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**Nutrient Levels of
Leafy Vegetable Plants
1987**



**Muck Crops Branch - OARDC
The Ohio State University
4875 State Route 103 South
Willard, Ohio 44890**

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INTRODUCTION AND ACKNOWLEDGEMENTS

The Horticulture Department of The Ohio State University and the Muck Crops Vegetable Growers of Ohio coordinated the efforts involved in this report. The publication is a survey of different vegetables at various stages of growth, covering a period of two growing seasons (1986, 1987). Sampling was carried out on six farms: Holthouse Farms, Wiers Farms, Inc., Buurma Farms, Inc., Stambaugh Co., K.W. Zeller and Sons, and Brinkle Farms. Much thanks is extended to the various farms for their utmost cooperation and assistance. The criteria for establishing the age and quantity of plants to be sampled was decided by the grower and researcher involved. (Plants sampled showed no visible nutrient deficiencies.)

The purpose of this report is to establish a foundation, thereby giving growers an idea of the range and averages in which the ideal level of each nutrient falls for the various crops. The information generated can be used as a foundation in further research to establish maximum and minimum levels for each nutrient. It is also the intent of this publication to aid the growers in deciding what areas of direction they could follow in correcting an undesirable field situation. This report is not to be considered a research publication.

The financial support for this project was focused in the direction of an assistantship for a horticulture graduate student at The Ohio State University. This was a cooperative venture between the Horticulture Department and the Muck Growers' Association of Ohio, with the leadership of Mr. Richard Hassell, Research Specialist. Much thanks is extended to these two organizations for their financial support. Appreciation is also extended to Debra Stoutenburg (graduate student) for her hard work, long hours, and dedicated service to the muck vegetable growers of Ohio in establishing this report. A special thanks is extended to the working staff (Frank Caudill, Danny Hall and Tim Hall) of the Muck Crops Branch for their hours of work that allowed the project to go forth.

Richard Hassell
Vegetable Research Specialist
Horticulture Department

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SOIL NUTRIENT AVAILABILITY

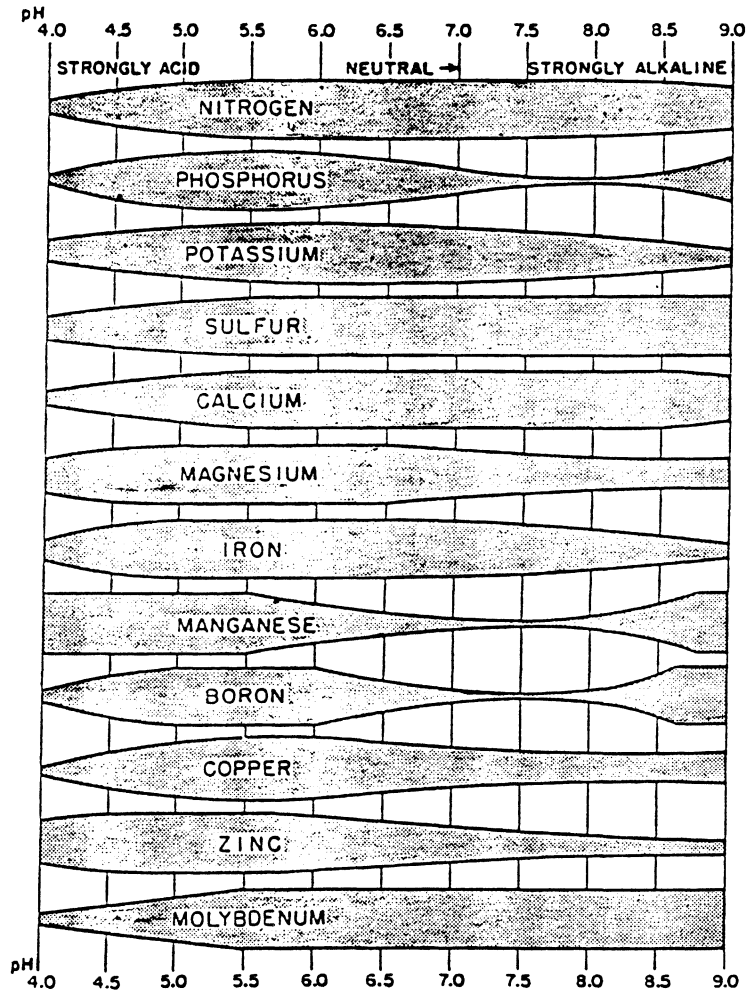


Chart 1

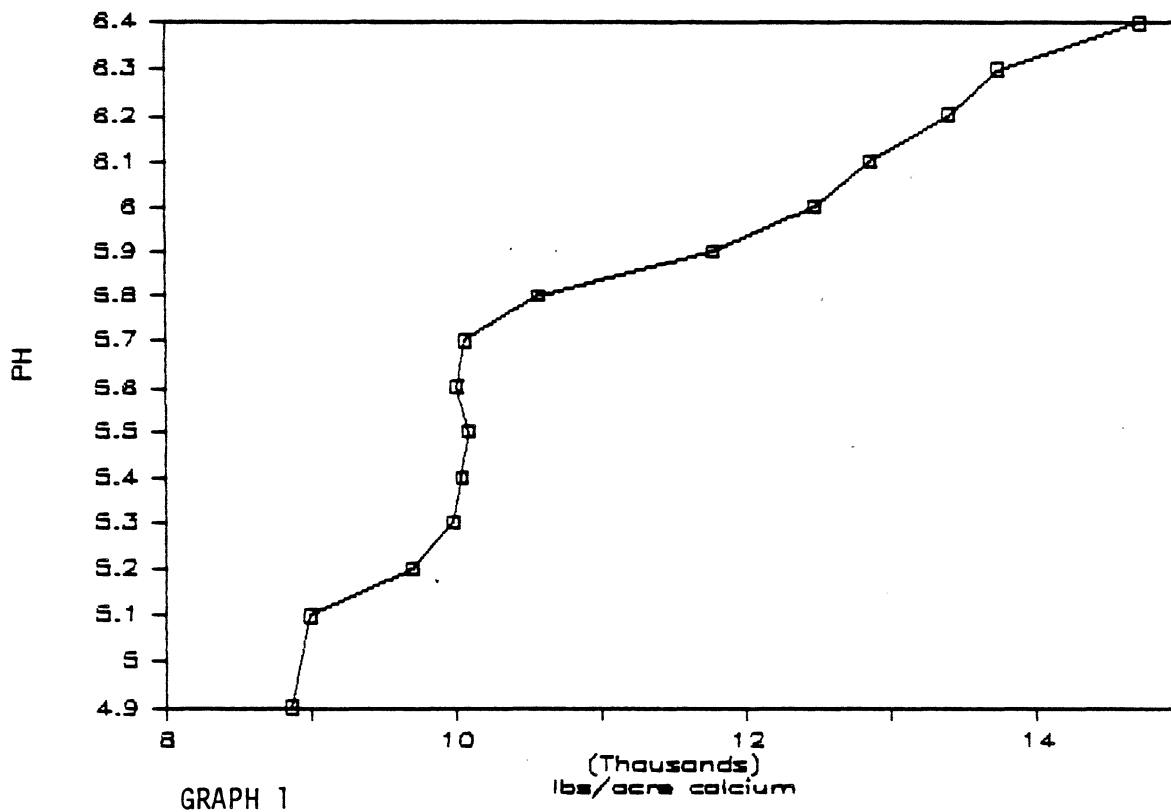
From: Lucas & Davis

The numbers received from an analytical laboratory from either soil or plant tissue analysis are useless unless they are compared to a set of standards. These standards have been developed by using exact procedures of sampling. These same procedures must be followed when samples are going to be compared to any published results! The standards will be of no use to samples incorrectly taken!

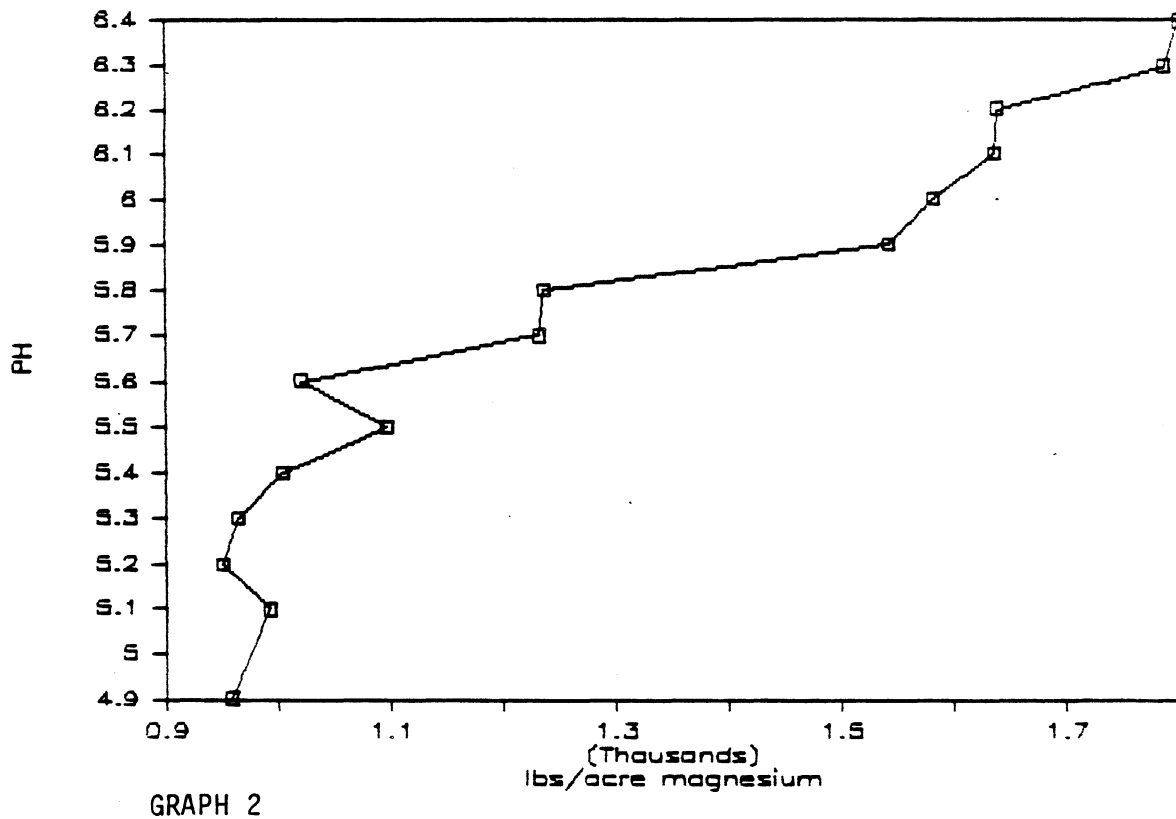
Soil Testing

In farming, soil testing helps indicate the status of the nutrients. Results properly interpreted can improve the quality of crops. A few concepts need to be understood about the results. 1) They are just numbers unless correlated to previous test values and crop responses. 2) The results and recommendations are different for mineral than for muck soils. 3) The pH of the soil greatly influences some of the nutrient availability to the plants. Work has previously been done on all of the above. Chart No. 1 (from Lucas and Davis) shows relative availability of the nutrients based on pH on muck soils. The widest part of the band is the maximum availability. The amount of an element in the soil in relation to soil pH is dependent on the element. Graphs No. 1 and 2 show that there are interrelationships between pH and calcium and magnesium. Potassium and phosphorus seem to have no relationship to pH (see Graphs 3 and 4).

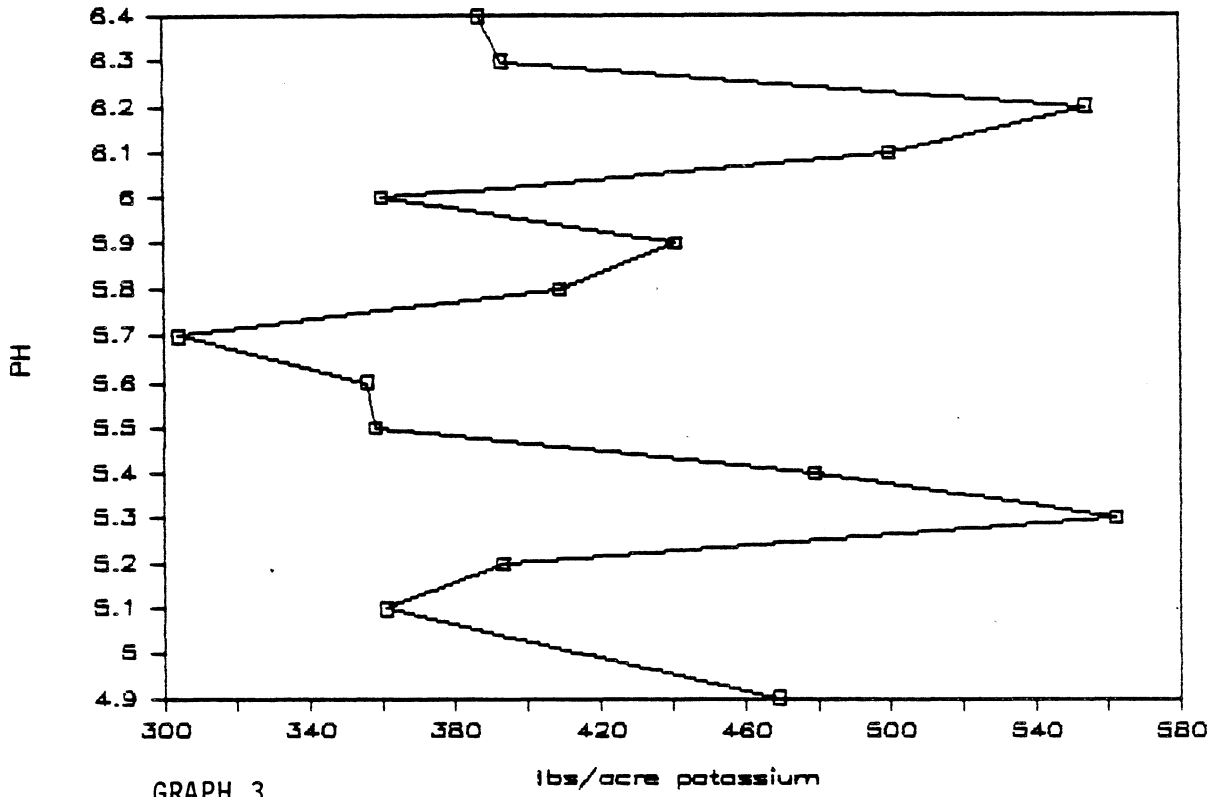
CALCIUM vs PH



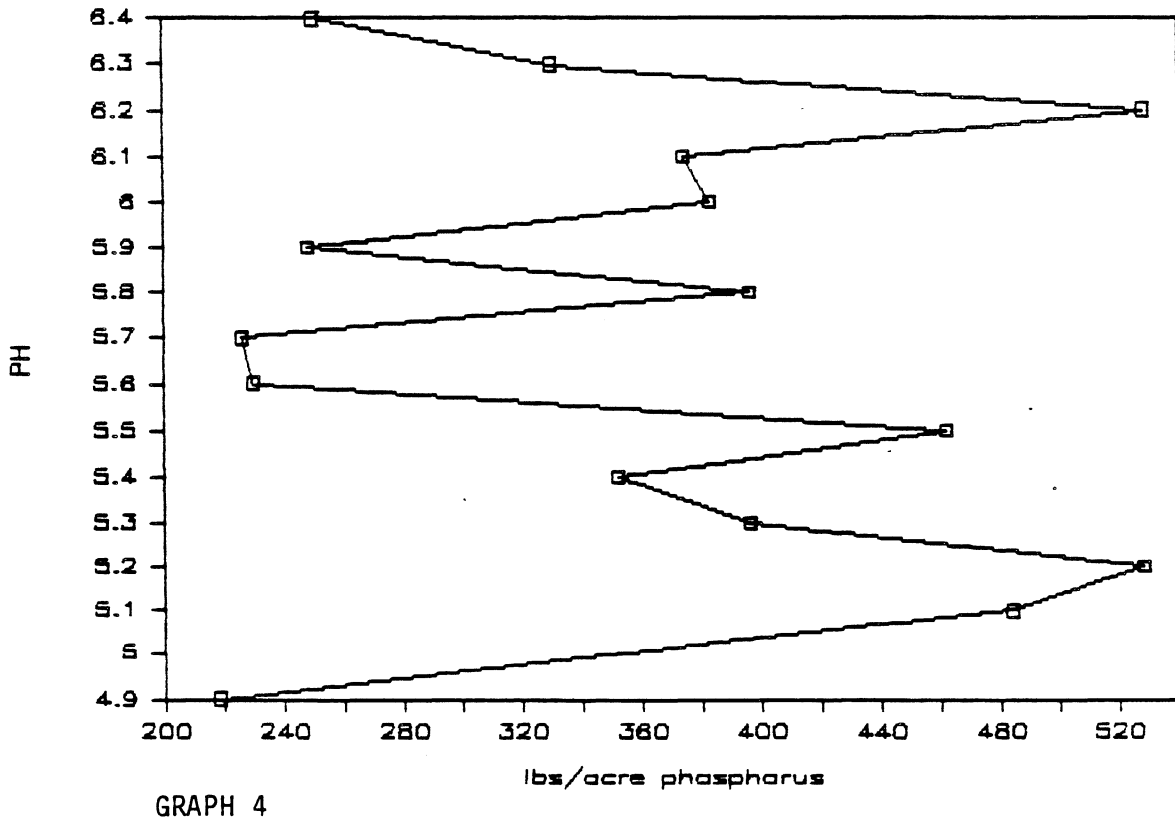
MAGNESIUM vs PH



POTASSIUM vs PH



PHOSPHORUS vs PH



How To Take A Soil Test

1. Materials:
 - a. soil probe
 - b. plastic container (any clean plastic container about a gallon in size).
 - c. soil testing kit (available through the county extension office or the Research-Extension Analytical Laboratory at Wooster).
2. Decide on the area to be tested. The area shouldn't be too big. Each soil sample can safely represent about 4 acres when taken properly.
3. Press soil probe into the soil to the prescribed depth (usually 6 inches).
4. Put full profile into plastic container.
5. Repeat steps 3 and 4, ten times in a diagonal line across field. DO NOT TAKE ALL SAMPLES IN ONE SPOT!
6. Mix the soil thoroughly in container.
7. Put the soil in sample bag to the line. The rest of the soil can be discarded. If a soil bag is not available, a small plastic bag that can be tightly closed can be used. Do not send in more than 1 cup of soil for the regular test. Make sure each bag is well identified.
8. Fill out the soil testing form for each sample.
9. Take the samples to the R.E.A.L. in Wooster.

TISSUE TESTING

The tissue sample ranges that are given at the end of this booklet are divided into old and young tissue. This has been done to try to get more accurate ranges on all elements. When a nutrient deficiency occurs, it usually appears in either the old leaves or the young leaves first and then progressively moves throughout the plant; the symptoms don't appear on the whole plant at once. The reason for this is that some elements are mobile within the plant and others are immobile.

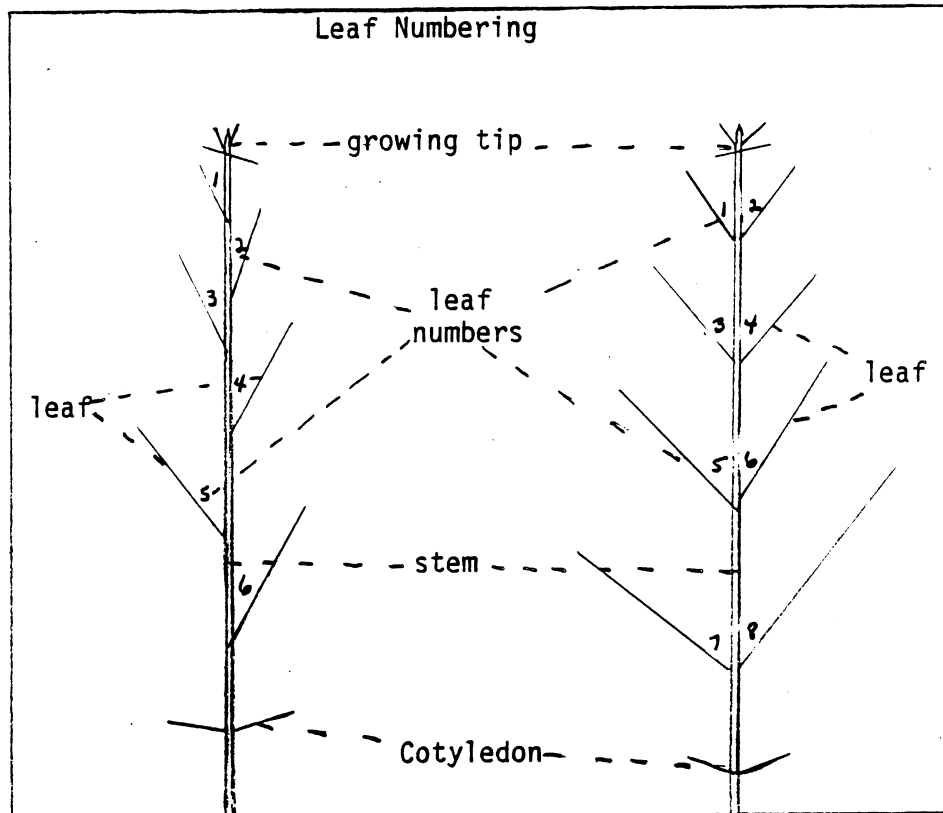
The mobile nutrients will translocate within the plant. When a plant is not getting enough of a mobile element, the element will move from the old leaves into the young, rapidly expanding leaves. This results in the old leaves having a deficiency and the symptoms of the deficiency will show in the old leaves.

The immobile nutrients will not translocate. When the plant goes under stress, the old leaves retain those nutrients and the deficiency occurs in the young leaves. With these nutrients, the symptoms first appear in the young leaves. For these reasons the proper sampling procedure is essential in determining a problem!

The mobile elements are nitrogen (N), potassium (K), magnesium (Mg), and phosphorus (P). The immobile elements are calcium (Ca), manganese (Mn), sulfur (S), iron (Fe), copper (Cu), and boron (B). A few elements in some plants will be mobile and in other plants will be immobile though they are usually mobile. These

elements are Zinc (Zn), Molybdenum (Mo), and chlorine (Cl).

When testing tissue for a deficiency, the tissue most likely to show the best results is the tissue with the first symptoms. By considering the way plant nutrients act, we have developed the following method of tissue sampling. The following diagram shows a plant and how the leaves are counted according to the directions on tissue sampling.



How To Take Tissue Samples

1. Examine the plants and decide if the symptoms first appeared in the young or old leaves.
2. Take a sample of the affected leaves as directed below.
 - a. Amount: For all tissue sampling there is a minimum amount of material that can be analyzed. The desired amount is 2 grams dry weight which is a large packed handful of fresh weight. When sampling some of the crops, especially young plants and young tissue, it will take quite a few plants to make a sample. If there is a lack of sampling material, the lab can run the test with half the amount, though it is undesirable since accurate results are harder to get. When sampling mature plants and old tissue, the required amount can be taken from just a few plants. This is also undesirable since it doesn't give a good representation of the field. A minimum of 8 plants should be sampled.
 - b. Young leaves: All leaves sampled should be the immature leaves that are still expanding rapidly. It consists of the growing tip and a few surrounding leaves. How many depends on the age of the crop and the crop being sampled.

Lettuce and endive/escarole:

mature plants 3-5 surrounding leaves
2-week plants 2-4 surrounding leaves
4-week plants 1-2 surrounding leaves

Green or dry onion:

all ages, youngest visible leaf only

Radish

all ages, 1-2 surrounding leaves

Broccoli

mature small leaves around head - Do Not take the head.
3- and 5-week plants 2-3 surrounding leaves
8-week plants 1-2 surrounding leaves

Mustard/turnip:

mature plants 2-3 surrounding leaves
2-week plants 2-3 surrounding leaves
4-week plants 1-2 surrounding leaves

Kale/collard:

mature plants 3-4 surrounding leaves
2-week plants 2-3 surrounding leaves
4-week plants 1-2 surrounding leaves

- c. Old leaves: Leaves toward the base of the plant. DO NOT take the cotyledon leaves!

Lettuce, endive/escarole:

mature and 2-week plants - cut the plant off at soil level and remove the first layer of leaves.

Take 1-2 leaves from the next layer.

4-week plants, oldest true leaf

Green or dry onion:

all ages - oldest leaf, but not the flag leaf

Radish

all ages - oldest true leaf - not cotyledon

Broccoli

mature plants =#5-7 mature leaf (see diagram)

other ages - oldest leaf

Mustard/turnip

mature plants -#5-7 mature leaf or oldest leaf

other ages - oldest leaf

Kale/collards

mature plants -#5-7 mature leaf or oldest leaf

other ages - oldest leaf

d. General Cautions:

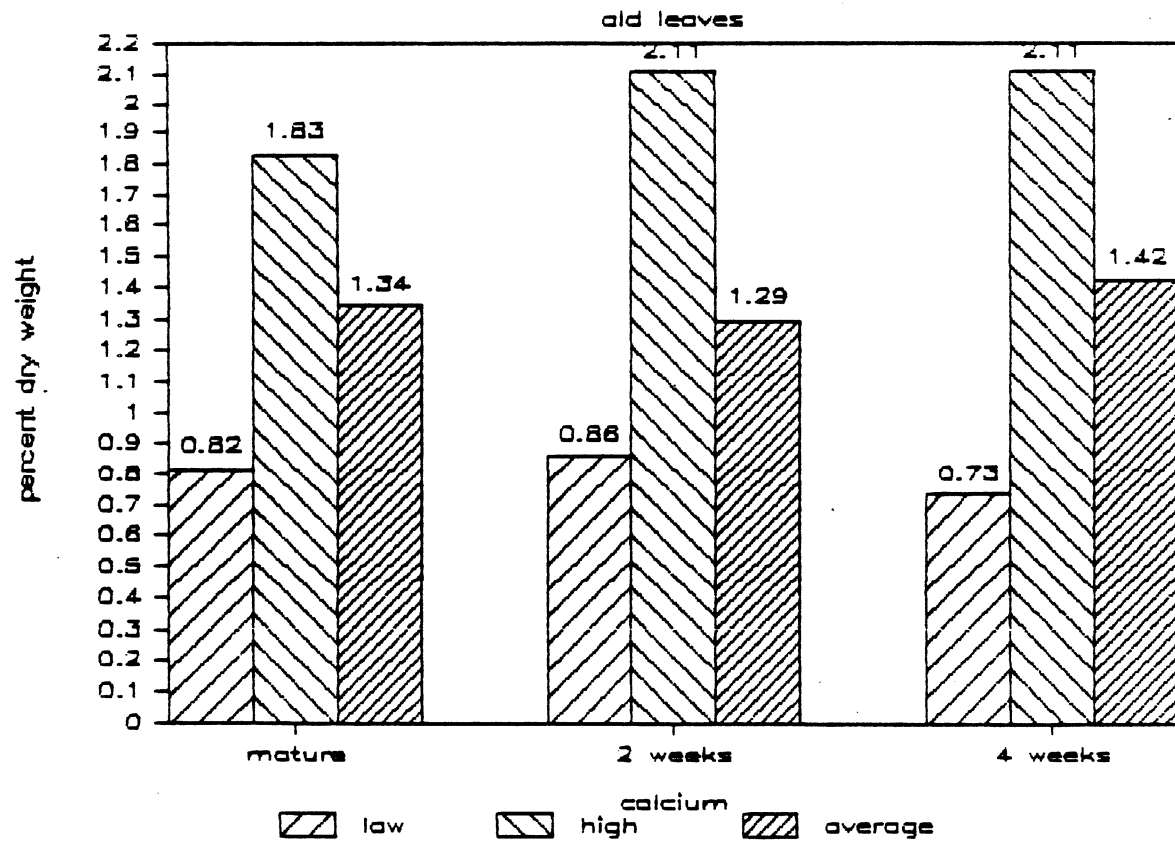
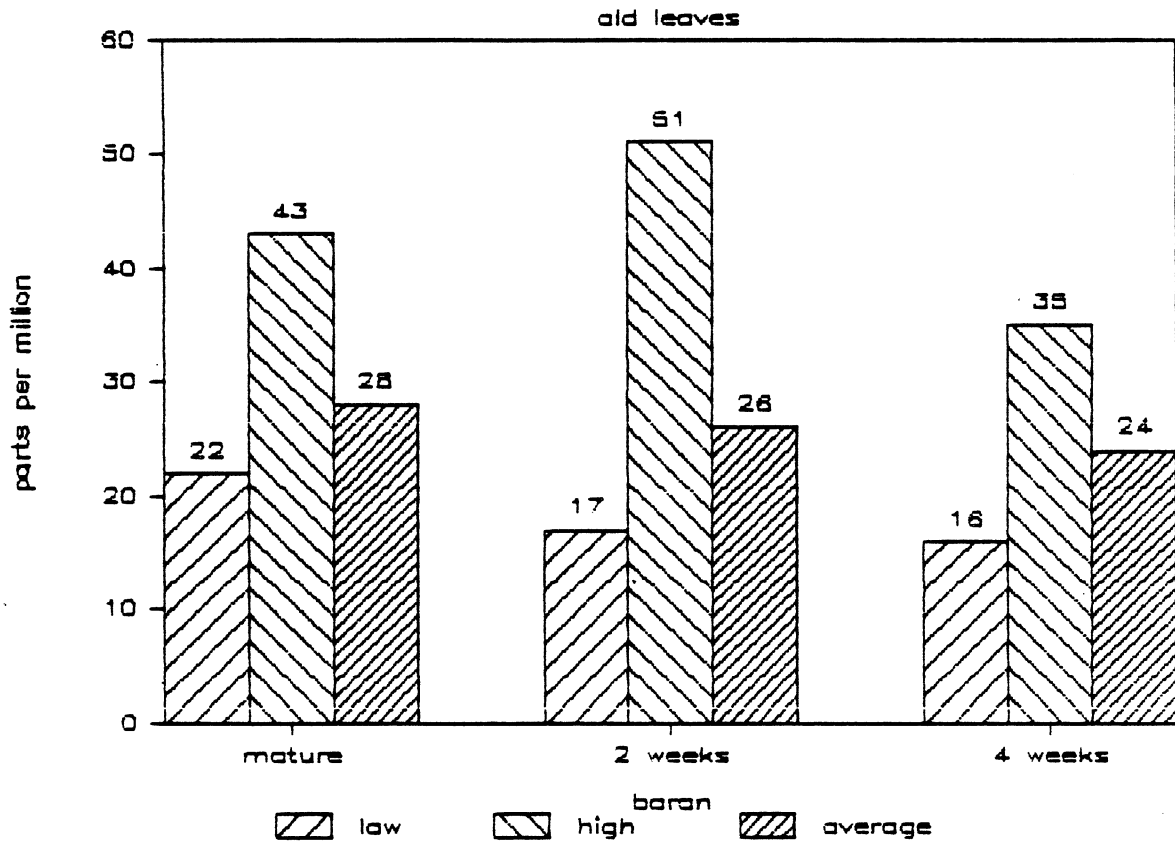
1. KEEP THE SAMPLES CLEAN! If soil particles are on the sample, the results will be distorted. This is especially true with iron.
2. TAKE ONLY THE LEAF AND PETIOLE! Do not take the stem or stock. The problem arises when sampling young tissue and the whole plant is cut and the old leaves are stripped off until the young leaves are left. On many crops this leaves a big stem attached to the young leaves. The young leaves need to be cut away from the stem and the stem discarded.
3. SAMPLE THE YOUNG AND OLD LEAVES SEPARATELY! If the tissue is sampled together, an average of the samples will occur and the results will be meaningless.
3. Place sample in tissue sampling kit envelope (available from the county extension office or from the Research-Extension Analytical Laboratory [R.E..A.L.] in Wooster). If kits are unavailable, small paper bags may be used. If the bags are used, an identification code needs to be printed on the bag, as well as sequential numbers if there are multiple samples.
4. Fill out the form that is attached to the kit envelope.

5. Take the sample to the R.E.A.L. in Wooster, preferably the same day. (Samples will keep in the refrigerator for up to two days.)
6. If a sample must be sent through the mail to Wooster, it must be DRIED first. Fresh samples usually do not stay good through the mail. To dry a sample, place it in an air dryer at 140°F until the tissue is brittle, about 2-3 days.

