# The Effect of Planting Date, Nitrogen Fertilizer Rate and Harvest Date on Seasonal Concentration and Total Content of Six Macronutrients in Sugarbeet

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## ABSTRACT

**Seasonal concentrations and total content of K, Na, P, S, Ca, and Mg were determined in the blades, petioles, crowns and roots of sugarbeet grown in a field experiment conducted at three levels of N fertilizer (0, 100 and 300 lb N/A) and two planting dates (April 22 and May 27). Average concentrations of K and P were higher for the April 22 planting but S was higher for the May 27 planting. Increasing N fertilizer increased the average concentrations of S, Na, and Mg, but decreased K and Ca when averaged over all treatments. Concentrations of P, S, Na and Mg decreased in all plant parts as the season progressed, but K in the blades and Ca in the petioles, crowns, and roots increased. Maximum total nutrient content of the harvested tops and roots was attained at the final harvest for P, K, Ca and Mg, but on August 9 for S and August 23 for Na. Total nutrient uptake, as measured by summing nutrients in the harvested crops, senesced leaves, and in fibrous root loss, was highest for Na, followed in decreasing order by K, Ca, Mg, S, and P. The results of this research provide basic seasonal nutrient uptake data that can be used to guide the development of improved fertilization programs. Also, the partitioning data, with uptake gains and losses by senescence, provides basic information for modelling sugarbeet nutrition and growth.**

**Additional Key Words:** *Beta vulgaris*, potassium, sodium, phosphorus, sulfur, calcium, magnesium, nutrient uptake, nutrient partitioning.

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The nutritional status of the plant is used to evaluate several growth conditions, e.g. to diagnose nutritional problems, to assist in making fertilizer recommendations, to determine total nutrient removal by a crop, to determine the time of maximum uptake by the plant, etc. The nutrient content will vary, not only with plant part selected, but also with position on the plant, stage of plant development, management practices, climatic environment and soil type.

This research was part of a growth study in which several plant growth parameters were evaluated to develop a growth model for sugarbeet in the production environment characteristic of Northern Colorado (Lee, 1983). In partitioning dry matter for the study, the plants were harvested at two- or three-week intervals during the growing season and separated into blades, petioles, crowns and storage roots (Lee et al., 1987). Chemical analysis of these materials provided a unique opportunity to study seasonal changes in concentration and content of plant nutrients among the four plant parts. The study is a presentation of the seasonal variation in the concentration and content of six macronutrients in each of four plant parts as affected by planting date, N fertility level and harvest date. Seasonal partitioning of nutrient uptake gives basic data needed to develop improved fertilization programs and to model nutrition and growth.

## METHODS AND MATERIALS

Sugarbeet variety Monohy A2 was grown in an experiment under furrow irrigation in the calcareous, non-saline Nunn silty clay loam at the Colorado State University Research Center near Fort Collins. The field design was a split-plot with date of planting as the main plot, split for three application rates of ammonium nitrate. There were two planting dates (April 22 and May 27), three N fertility levels (0, 100 and 300 lb N per A) and four replications. Each treatment was harvested seven times during the season.

A fertility analysis of the surface soil indicated that N was the only limiting nutrient (Eslami et al., 1988). Concentrated superphosphate was applied uniformly to the experimental area to give a rate of 27 lb. P per A to ensure an adequate level of this nutrient. Soil moisture was maintained at an optimum level by irrigation. Details of the cultural practices are given by Lee, et al. (1987).

### *Plant Sampling Procedure*

Three plants per plot were hand harvested at approximately 2-week intervals from July 12 to September 6, then 3-week intervals to October 18 for a total of seven harvests. Alternate rows were harvested during the season to maintain continuous and uniform competition throughout the season.

*Sample Preparation*

After harvesting, the plant materials were taken to the laboratory in paper bags, washed with distilled water, and separated into blades, petioles, crowns and roots. Each sample was dried at 65°C in a forced-air oven, then weighed for determination of dry matter yield (Lee et al., 1987). The samples were prepared for chemical analysis by grinding in a stainless-steel Wiley Mill to pass a 20-mesh sieve. The ground samples were stored in plastic bottles with tightly closed tops until analysis.

After grinding, equal weights of plant material from each of the four replicates were composited to give a single sample to represent each plant part, treatment and harvest date. Compositing was required to accomodate the number of chemical analyses.

*Plant Chemical Analysis*

The plant material was digested to bring the nutrients into solution for analysis. Two digestion methods were used. A wet digestion procedure (a nitric-perchloric acid mixture) was used for the determination of P, K, Na, Ca and Mg (Greweling, 1976). Atomic absorption spectrophotometry was used for all elements except P which was determined colorimetrically using the molybdovanadophosphoric acid procedure (Greweling, 1976).

A dry-ash procedure was used to prepare the plant material for the determination of S. Total S was determined turbidimetrically as $BaSO_4$ (Greweling, 1976).

