

FERTILIZER UPTAKE IN RELATIONSHIP TO GROWTH STAGES OF DAFFODILS

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A growth analysis experiment was undertaken as part of a broad research effort to determine the appropriate timing and rates of fertilizer applications to obtain optimum yields and quality of daffodils. Rees (1972) showed that daffodil bulbs lose weight shortly after planting until the Spring when the grand period of growth begins. This weight loss is associated with the conversion of stored carbohydrates into the initiation of the roots, leaves and flowers. This experiment was designed to determine the timing of nutrient absorption so that fertilizer applications can be applied for more efficient uptake and utilization in the growth of the crop.

METHODS AND MATERIALS

The cultivar, Fortune, was used throughout this experiment. Three No. 1 bulbs were planted in fiber pots 12 inches in diameter and depth that were buried in the field. The planting media was field soil that had received a supplemental treatment of 15 grams per pot of 16-16-16 plus trace elements placed in a ring about 1 inch below the bulb. The 3 replicated pots were harvested at each harvest date. The plant organs sampled were bulb, root, leaves, scape and flower. The scape and leaves were cut at the neck of the bulb. The data obtained was dry weight of each organ, plant tissue analysis of each organ and the green foliage area of the leaves and scape. The plant tissue analysis samples were dried in a forced draft oven at 60°C and ground to pass through a 40 mesh screen before being sent to Oregon State Plant Tissue Analysis Lab. for analytical determination of nutrient composition.

RESULTS

Total Plant and Bulb Weight - The data showed a continued drop in bulb weight from planting until early April (Figure 1). The grand period of bulb growth occurred from early April until early June. Growth of the whole plant parallels that of bulb growth.

Growth of Plant Parts Other Than the Bulb - Root initiation occurred shortly after planting and root growth continued rapidly until early January (Figure 2). After this time there was very little additional growth. The grand period of leaf growth began in late December and continued through May. After that time normal senescence occurred. Scape and flower growth began in late February and continued to a maximum in late April even though the scape continued to grow through May.