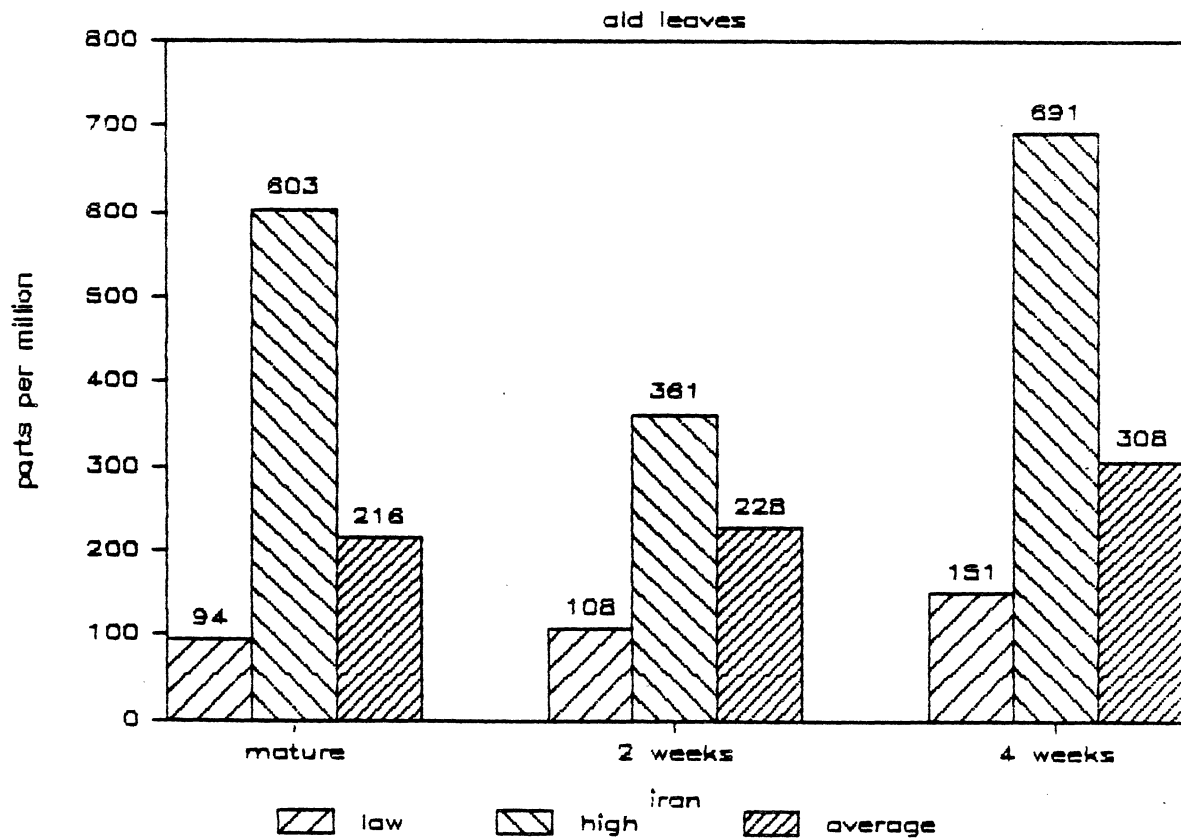
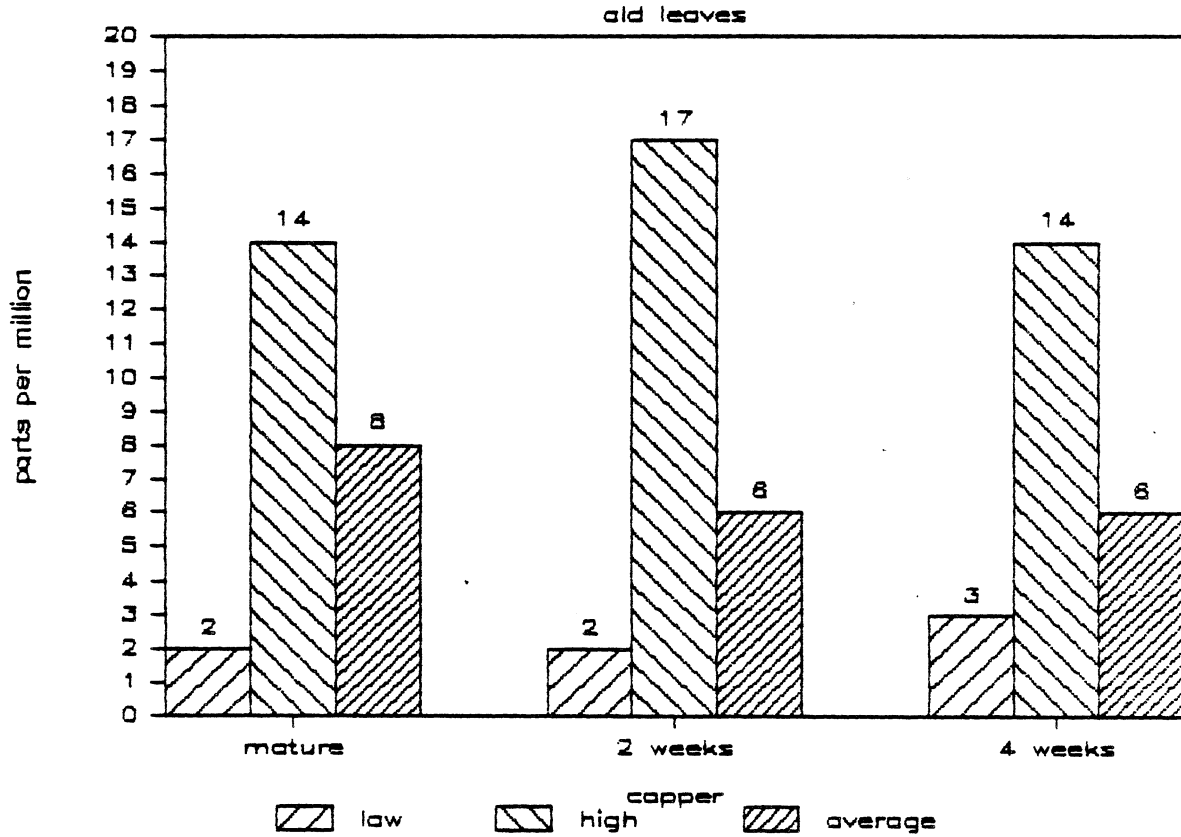
Samples should be sent to:

Ohio State University
Plant Analysis Laboratory
Research-Extension Analytical Laboratory
O.A.R.D.C.
Wooster, Ohio 44691

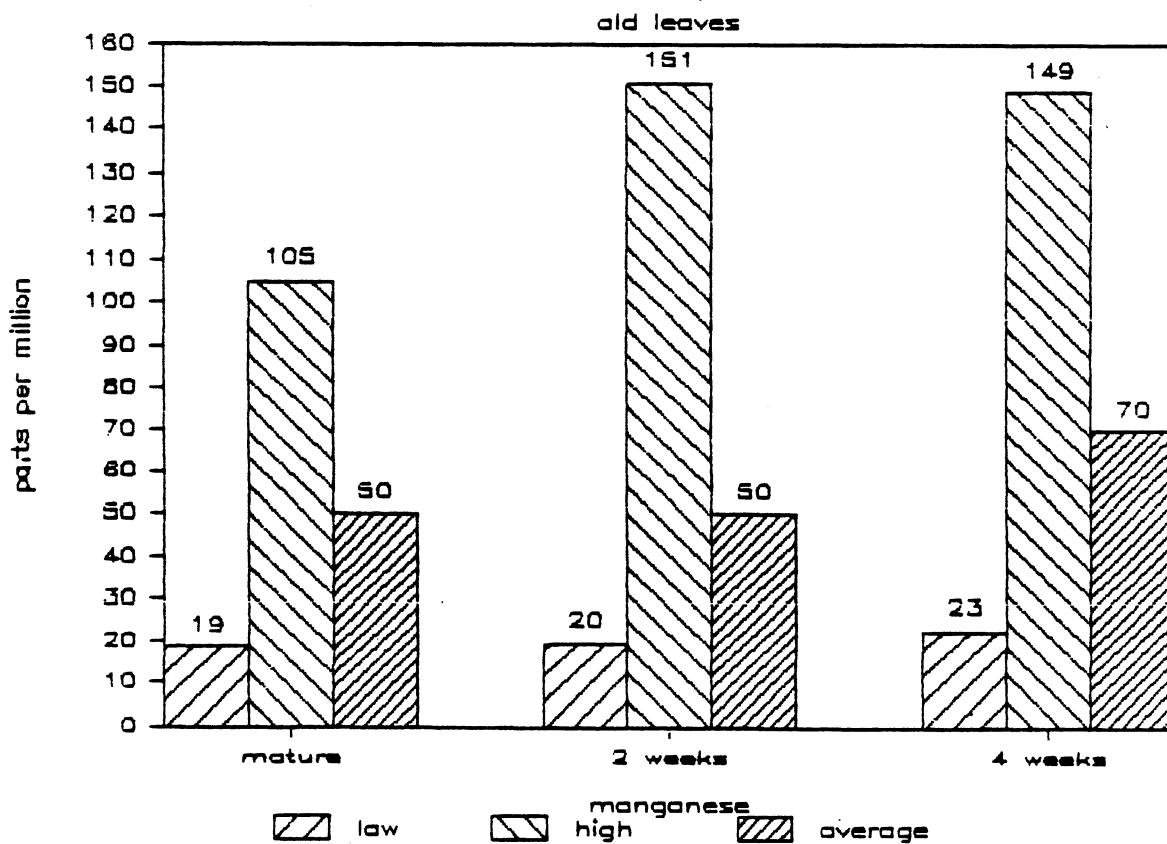
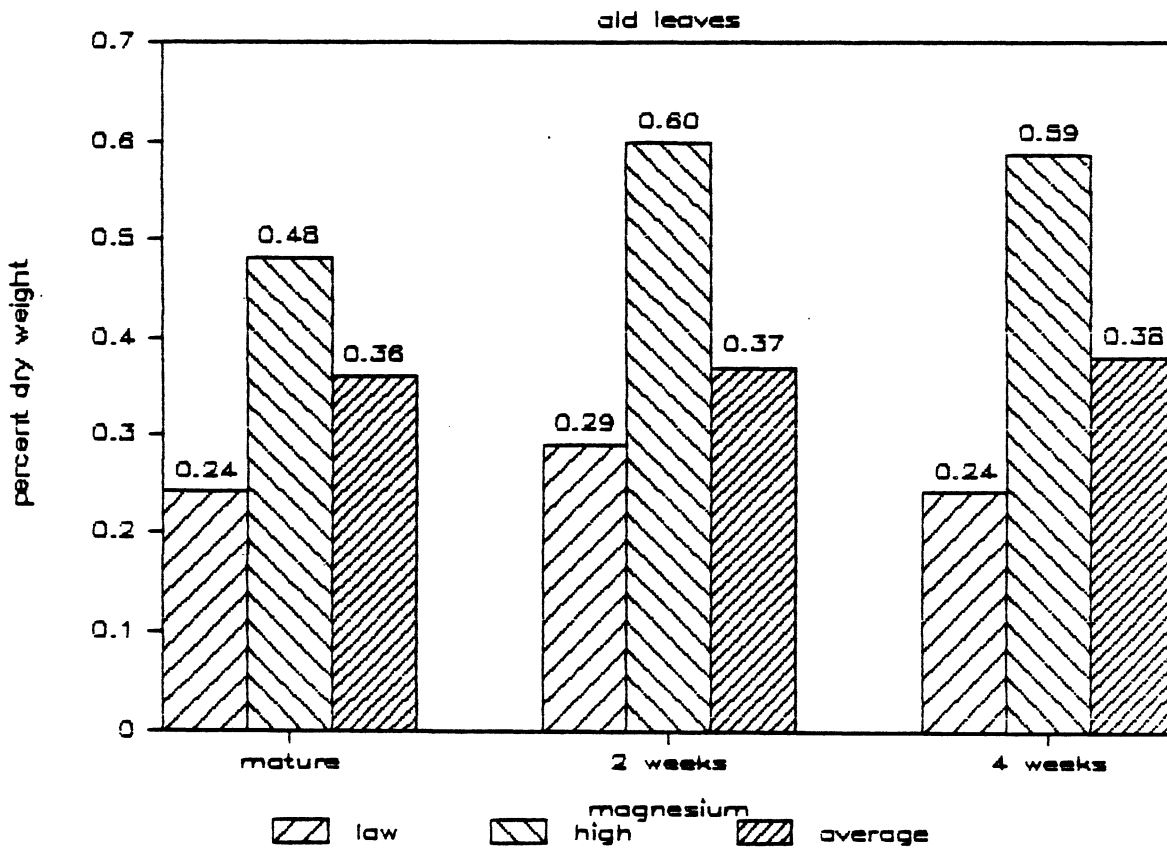
LEAF LETTUCE



LEAF LETTUCE

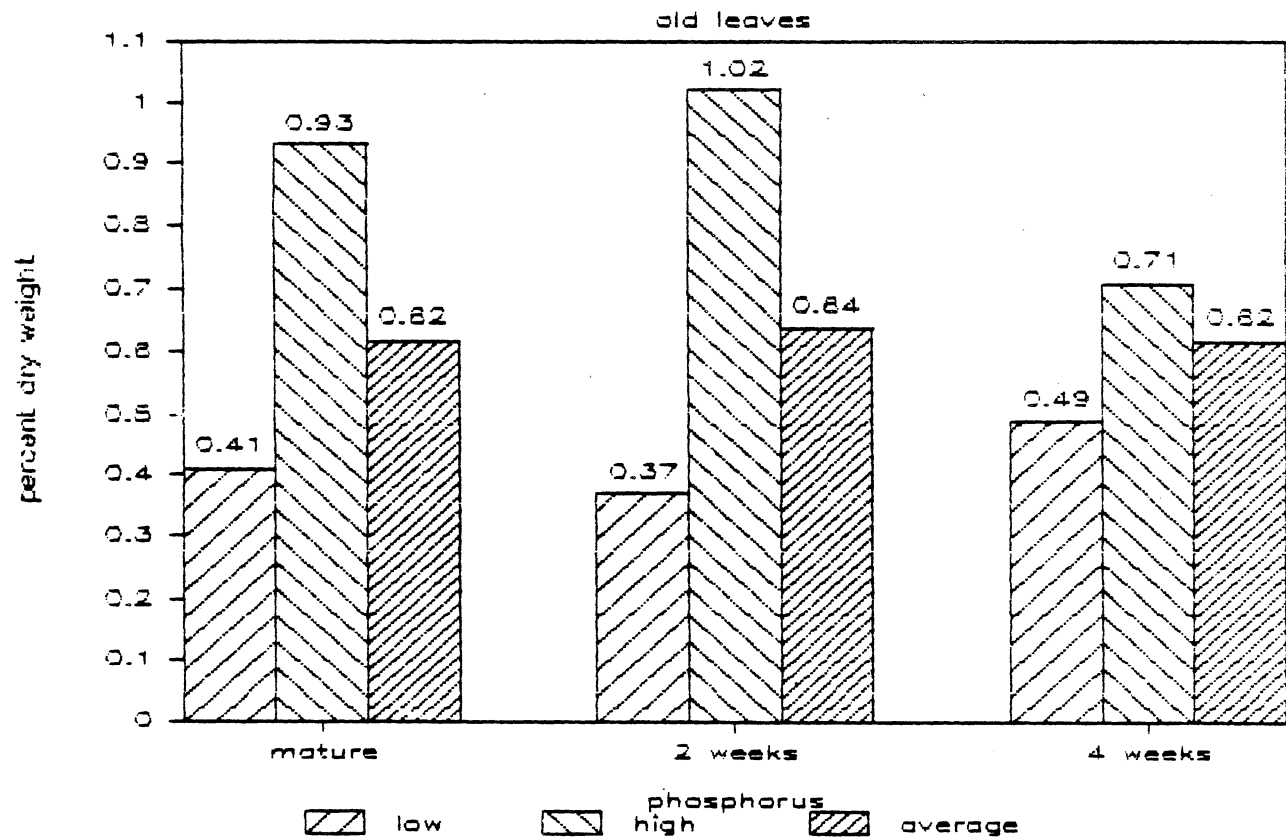
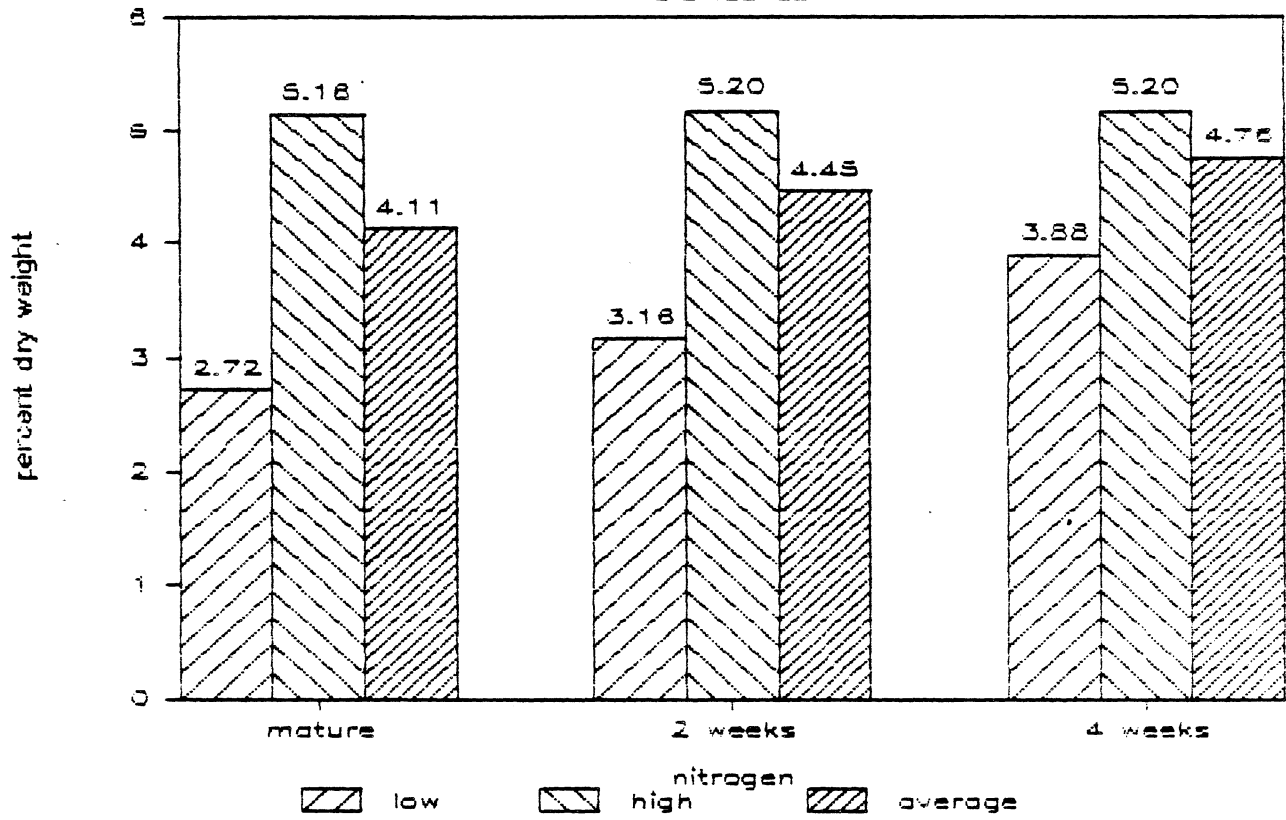


LEAF LETTUCE



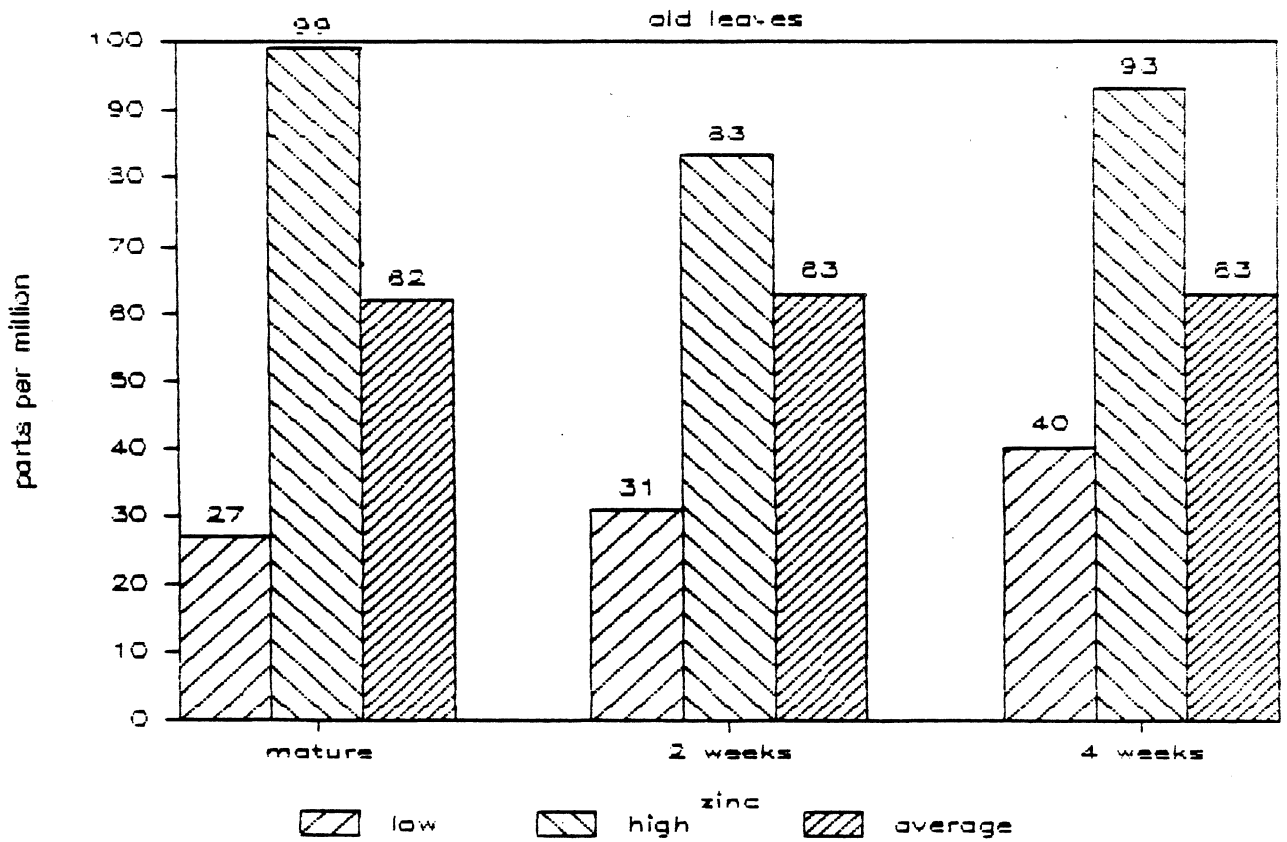
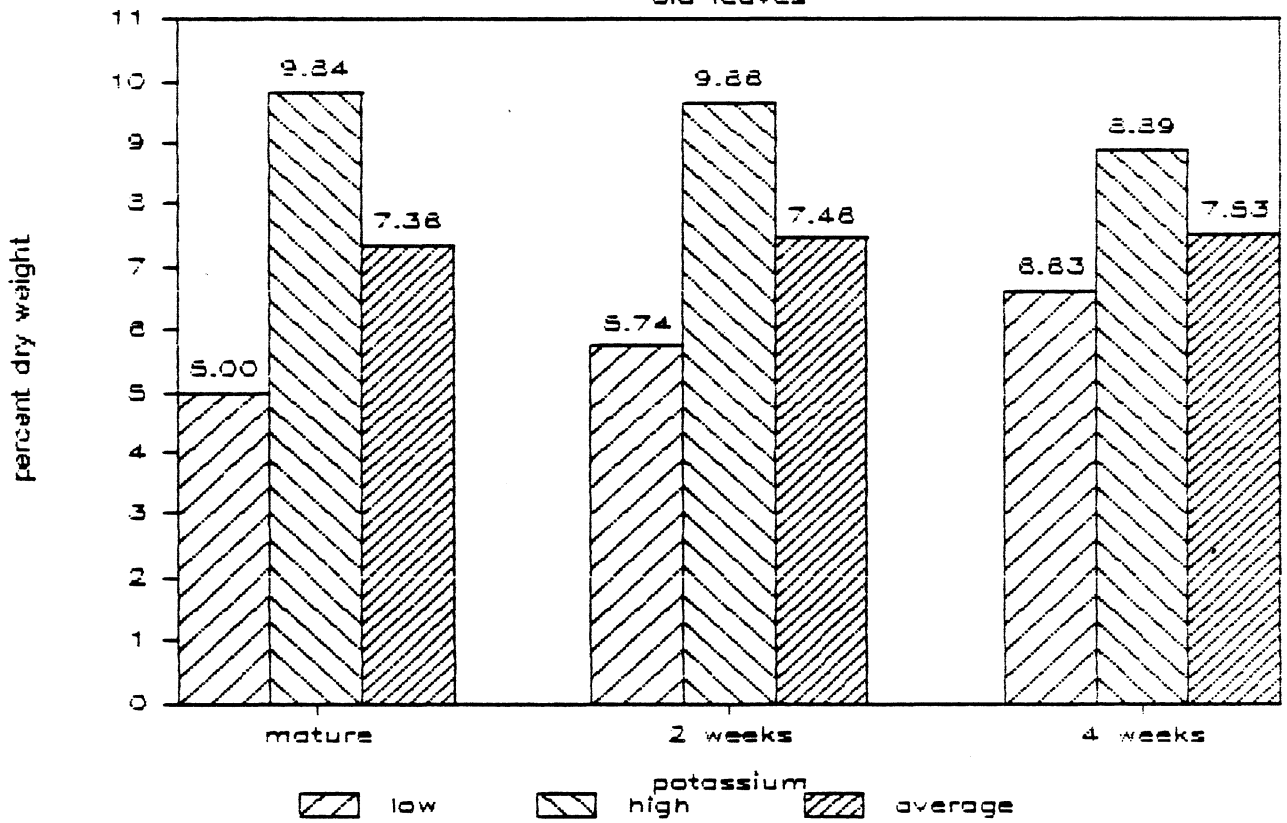
LEAF LETTUCE

old leaves



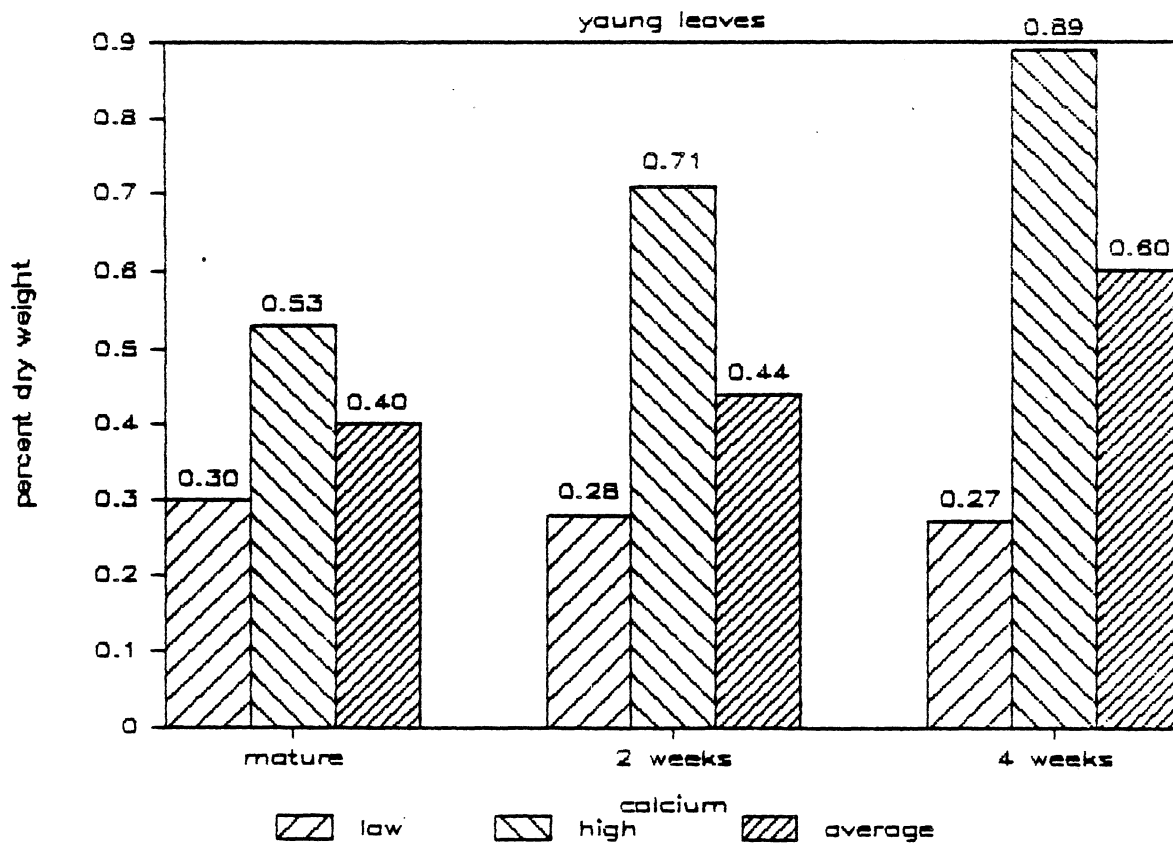
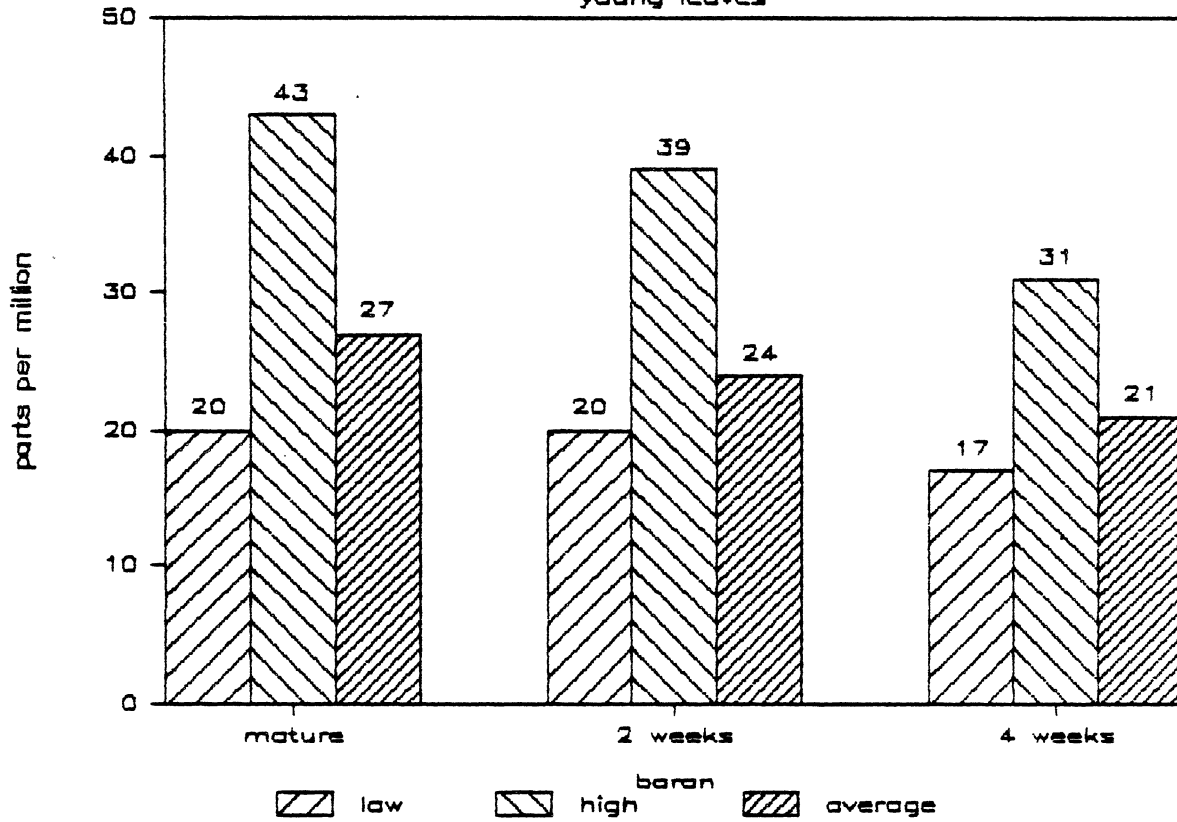
LEAF LETTUCE

old leaves

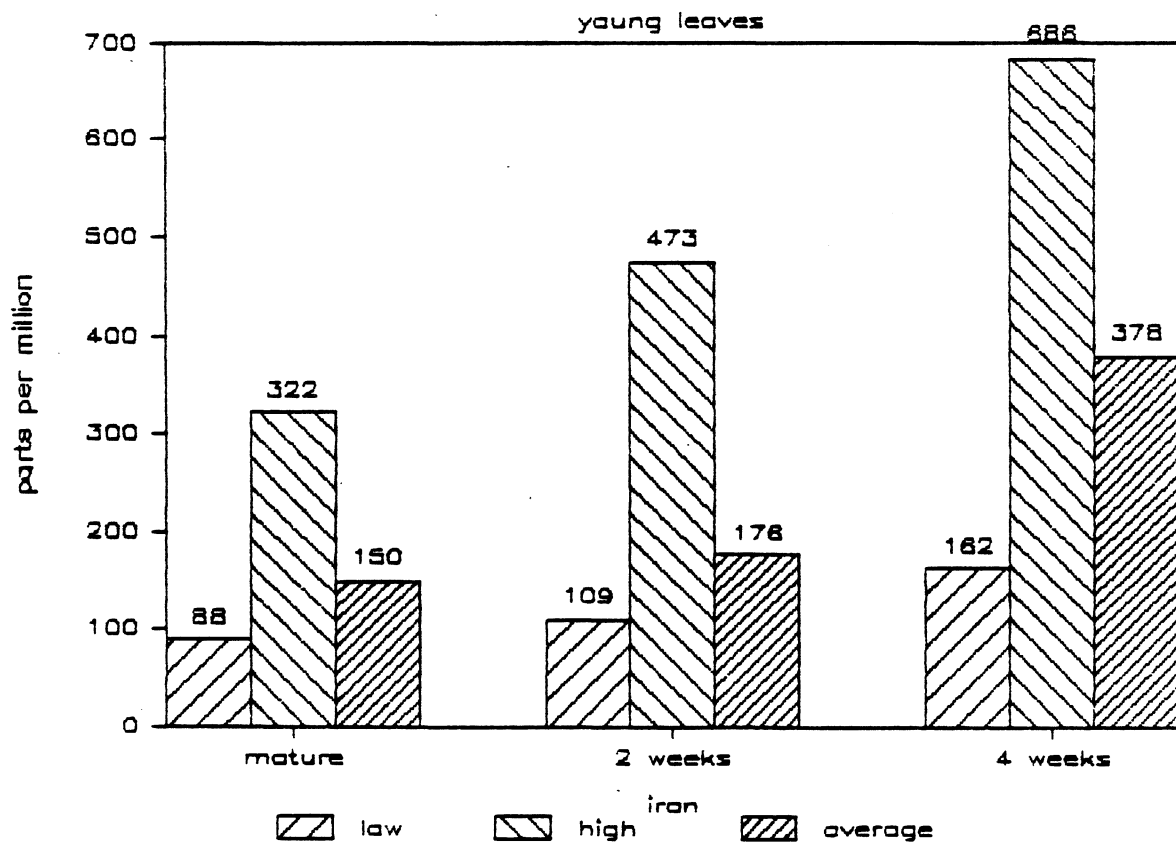
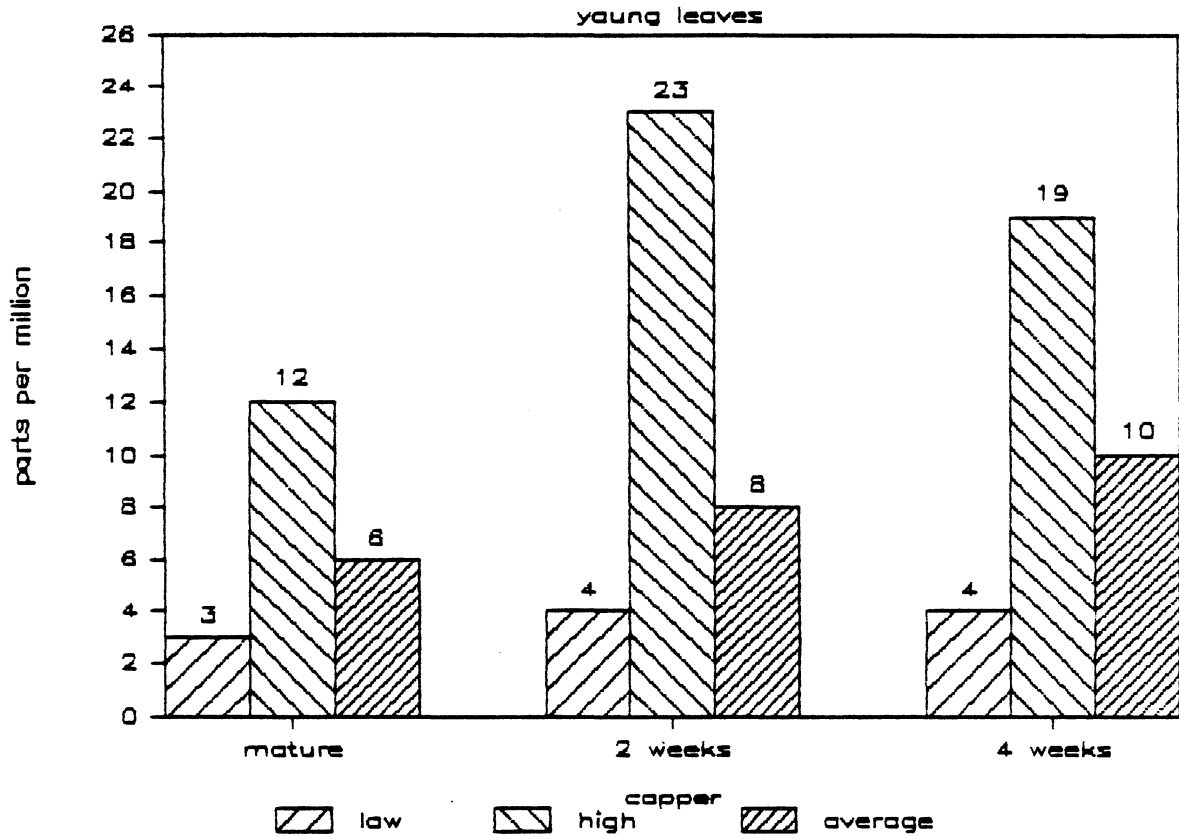