*Statistical Analysis*

Since the plant samples from the four replications were composited by treatment for chemical analysis of each treatment and sampling date, statistical computer package STATO2V was used for the analysis of variance of nonreplicated data in a factorial arrangement.

## RESULTS AND DISCUSSION

The average yield for the April planting (24.6 T/A, Lee et al., 1987) indicates that both cultural practices and climatic conditions were good for sugarbeet growth in the Fort Collins area. The yield for the optimum N rate (100 lb/A) for the early planting was 27.7 T/A, and when averaged for the two planting dates was 21.6 T/A. The yield averaged for both planting dates and N rates was 19.8 T per A, about five percent below that for an average year. Nutrient concentrations in the plant material from this experiment should, therefore, be characteristic of a fertile soil for an average production year under the climatic and soil conditions of Northern Colorado.

*Nutrient Concentrations in the Plant*

The analysis of variance of main effects and the first order interactions for the nutrient concentrations are summarized in Table 1 to give an overview of the results. Planting date (D) was significant for P, S, and K, and the N effect (N) was significant

Table 1. Statistical significance of the main effects of planting date, nitrogen fertilizer level, harvest date and plant part, and of first order interactions for the concentrations six macronutrients.

| Source of variation | d.f. | % P | % S | % K | % Na | % Ca | % Mg |
|---|---|---|---|---|---|---|---|
| Planting date (D) | 1 | ** | ** | * | NS | NS | NS |
| Nitrogen (N) | 2 | NS | * | ** | ** | ** | ** |
| Harvest date (H) | 6 | ** | ** | ** | ** | ** | ** |
| Plant part (PP) | 3 | ** | ** | ** | ** | ** | ** |
| D x N | 2 | NS | NS | NS | NS | NS | NS |
| D x H | 6 | NS | NS | * | NS | NS | NS |
| D x PP | 3 | ** | ** | NS | NS | ** | NS |
| N x H | 12 | NS | NS | * | NS | NS | NS |
| N x PP | 6 | * | ** | ** | ** | ** | ** |
| H x PP | 18 | ** | ** | ** | ** | ** | ** |

* Significant at 0.05 probability level.
** Significant at 0.01 probability level.

for K, Na, Ca, Mg, and S. Harvest date (H) and plant part (PP) effects were significant for all six nutrients.

The harvest date and N treatment by plant part interactions (HxPP and NxPP) were significant for the six nutrients. Effects of the other interactions were not consistent. Emphasis in the discussion will be placed on the main treatment effects and the two first order interactions HxPP and NxPP. Complete presentation of the data is given by Bravo (1979).

The main effects of treatment on nutrient concentration are summarized for planting date (Table 2), N rate (Table 3), plant part (Table 4), and harvest date (Table 5). The data will be discussed for each nutrient.

*Phosphorus and sulfur:* The interaction of harvest date and plant part (HxPP) for concentrations of P and S are shown in Figure 1.

The concentration of P in all plant parts generally decreased as the season advanced (Figure 1a and Table 5). The highest concentrations were in the blades, lowest in the roots. Phosphorus concentrations in petioles and crowns were similar throughout the season. The main effects revealed similar results (Table 4). Comparable results were presented by Schmehl and

Table 2. Main effect of planting date on nutrient concentrations[1]

| Planting date | K* | P* | S* |
|---|---|---|---|
| | % | | |
| April 22 | 1.69 | 0.21 | 0.26 |
| May 27 | 1.75 | 0.23 | 0.22 |

[1] Average for three N rates, seven harvests and four plant parts.
* Significant date effect at 0.05 or higher probability level.

James (1971), Storer (1969) and Peterson et al. (1966).

The main effect of N fertilization on the concentration of P was not significant, but the NxPP interaction was significant at the 5 percent level. Phosphorus in the blades, petioles and crowns was little affected by increasing N fertilization while that in the roots decreased (Table 6), although the effect was small. The results are in contrast to other data reported in the literature (Dubetz and Russell, 1964; Soine, 1968) showing that the application of N increased the P concentration in blades. The average P concentration was lower for the early planting (0.21 vs. 0.23%, Table 2). The

**Table 3.** Main effect of nitrogen fertilizer rate on nutrient concentrations.†

| N rate | K* | Na* | Ca* | Mg* | S* |
|---|---|---|---|---|---|
| lb/A | | | % | | |
| 0 | 1.78 | 1.69 | 0.48 | 0.31 | 0.23 |
| 100 | 1.67 | 1.89 | 0.41 | 0.31 | 0.24 |
| 300 | 1.71 | 1.95 | 0.40 | 0.36 | 0.25 |

† Average of two planting dates, seven harvests and four plant parts.
* Significant N rate effect at 0.05 or higher probability level.