FIGURE 1 - Time Course on Total Plant and Bulb Dry Weight

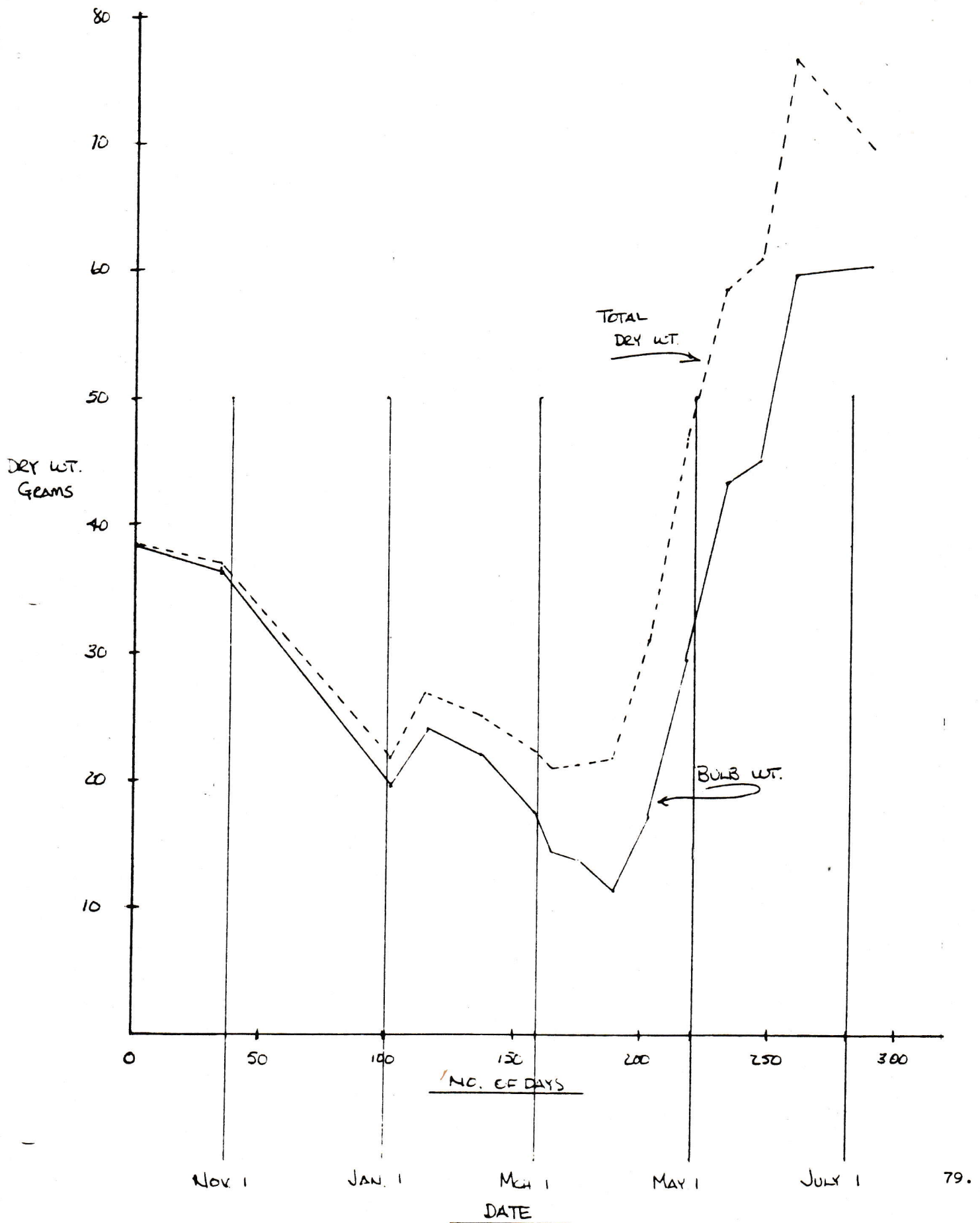
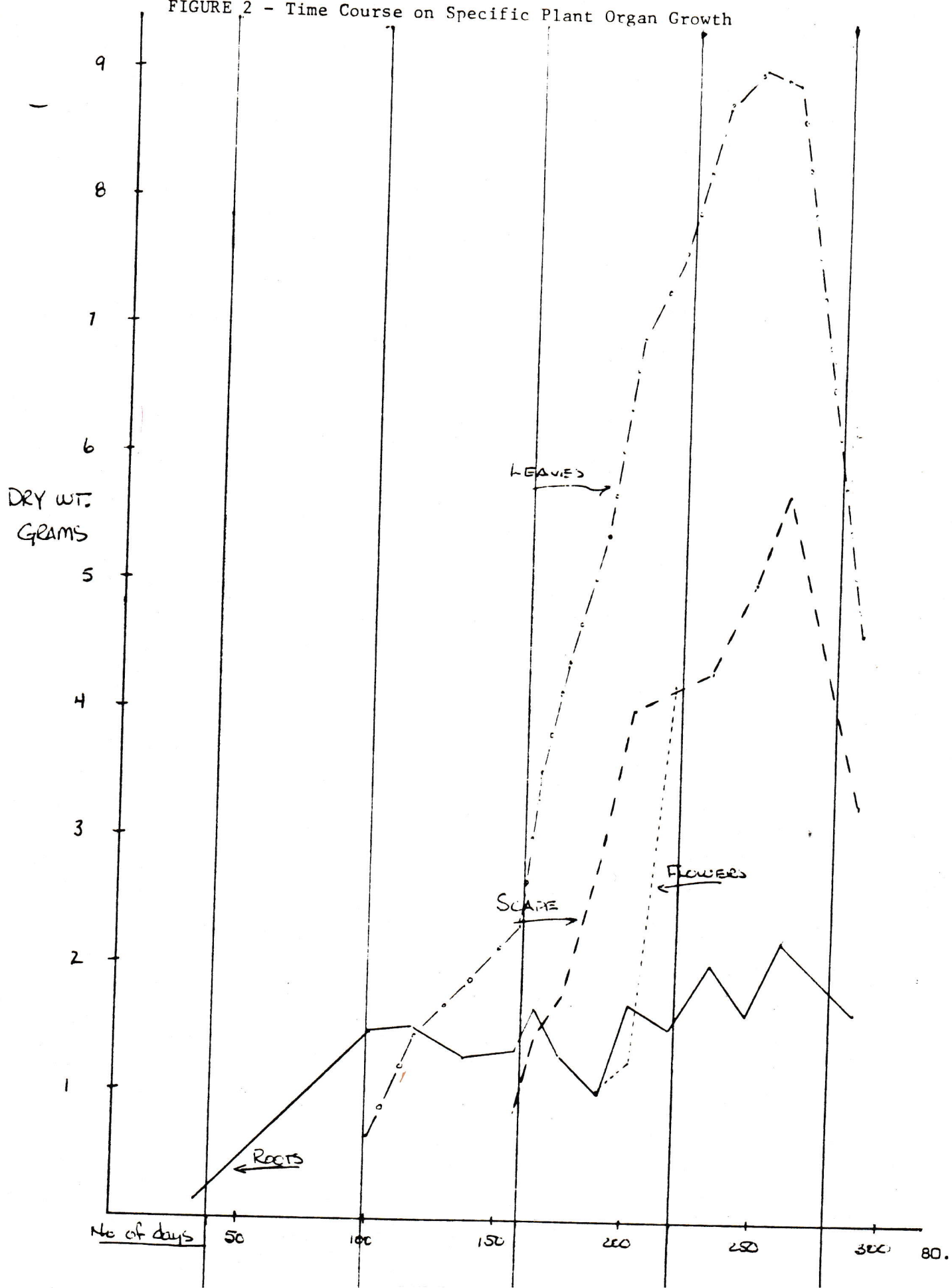


FIGURE 2 - Time Course on Specific Plant Organ Growth



Foliage Area Measurements - Area measurements were initiated in early March after green foliage began rapid growth. The leaf area measurements indicated that the foliage area capable of photosynthetic activity started sometime in February and peaked in mid-May (Figure 3). The scape tissue area contributed between 15-25% of the total photosynthetic area and must be considered a valuable organ for carbohydrate production in the plant.