LEAF LETTUCE

young leaves

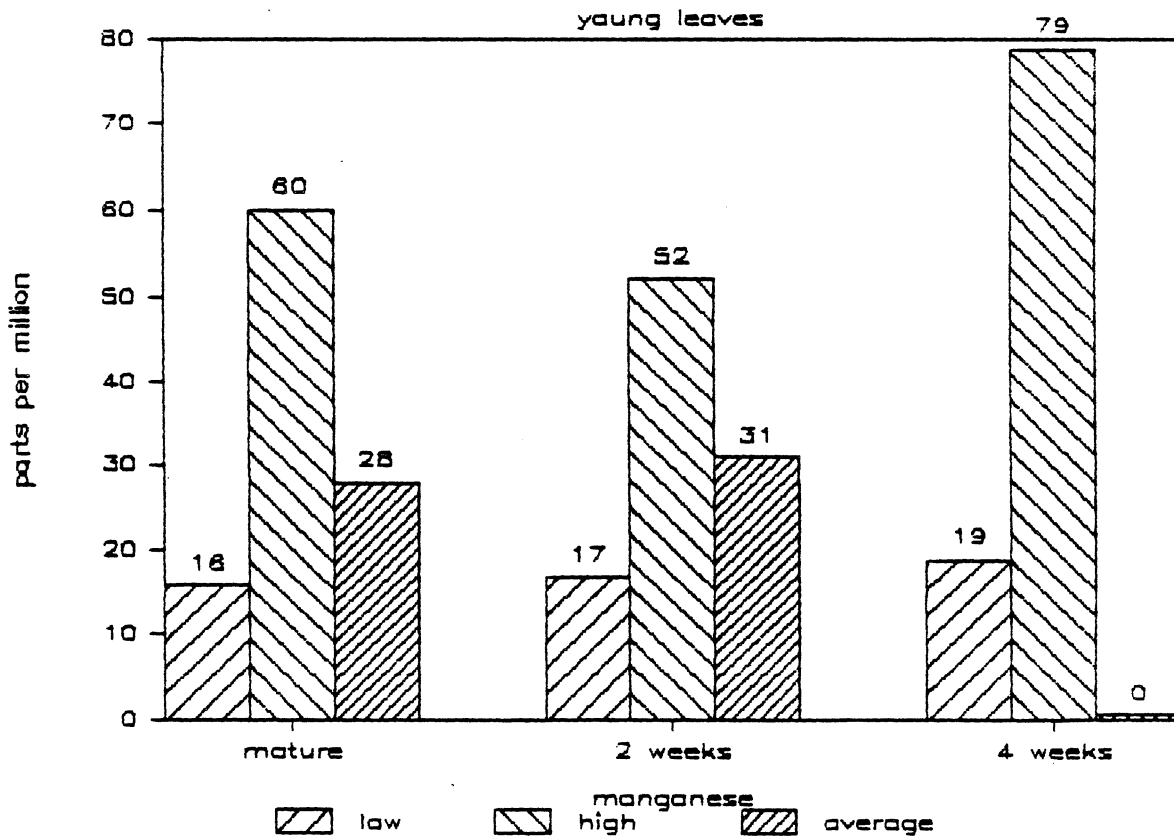
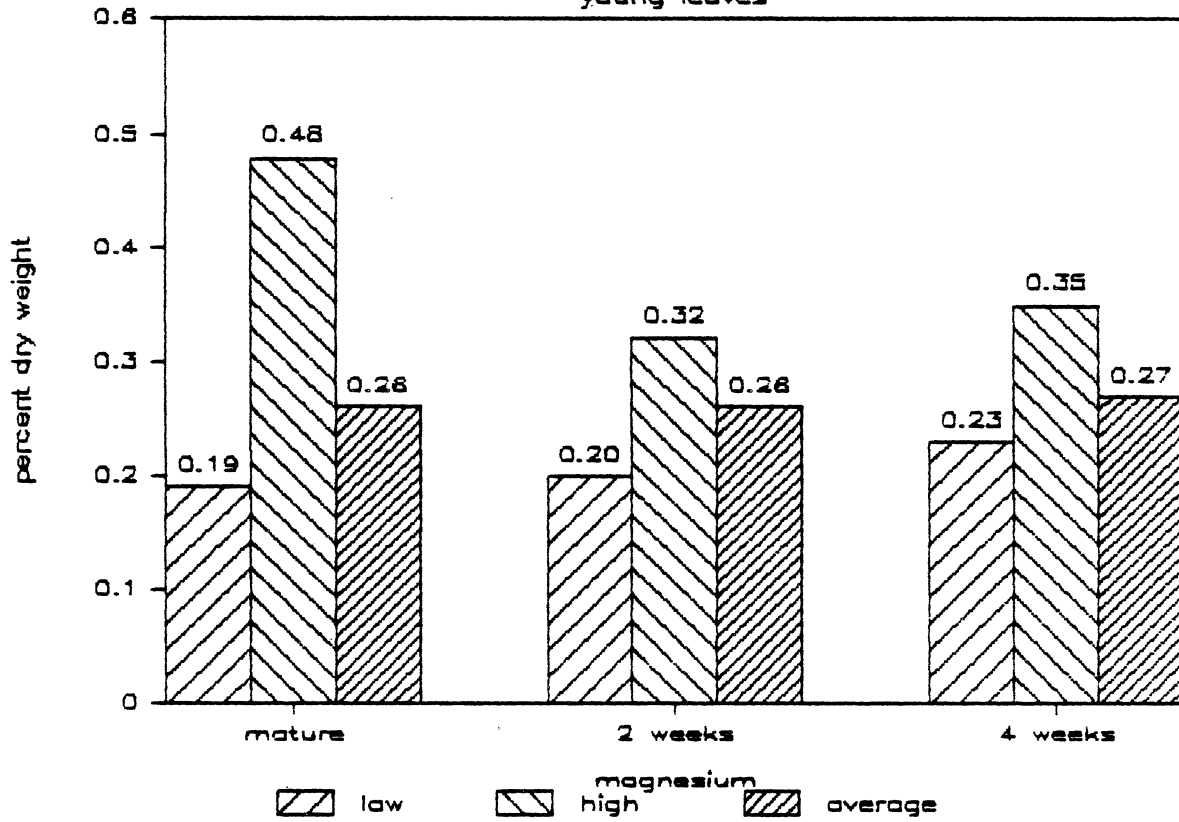


LEAF LETTUCE



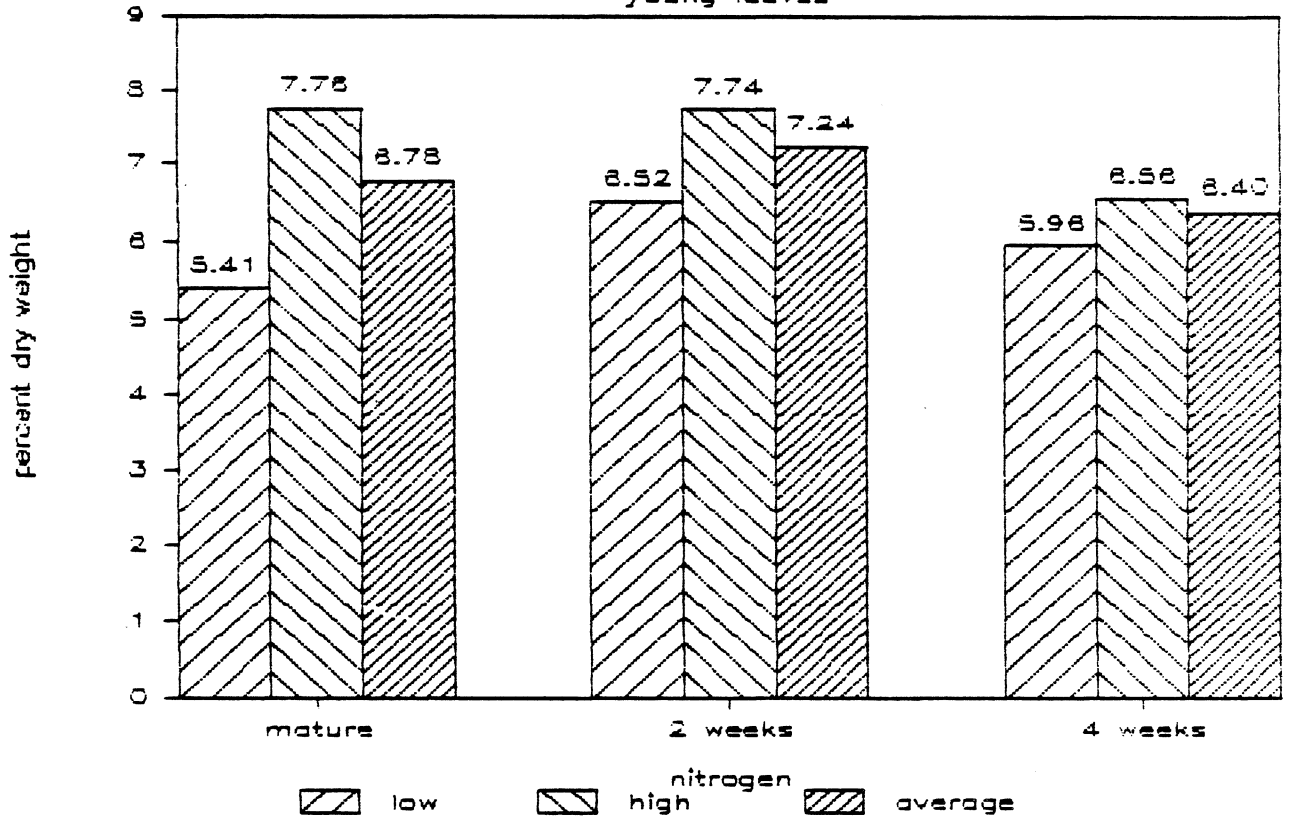
LEAF LETTUCE

young leaves

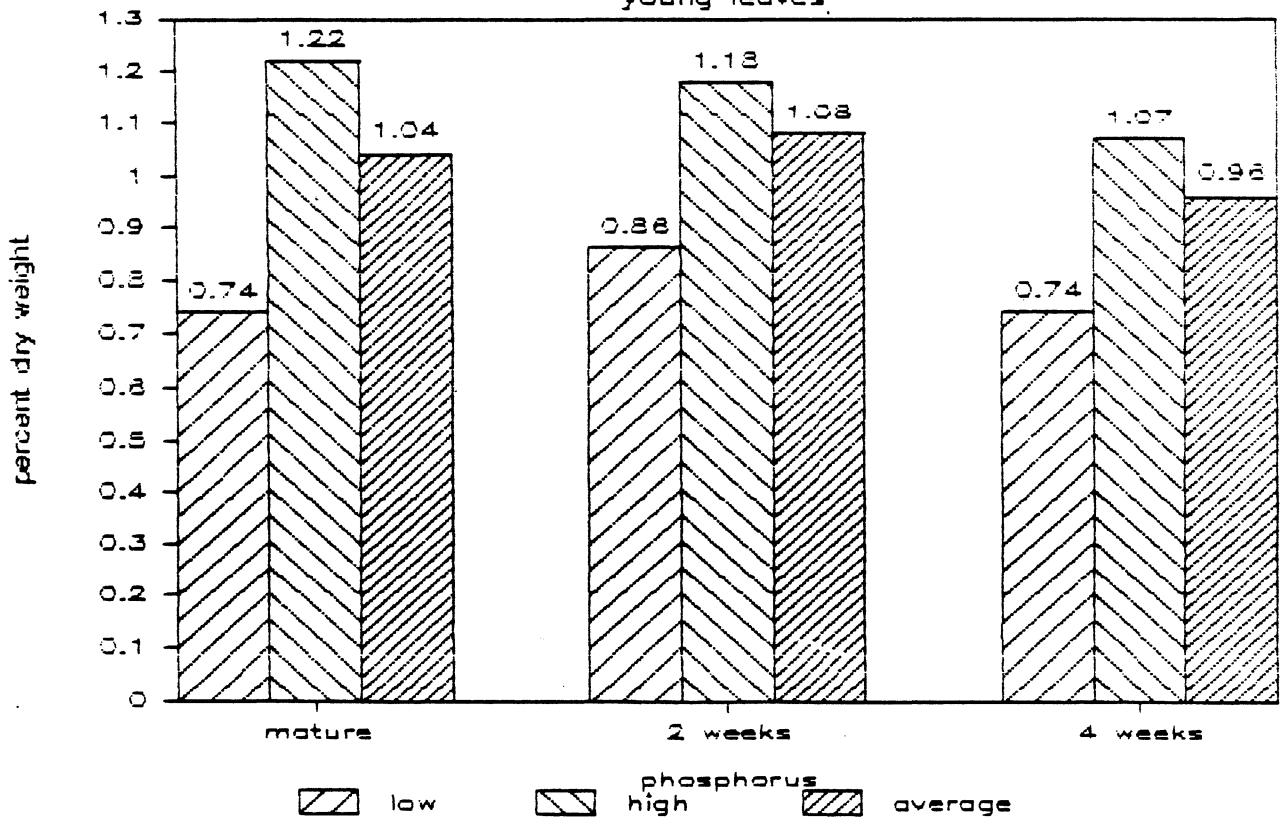


LEAF LETTUCE

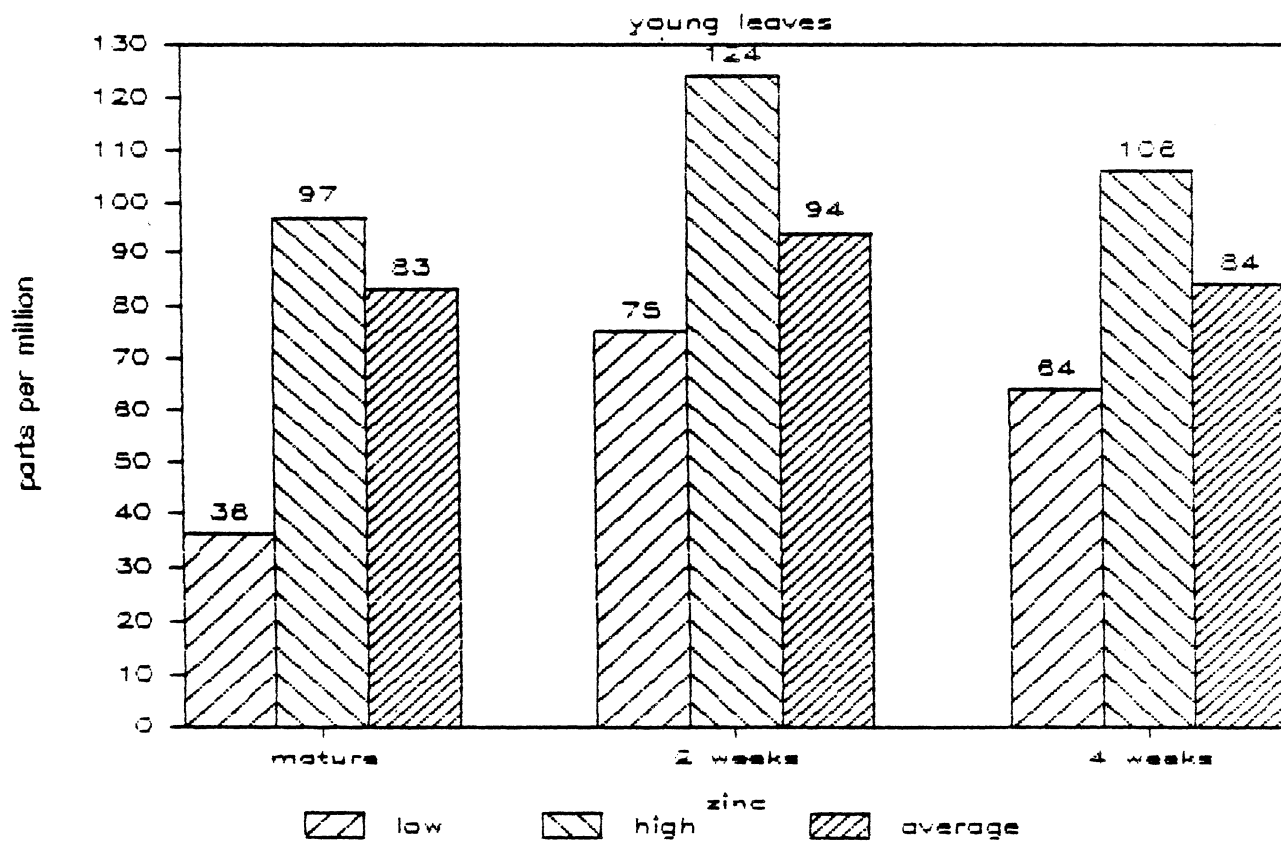
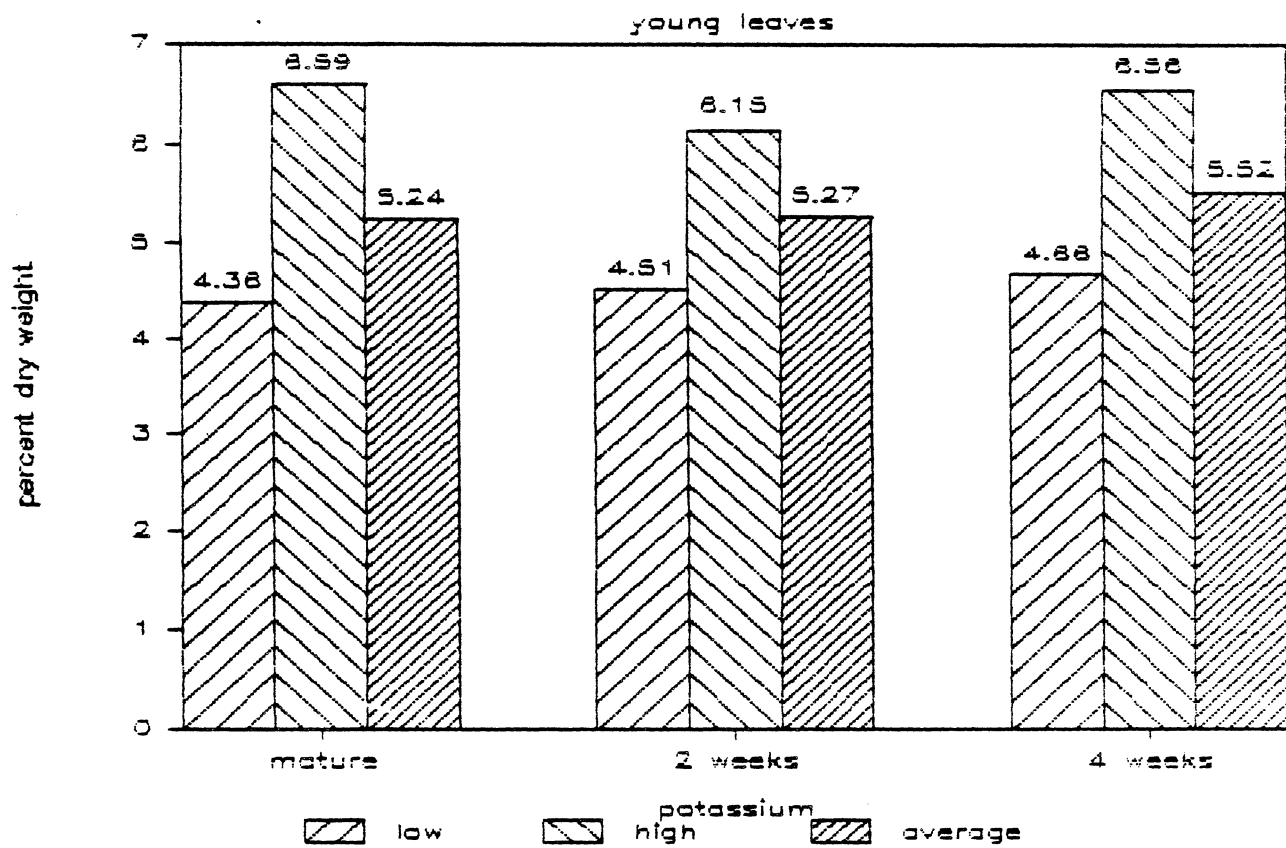
young leaves



young leaves

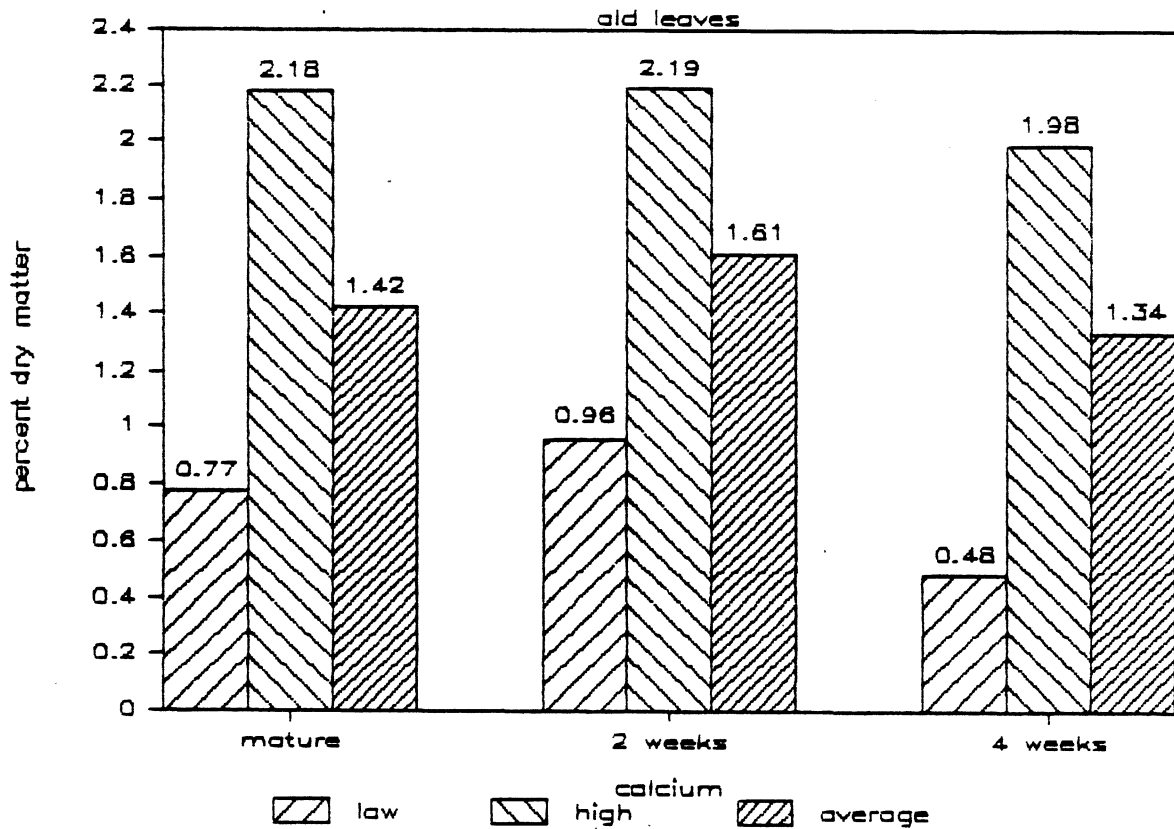
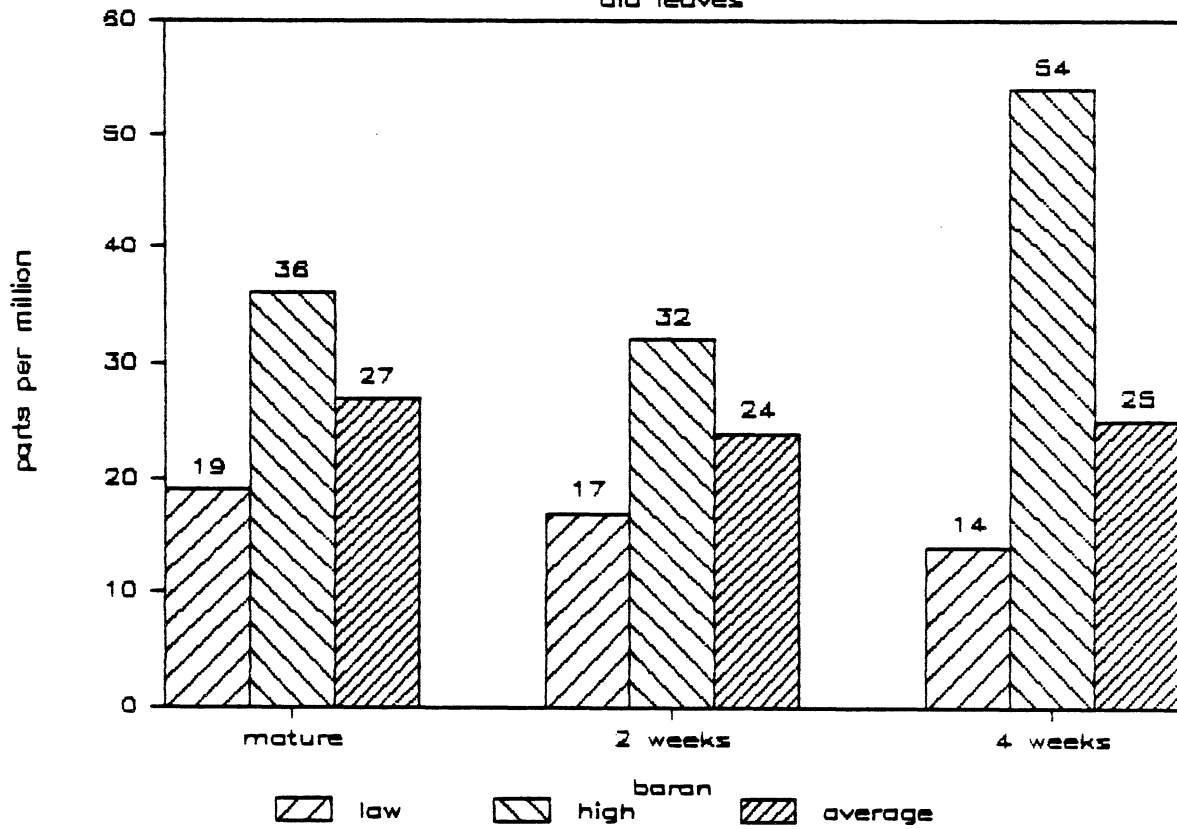


LEAF LETTUCE



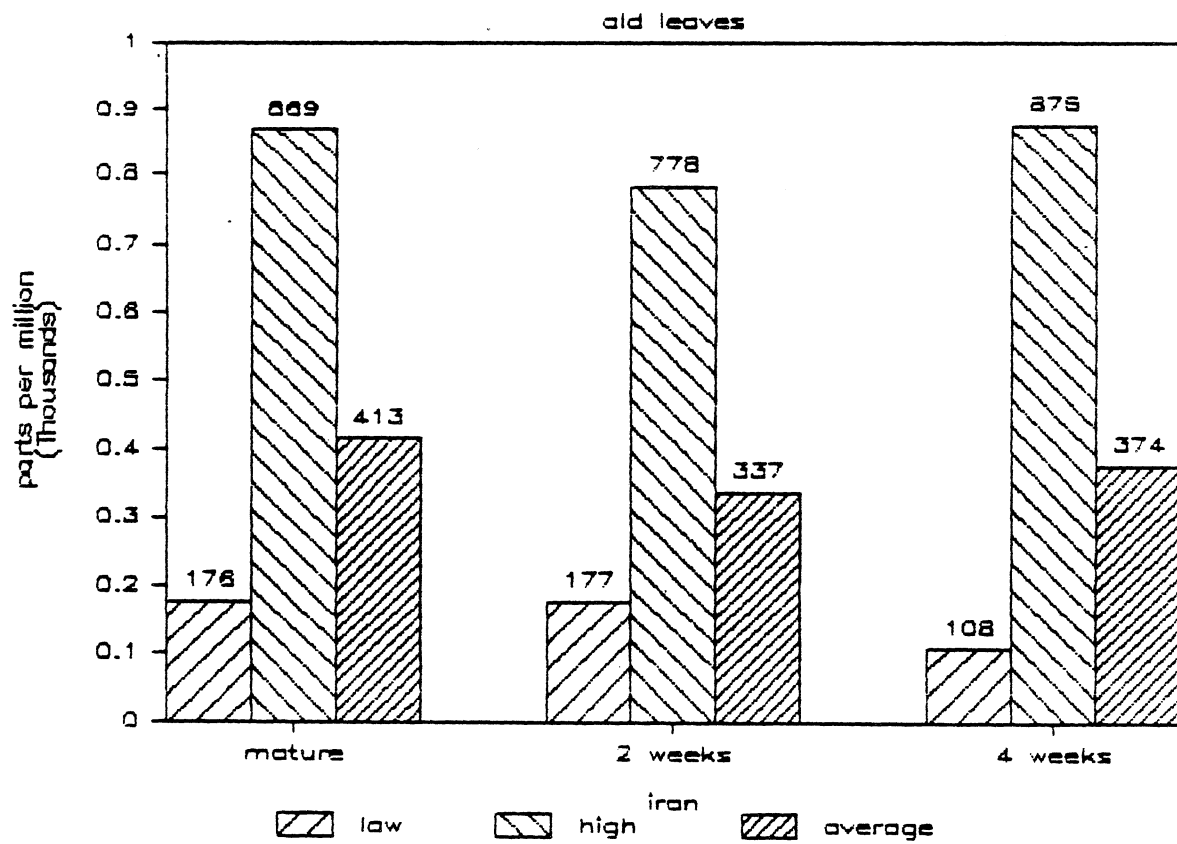
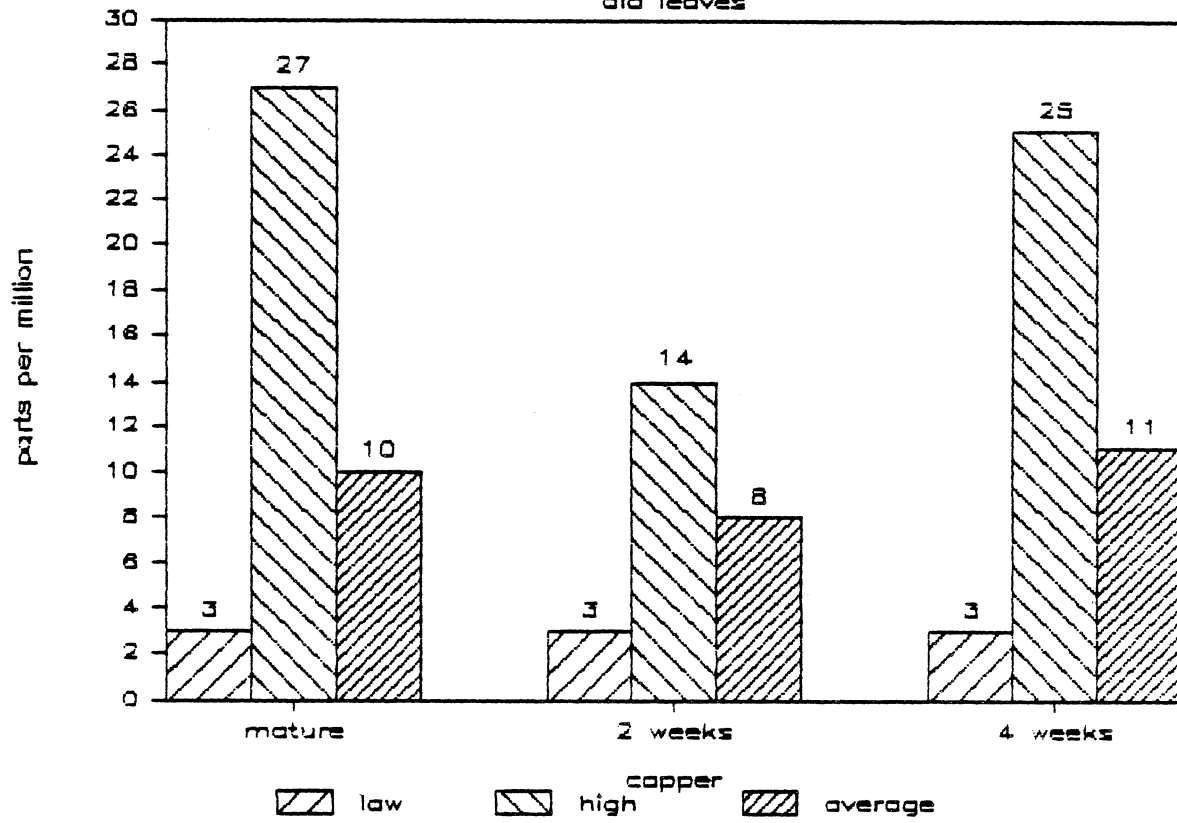
BOSTON

old leaves

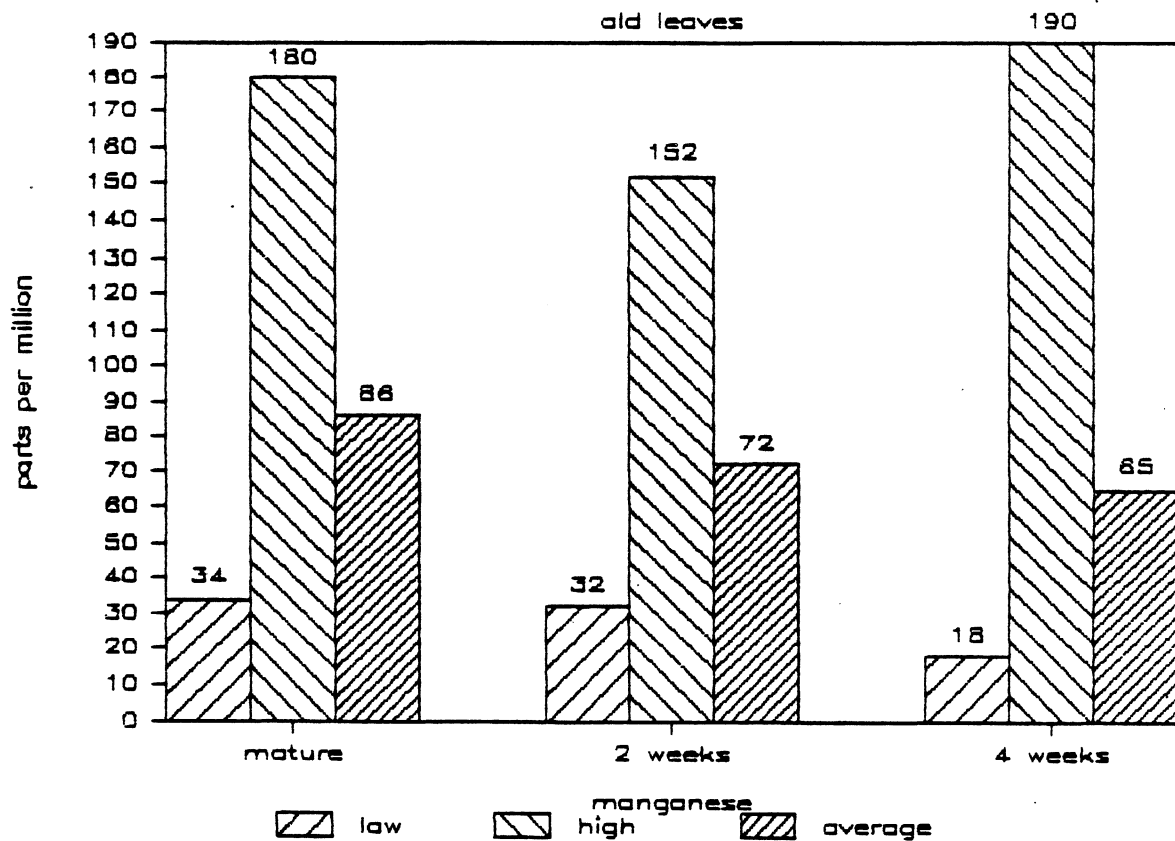
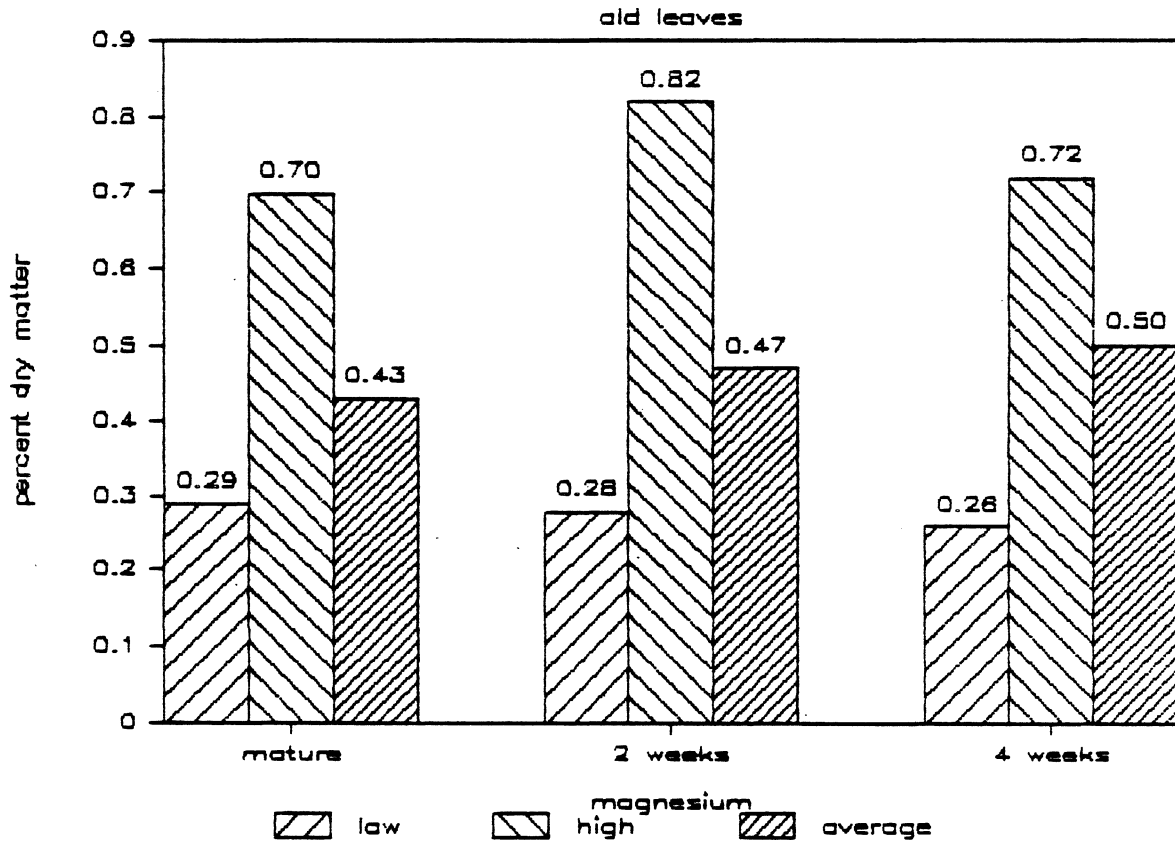