**Table 4.** Average concentration of six macronutrients in sugarbeet plant parts.†

| Plant Part | Macronutrient* | | | | | |
|---|---|---|---|---|---|---|
| | K | Na | P | S | Ca | Mg |
| | | | % | | | |
| Blades | 2.71 | 3.10 | 0.26 | 0.56 | 0.78 | 0.60 |
| Petioles | 2.44 | 3.09 | 0.22 | 0.15 | 0.55 | 0.32 |
| Crowns | 0.93 | 0.81 | 0.22 | 0.17 | 0.29 | 0.23 |
| Roots | 0.79 | 0.35 | 0.16 | 0.07 | 0.10 | 0.15 |

† Average for three N rates, two planting dates and seven harvests.
* Plant part significant for each nutrient at 0.01 probability level.

**Table 5.** Main effect of harvest date on the concentration of six macronutrients.†

| Nutrient | Harvest Date* | | | | | | |
|---|---|---|---|---|---|---|---|
| | July 12 | July 28 | Aug 9 | Aug 23 | Sept 7 | Sept 27 | Oct 18 |
| | | | | % | | | |
| K | 1.73 | 1.47 | 1.79 | 1.71 | 1.80 | 1.71 | 1.82 |
| Na | 2.76 | 2.17 | 2.05 | 1.82 | 1.68 | 1.29 | 1.09 |
| P | 0.25 | 0.22 | 0.21 | 0.21 | 0.20 | 0.21 | 0.20 |
| S | 0.27 | 0.36 | 0.30 | 0.23 | 0.19 | 0.17 | 0.15 |
| Ca | 0.41 | 0.39 | 0.49 | 0.42 | 0.42 | 0.41 | 0.48 |
| Mg | 0.52 | 0.31 | 0.33 | 0.30 | 0.27 | 0.27 | 0.29 |

† Each value the average for two planting dates, three N rates and four plant parts.
* Harvest date significant for each nutrient at 0.01 probability level.

**Table 6.** Data showing the significant effects for the nitrogen rate by plant part interactions*

| Nutrient | Plant Part Affected (NxPP) | Nitrogen Rate, lb/A 0 | 100 | 300 |
|---|---|---|---|---|
| | | | % | |
| P | Root | 0.17 | 0.16 | 0.15 |
| S | Blade | 0.53 | 0.58 | 0.57 |
| K | Blade | 2.84 | 2.64 | 2.66 |
| K | Petiole | 2.66 | 2.36 | 2.30 |
| K | Root | 0.68 | 0.75 | 0.93 |
| Na | Blade | 2.96 | 3.04 | 3.31 |
| Na | Petiole | 2.76 | 3.32 | 3.20 |
| Na | Crown | 0.76 | 0.77 | 0.89 |
| Na | Root | 0.28 | 0.36 | 0.40 |
| Ca | Petiole | 0.68 | 0.53 | 0.43 |
| Mg | Blade | 0.53 | 0.58 | 0.68 |

* Average for two planting dates and seven harvests.

experimental area was fertilized uniformly with phosphate and, based both on tissue testing guidelines (Hills and Ulrich, 1971) and soil test data (Soltanpour, et al., 1978), the plants were adequately supplied with phosphate for both planting dates throughout the season. The lower P content for the early planting probably was related to the greater dilution effect because of higher yields.

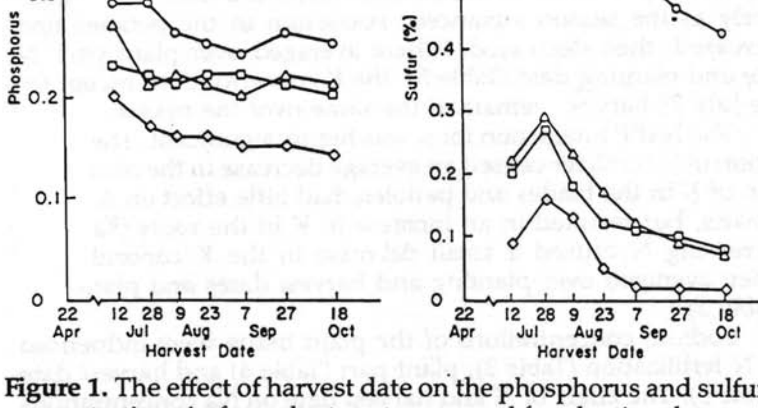


**Figure 1.** The effect of harvest date on the phosphorus and sulfur concentrations in four plant parts averaged for planting date and nitrogen rate.

The four main treatment effects for the concentration of total S were significant and also the DxPP, NxPP, and HxPP interactions. In contrast to P, the S content in the plant tissue (Table 2) was lower for the second planting date (0.26 vs. 0.22%). The significant DxPP interaction resulted because the S content was higher in blades and petioles for the earlier planting but was about the same for the crowns and roots for both planting dates.

There were differences in S concentrations among the plant parts. The average S content for the season was highest in blades, followed in decreasing order by crowns, petioles and roots (Table 4). Sulfur concentrations in all plant parts increased early in the season to late July, then decreased progressively to the October harvest (Figure lb and Table 5).