Tissue Analysis of the Plant - The tissue analysis data shows the concentration of elements in the plant based on the dry weight (Figure 4). This data is useful as a diagnostic tool in the determination of nutrient deficiency-sufficiency concentrations of specific organs at a specific period of growth. This data, however, does not take into consideration the growth dynamics of the plant. When we multiply the tissue analysis data by the weight of the plant organ we can determine the amount of each element that is in that specific organ. This data will be discussed in another section.

Percent Nitrogen - The beginning concentration of nitrogen in the bulb was about 1.5% and ended at 1%. The N in the leaves and root tissue picked in early March ranged in 3-4% N and then dropped rapidly after that time to nearly 2% by early May.

Percent Phosphorus - The beginning concentration of P in the bulb was .22% and ended in July at about .15%. The leaves and roots reached a peak concentration in late February - early March of .55% and then rapidly dropped to about .3% by May 1.

Percent Potassium - The beginning K concentration of the bulb was about 1% and ended at about .8%. The leaves began in January to contain about 2% K and continued to accumulate K to 3% in late May.

Percent Calcium - The Ca concentration in the bulb began at about .38% Ca and peaked in early April at .6%. After that it dropped back down to about the original concentration by June 1. The leaf concentration in January started at about .2% and began to climb rapidly in March.

Percent Magnesium - The bulb Mg concentration started at .006% and increased to about .08% in March and then dropped back to .03% in June.

Manganese ppm - The bulb Mn started at 11 ppm and increased in March through May to about 25 ppm and then tailed off to about 10 ppm in June. The leaf tissue began accumulating Mn in January and continued increasing up to 175 ppm by June.

Zinc ppm - The bulb Zn concentration began at about 40 ppm and later in the season tailed off to about 27 ppm. The leaf tissue accumulated a maximum concentration of 75 ppm in February and then dropped rapidly down to 25 ppm by June.

Boron ppm - The bulb initially started with 11 ppm B and reached a maximum concentration of 30 ppm in April and then dropped back to about 20 ppm in July. The leaves constantly increased in concentration of B throughout the growing season and reached a maximum peak of about 55 ppm.