BOSTON

aid leaves

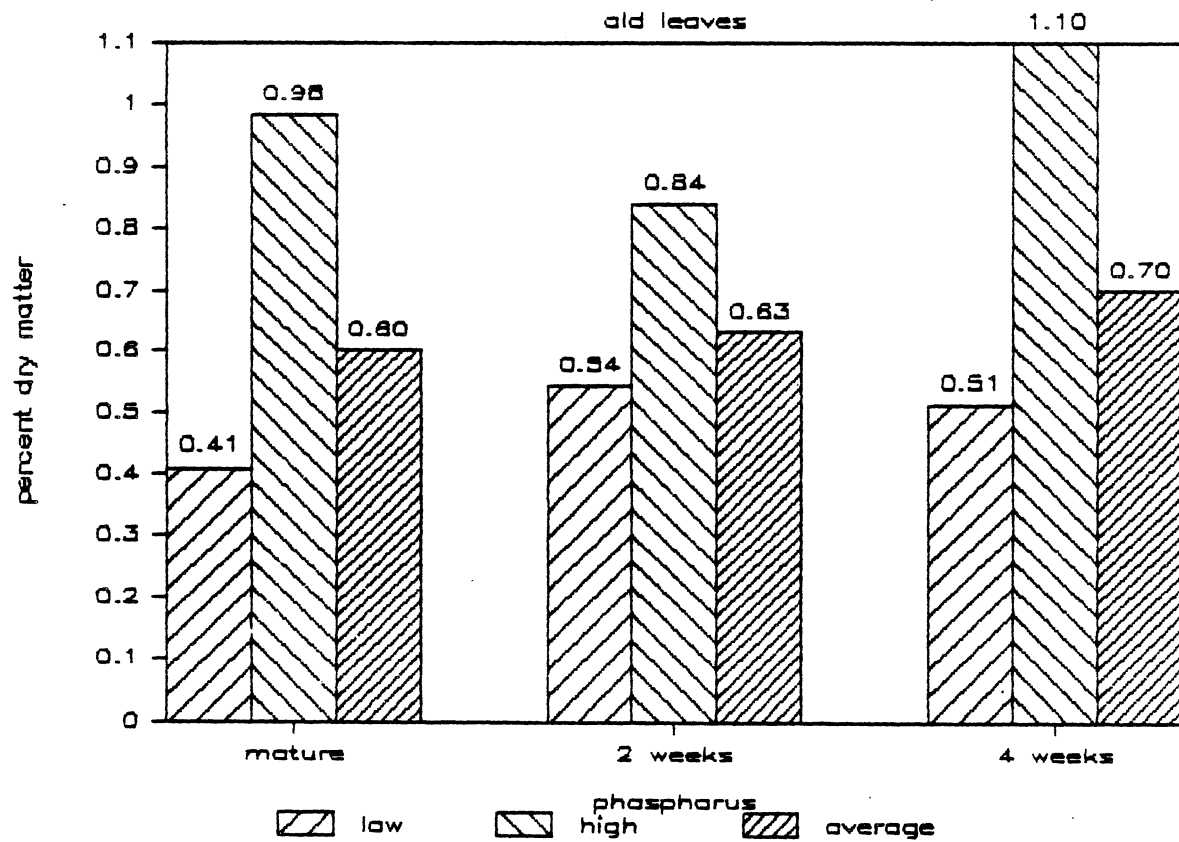
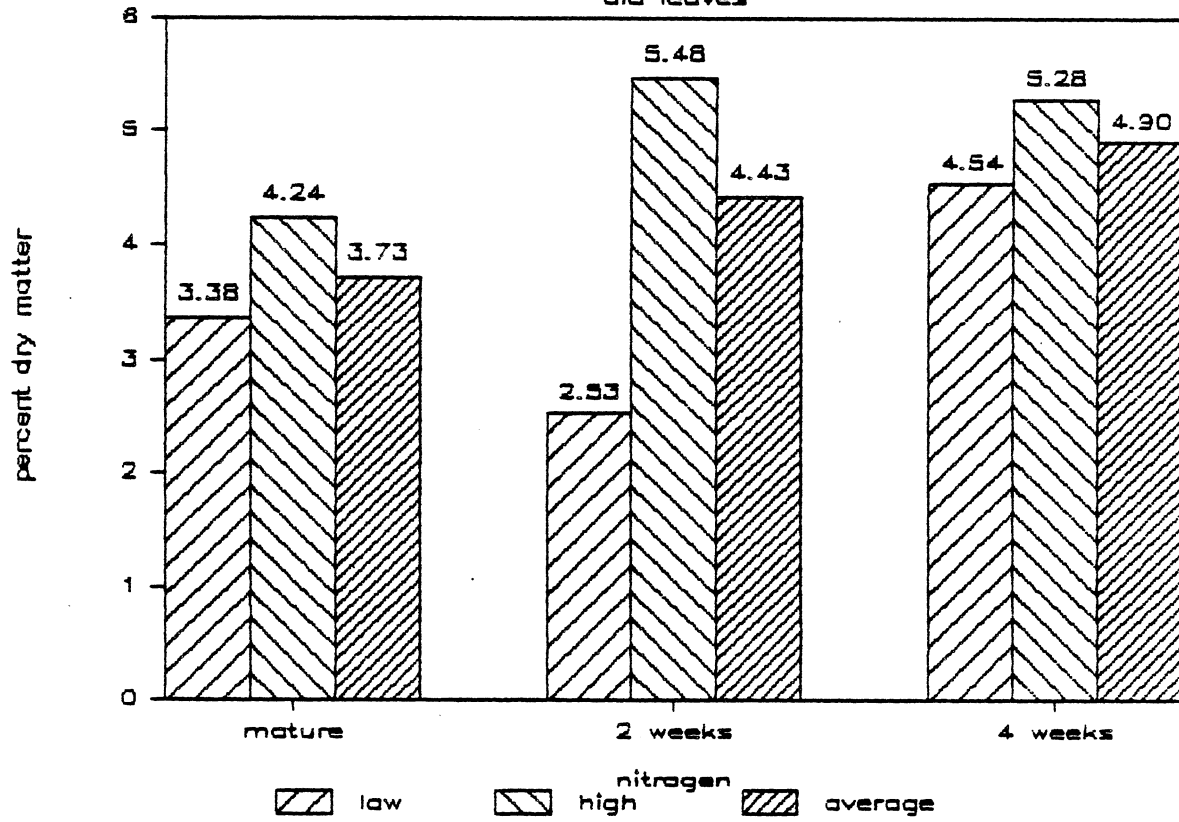


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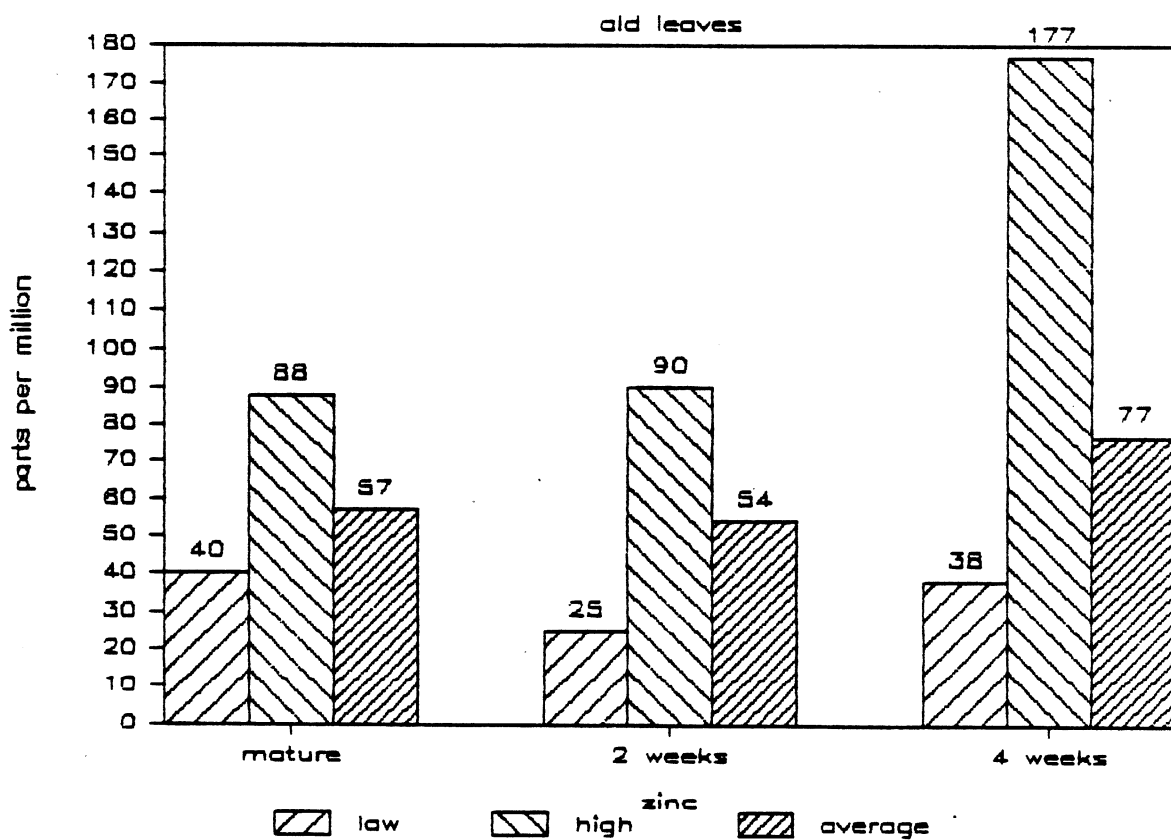
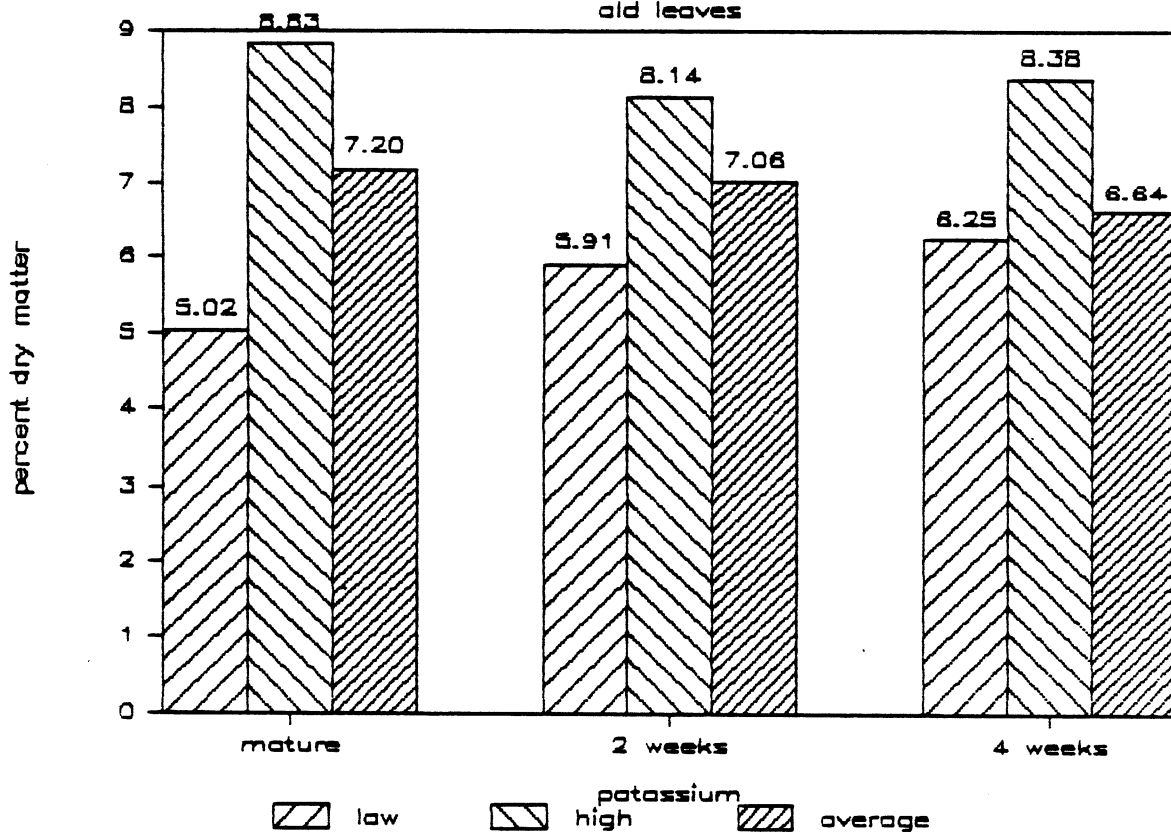


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aid leaves

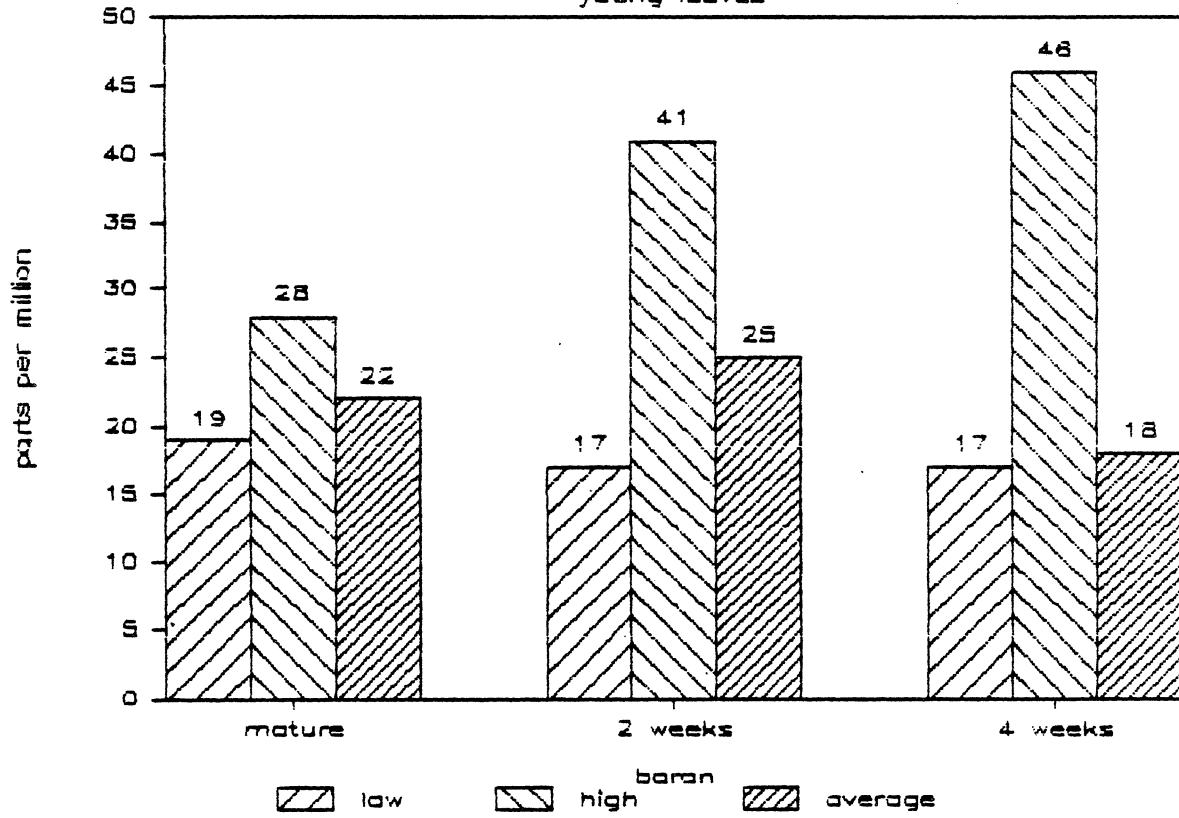


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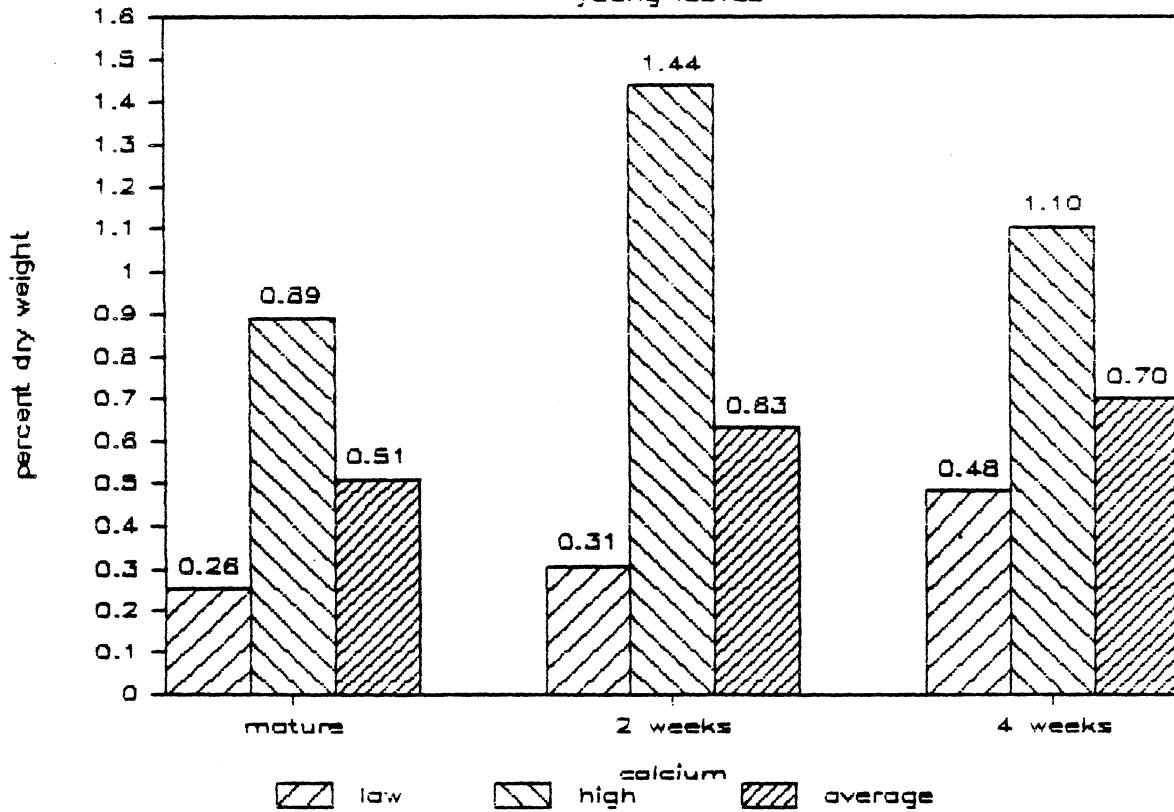


BOSTON

young leaves

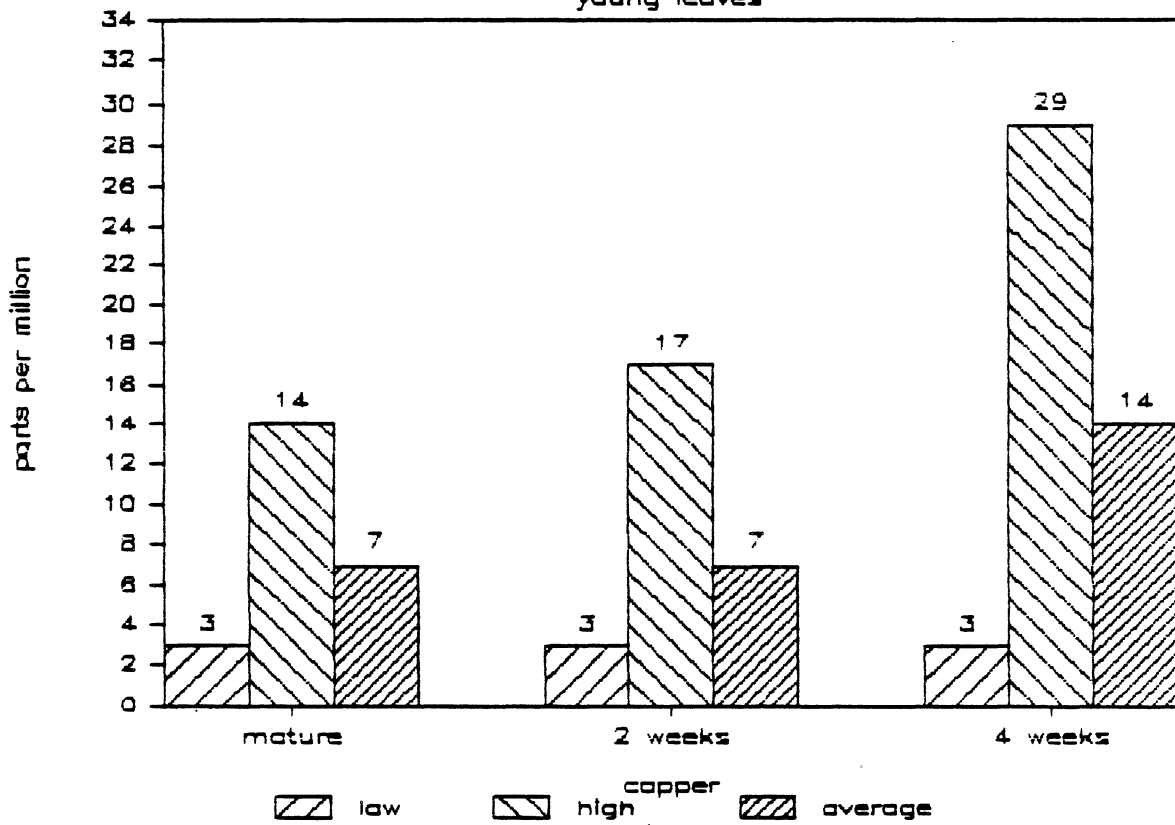


young leaves

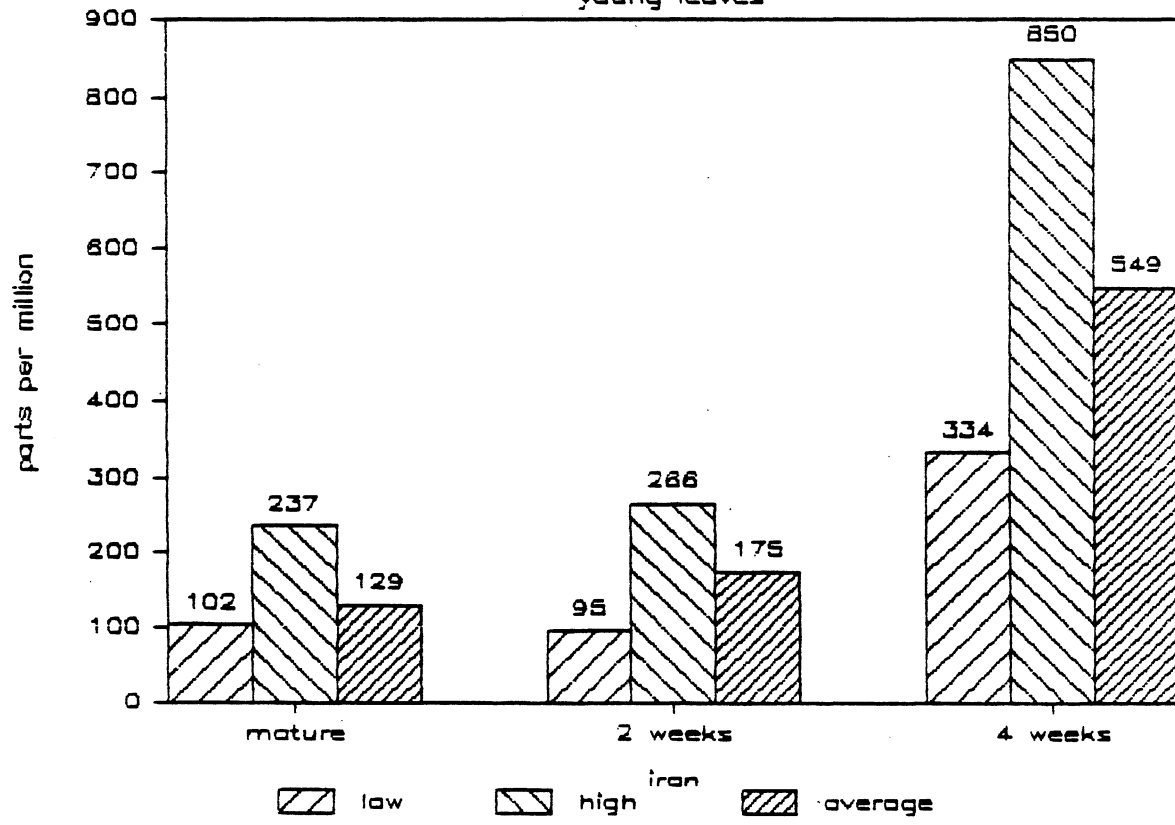


BOSTON

young leaves

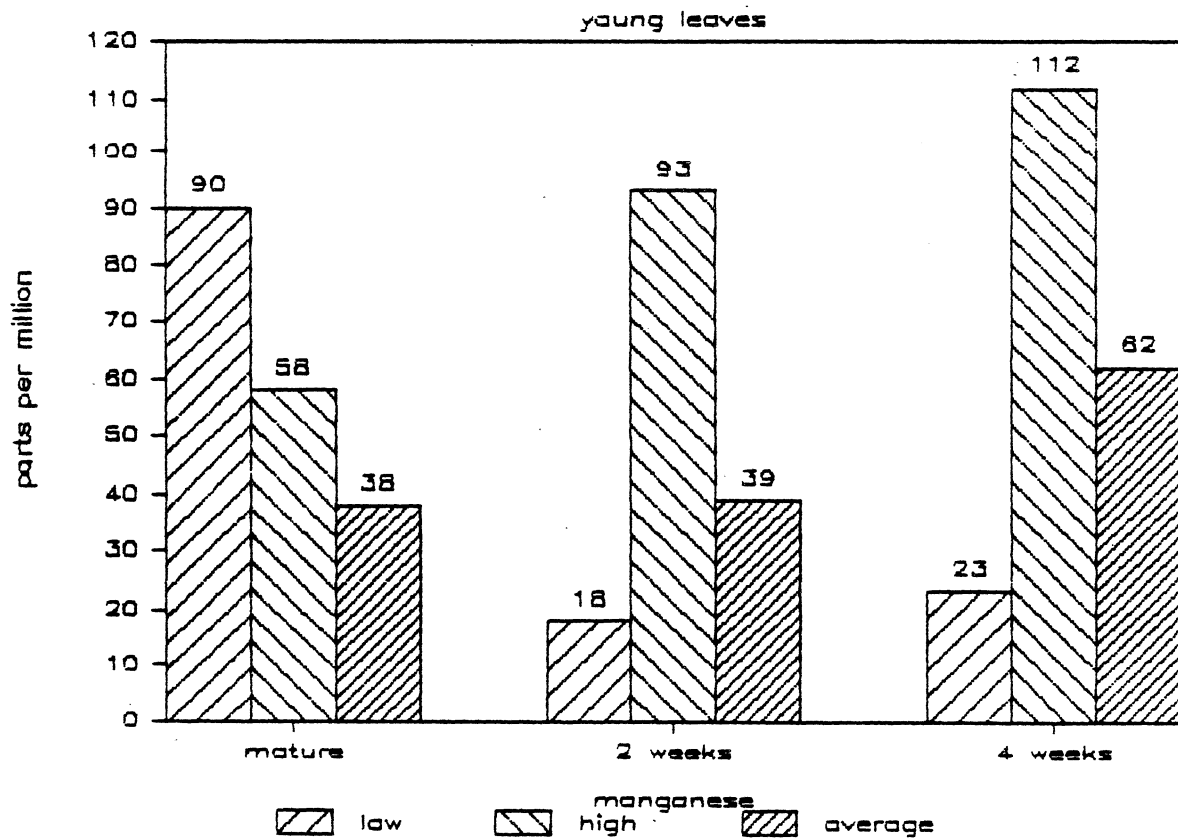
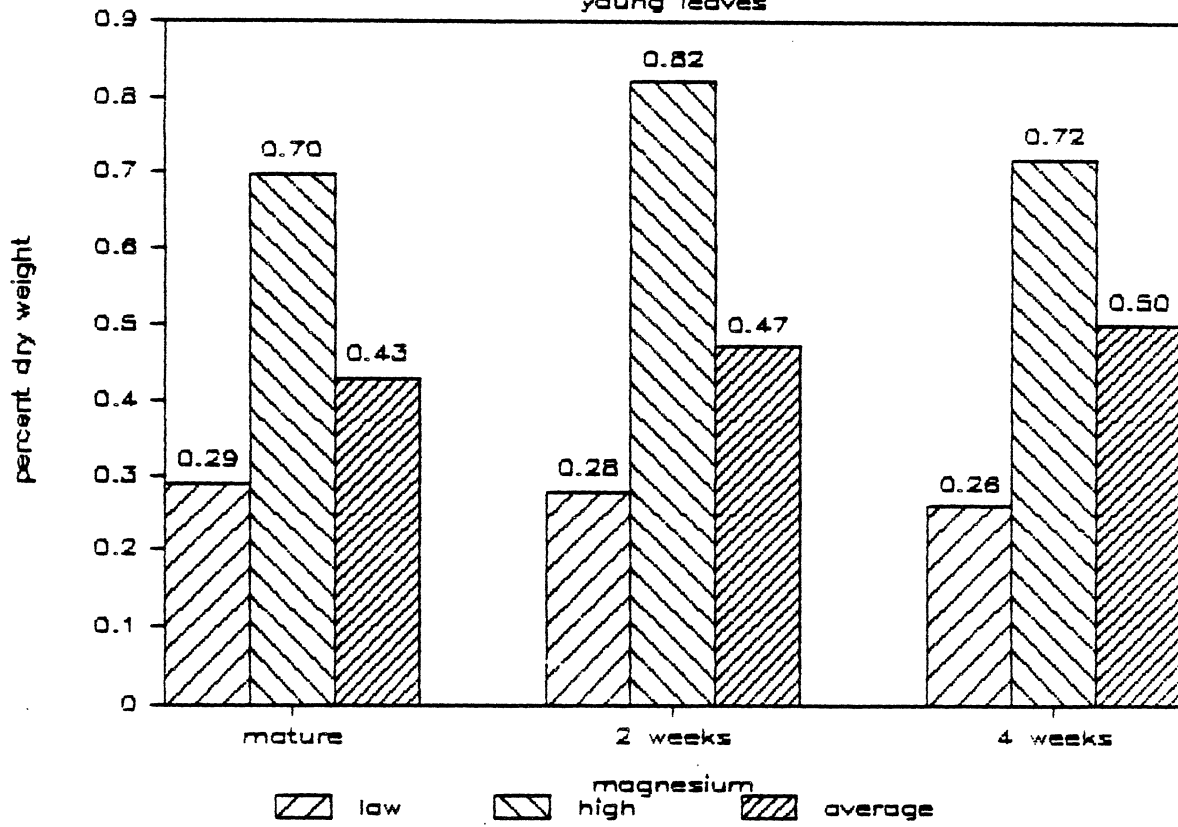


young leaves



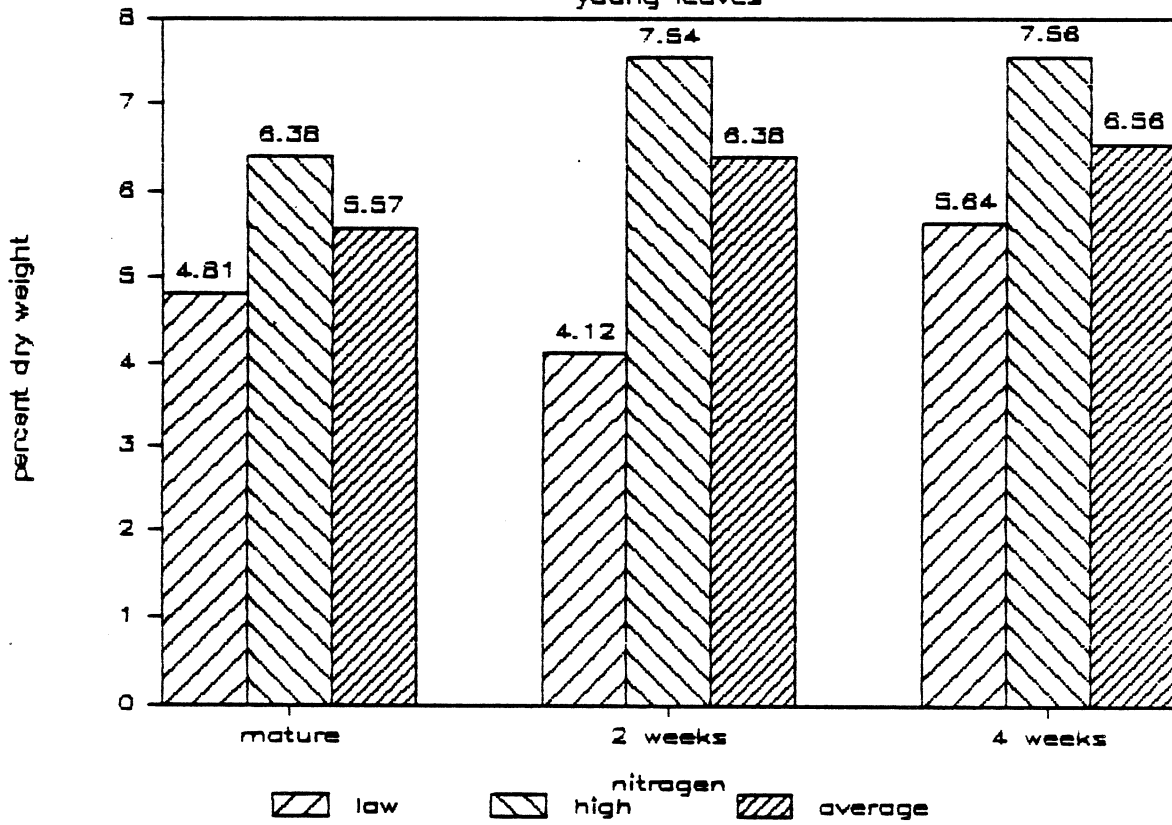
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young leaves