Increasing N fertilizer increased the average S concentration in the plant tissue (0.23 to 0.25%, Table 3). There was a NxPP interaction caused by the N fertilizer increasing the S concentration in the blades (Table 6) but having little effect on S in the other plant parts.

*Potassium and sodium:* All four main treatment effects were significant for K concentrations in the plant tissue as well as for the interactions except for DxN and DxPP (Table l). Although the planting date effect was small, the K concentration was higher in the plant for the later planting. Since available soil K was high (300 ppm available K, Eslami et al., 1988), the average K content for the later planting (Table 2) probably was largely an expression of greater luxury consumption that was associated with the lower yield.

The average K concentration for the season was highest in the blades, then followed in decreasing order by petioles, crowns, and roots (Table 4). Potassium concentrations in the various plant parts over the season were complex, as shown by the HxPP interaction (Figure 2a). Potassium in the blades increased while, in general, potassium in the crowns and roots decreased progressively as the season advanced. Potassium in the petioles first increased, then decreased. Where averaged over plant part, N rate and planting date (Table 5), the K concentration, except for the July 28 harvest, remained the same over the season.

The NxPP interaction for K was highly significant. The application of N fertilizer caused an average decrease in the concentration of K in the blades and petioles, had little effect on K in the crowns, but resulted in an increase in K in the roots (Table 6). Increasing N caused a small decrease in the K concentration when averaged over planting and harvest dates and plant part (Table 3).

Sodium concentrations of the plant tissue were influenced by N fertilization (Table 3), plant part (Table 4) and harvest date (Table 5). The effect of N and harvest date on Na concentrations in the plant parts can be observed by looking at the interactions HxPP and NxPP. In contrast with K, Na concentrations of all

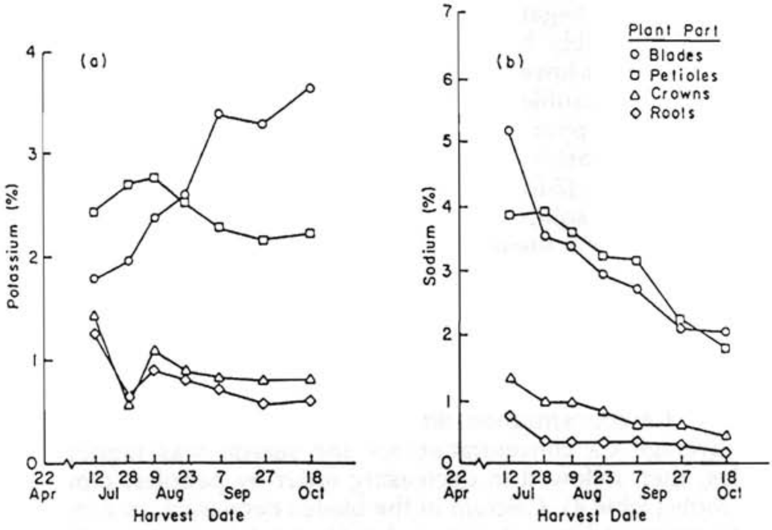


**Figure 2.** The effect of harvest date on the potassium and sodium concentrations in four plant parts averaged for planting date and nitrogen rate.

plant parts decreased as the season advanced (Figure 2b). With K, the concentration in the blade increased. Another difference between Na and K was that the application of N fertilizer caused an increase in Na in all plant parts (Table 6), but N fertilization increased the K concentration only in the roots. Finkner et al. (1958) noted also, that increasing N fertilizer increased Na in the beet root.

Both Na and K salts are quality factors to be considered in the processing of roots for sugar. Increasing soluble salts in the root at harvest decreases the crystallization of sugar and results in more sucrose going into the molasses. Nitrogen fertilization apparently affects the cation-anion balance and uptake mechanism when the available N is in the nitrate form. In this experiment and also as noted by Husseini (1966), N fertilization increased both Na and K concentrations in the root (Table 6).

In an Idaho study, Carter (1986a, b) found a high positive linear correlation between the K/Na dry-matter concentration ratio in the root and sucrose in the fresh root. Ratios below 5 resulted in sucrose concentrations below 17%. A relationship of N rate to the root K/Na ratio and sucrose in the root was also observed in this study, but the effects were less pronounced. For the October harvest the K/Na ratios decreased from 6.5 to 4.7 to 2.9 for the 0, 100, and 300 lb N rates, respectively. Sucrose percentages for the same N treatments were 19.2, 18.5, and 17.0, respectively (Lee t al., 1987).

The greater negative effect of Na on root quality in the Carter study can possibly be explained by comparing soil analyses. Carter reported a lower K level in relation to Na for both exchangeable and water soluble forms than observed herein. In the present study the K/Na ppm ratio for the water soluble ions in the soil was 3; in the Carter study the ratio for the median K and Na values was 0.25, 12-fold lower. The K/Na ratio for the exchangeable plus water soluble ions was 4.9 for the present study. The same ratio for the median values in the Carter study was 1.36, 3.6-fold lower.