FIGURE 3 - Time Course on Foliage Area Measurements

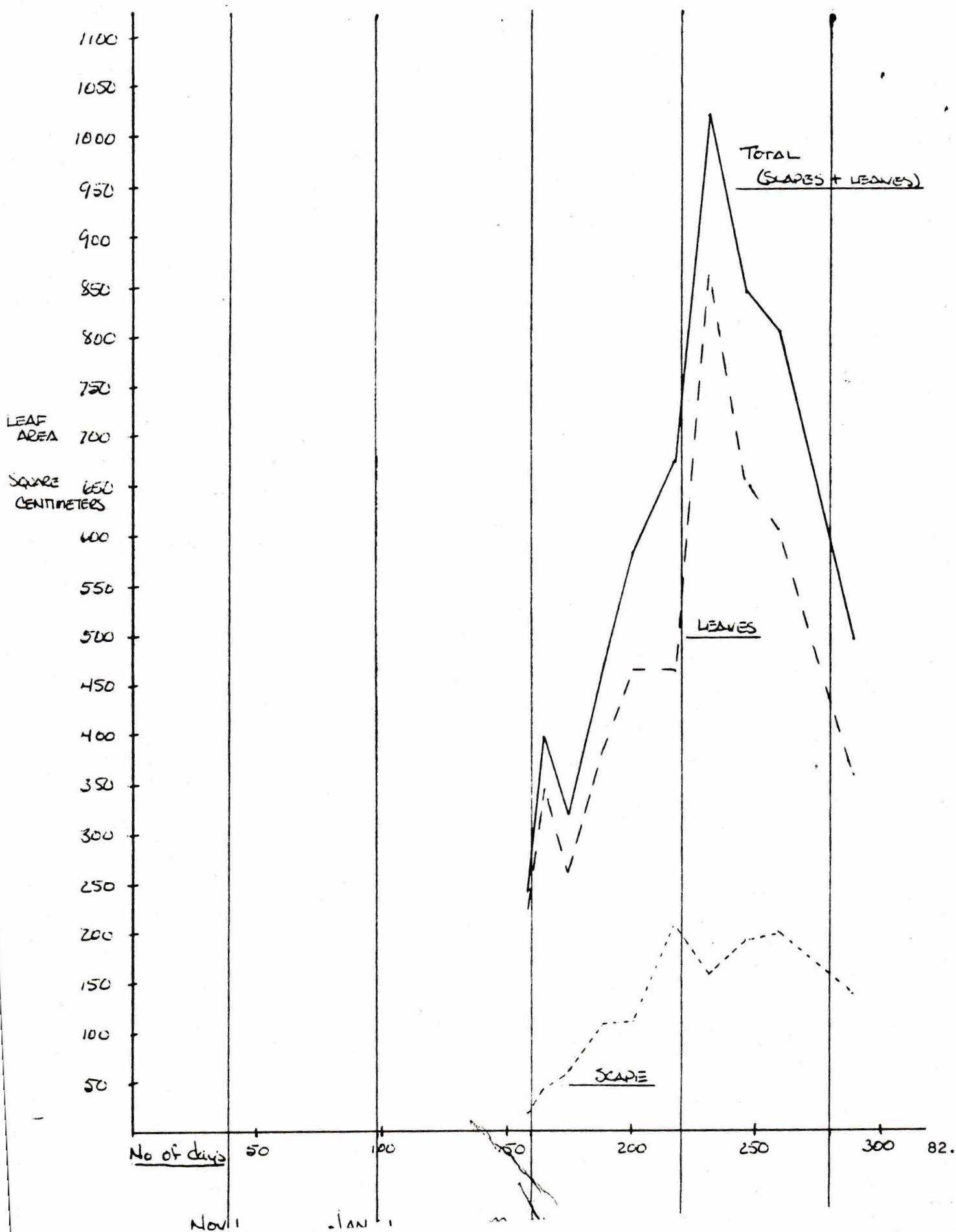
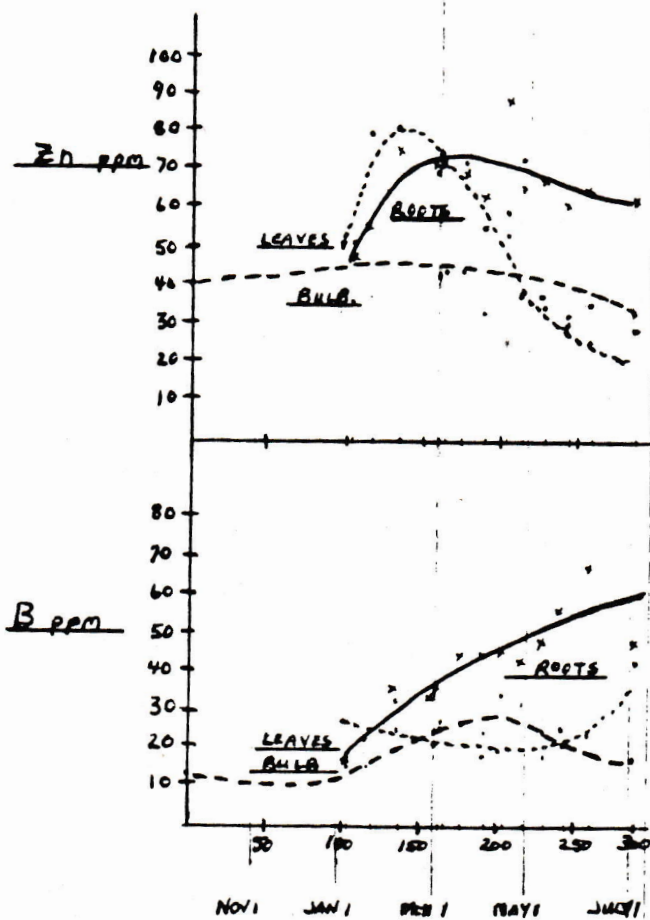
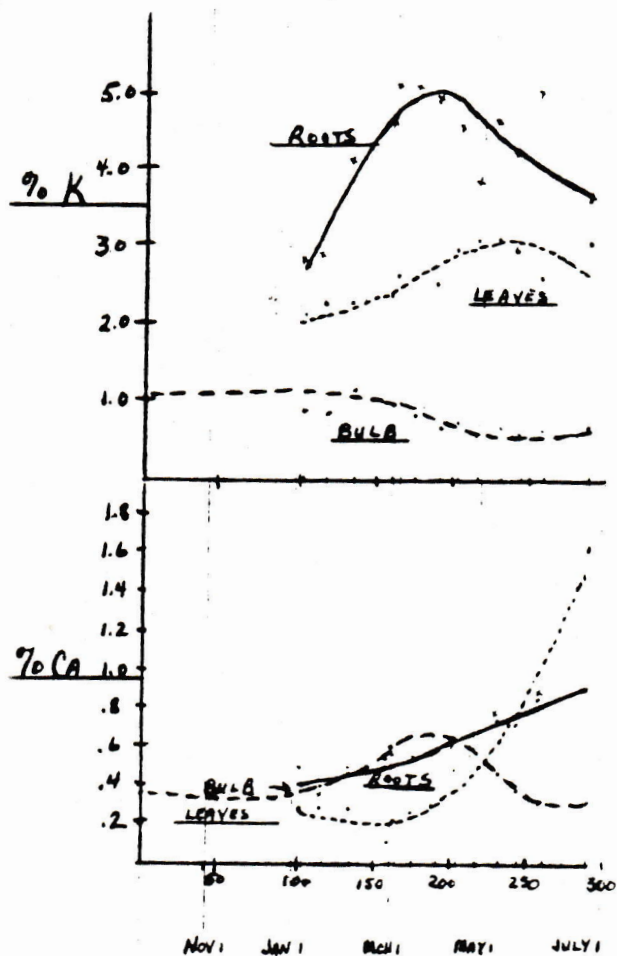
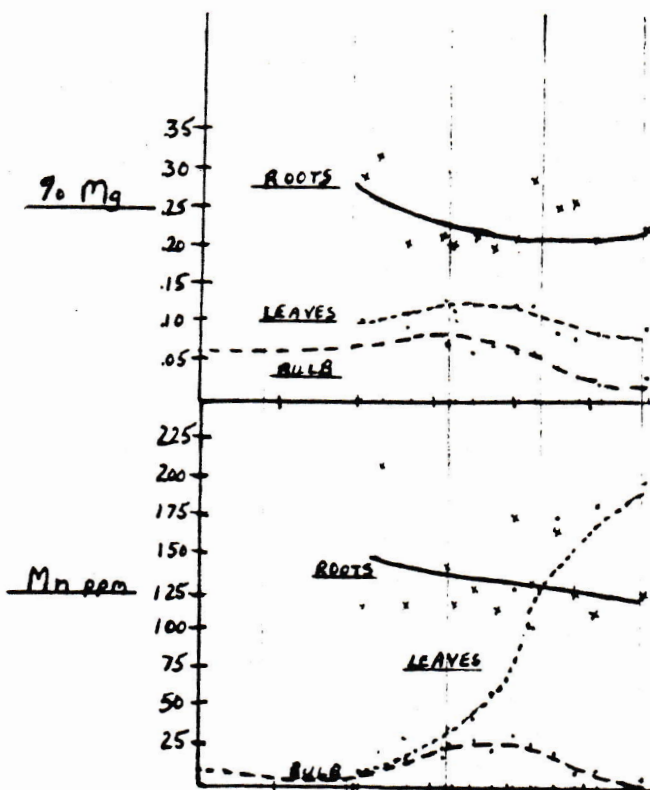
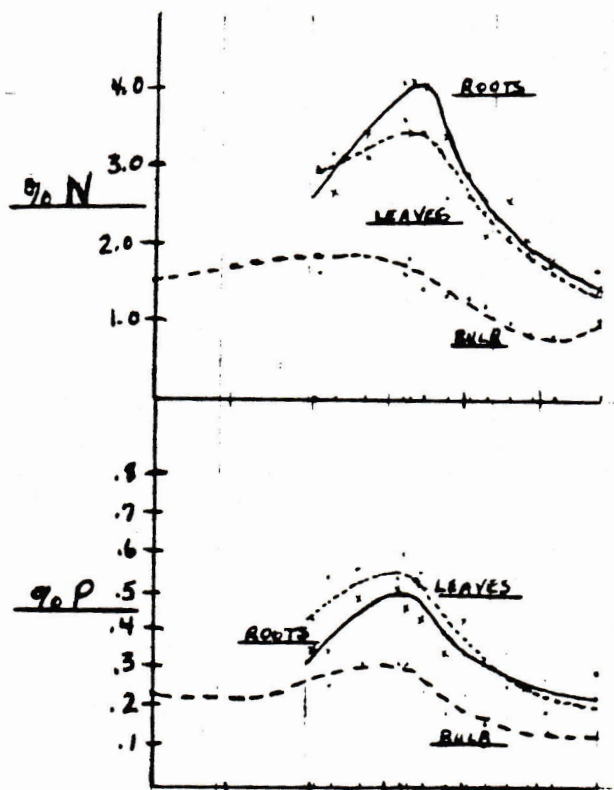