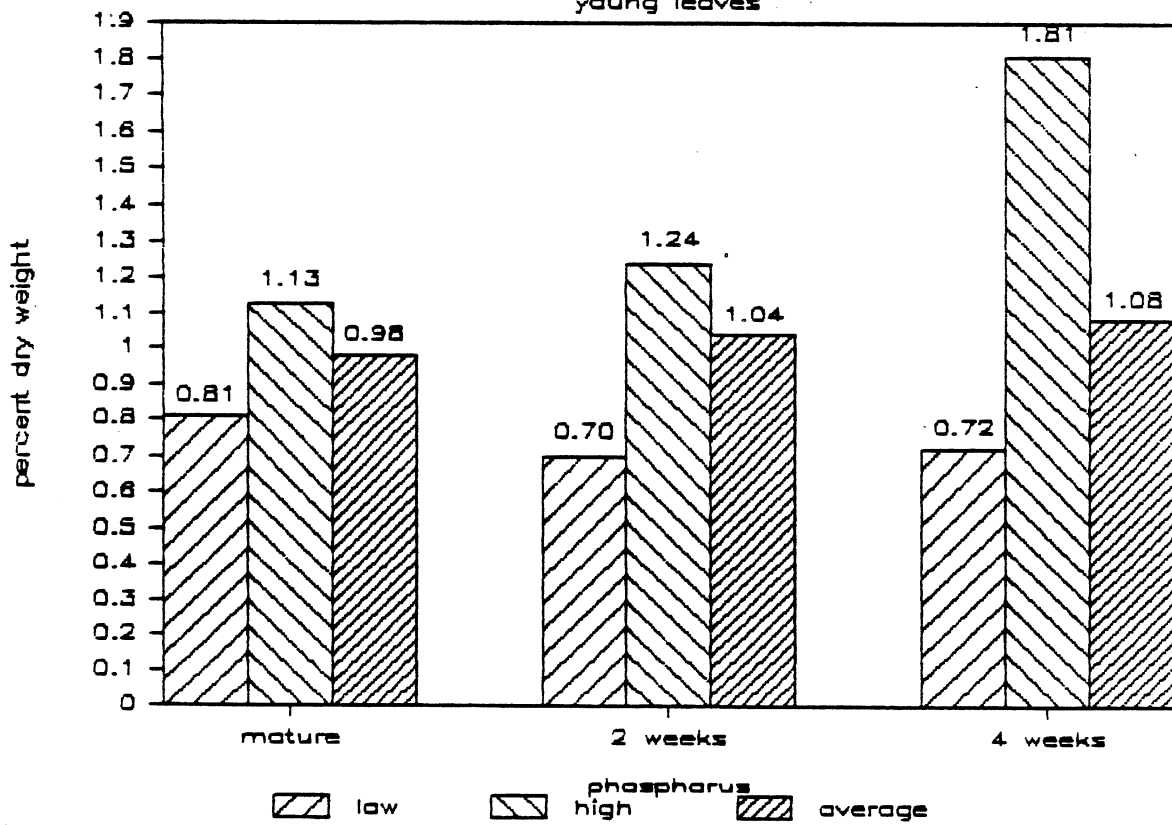


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young leaves

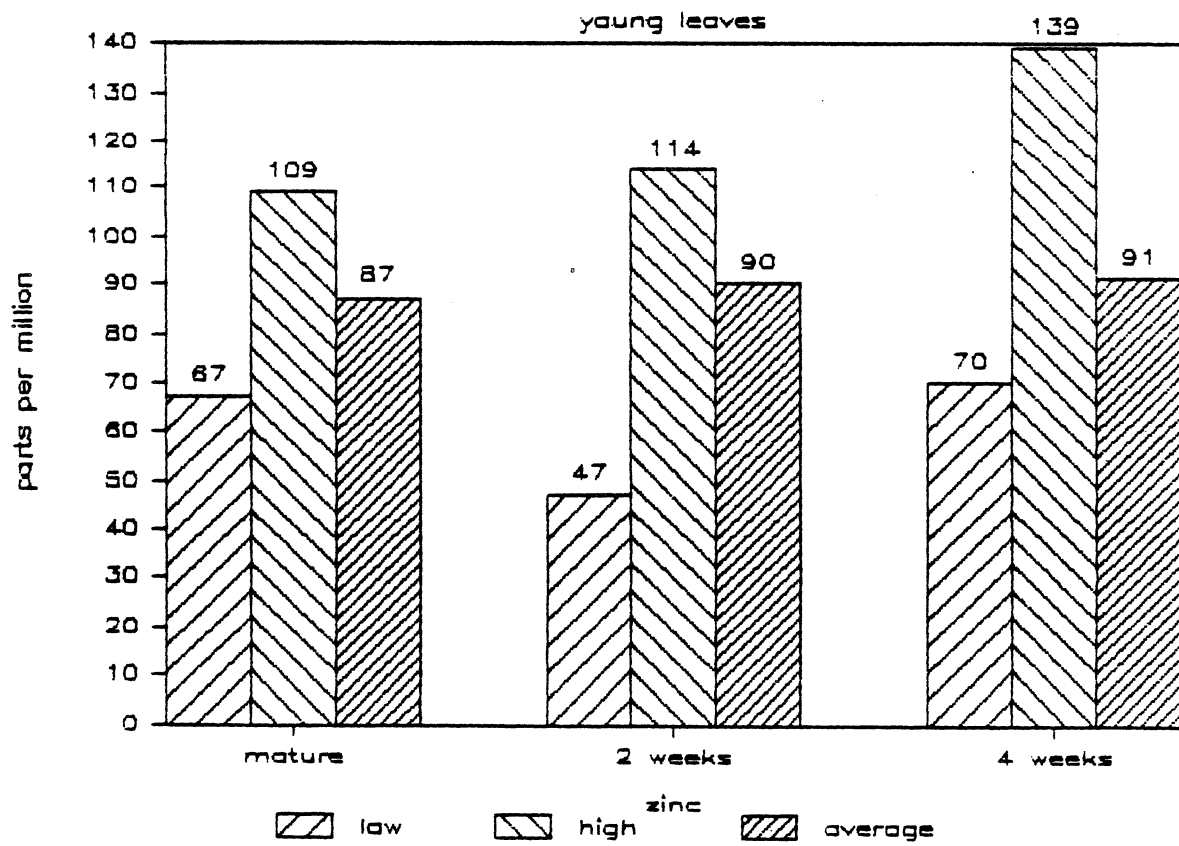
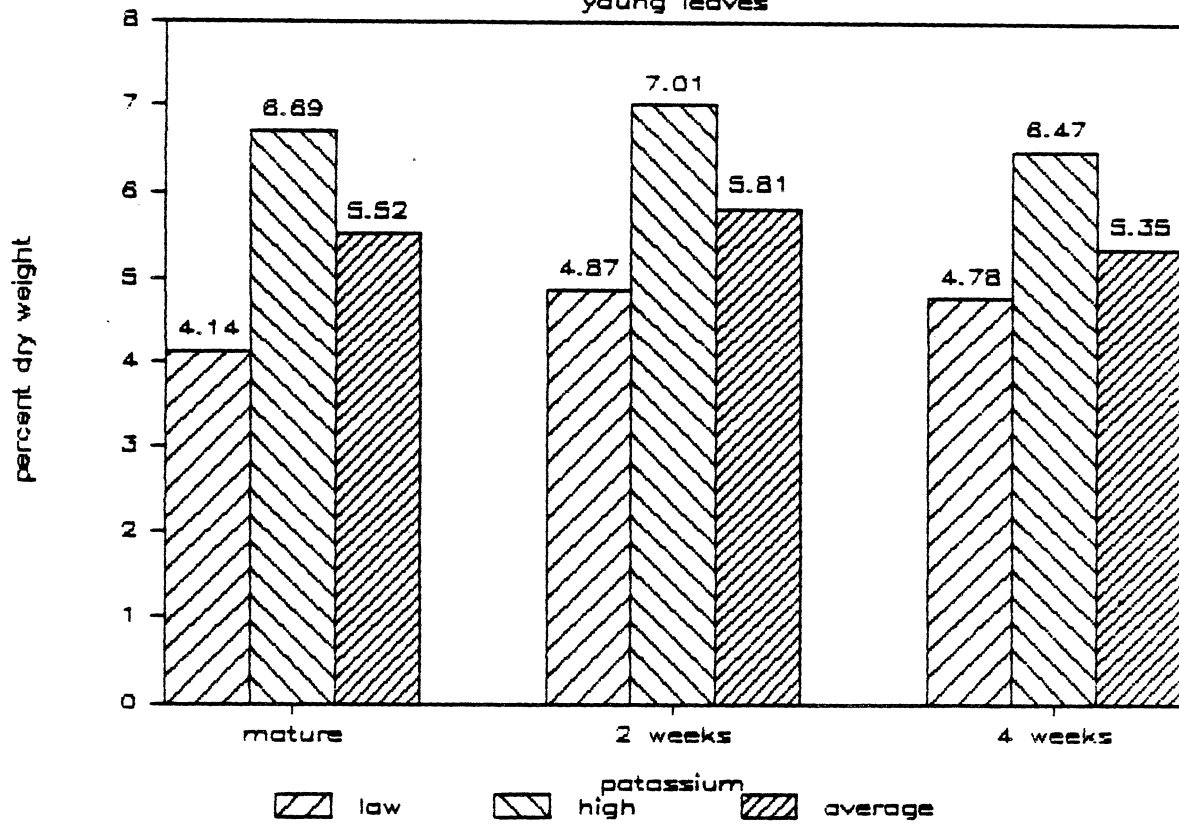


young leaves



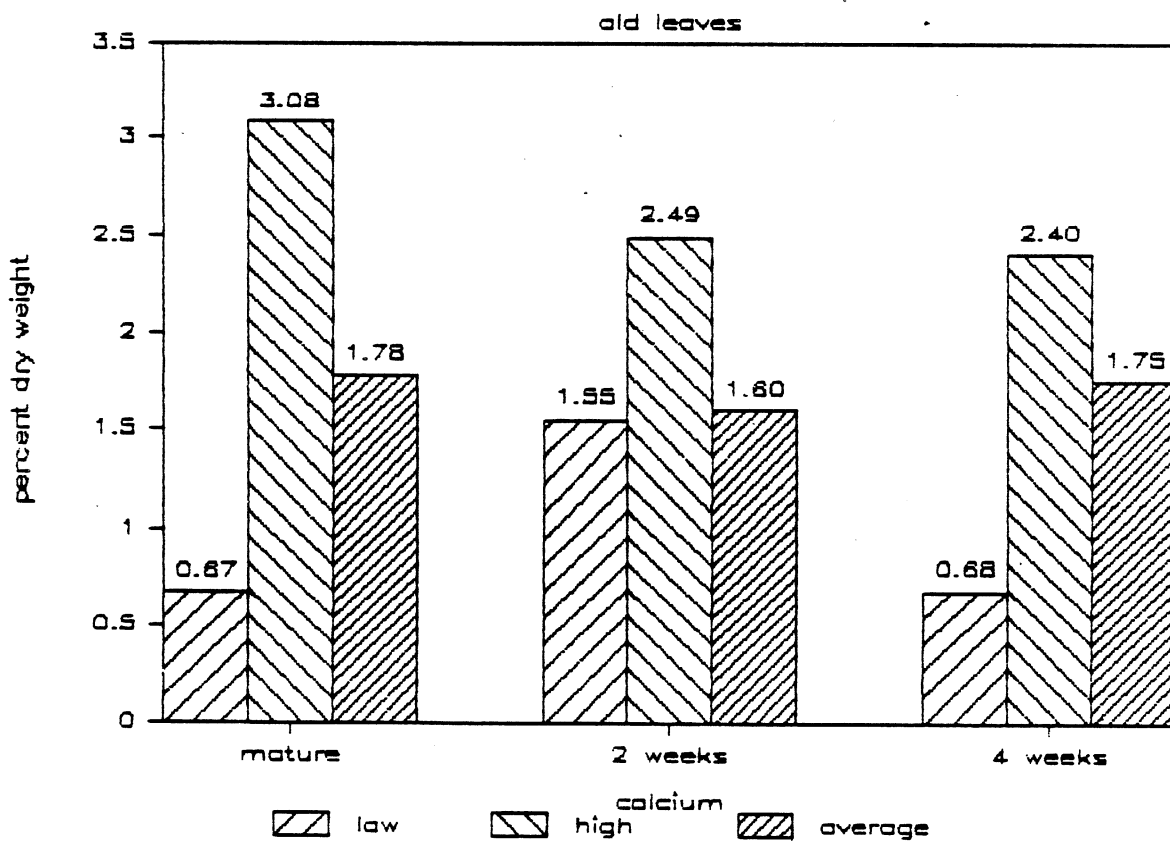
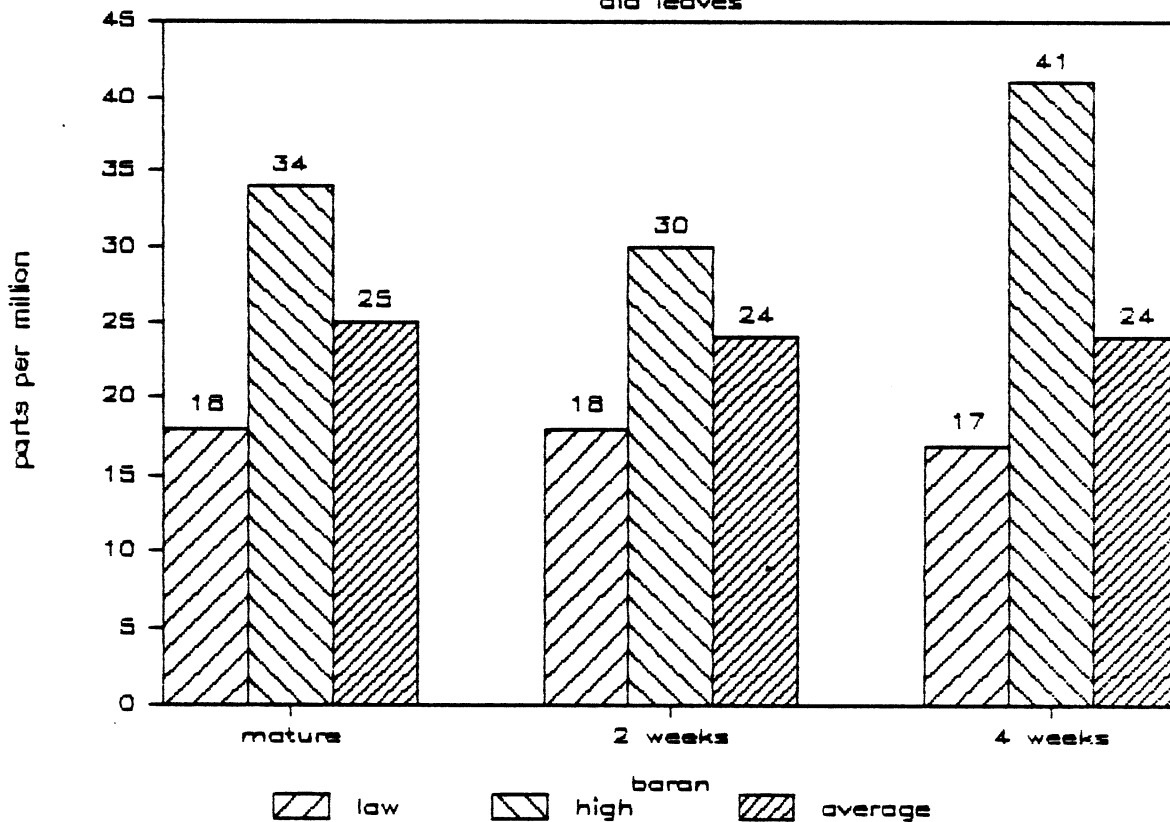
BOSTON

young leaves



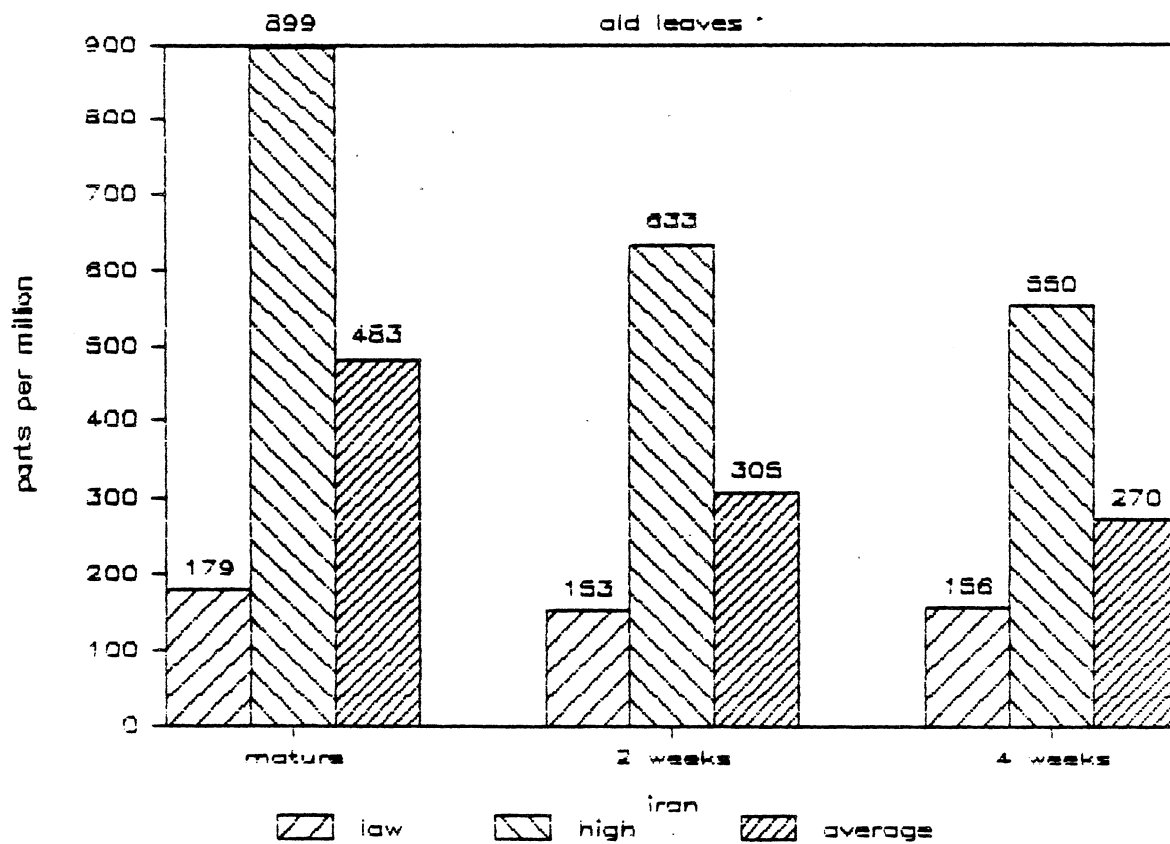
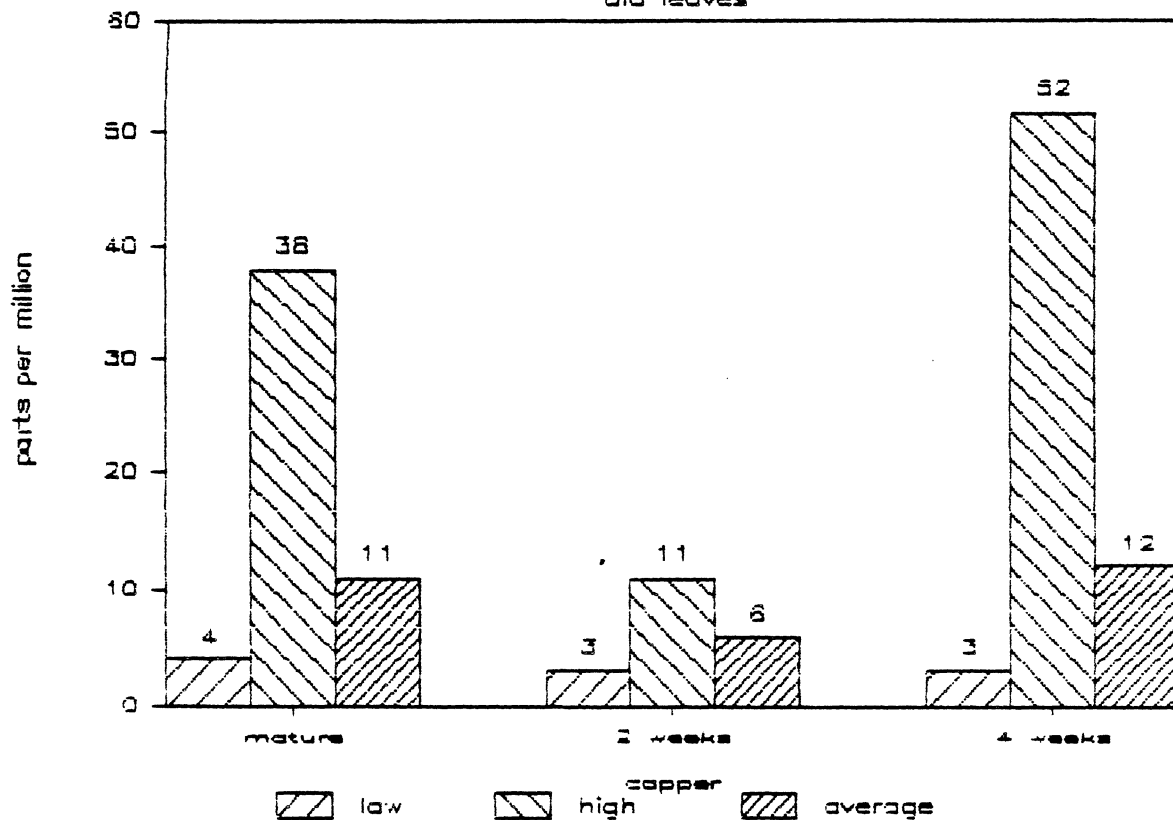
BIB LETTUCE

old leaves

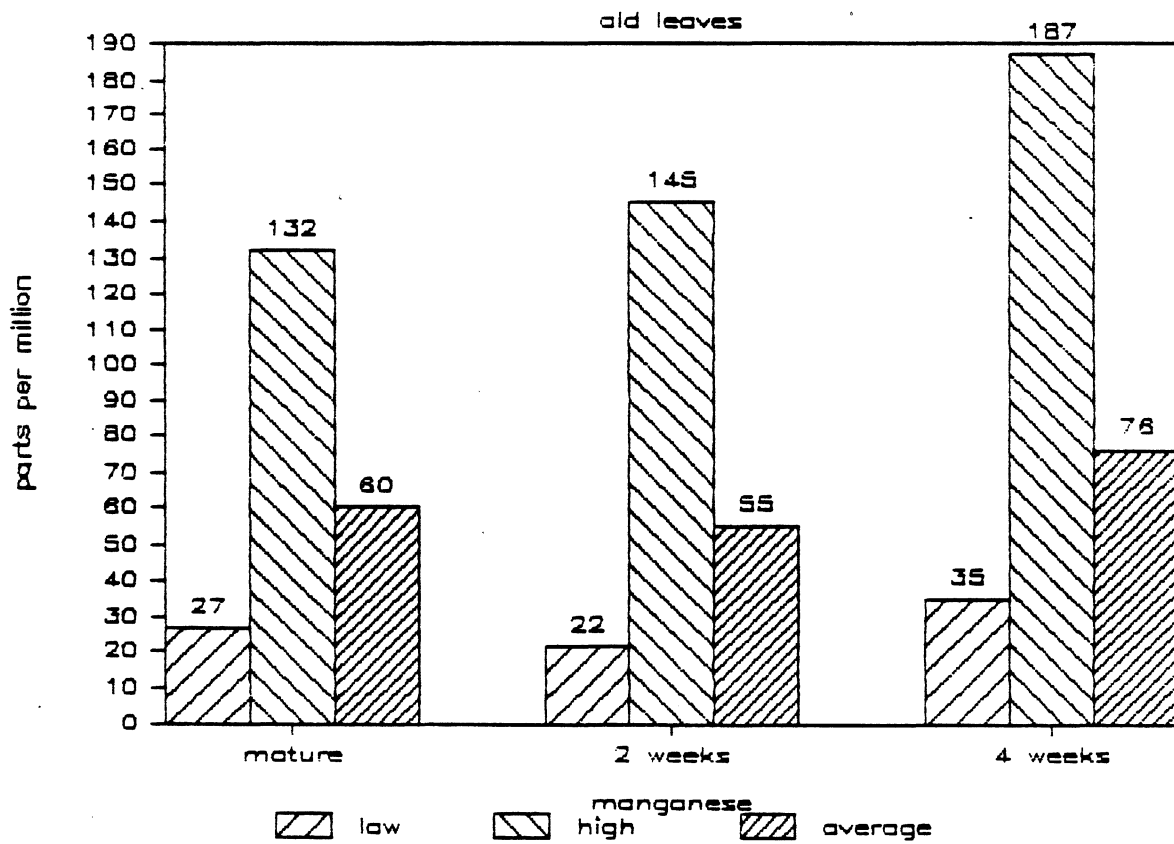
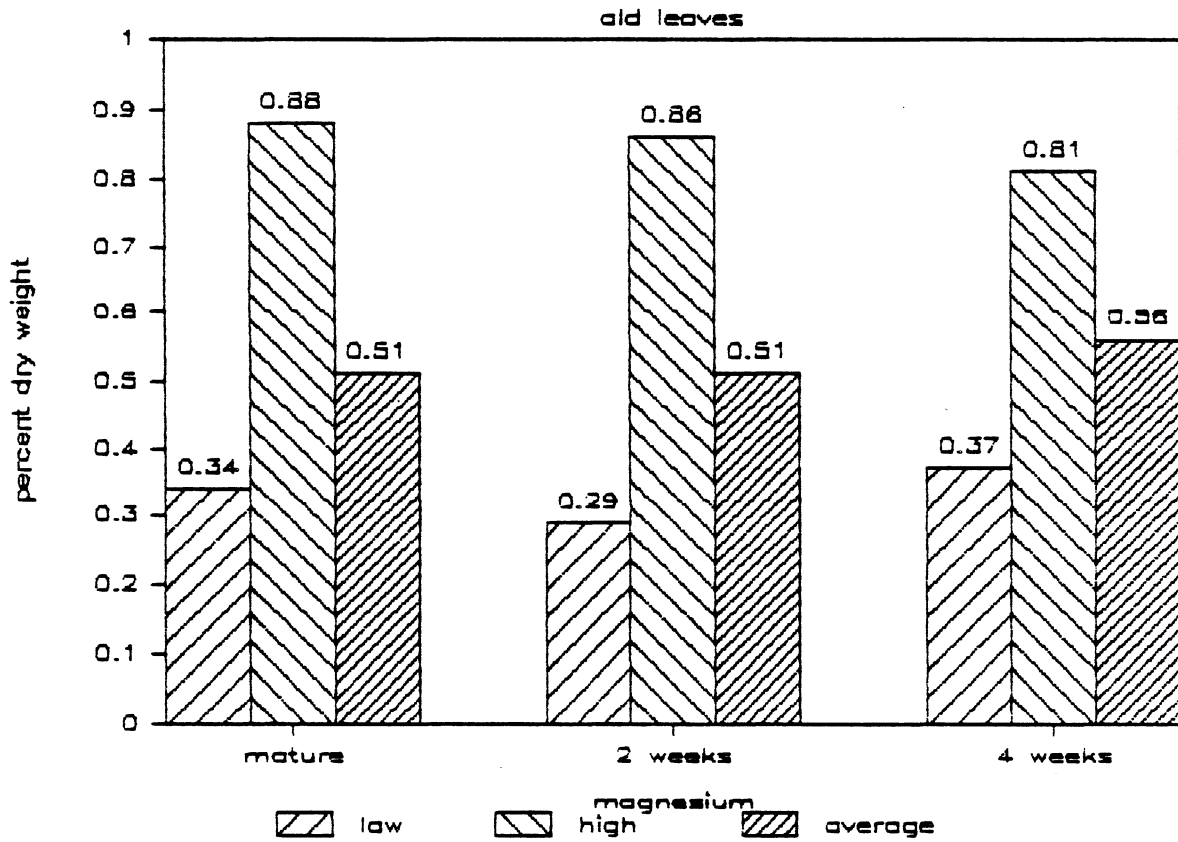


BIB LETTUCE

old leaves

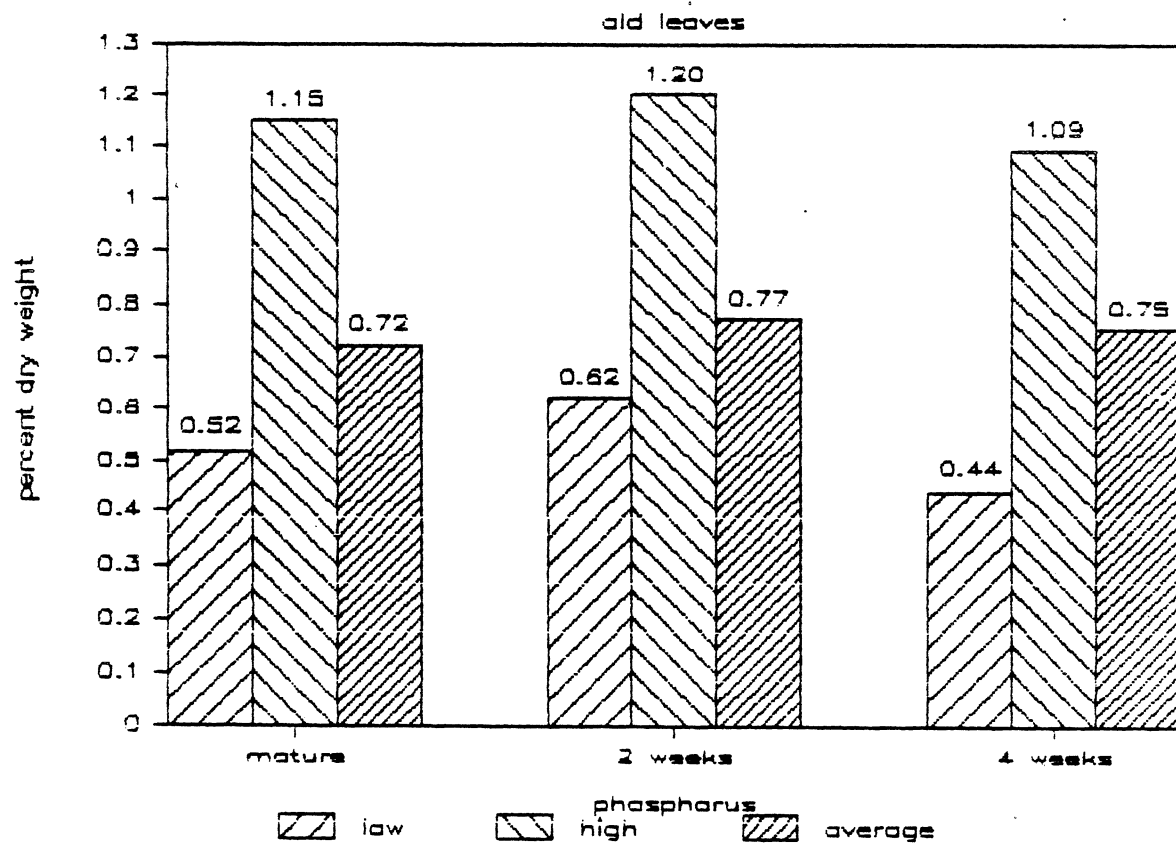
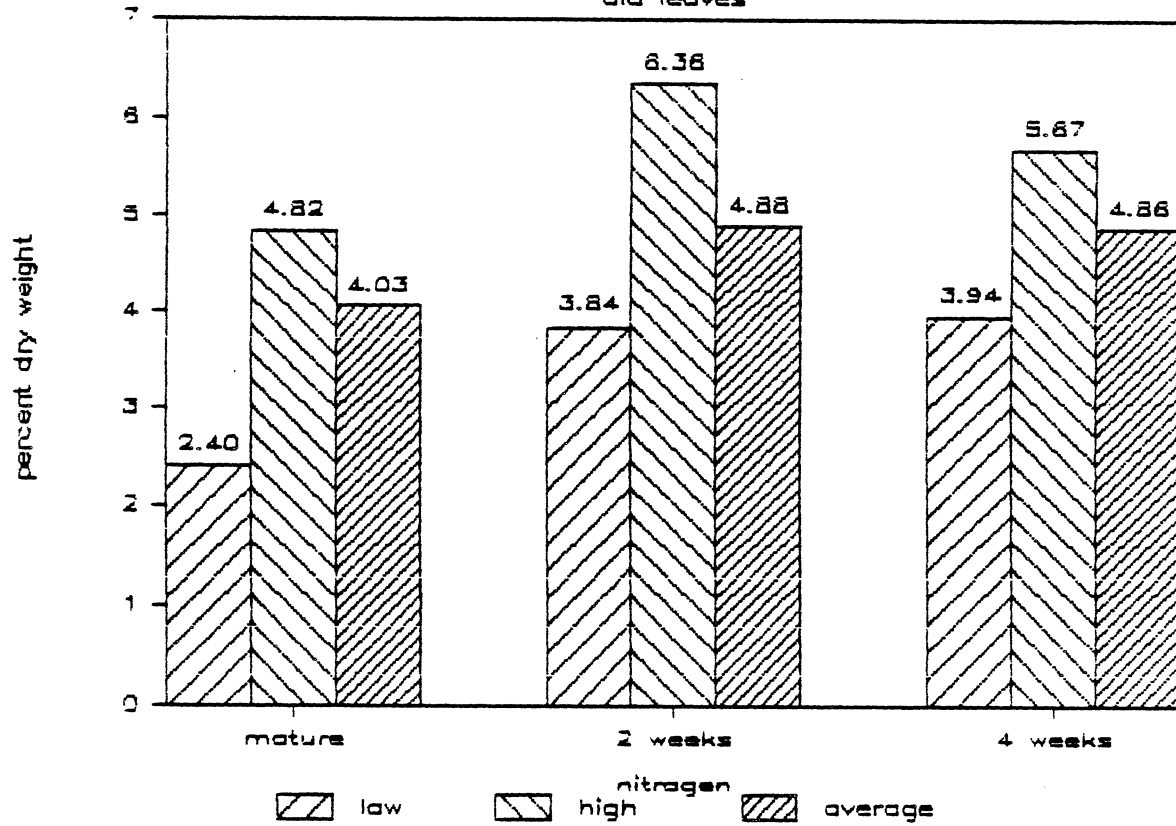