*Calcium and magnesium:* All main treatment effects except the date of planting were significant for Ca concentrations in the plant tissue as well as the DxPP, NxPP and HxPP interactions (Table 1).

The Ca concentration differed widely among plant parts. The average Ca concentration for the season was highest in blades, then followed in decreasing order by petioles, crowns, and roots (Table 4). Calcium in the blades decreased, in general, as the season advanced (Figure 3a). Conversely, in the petioles, crowns, and roots the trend was the opposite, and Ca generally increased in these tissues as the season advanced although the petiole data was quite variable. The Ca concentration averaged for harvest date over planting date, N rate, and plant part (Table 5) reflected the seasonal variability among plant parts.

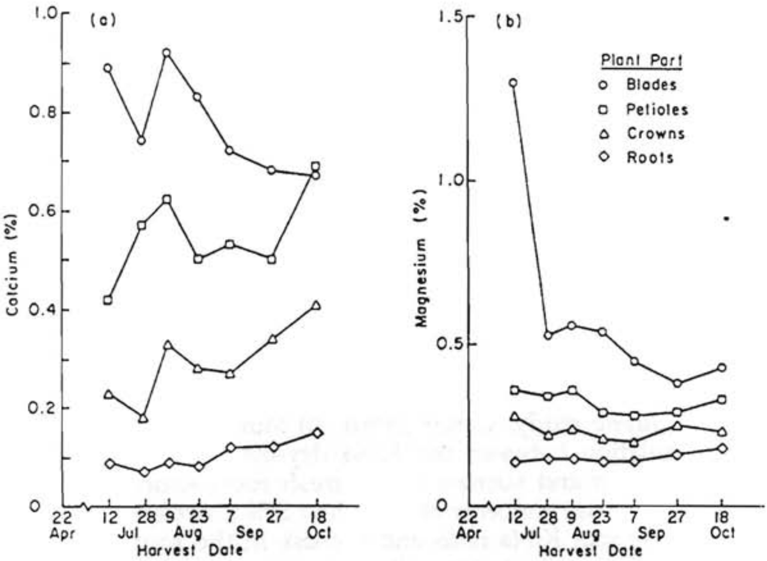


**Figure 3.** The effect of harvest date on the calcium and magnesium concentrations in the four plant parts averaged for planting date and nitrogen rate.

The NxPP interaction was highly significant (Table 1). The application of N fertilizer caused a decrease in Ca in the petioles (Table 6) but had little effect on Ca in the other plant parts. Averaged over all treatments, increasing the N rate decreased the Ca concentration (Table 3). Finkner, et al. (1958) also noted that increasing the application of N decreased the Ca concentration in beets.

The average Mg concentration increased with an increase in N fertilizer rate (Table 3). Average Mg concentrations in the plant parts decreased in order from the highest in the blades to petioles, to crowns, to the lowest in the roots (Table 4). The interaction of plant part and harvest date can be observed in Figure 3b. The Mg concentration in blades decreased rapidly early, then more slowly as the season advanced, but the concentration in petioles and crowns and roots changed only slightly during the season. This is contrasted with Ca which increased in the petioles, crowns, and root tissue as the season progressed. The main effect of harvest date on Mg concentration is shown in Table 5.

The effect of N fertilizer on the Mg concentration in the plant parts tended to have an effect opposite to that on Ca. Increasing N increased Mg in the blades (Table 6), but had little effect on other plant parts. With Ca, N application generally decreased the average Ca content of the petioles.

*Total Nutrient Content*

Total nutrient content of the harvested living tissue was calculated for each sampling date during the season using concentration data of Bravo (1979) and dry matter production data of Lee et al. (1987). The nutrient contents in Figures 4 to 6 were calculated for a 21.6 T/A root yield, the production level attained with 100 lb N averaged for two planting dates. The mean nutrient concentration for each harvest was used to calculate the nutrient content. The average concentration for the three N levels did not differ significantly from the value for 100 lb N, nor was the DxH interaction significant except for K (Table 1). Analysis of variance of the total nutrient content without replication showed that harvest date, plant part, and the interaction were significant at the 5% level or higher for each plant nutrient except Na.

The HxPP interaction for the content of the six nutrients in each plant part are shown in Figures 4, 5, and 6. Total nutrient content of the harvested crop during the season is represented by the top line in the figures. Calcium, Mg, and P were maximum at the final harvest. Total Na was highest on August 23 and total S on August 9. Potassium was a maximum by August 23, then remained about the same to the final harvest. The loss of K by leaf senescence after August 23 was approximately balanced by an increase in K in the crown plus root.

Throughout the season there was loss of each nutrient from the tops (blades plus petioles) both by leaf senescence and translocation, but there was continued nutrient uptake by new top growth. Until August 23 (or August 9 for Ca) the net effect was an increase in nutrients in the harvested top (Figure 4, 5, and 6). After August 23 the net effect was a progressive decrease in nutrients in the harvested top to the final harvest.