FIGURE 4 - Plant Tissue Analysis Curves



Analysis of Total N, P and K in the Whole Plant with Time - As was pointed out, the whole plant weight drops until early April and then the grand period of growth started and continued through April, May and early June. The accumulation of N and K paralleled the grand period of growth of the plant (Figure 5). There appears to be significant changes in nutrient concentrations occurring earlier, during the period of January through March, but it is clear that the major N and K accumulation occurred during April and May. The P concentration stayed static throughout the growth cycle and would appear to be an experimental problem associated with P availability related to the potting and fertilization of bulbs.

Nitrogen Concentration in Plant Parts - The N appeared to start accumulating in the roots in November and December and remained constant throughout the remainder of the growth cycle (Figure 6). The N in the flowers and foliage began accumulating in January and peaked in late April and then fell off rapidly. This drop in foliage and flower N may be due to the bulb becoming the nutrient sink. This data could indicate either a normal redistribution of N in the plant or a deficiency of N occurring in the foliage and flower organs.

The bulb N dropped rapidly until early April. The N was being accumulated in other organs that were rapidly developing during this period. At about flower picking time the bulb becomes the primary sink for N and starts accumulating rapidly until July, even after much of the foliage has senesced.

Phosphorus Concentrations in Plant Parts - The pattern of P distribution parallels that of the N story with P accumulating in the foliage and flowers in early January and continuing to mid-April and then rapidly falling off (Figure 7). The bulb P dropped until early April and then rapidly increased in April and May. The plateau of whole plant P that develops in June and July may indicate an occurrence of P deficiency.

Potassium Concentrations in Plant Parts - The whole plant K appeared to originally drop down until early January and then increased at a slow rate until early April (Figure 8). A major accumulation of K occurred during the months of April through mid-June. The bulb K dropped until early April and then rapidly increased during the grand period of growth.

SUMMARY

These results on growth of the plant compare to those described by Rees (1972) showing a decrease in bulb weight shortly after planting and continuing until the flower picking stage which was early April in this experiment. At this point, the grand period of bulb growth began and continued until early June. The total plant growth follows a similar pattern to bulb growth. Root growth began shortly after planting and was mostly completed by early January. Leaf growth began in late December and grew constantly until June and then normal senescence began. The scape and flower started active growth in February and constantly increased until early May. The total green foliage area reached a peak in mid-May and rapidly began to drop off. The scape tissue is probably a significant producer of carbohydrates as it constitutes between 15-25% of the total foliage area during the months of April through June.