BIB LETTUCE

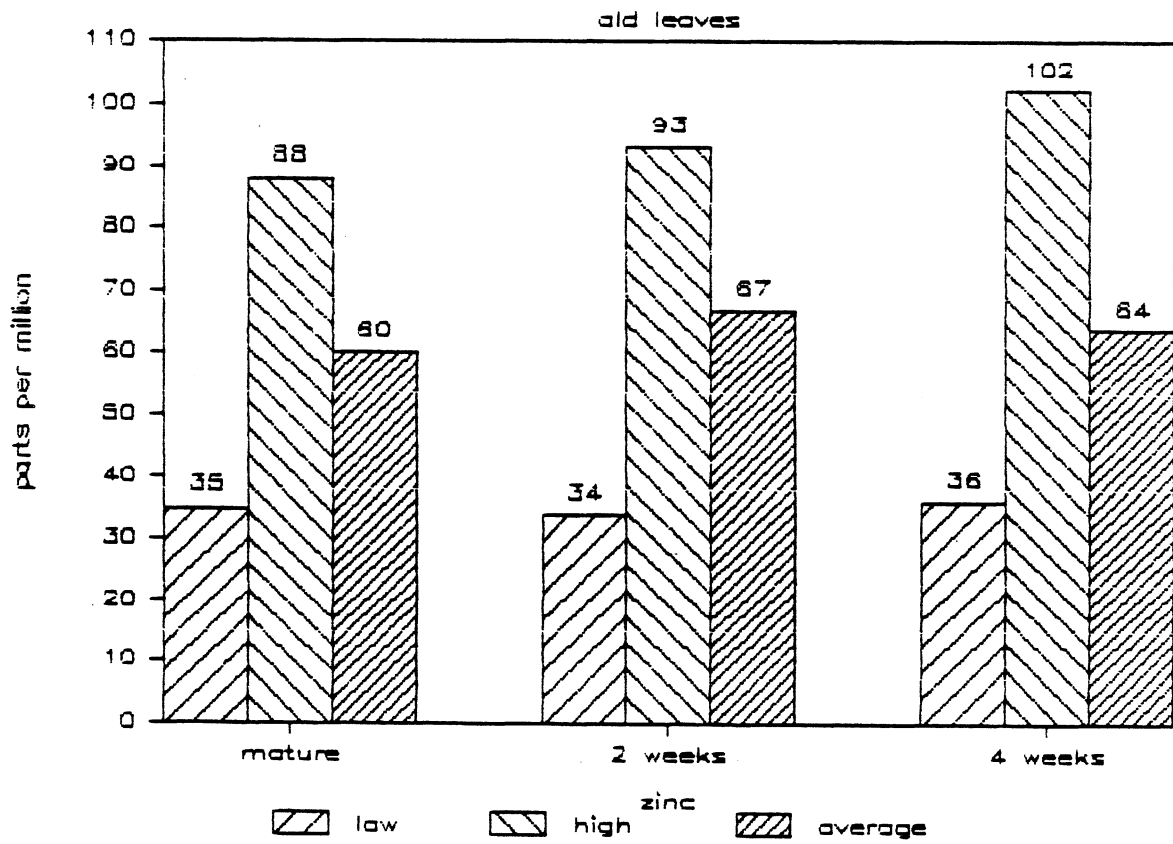
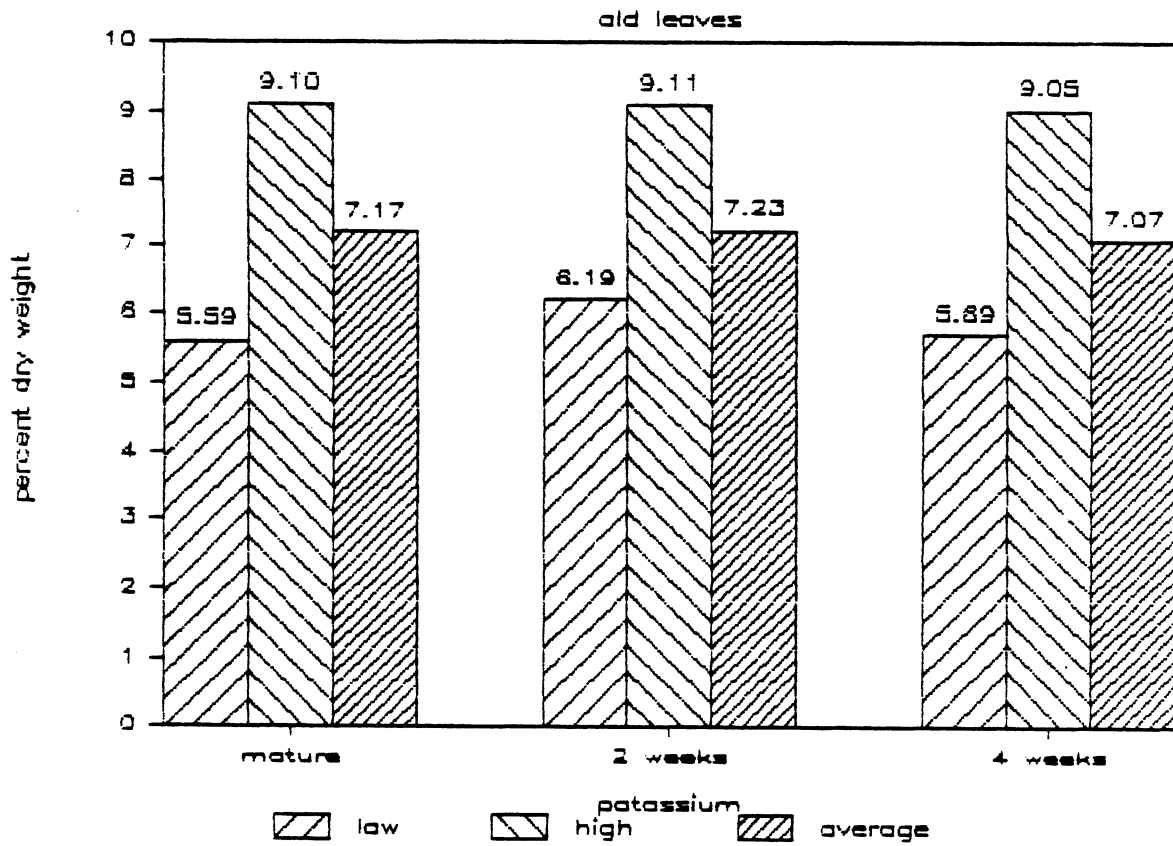


BIB LETTUCE

old leaves

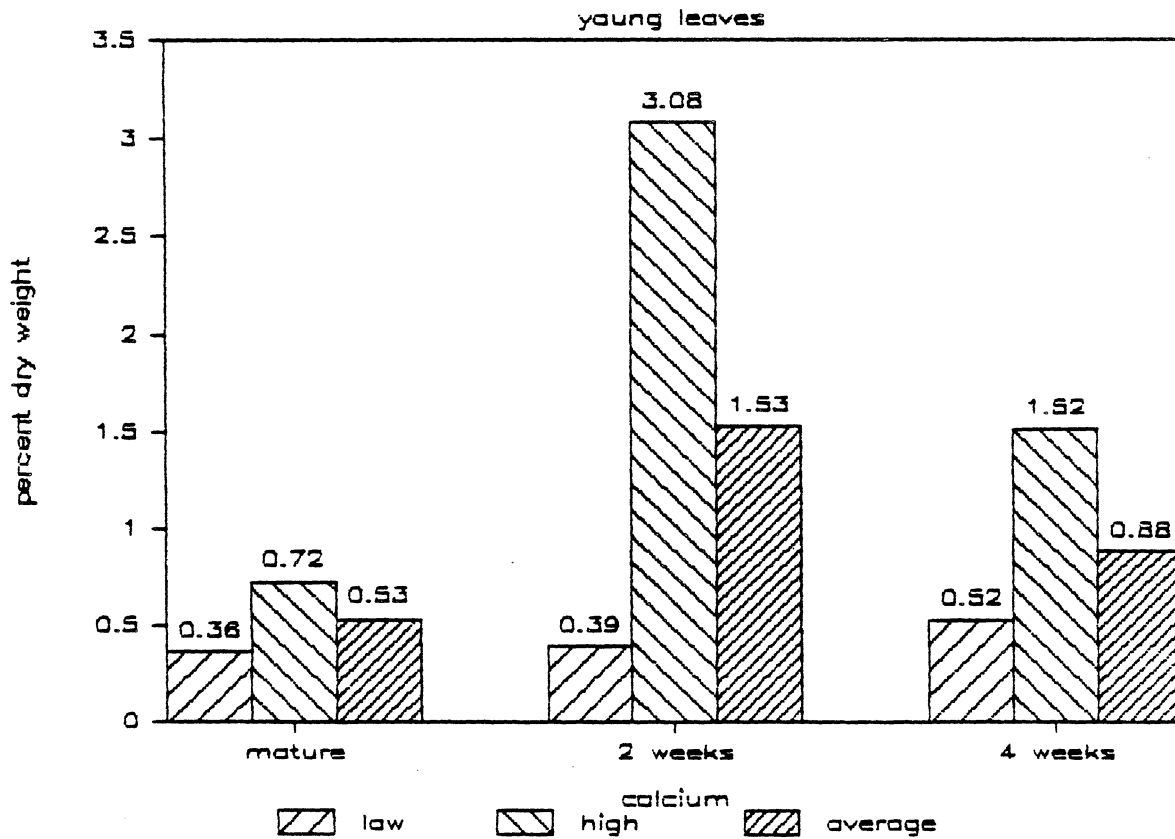
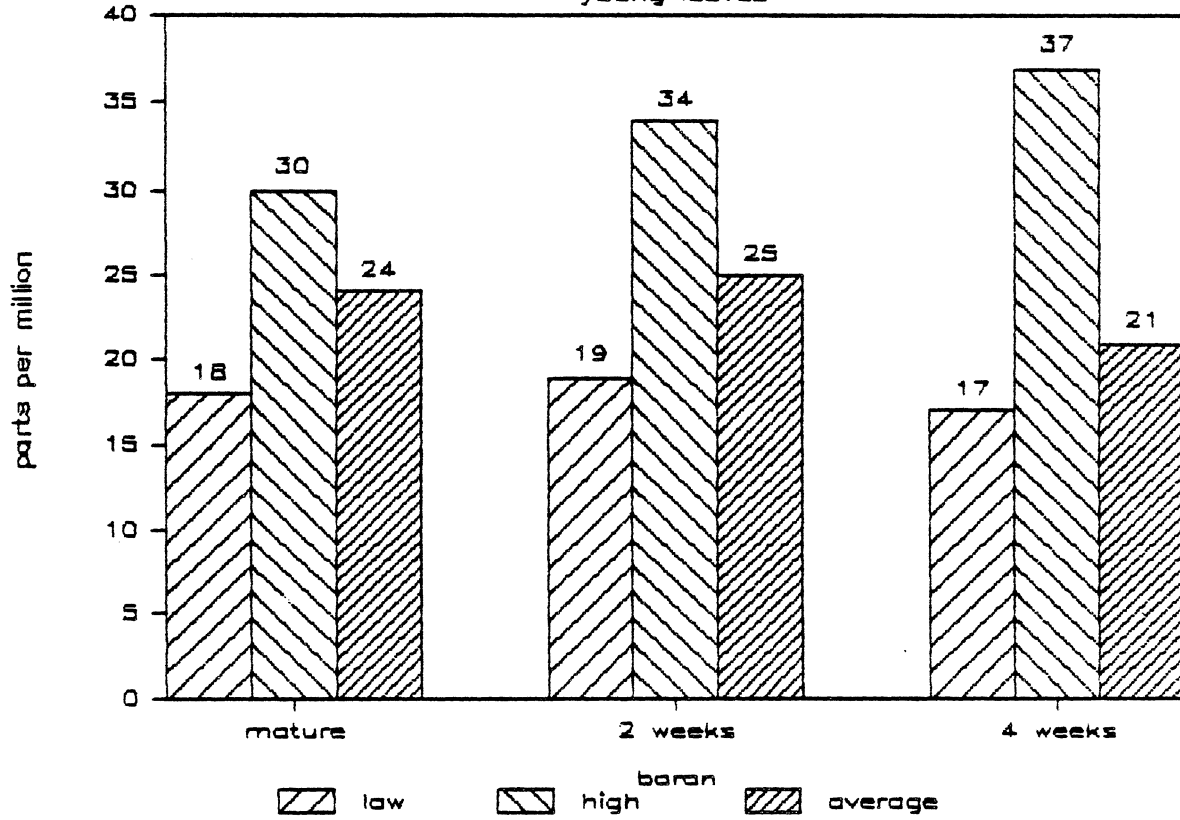


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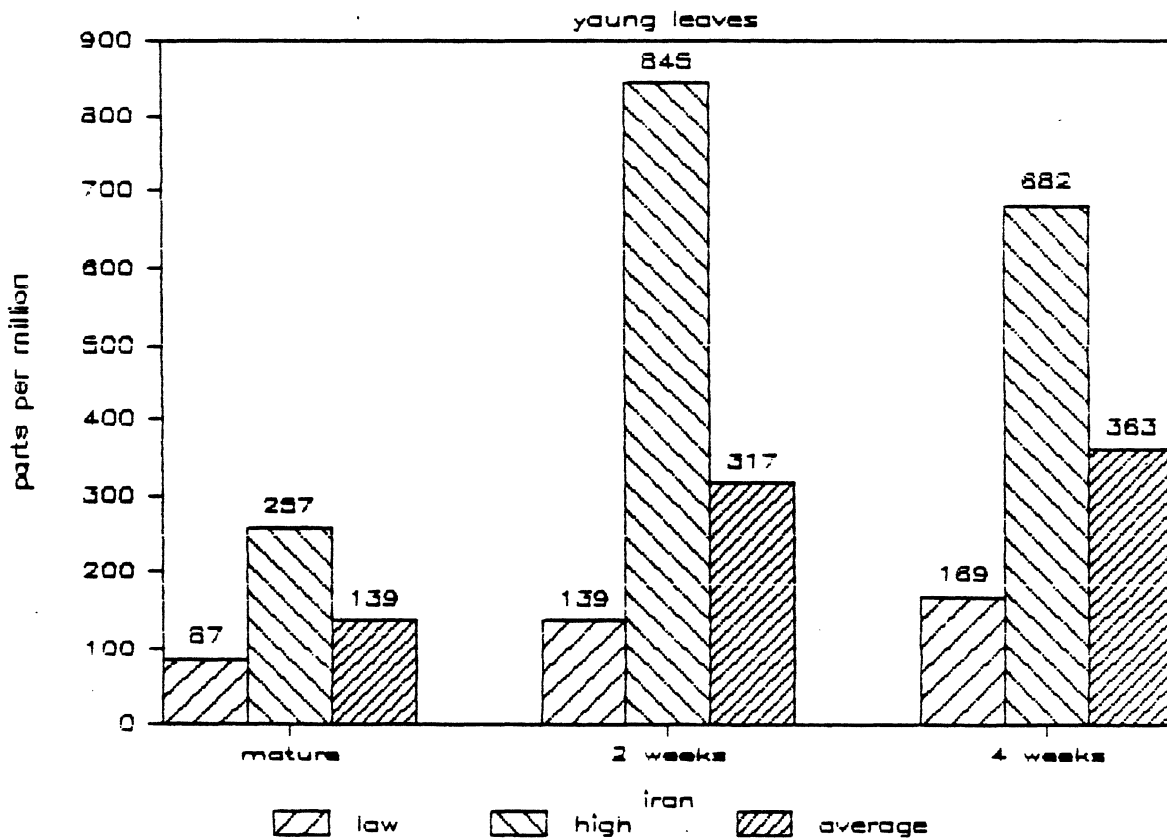
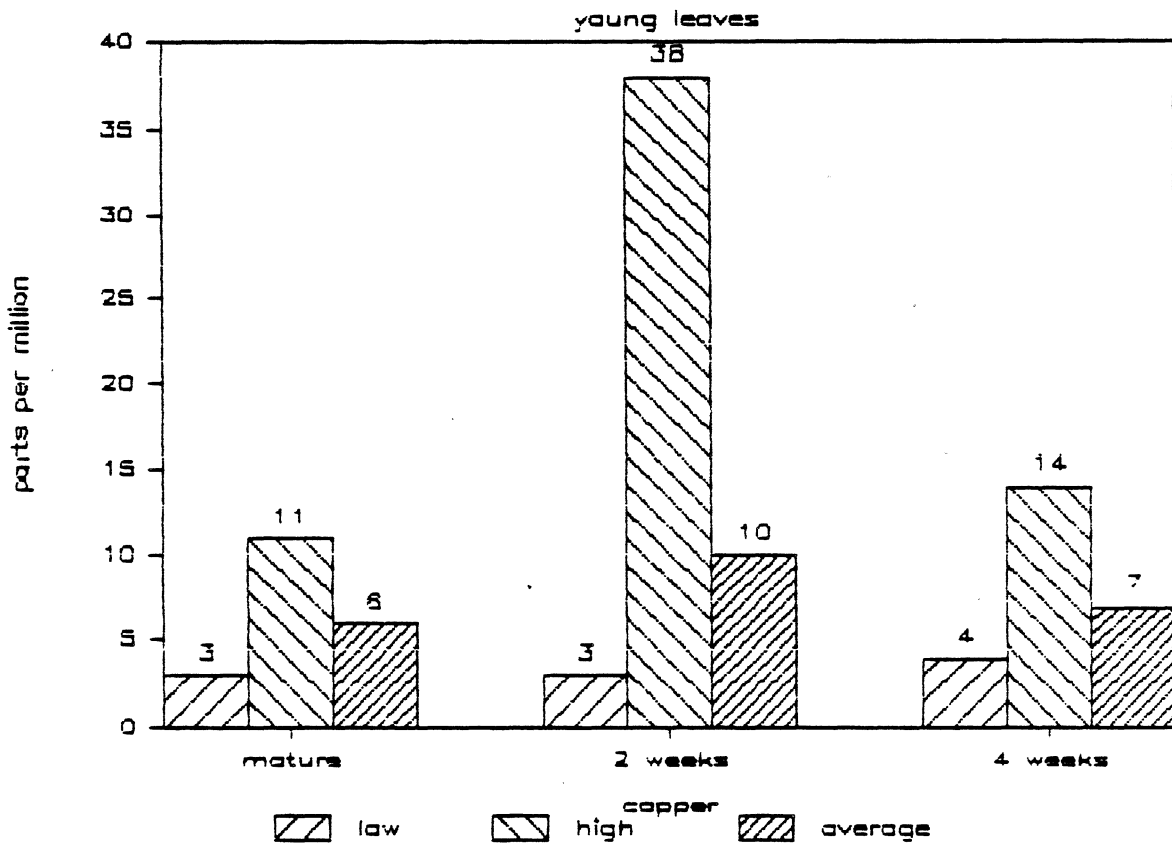


BIB LETTUCE

young leaves

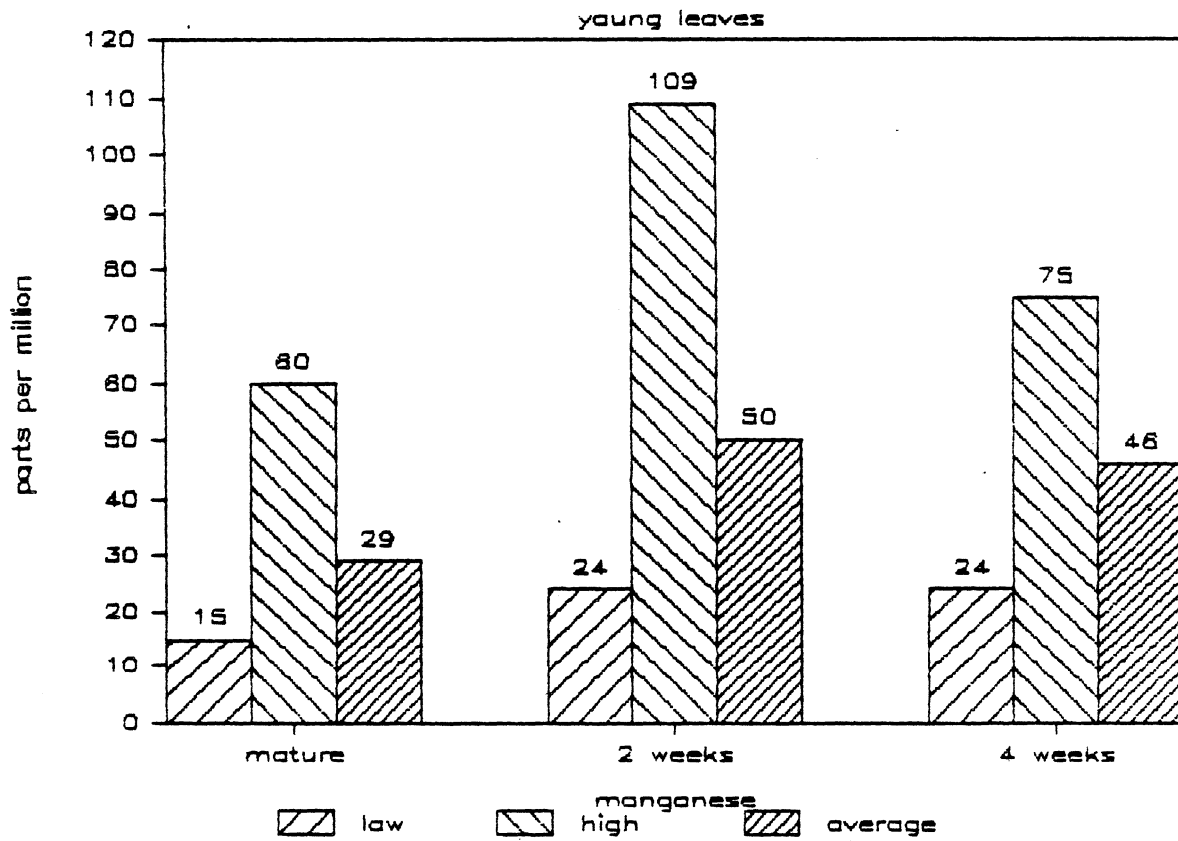
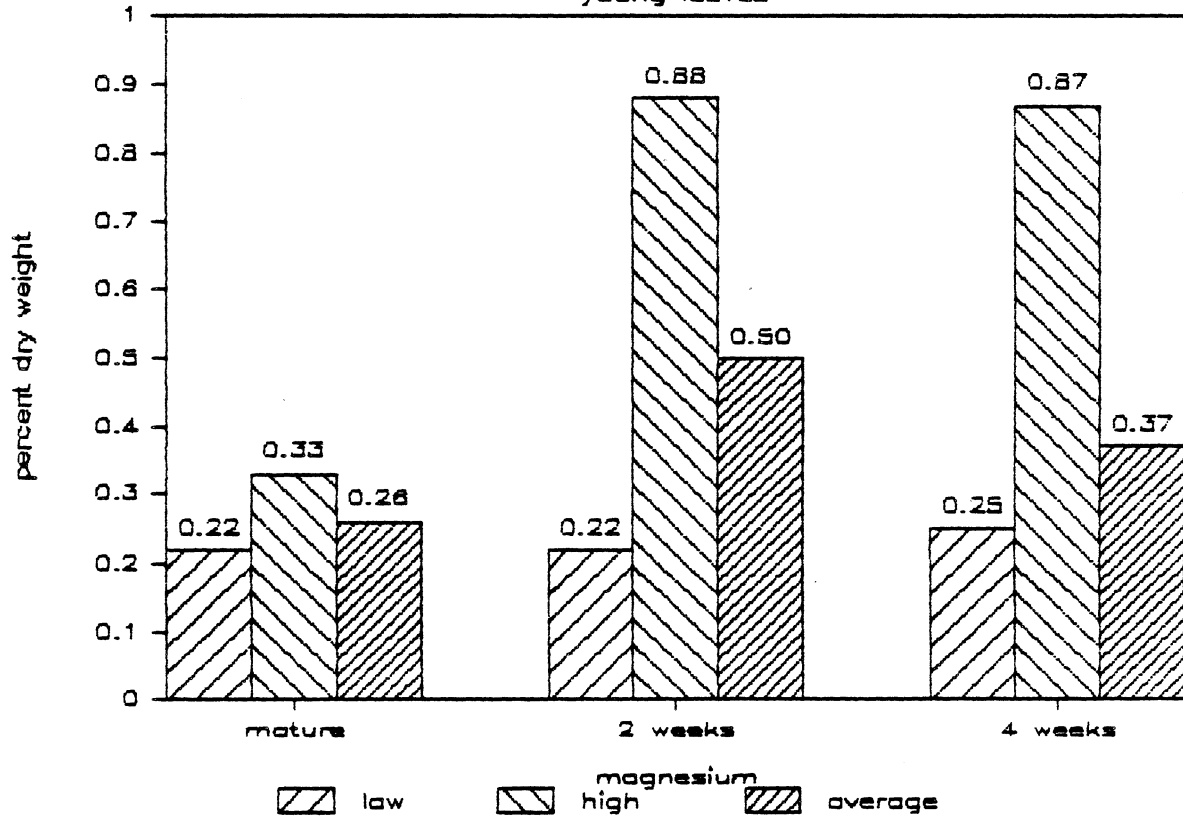


BIB LETTUCE

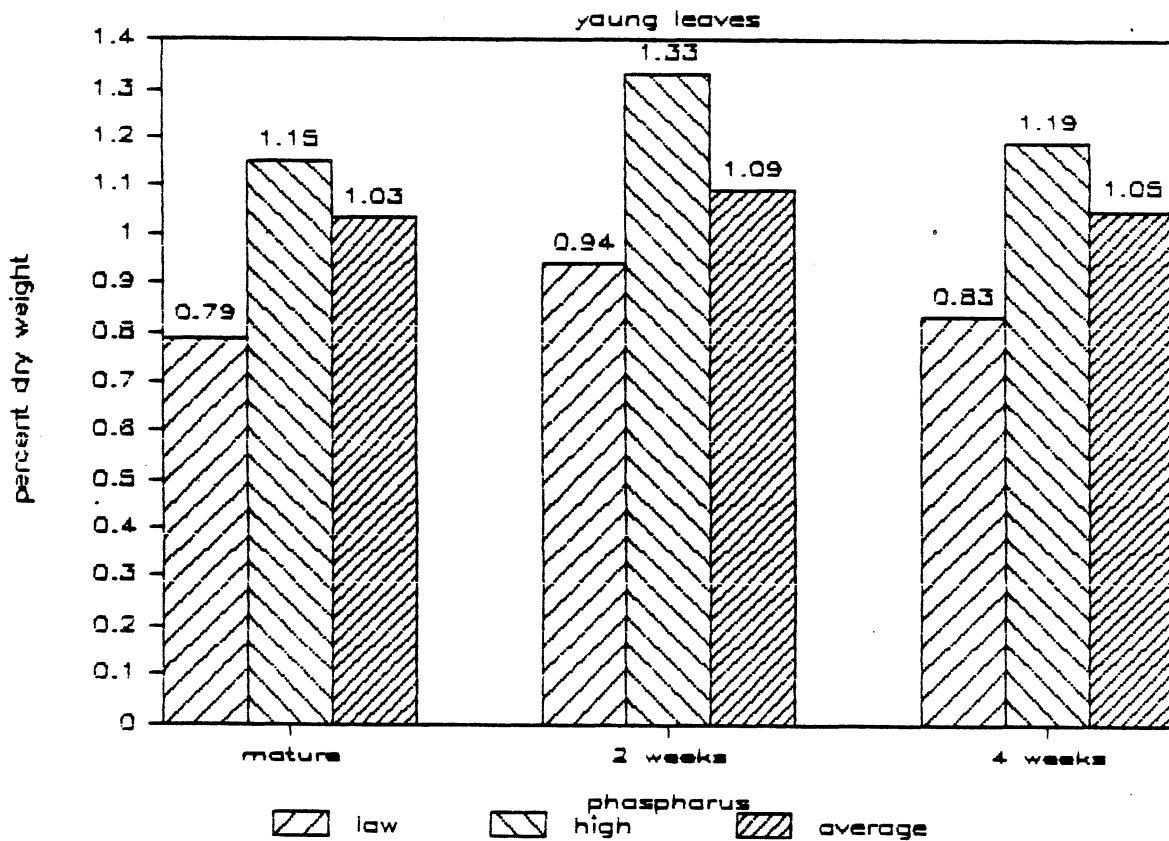
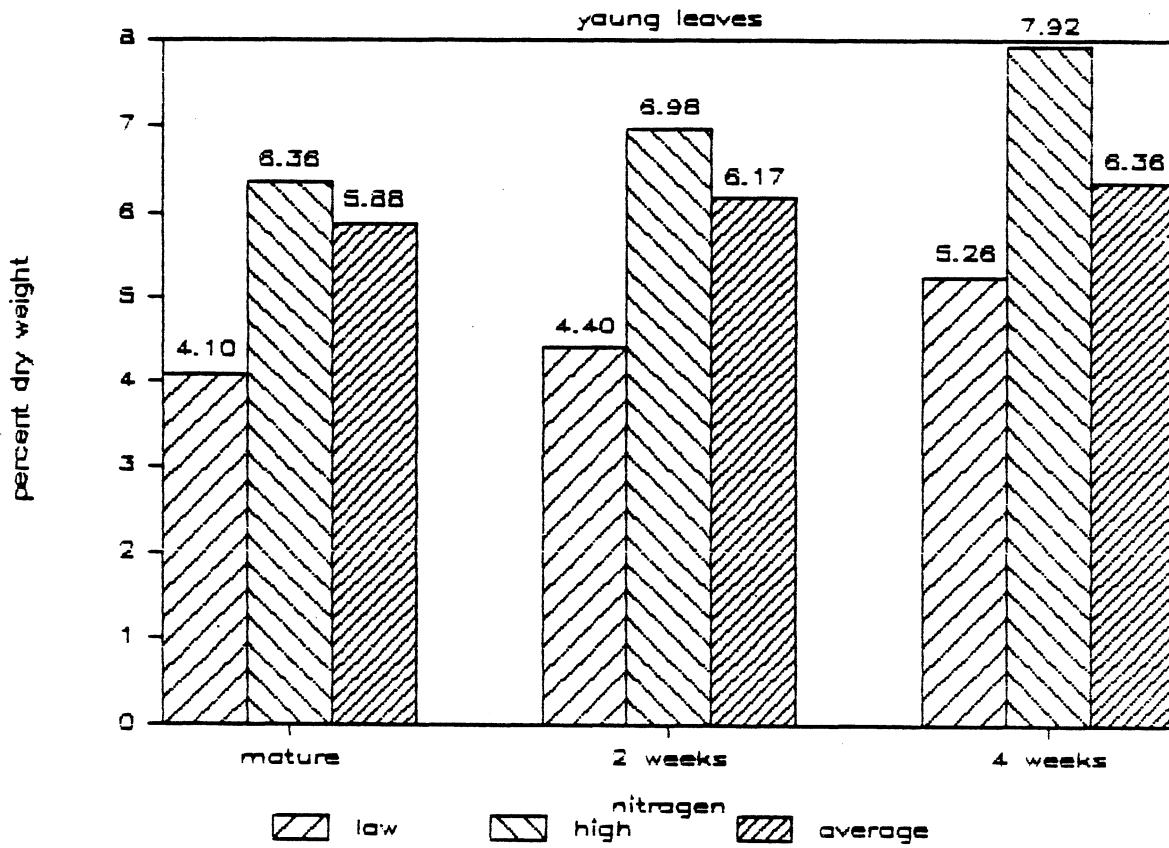


BIB LETTUCE

young leaves

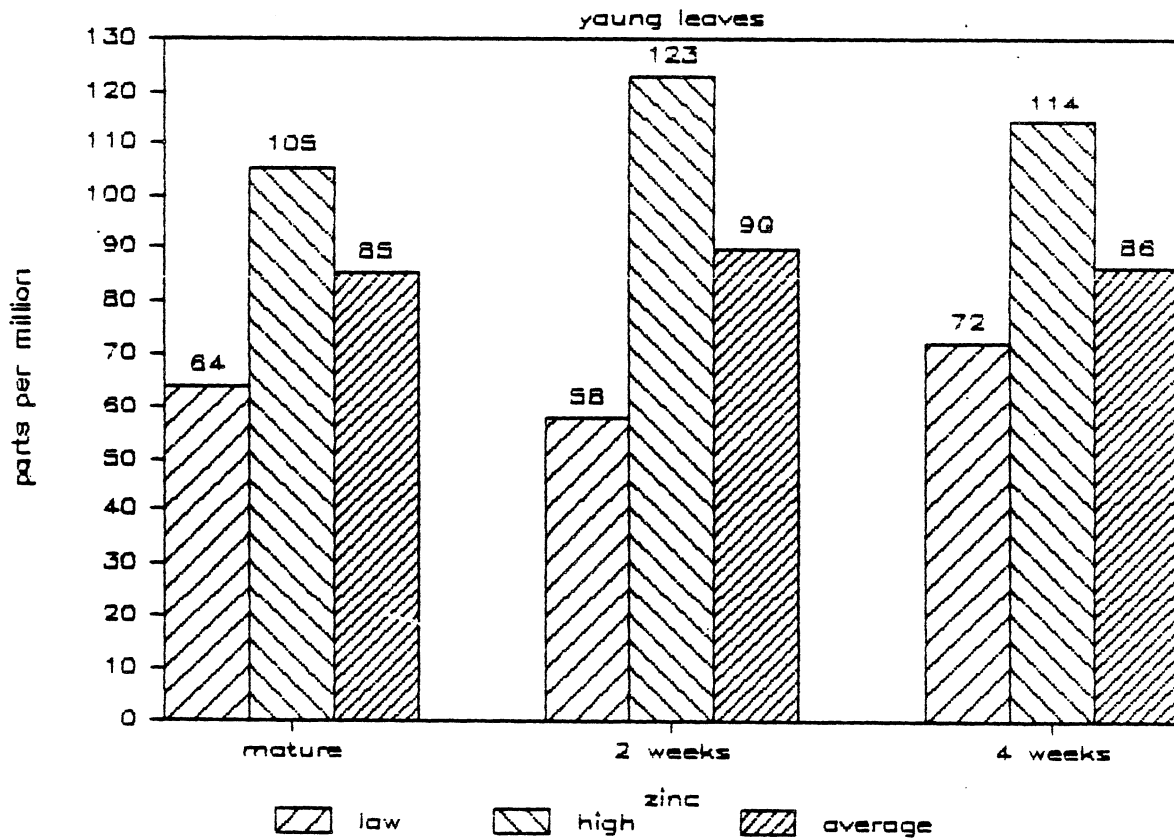
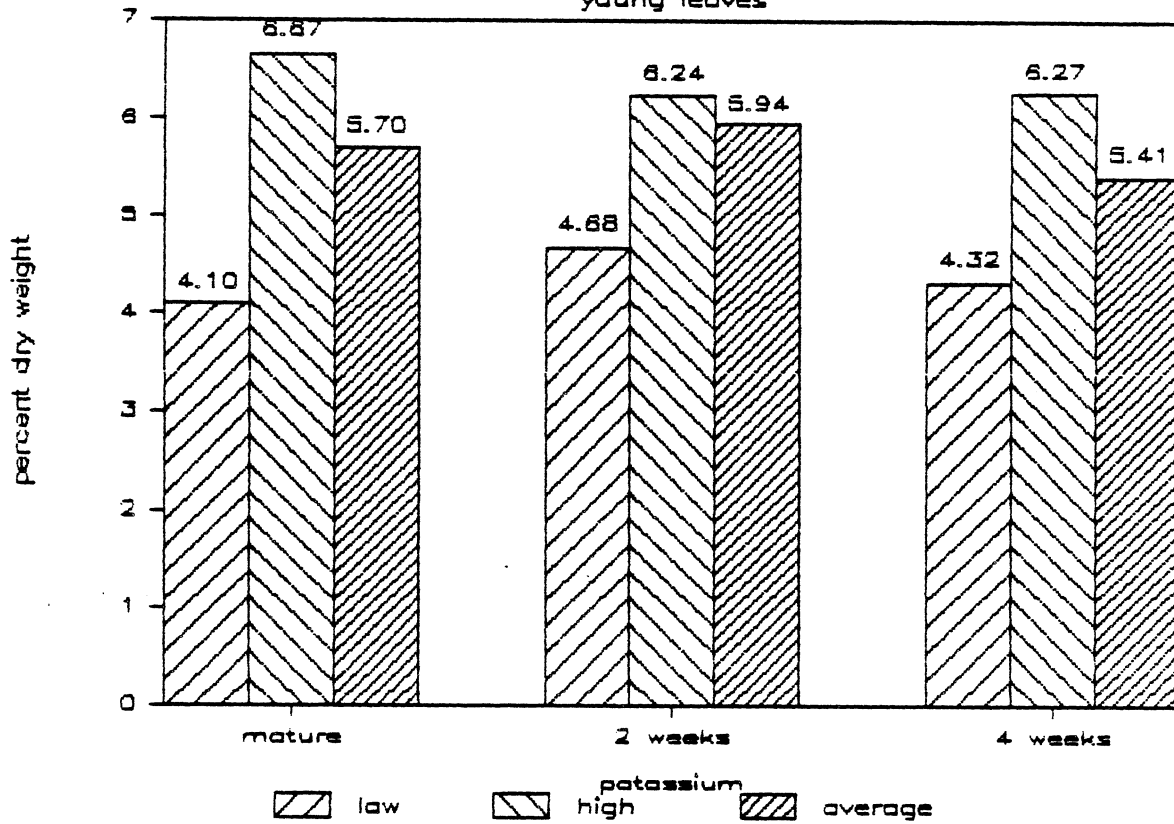


