Research Report to the Oregon Processed Vegetable Commission

Title of Project: Effects of nitrogen fertilizer rates and tillage treatments (soil compaction) on carrot root yields and root characteristics.

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Project Status: Terminating, June 30, 1988

Project Funding by Commission for this Report Period: $2,500

Funds were used for student labor, land use charge, materials and supplies, penetrometer measurements, and travel.

Objectives:

1) to evaluate effects of supplemental nitrogen rates, in addition to growers base rates, on yield and root characteristics.
2) To evaluate effects of four or five tillage treatments that result in various degrees of soil compaction on carrot root growth and yield of two varieties (O.S.U. Vegetable Research Farm).

Report of Progress:

Nitrogen rates - grower fields. Supplemental N rates were established at two grower locations in which yields were obtained. In one location N rates were: 151 (grower base rate), 186 and 221 lbs. N/acre on 'Royal Chantenay'. At another grower location, N rates were: 120 (grower rate), 155 and 190 lbs. N/acre, also on 'Royal Chantenay'.

Results in Table 1 indicate that there were very little difference in yields at the varying nitrogen rates. Likewise, N rates had very little effect on size distribution of roots or length of roots (1 1/2 to 2 inches in diameter). Plant stand apparently had the major influence on size distribution since the stand averaged about 40 roots/foot at the first grower location and about 27 roots per lineal foot at the second grower location.

Nitrogen rates - NWES. Dr. Delbert Hemphill conducted a trial in which N rates of 50, 80, 110, 140 and 170 lbs. N/A were used on 'Nantes' carrots. Results, summarized in Table 2, indicate that total yield varied significantly with N rate, reaching a maximum of 140 lbs. N/acre. There was an increase in large diameter roots (over 2-inch shoulder diameter) with increasing N rates but most of the increase occurred between 50 and 110 lbs. N/acre. The percentages of cracked and rotten roots did not vary significantly with N rate but there was a strong trend for greater numbers of cracked roots at the higher N rates.

Tillage treatment effects (thesis study by Jim Thomasson). The following treatments were applied to a sandy loam soil at the OSU Vegetable Research Farm in April, 1987:

| | | |
|---|---|---|
| 1. | Minimum Tillage (MT) | moldboard plow<br>cultimulcher<br>Lely roterra and roller |
| 2. | Conventional Tillage (CT) | moldboard plow<br>cultimulcher<br>disk and roller (2x)<br>Lely roterra and roller |
| 3. | Excessive Tillage (ET) | moldboard plow<br>cultimulcher<br>Danish harrow (3x)<br>disk and roller (5x)<br>Lely roterra and roller |
| 4. | Subsoil before Tillage (SB) | subsoil<br>moldboard plow<br>cultimulcher<br>Lely roterra and roller |
| 5. | Subsoil After Tillage (SA) | moldboard plow<br>cultimulcher<br>subsoil<br>spiketoothed harrow<br>Lely roterra and roller |

Soil moisture content at the time of tillage was 15.4%. Royal Chantenay and Orlando gold carrots were planted into all tillage treatments and were harvested on October 4. Penetrometer measurements and soil bulk density measurements were taken at various times throughout the growing season. Tillage treatments were replicated four times. A uniform rate of broadcast fertilizer was 80 lbs. N, 240 lbs. $P_2O_5$ and 80 lbs. $K_2O$ per acre.

Penetrometer measurements taken on June 6 (Fig. 1) indicate that soil compaction was greatest in the excessively tilled soil to a depth of 11 inches. The least amount of compaction tended to be in the minimally tilled soil to a depth of 8 inches. Beyond 8 inches, subsoiling before tillage reduced compaction the most.

Total yields of Royal Chantenay were higher than those of Orlando Gold (Table 3). There were also more misshapen and forked roots in the Orlando Gold variety. There was not a significant difference in total yield, density, or percent culls between treatments in either variety. However, both varieties had a greater percentage of grade #1 carrots (smaller than 1.5 inches in diameter) in the minimum tillage treatment than in any of the other treatments.

These results indicate that the differences in soil compaction due to the different amounts of tillage represented in this study were not enough to affect total yields when the soil was tilled at or near 15% moisture content. However, size distribution may be affected, with minimum tillage resulting in a higher percentage of smaller carrots. Further work would be justified to determine if these results would be consistent in a different year, at different locations, and under different moisture conditions.