FIGURE 5: TIME COURSE ON WHOLE PLANT N,P,K CONTENT PER PLANT

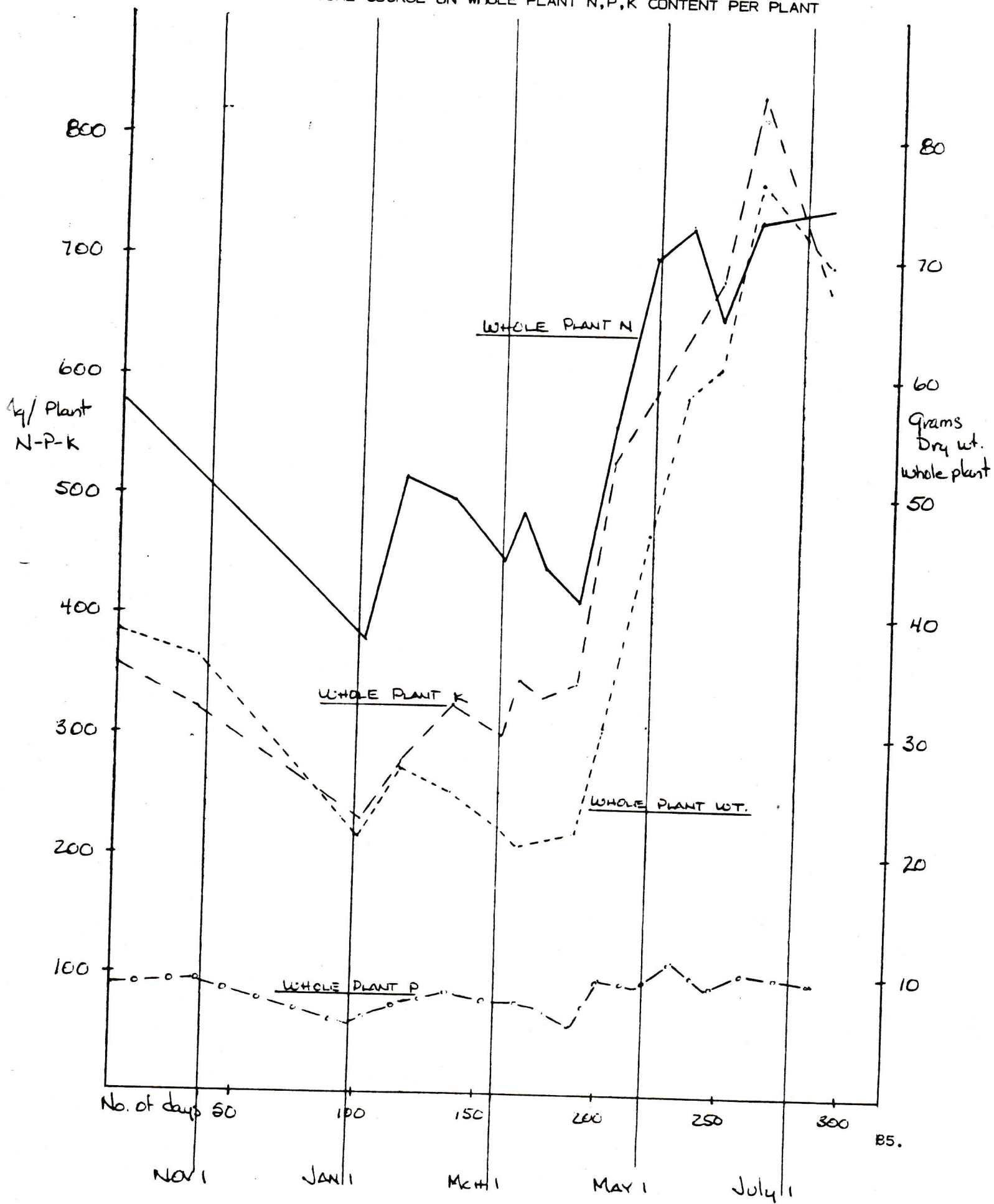


FIGURE 6: TIME COURSE