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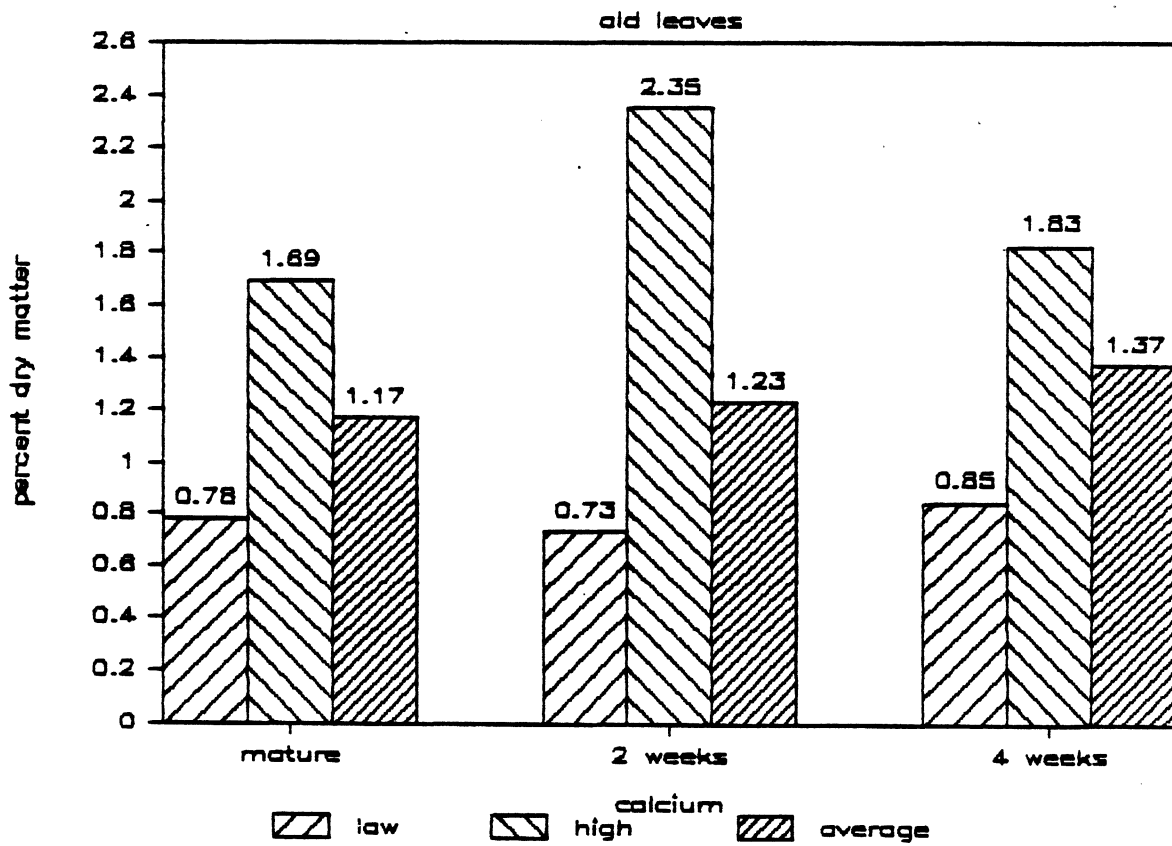
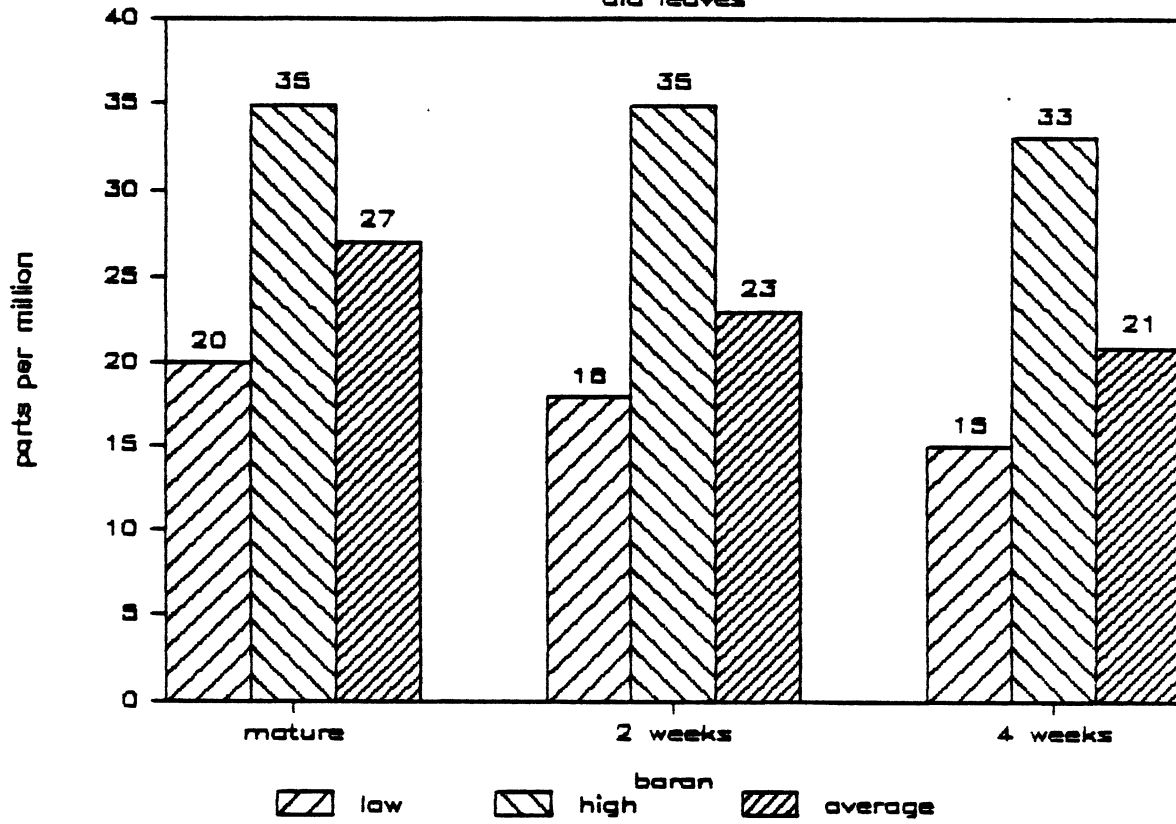
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young leaves

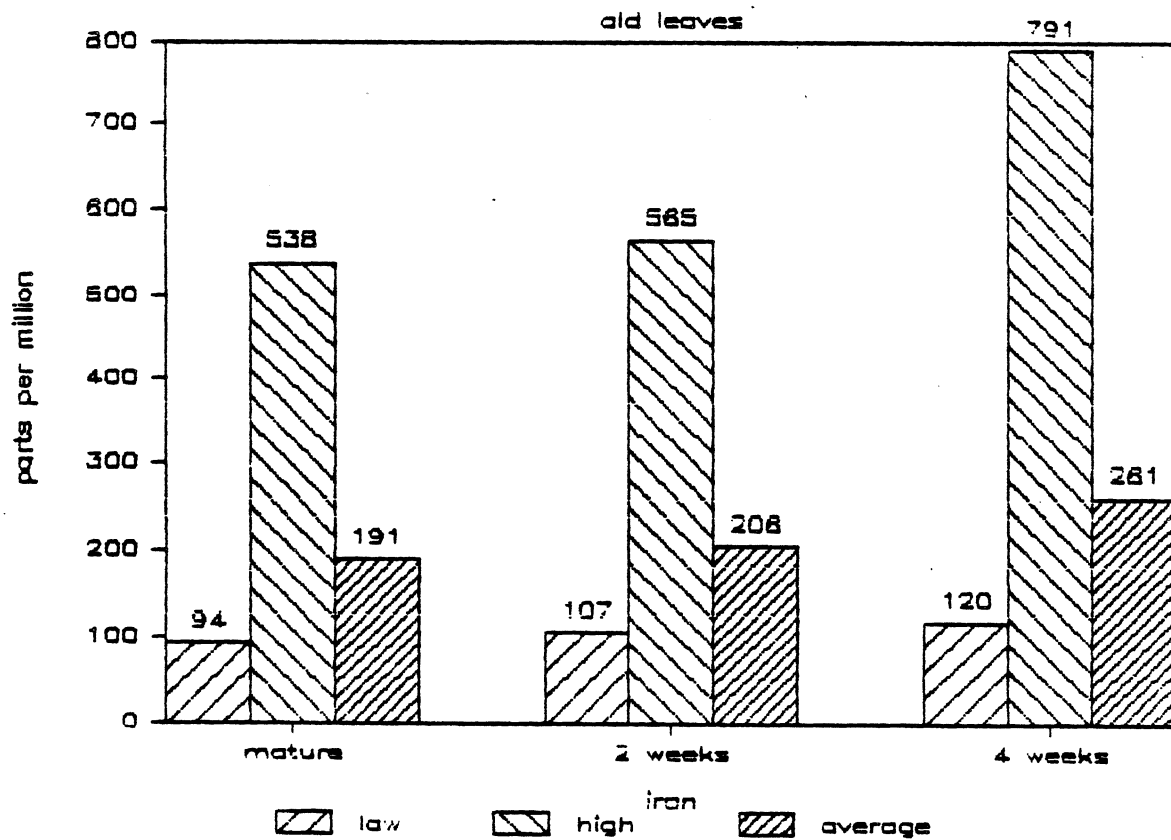
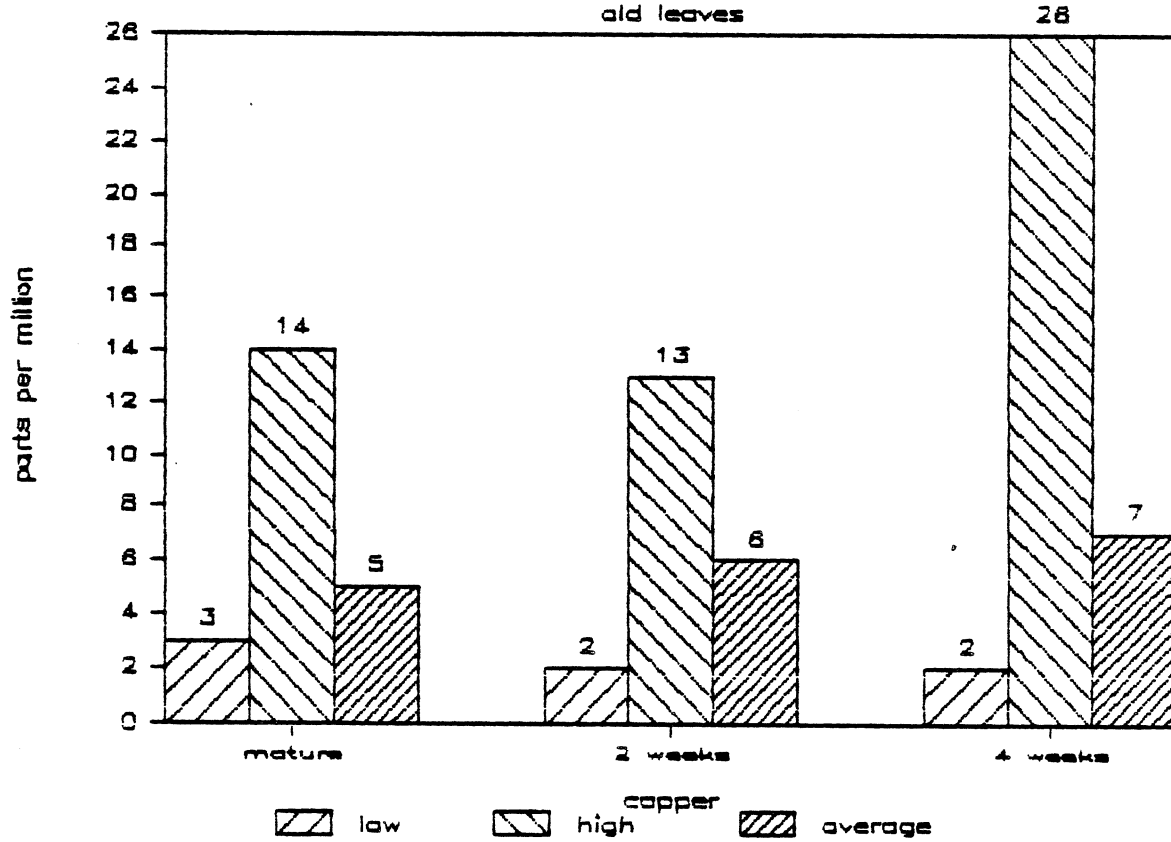


ROMAINE

old leaves

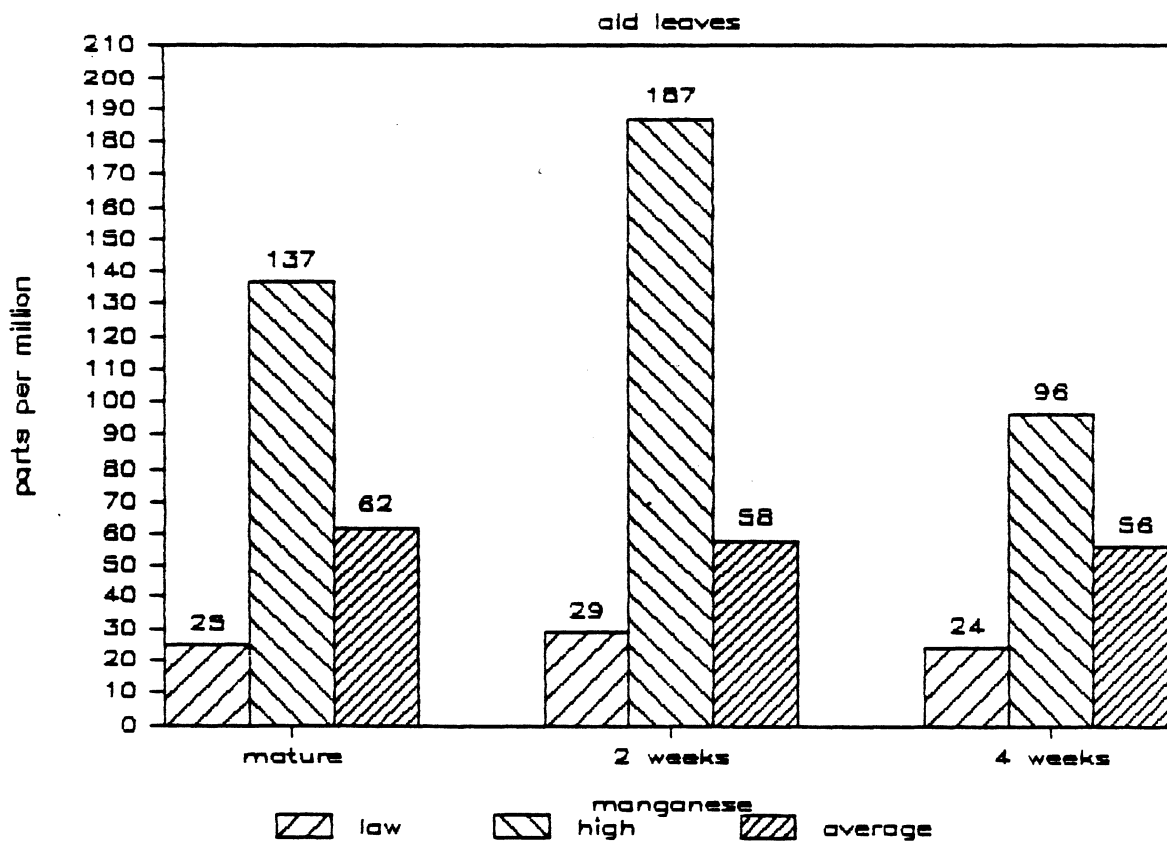
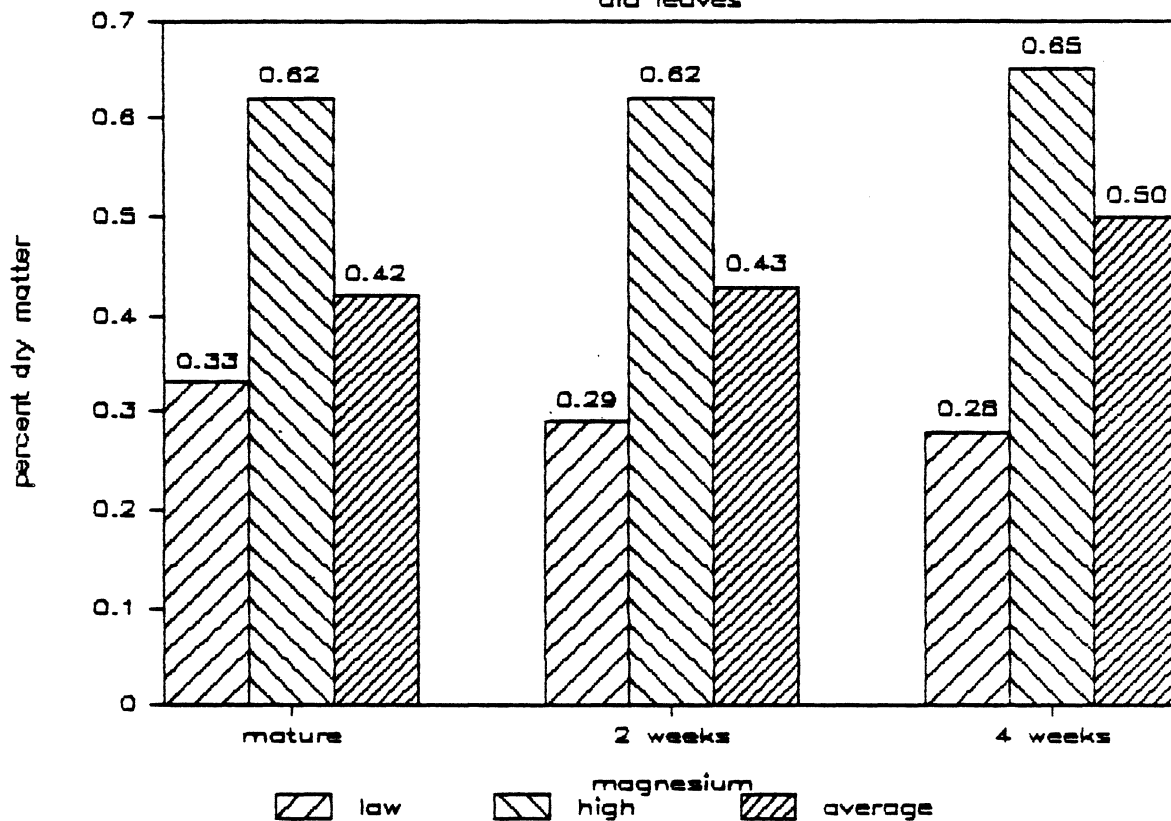


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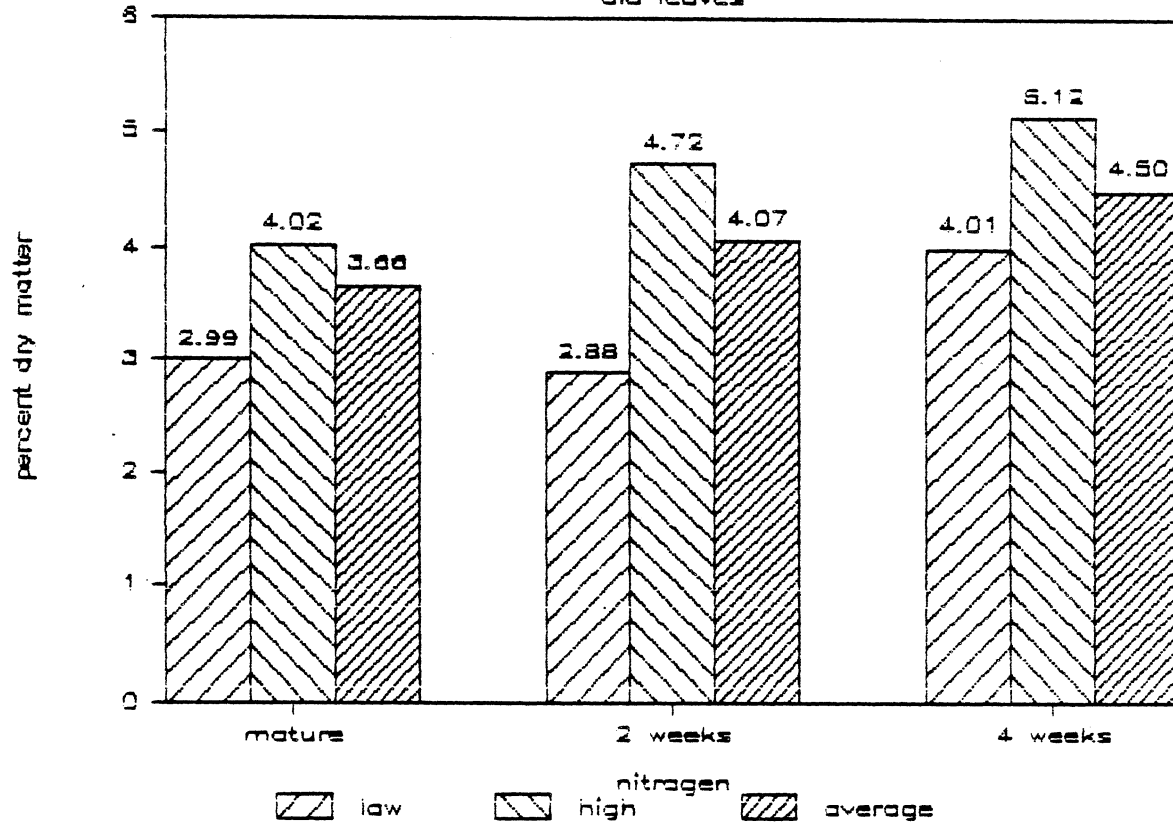
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old leaves

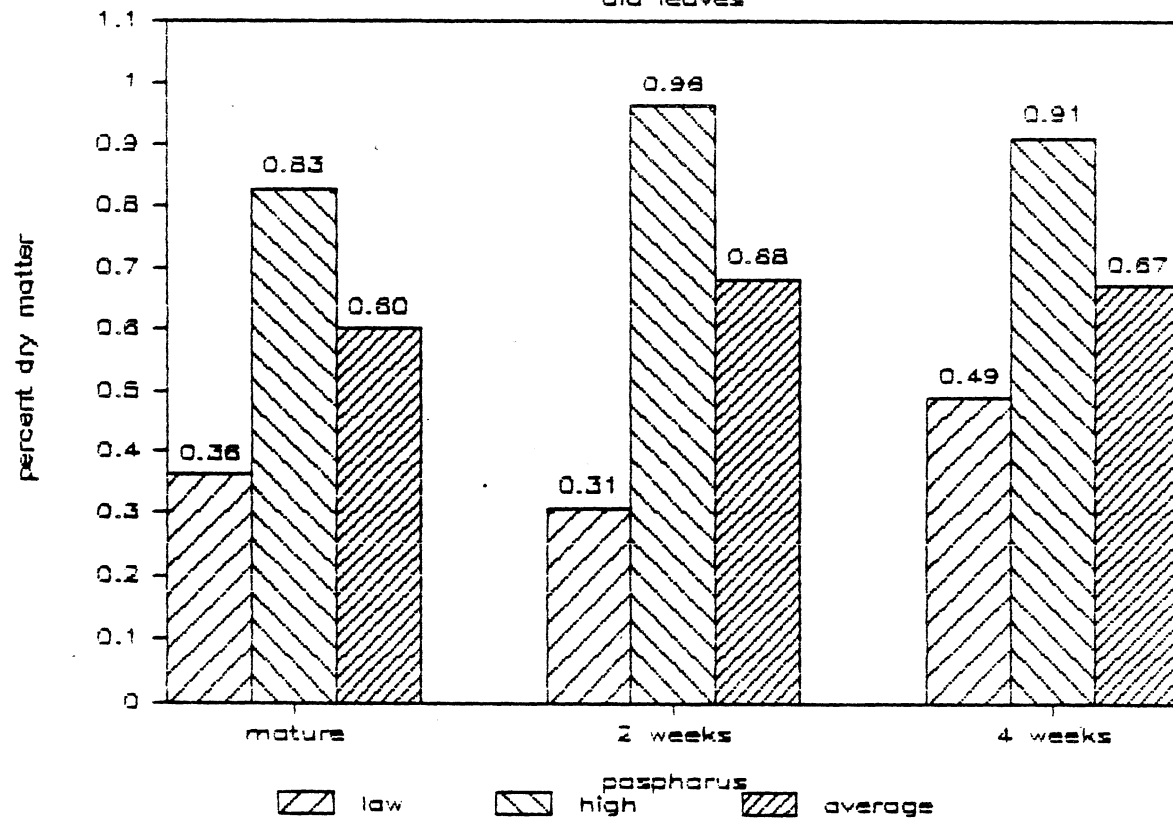


ROMAINE

old leaves

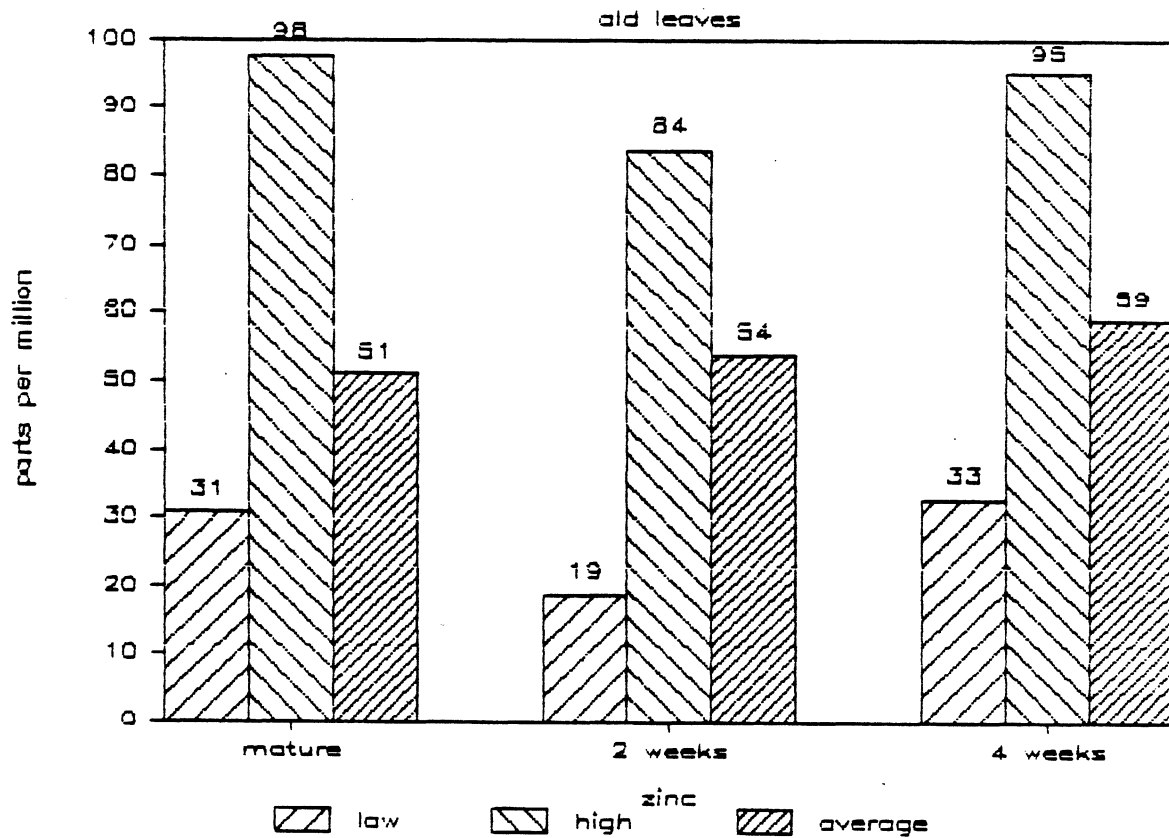
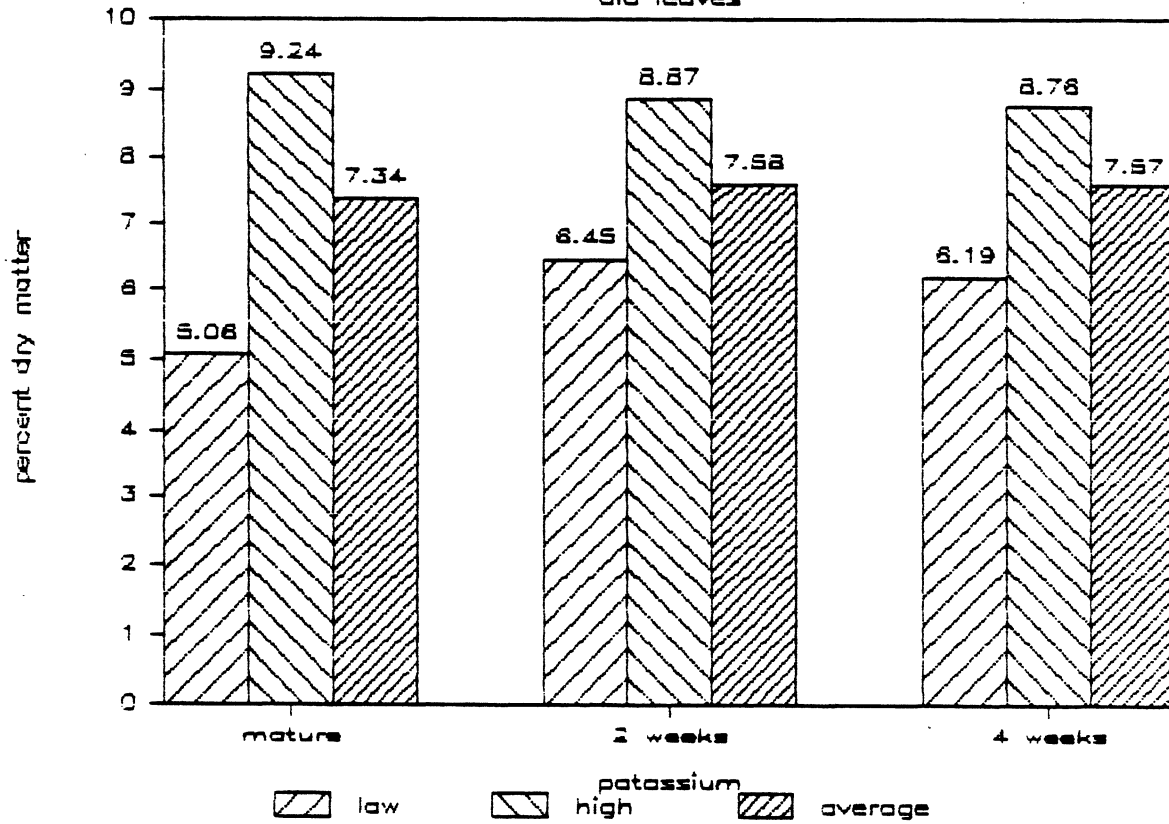


old leaves



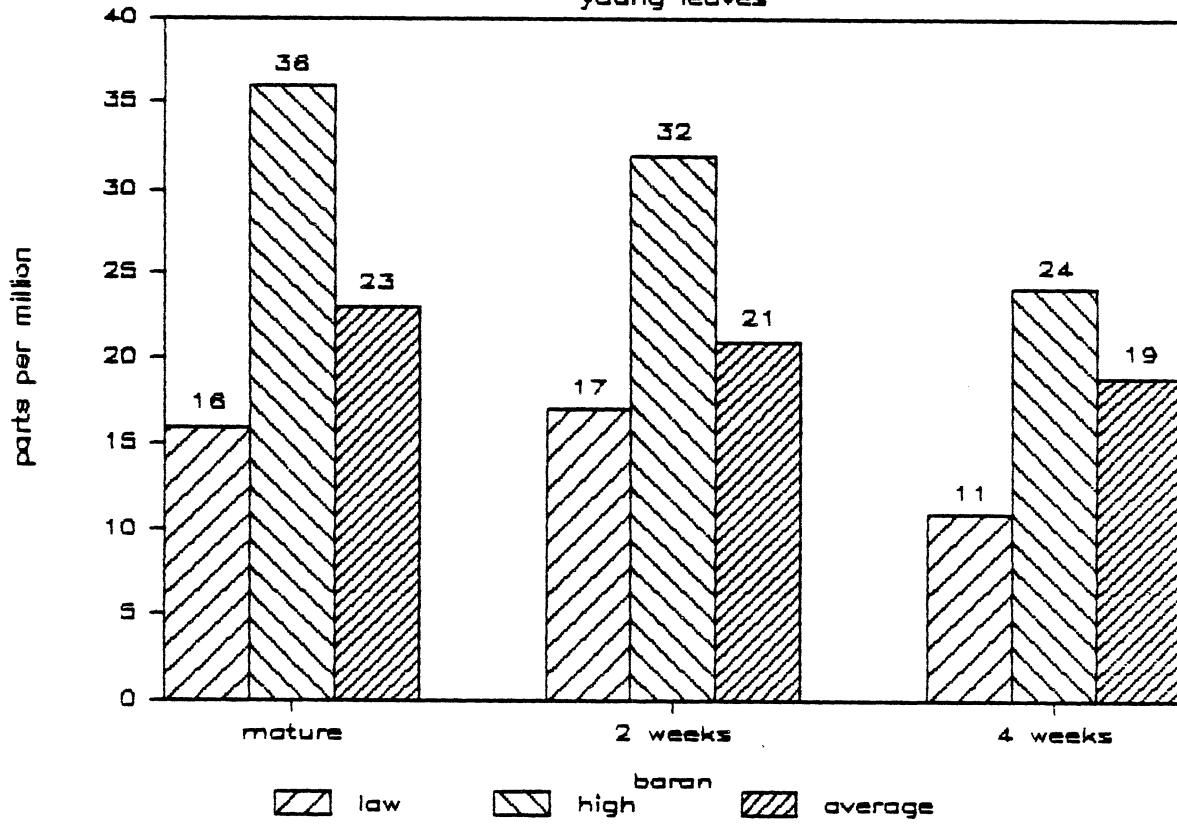
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old leaves