Summary:

No differences in yields of carrot roots were evident when nitrogen fertilizer rates were increased above growers base rates of 120-150 lbs. N/acre. At North Willamette Experiment Station total yield reached a maximum at 140 lbs. N/acre. Based on results of the current season and those of last year, N rates of 90-140 lbs./A appear to be adequate for production of processing carrots. At higher N rates than these, there is danger of more splitting, cracking and rotting of roots.

A one-season study of five tillage methods showed no difference in yield of roots although there was indication of more soil compaction (penetration resistance) in the "excessive" tillage treatment.

Table 1. Effect of nitrogen rates on yield and size distribution of carrot roots, two grower locations, 1987.

| | lbs N/acre | Tons/A | % of Yield in Sizes (root diameter) -1" | 1-1½" | 1½-2" | +2" | Average Root Length (1½-2" diam) |
|---|---|---|---|---|---|---|---|
| Grower 1 (H) | 151 | 34.7 | 14 | 41 | 38 | 7 | 4.4" |
| | 186 | 31.1 | 28 | 45 | 21 | 6 | 4.2 |
| | 221 | 37.0 | 17 | 47 | 29 | 7 | 4.3 |
| Grower 2 (D) | 120 | 40.9 | 8 | 48 | 39 | 5 | 4.6" |
| | 155 | 40.3 | 9 | 45 | 38 | 8 | 4.8 |
| | 190 | 40.5 | 10 | 44 | 41 | 5 | 4.8 |

(no apparent differences in cracking or rots at different N rates)

Table 2. Main effects of N rates and banded P on yield and root characteristics of carrot, 1987

| Treatment | Root yield (tons/acre) Large | Med. | Small | Total | No. roots/ foot | No. large roots/foot | Mean root wt. (g) | % cracked roots | % soft-rotted roots | No. of defect-free roots/foot |
|---|---|---|---|---|---|---|---|---|---|---|
| N rate (lb/acre) | | | | | | | | | | |
| 50 | 2.4 | 27.7 | 2.9 | 33.0 | 11.4 | 0.3 | 131 | 21.3 | 8.0 | 8.8 |
| 80 | 3.5 | 31.9 | 2.6 | 38.0 | 12.1 | 0.5 | 139 | 19.8 | 5.6 | 9.8 |
| 110 | 6.6 | 28.7 | 2.5 | 37.8 | 11.0 | 0.9 | 148 | 32.2 | 10.4 | 8.1 |
| 140 | 7.0 | 34.6 | 1.7 | 43.3 | 11.4 | 0.8 | 167 | 33.6 | 15.8 | 7.8 |
| 170 | 7.2 | 29.7 | 3.4 | 40.3 | 12.0 | 1.0 | 150 | 33.6 | 8.8 | 7.8 |
| Linear | *[a] | NS | NS | NS | NS | * | NS | NS | NS | NS |
| Quadratic | * | NS | NS | * | NS | ** | * | NS | NS | NS |
| P rate (lb/acre) | | | | | | | | | | |
| 0 | 5.5 | 28.6 | 2.9 | 37.0 | 11.5 | 0.7 | 142 | 30.1 | 9.4 | 8.2 |
| 50 | 4.9 | 29.4 | 2.3 | 36.6 | 11.0 | 0.6 | 146 | 25.9 | 7.9 | 8.3 |
| | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS |

[a] *, **, NS: significant differences at 5% and 1% levels, and no significant differences, respectively.

Table 3. Effects of tillage on yield, density, cullage, and size grades of carrots.

ORLANDO GOLD

| Treatment | Total Yield (tons/acre) | Density (plants/ft) | % Culls | % Grade 1 (<1.5" diam) |
|---|---|---|---|---|
| Minimum | 35.5 | 16.7 | 19.8 | 61 |
| Conventional | 36.7 | 16.2 | 21.0 | 50 |
| Excessive | 34.4 | 15.0 | 19.8 | 44 |
| Subsoil Before | 33.8 | 16.1 | 18.1 | 58 |
| Subsoil After | 35.1 | 14.3 | 20.3 | 46 |

ROYAL CHANTENAY

| Treatment | Total Yield (tons/acre) | Density (plants/ft) | % Culls | % Grade 1 (<1.5" diam) |
|---|---|---|---|---|
| Minimum | 45.9 | 15.0 | 8.9 | 23 |
| Conventional | 46.4 | 15.4 | 6.2 | 14 |
| Excessive | 45.1 | 14.5 | 7.5 | 14 |
| Subsoil Before | 46.2 | 14.4 | 10.5 | 12 |
| Subsoil After | 46.8 | 15.2 | 8.0 | 13 |

Fig. 1 Penetrometer Measurements