50	-553.3

Final harvests were taken in conjunction with the commercial harvest. In addition to the growth measurements, data on recovery of various grades for determining quality was recorded. The carrots were also subjected to a top strength test using an extensometer (Lloyd Instruments).

Data was subjected to a non-linear regression analysis using Sigma Plot (SPSS Inc.) to determine the correlation, if any, between yield and cumulative weather parameters. Final yield, recovery and top strength was analyzed using the GLM procedure (SAS Institute Inc. Cary NC, USA) for an ANOVA test. Means were separated using Fisher's protected LSD (p=<0.05) when F-tests were determined to be significant.

Results

Drought conditions in 2001 had a severe effect on yields in both locations, reducing the yield by more than 50%. R^2 values for yields from all of the varieties vs. cumulative rainfall, cumulative degree days, cumulative solar radiation, cumulative high temperature and cumulative evaporation suggests that all of these weather factors have a strong influence on yield. In particular, the slicer variety Bergen showed the highest correlation between yield and the cumulative weather parameters in both locations. In dicers, Cascade showed the highest correlation between yield and rainfall, while R^2 values were higher for RCC when yield was compared to degree days, solar radiation and cumulative high temperature (Table 2).

These relationships between yield and the various weather parameters could be used to predict yields of these varieties according to the current growing season and would be useful in determining if there is a need for supplemental irrigation.

Final root yield did not differ significantly between the slicer varieties in location 2, however, in location 1 Bergen yielded significantly more than Nantindo or Oranza. There was no difference in recovery of 3/4" - 1 ½" roots in location 1. In location 2, Stylus recorded the greatest amount of roots 3/4" - 1 ½" (19.38 ton/ha) followed by Bergen (17.51 ton/ha), Oranza (14.81 ton/ha) and Nantindo (10.85 ton/ha).

Among the dicer varieties, Cascade yielded significantly higher than the others. Cascade also recorded the highest amount of greater than 1 ½" (27.72 ton/ha) roots followed by RCC (25.76 ton/ha) which were both significant over Carson (7.52 ton/ha) and Fontana (2.82 ton/ha)

Table 2. Models used to predict yield of various carrot varieties in Colchester County

Variety	Equation
Yield vs. Cumulative Degree Days	
Oranza	yield = $-143.8261 + 1.5574x + (-0.0050x^2) + 0.0000x^3$
RCC	yield = $-511.5702 + 4.6228x + (-0.0112x^2) + 0.0000x^3$
Yield vs. Cumulative Rainfall	
Oranza	yield = $2316.8449 + (-85.2337x) + 0.8898x^2 + (-0.0022x^3)$
RCC	yield = $1063.0537 + (-45.0526x) + 0.5257x^2 + (-0.0011x^3)$
Yield vs. Cumulative Maximum Temperature	
Oranza	yield = $307.2040 + (-1.0150x) + 0.0009x^2 + (-0.000x^3)$
RCC	yield = $42.0038 + 0.1701x + 0.0001x^2 + (-0.000x^3)$
Yield vs. Cumulative Solar Radiation	
Oranza	yield = $388.8486 + (-0.0051x) + 0.0000x^2 + (-0.0000x^3)$
RCC	yield = $81.3780 + (-0.0018x) + 0.0000x^2 + 0.0000x^3$
Yield vs. Cumulative Evaporation	
Oranza	yield = $-1140.3919 + (-17.9085x) + (-0.0762x^2) + (-0.0001x^3)$
RCC	yield = $-771.8018 + (-12.2551x) + (-0.0544x^2) + (-0.0001x^3)$

Conclusion

Since gross yield correlated with cumulative rainfall, degree days, solar radiation, max temperature and evaporation significantly, one or many of these factors can be used to predict gross yield and quality of both slicer and dicer varieties for both Kings and Colchester counties of Nova Scotia. Models that are developed to predict yield of slicer and dicer varieties can be used in both locations. Genotypes differed in their performance depending on the location. Bergen yielded higher compared to the other slicer varieties. Among dicers, Cascade recorded the highest yield and recovery compared to Carson, Fontana and RCC. These models are specific to varieties and locations that can be used to forecast when to harvest to obtain optimal yield.

Funding Agencies

Agrifocus 2000 Technology Development; Bragg Lumber Co. Ltd.