ON N CONTENT OF SPECIFIC PLANT ORGANS

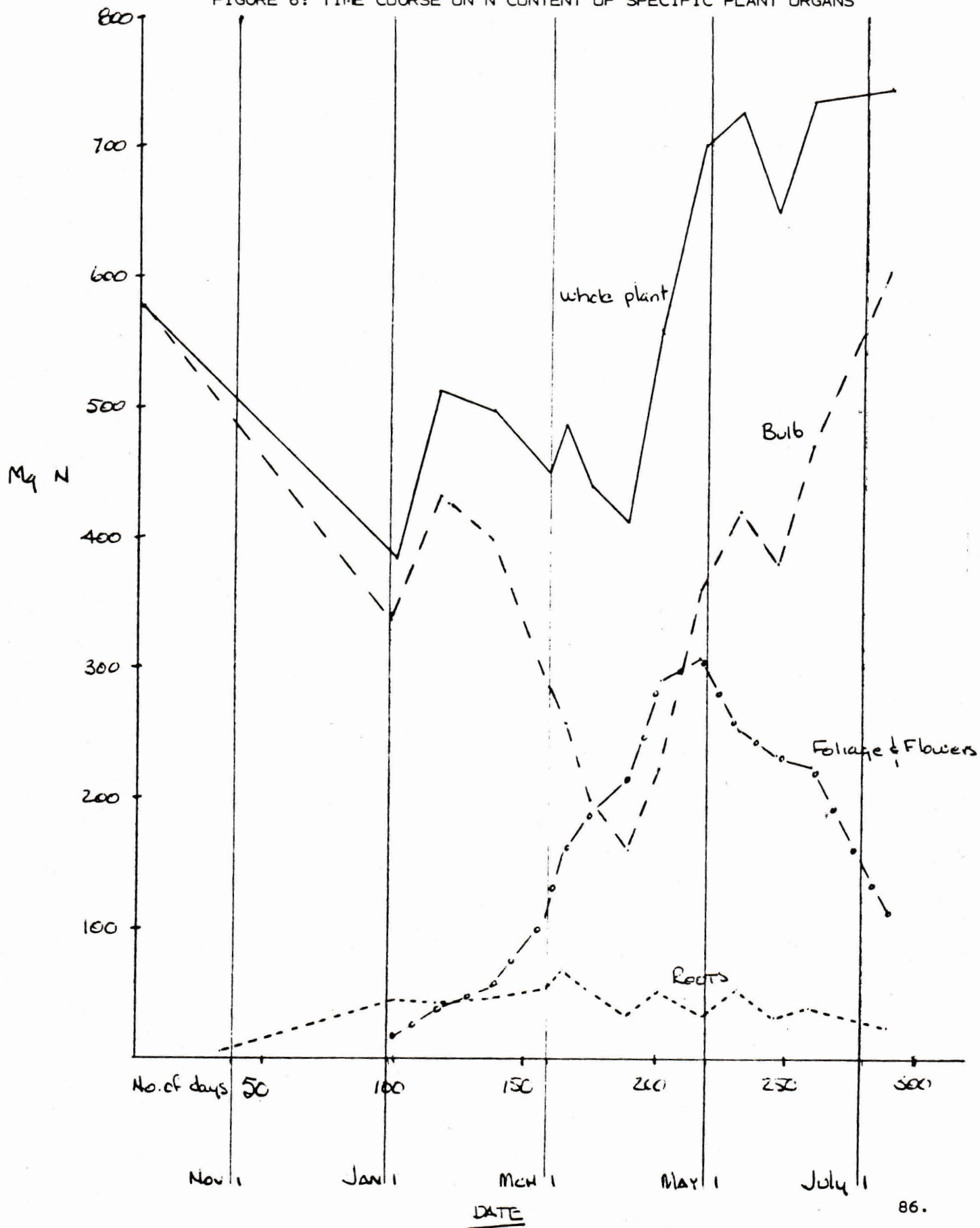
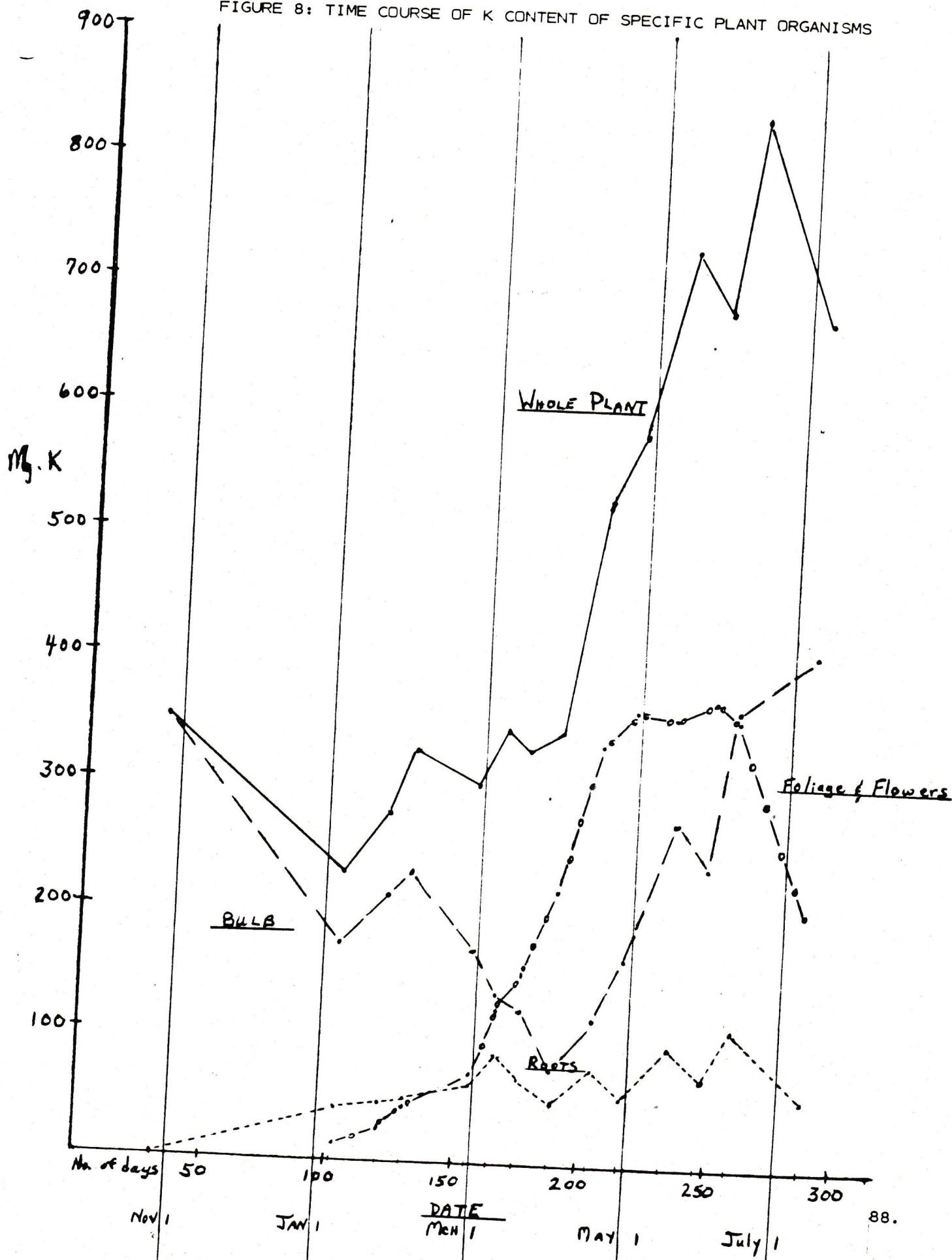