Seasonal dry matter accumulation to harvest, partitioned into harvested plant parts, senesced leaves and 25% fibrous root

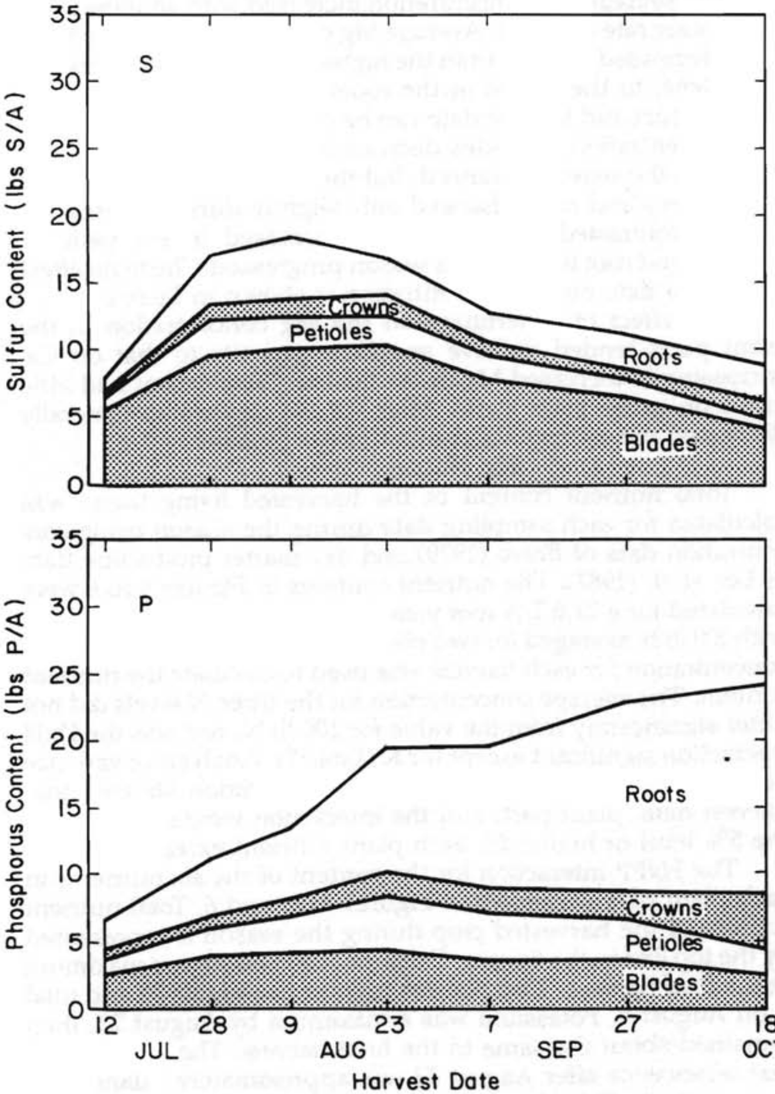


**Figure 4.** The effect of harvest date on the total phosphorus and sulfur content of sugarbeet – 100 lb N rate averaged over two planting dates.