FIGURE 8: TIME COURSE OF K CONTENT OF SPECIFIC PLANT ORGANISMS



Nutrients appeared to be initially lost from the plant in the fall and early winter months through possible leaching and diffusion from the bulb and roots. In January it was apparent, particularly with K, that the plant actively accumulated nutrients. However, in the case of N and K, the major accumulation occurs during the grand period of plant growth during the months of April and May. The implications from a soil fertilization standpoint are that fertilizer must be available to the plant during the months of April and May. Availability of N then is of major concern as there is no guarantee that N applied in the fall will be available in April and May. Much of the N may have been leached away through precipitation and high water table conditions that occur during the winter months. These results may indicate that early spring applications of N are necessary for efficient crop utilization. The normal application of P may be adequate providing that P has not been tied up in an inactive state during the 6 month wait before utilization occurs. Further investigation is required to definitely answer the effectiveness of the present N and P timing and application procedures currently being used. Apparently there is an adequate amount of K being provided through the commercial applications presently being made.

The data would indicate the most effective tissue sampling for nutritional deficiencies in daffodils would be sampling whole leaves about 2 weeks after the flowers are spent. The proper time for sampling Fortune daffodils in Mount Vernon would be about May 15. A sample should consist of about 50 individual whole leaves (1 per plant) that have been dried to a constant weight before sending for tissue analysis. More information is required before accurate estimates of deficiency-sufficiency nutrient concentrations can be recommended.

LITERATURE CITED

Rees, A.R. 1972. The Growth of Bulbs. Academic Press. pp 50.