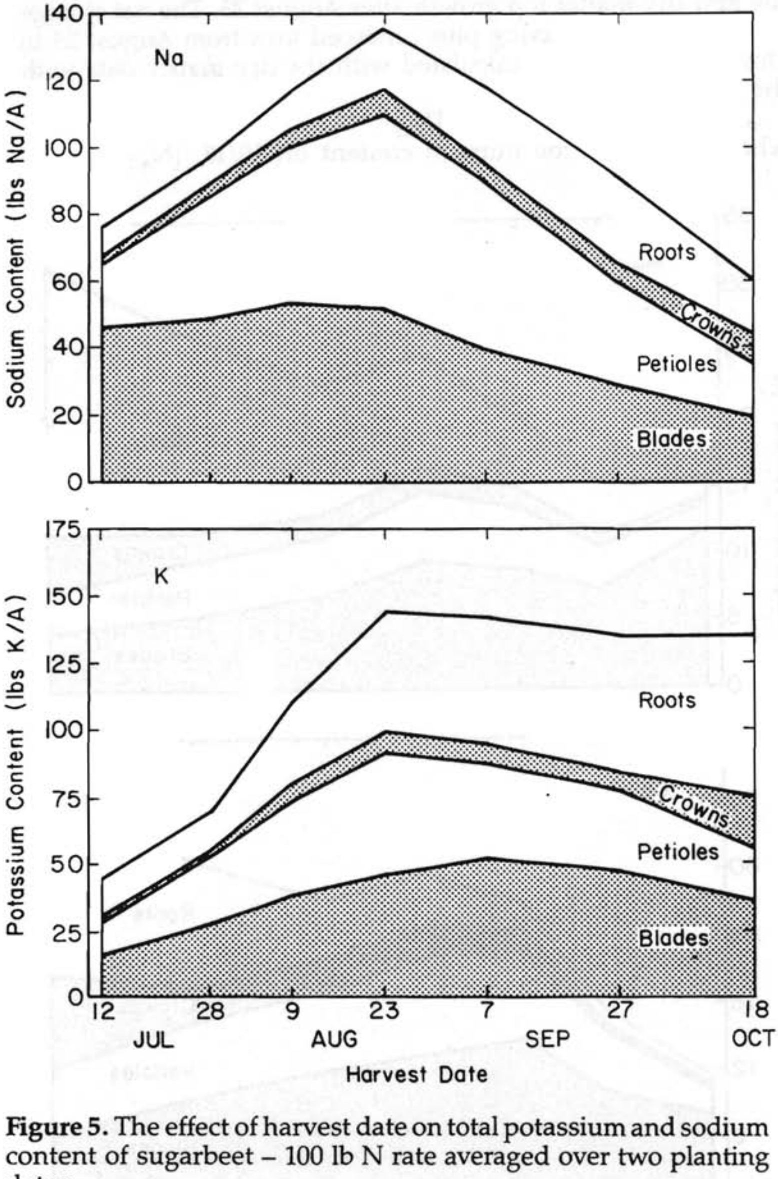


**Figure 5.** The effect of harvest date on total potassium and sodium content of sugarbeet – 100 lb N rate averaged over two planting dates.

loss (Kelley and Ulrich, 1966), is shown in Figure 7. Total dry matter of the living leaves was 1.80 T/A on August 23, then decreased to 0.95 T/A on October 18 (Lee et al., 1987), a decrease of 0.85T. During the same period leaf senescence increased 1.44 T/A (0.55 to 1.99 T/A). The difference, 0.59 T/A (1.44-0.85 T), is the new dry-matter top growth after August 23. The net change in nutrients in the living plus senesced tops from August 23 to October 18 ($\Delta N$) was calculated with the dry matter data with the equation:

$$\Delta N = [N_{10/18}] - [N_{8/23}] + [N_s]$$

where $[N_{10/18}]$ is the nutrient content on 10/18, $[N_{8/23}]$ is the

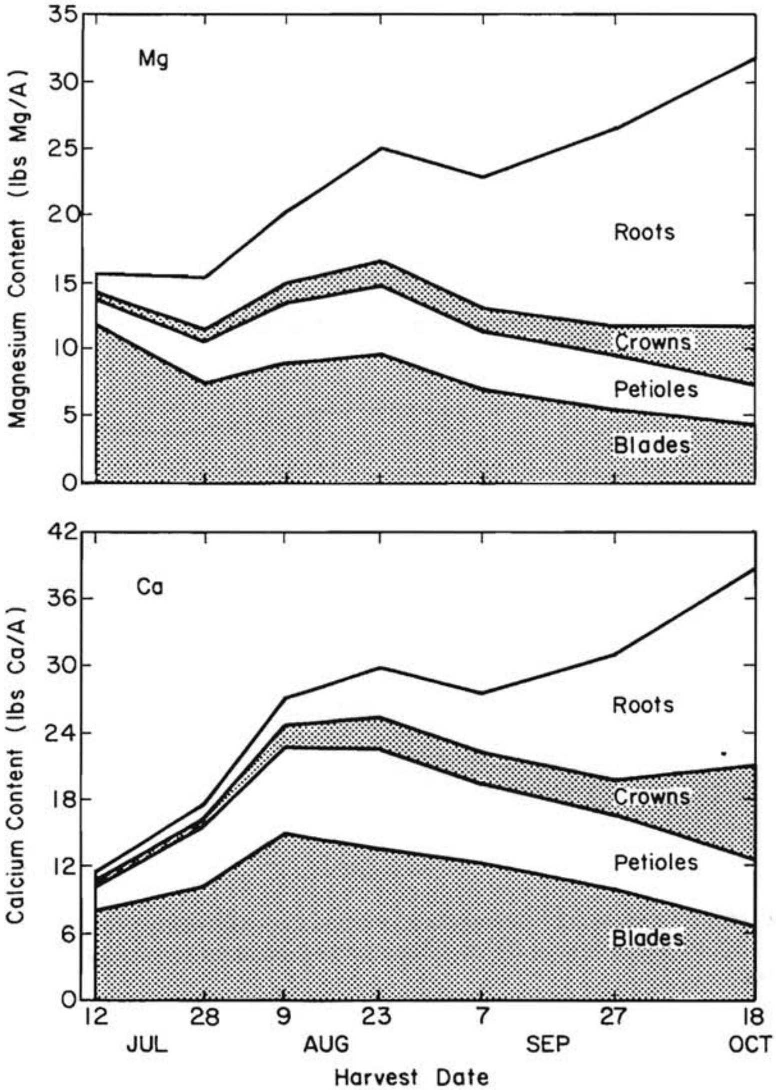


**Figure 6.** The effect of harvest date on total calcium and magnesium content of sugarbeet – 100 lb N rate averaged over two planting dates.

nutrient content on 8/23, and $[N_s]$ is the nutrient content in senesced leaves. The calculations are summarized in Table 7. The net change (column 5) is the sum of the uptake for new growth and gain by retranslocation from the senesced leaves. For P the net change was zero and indicates that retranslocation was the same order of magnitude as uptake. For the Na, Ca, Mg, and S the net was positive, thus, uptake was in excess of retranslocation. This would be expected because these nutrients are relatively immobile (Eslami et al., 1988). The K concentration was about the same among leaves of varying ages (Eslami et al., 1988), thus its net content is a reflection of the net change in dry matter.

The nutrient content of the root (crown plus root) continued to increase to the final harvest for P, K, Ca, and Mg (Figures 4, 5, and 6). There was little change in total Na in the root after August 23. Total S in the root was a maximum August 9, decreased about 10% to September 7, then remained about the same to the final harvest.

The total nutrient content of the tops (blades and petioles) and root (crowns and roots) for the harvested crop in October is given in Table 8. A smaller proportion of Na and S partitioned into the root than did the other nutrients. The proportion of total

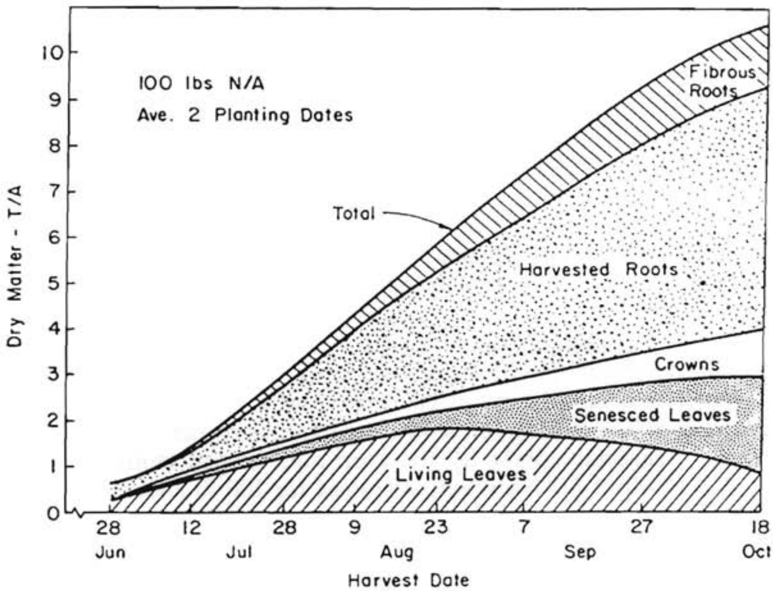


**Figure 7.** Seasonal dry matter accumulation averaged for 100 lb N/A averaged for two planting dates partitioned into harvested plant parts, senesced leaves and fibrous root loss. Drafted from data of Lee, et al., 1987.

Table 7. The net change in nutrient content of the tops (leaves plus petioles) from August 23 to October 18*.

| Nutrient | Content in tops-Aug 23 | Content in senesced leaves** Aug 23-Oct 18 | Content in tops-Oct 18 | Net change Aug 23-Oct 18 |
|---|---|---|---|---|
| | lbs/A | | | |
| K | 92 | 72 | 57 | 37 |
| Na | 111 | 104 | 36 | 29 |
| P | 8 | 4 | 4 | 0 |
| S | 13 | 16 | 5 | 8 |
| Ca | 24 | 36 | 13 | 25 |
| Mg | 15 | 19 | 7 | 11 |

* Averaged for 100 lb N and two planting dates.
** Calculated from data of Eslami et al. (1988).

Table 8. Total nutrient content of the tops and roots of the harvested crop on October 18, and total seasonal nutrient uptake*.

| | Harvested crop – Oct. 18 | | | | |
|---|---|---|---|---|---|
| Nutrient | Tops | Roots | Total | Percentage of total in roots | Total season nutrient uptake** |
| | lb/A | | | | lb/A |
| K | 57 | 81 | 138 | 59 | 292 |
| Na | 36 | 25 | 61 | 41 | 324 |
| P | 4 | 20 | 24 | 83 | 38 |
| S | 5 | 4 | 9 | 44 | 43 |
| Ca | 13 | 24 | 37 | 65 | 111 |
| Mg | 7 | 24 | 31 | 77 | 79 |

* Average for 100 lb N and two planting dates, yield 21.6 T/A.
** Includes nutrients lost to leaf senescence and unharvested fibrous roots.

nutrient of the harvested crop that was in the root for the October 18 harvest ranged from 41% for Na to 83% for P (Column 5, Table 8).

Total seasonal nutrient uptake (Column 6, Table 8) is the sum of nutrients in the harvested crop plus nutrient loss to senescent leaf fall (Eslami et al., 1988) and to an estimated 25% fibrous root loss during harvest. These values represent the total nutrient seasonal uptake by the crop and ranged from 38 lb/A for P to 324 lb/A for Na when averaged for 100 lb N/A over two planting dates.

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