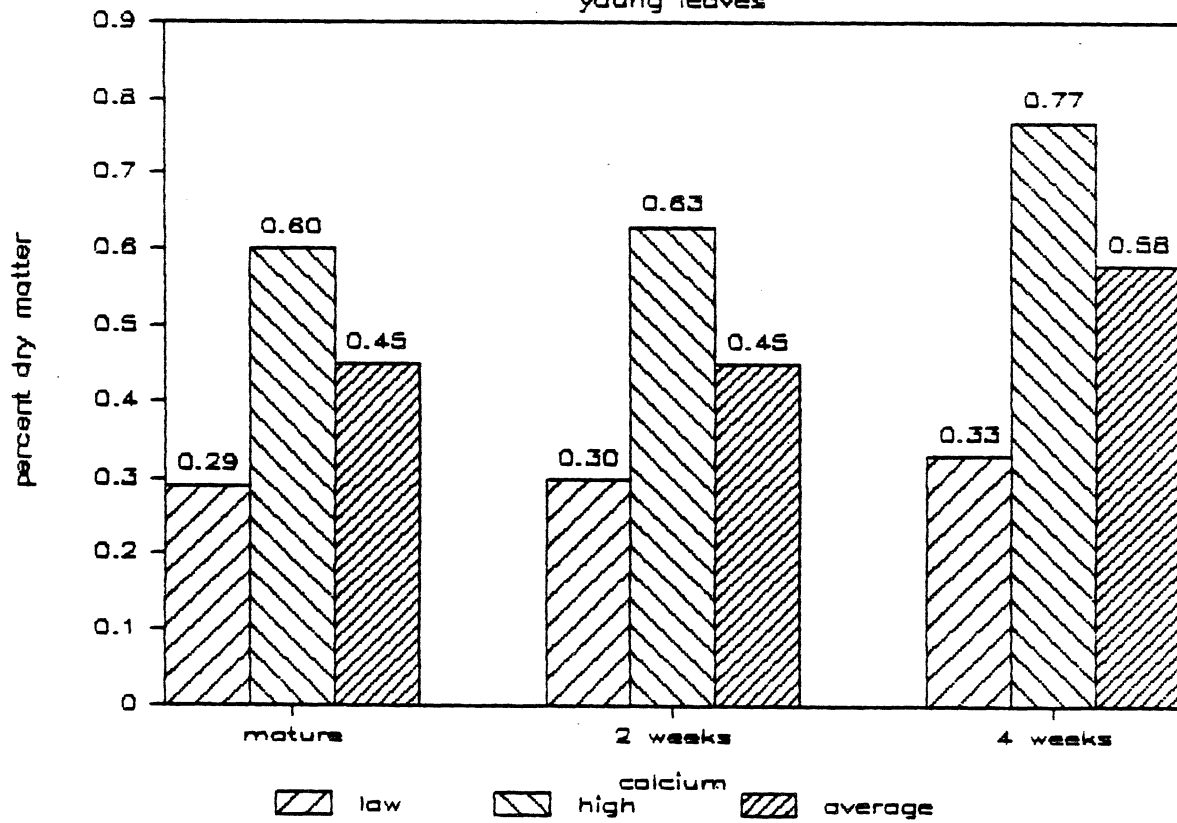


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young leaves

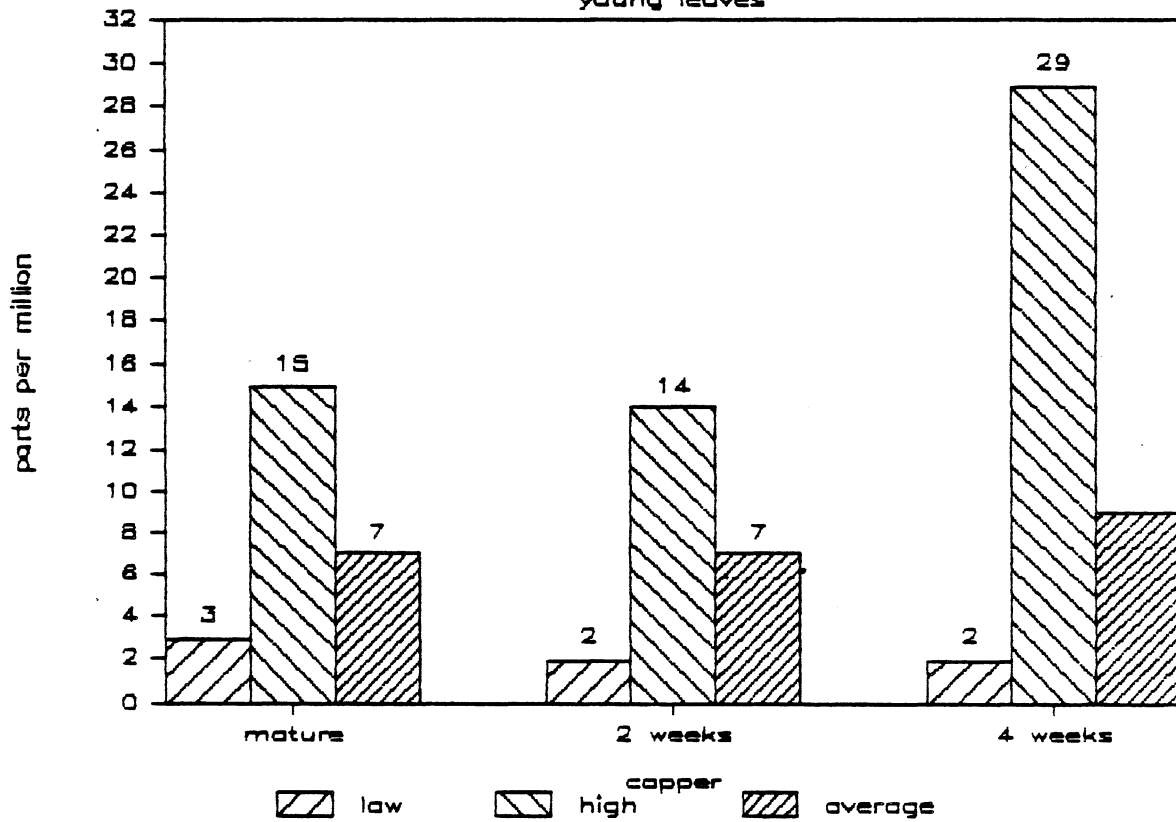


young leaves

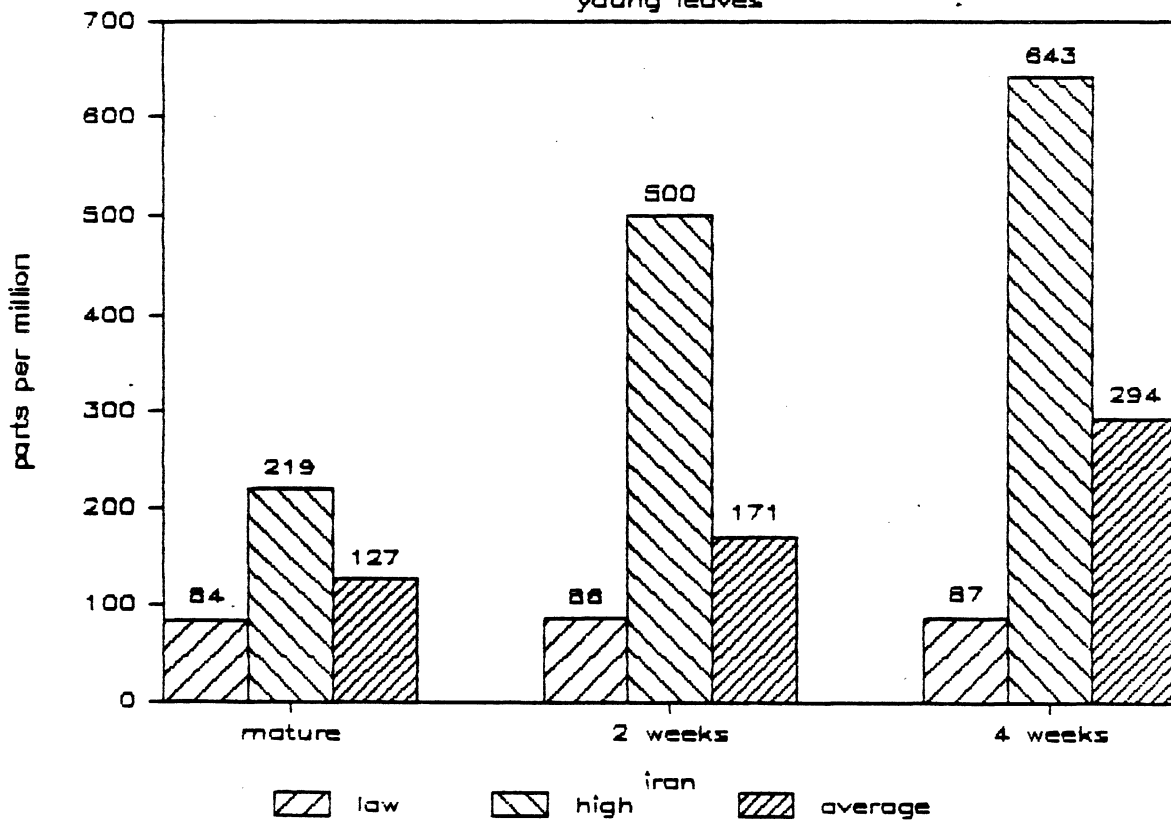


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young leaves

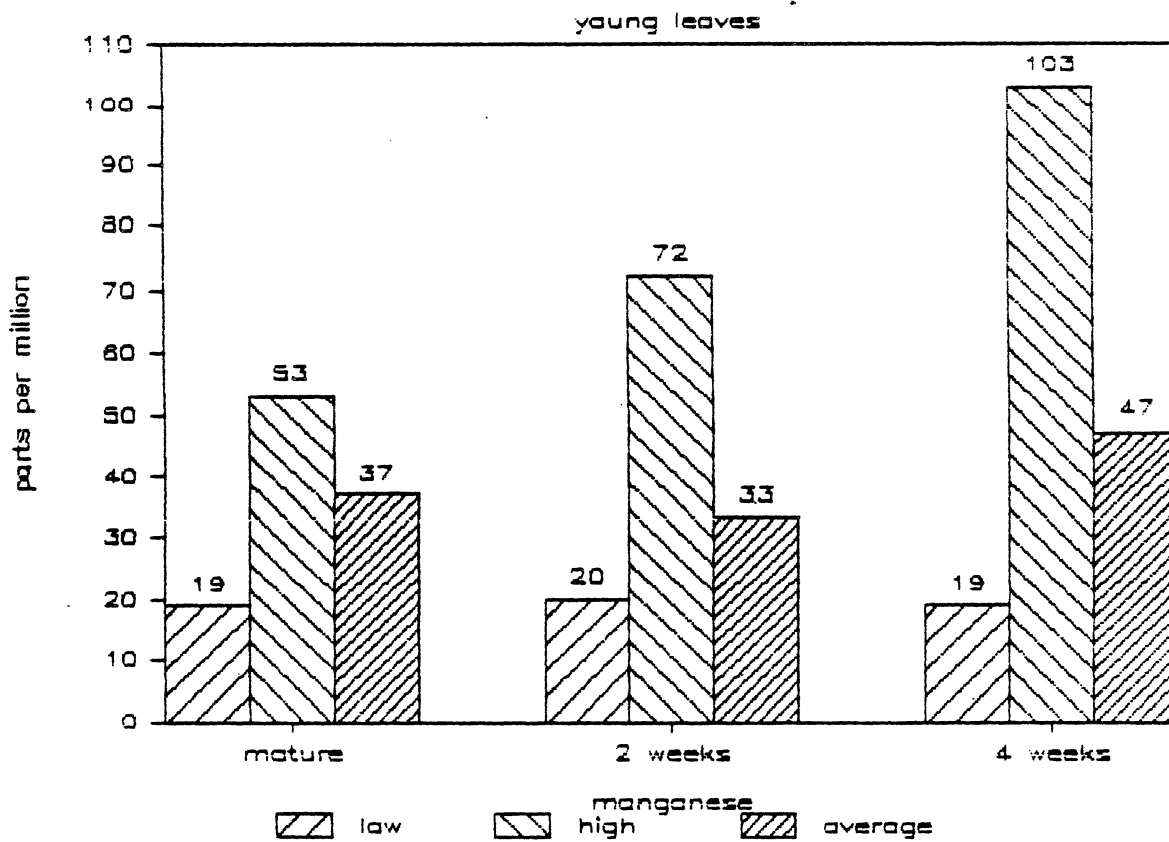
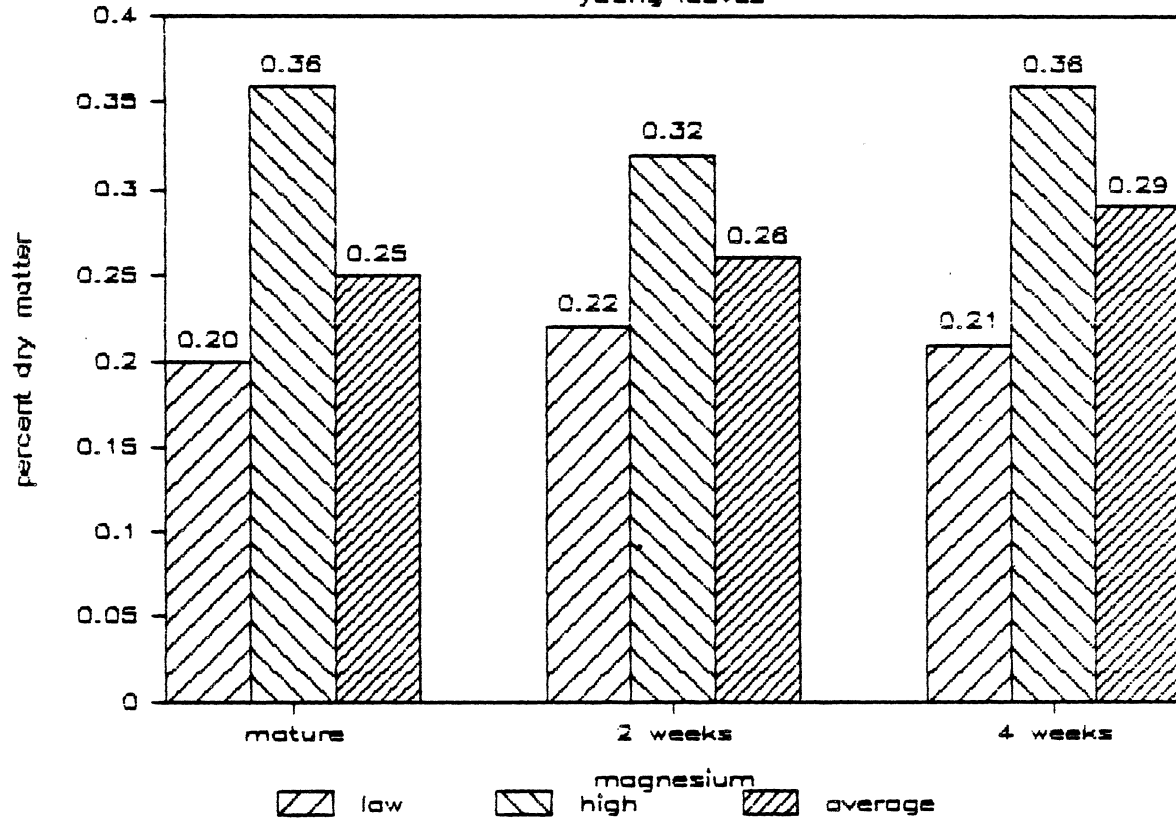


young leaves



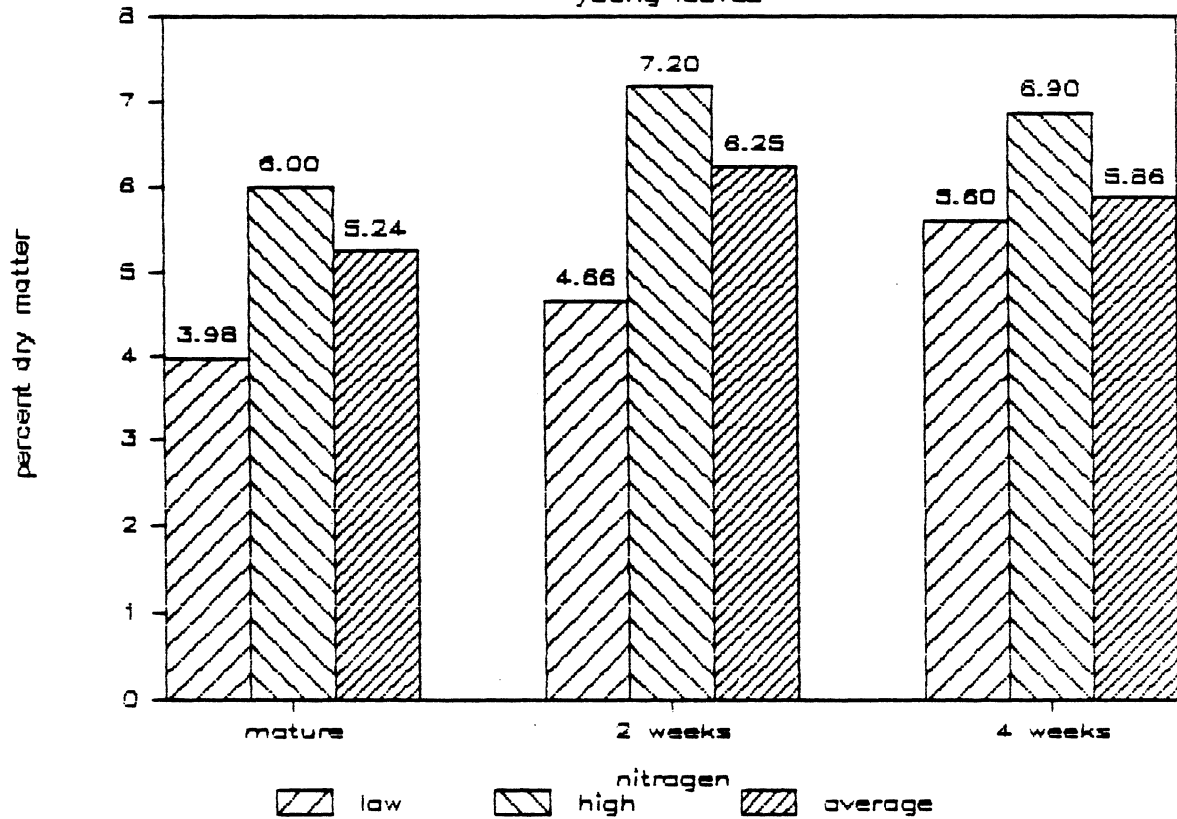
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young leaves

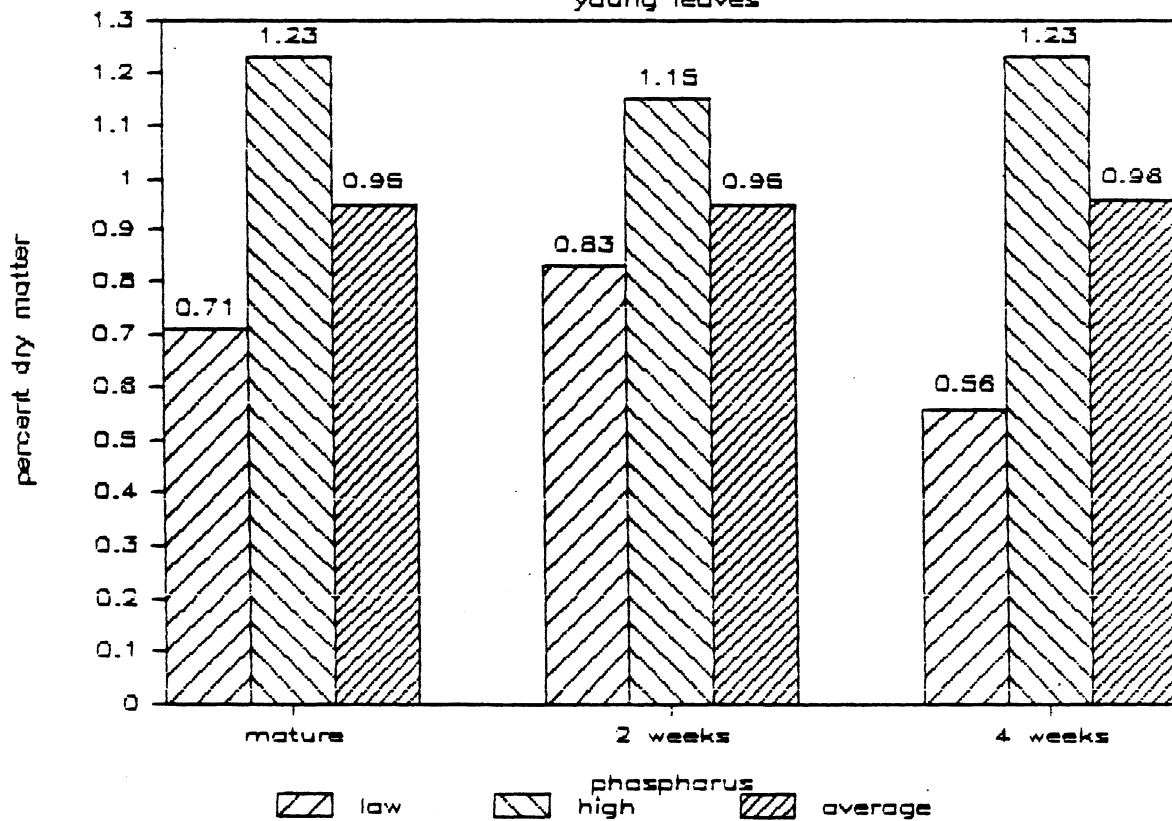


ROMAINE

young leaves

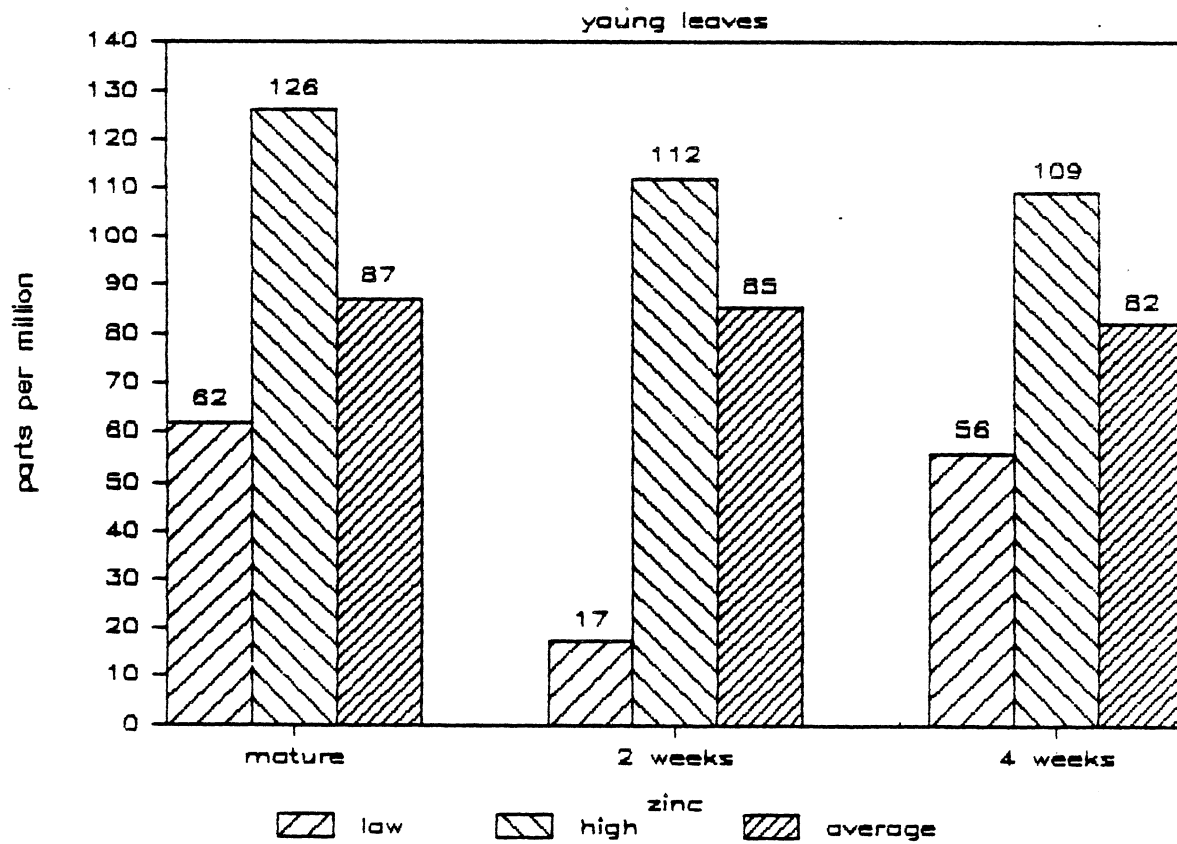
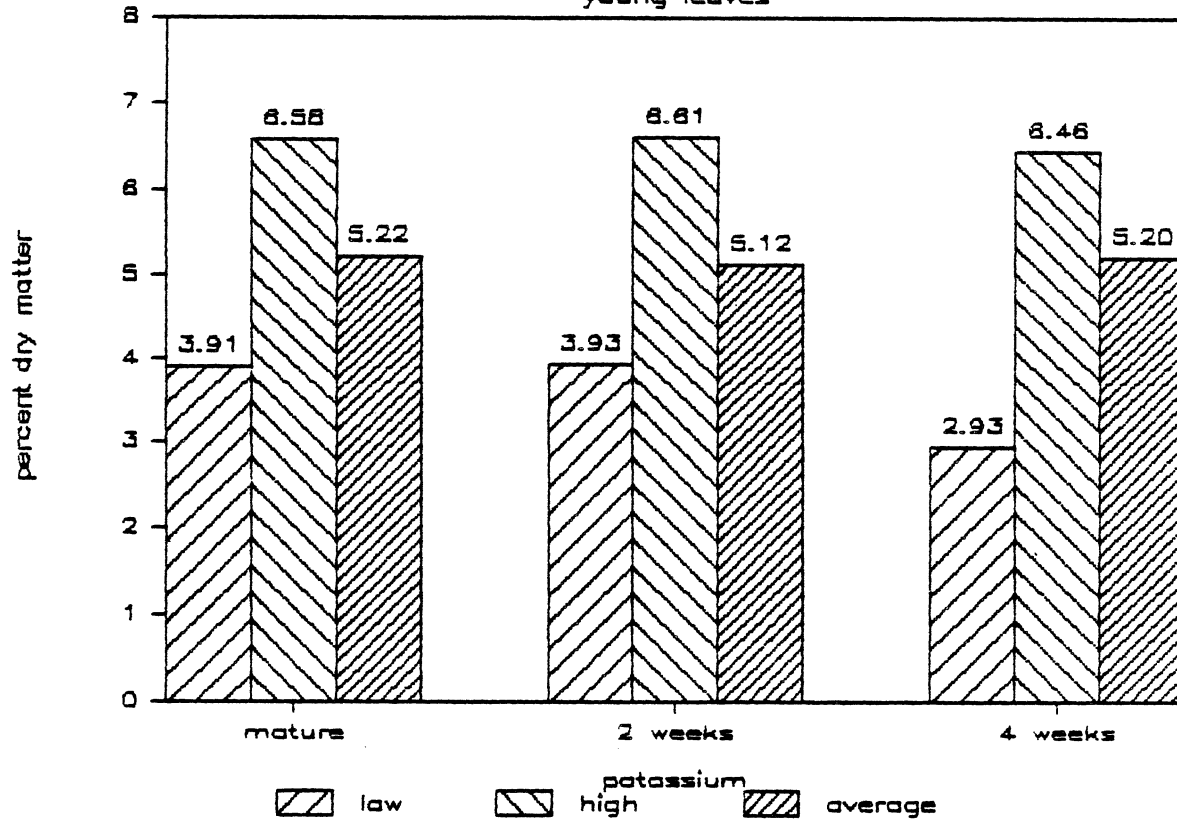


young leaves



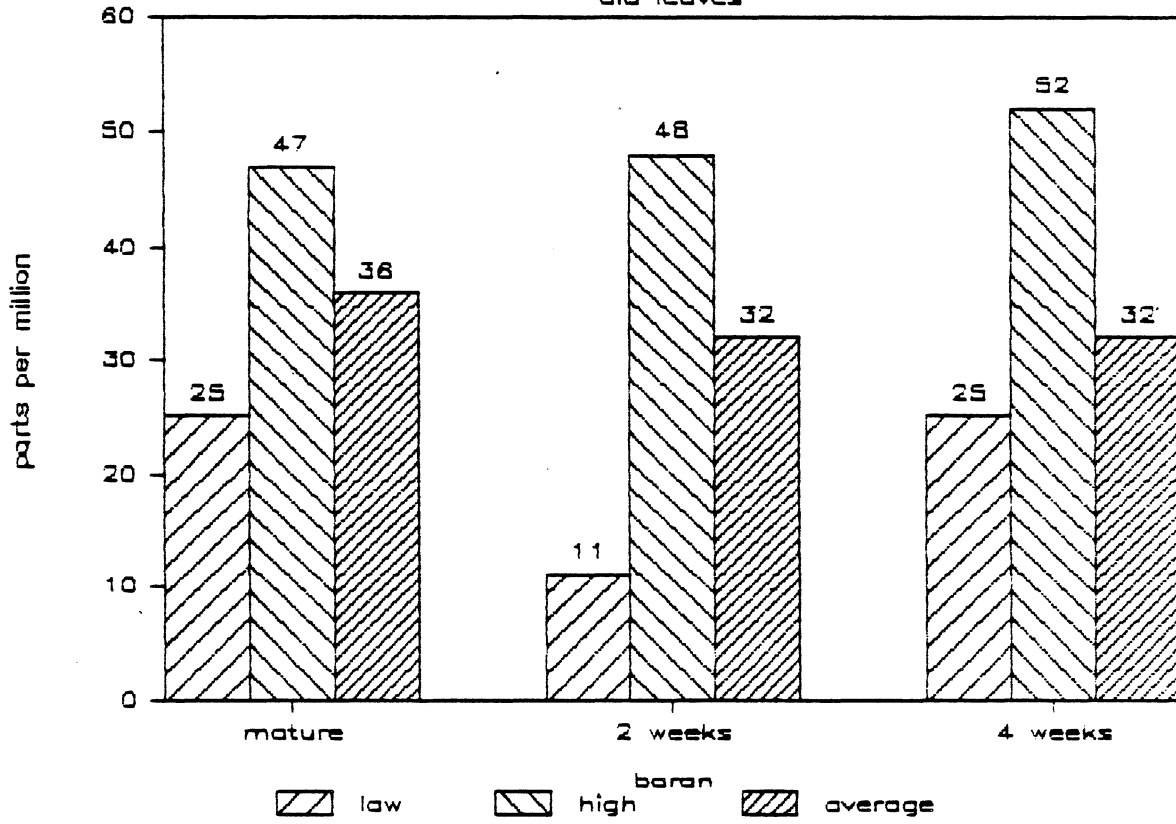
ROMAINE

young leaves

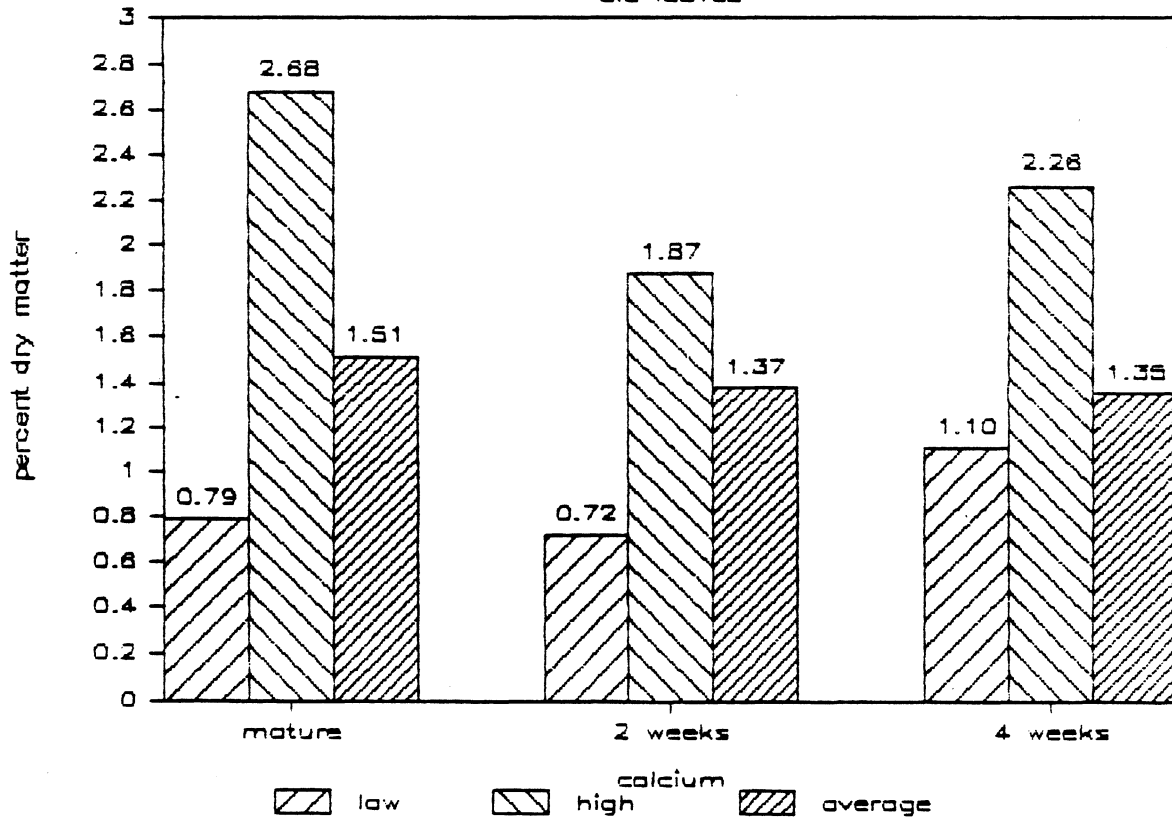


ENDIVE

old leaves

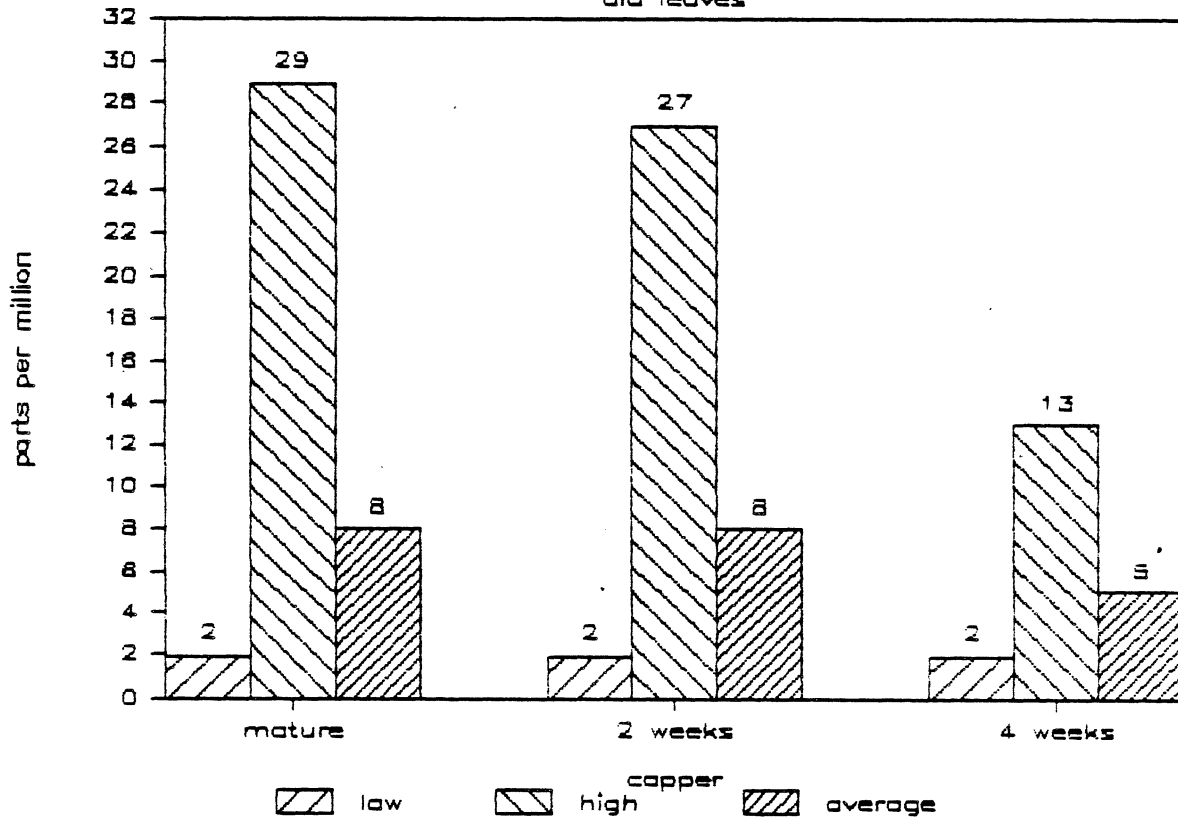


old leaves

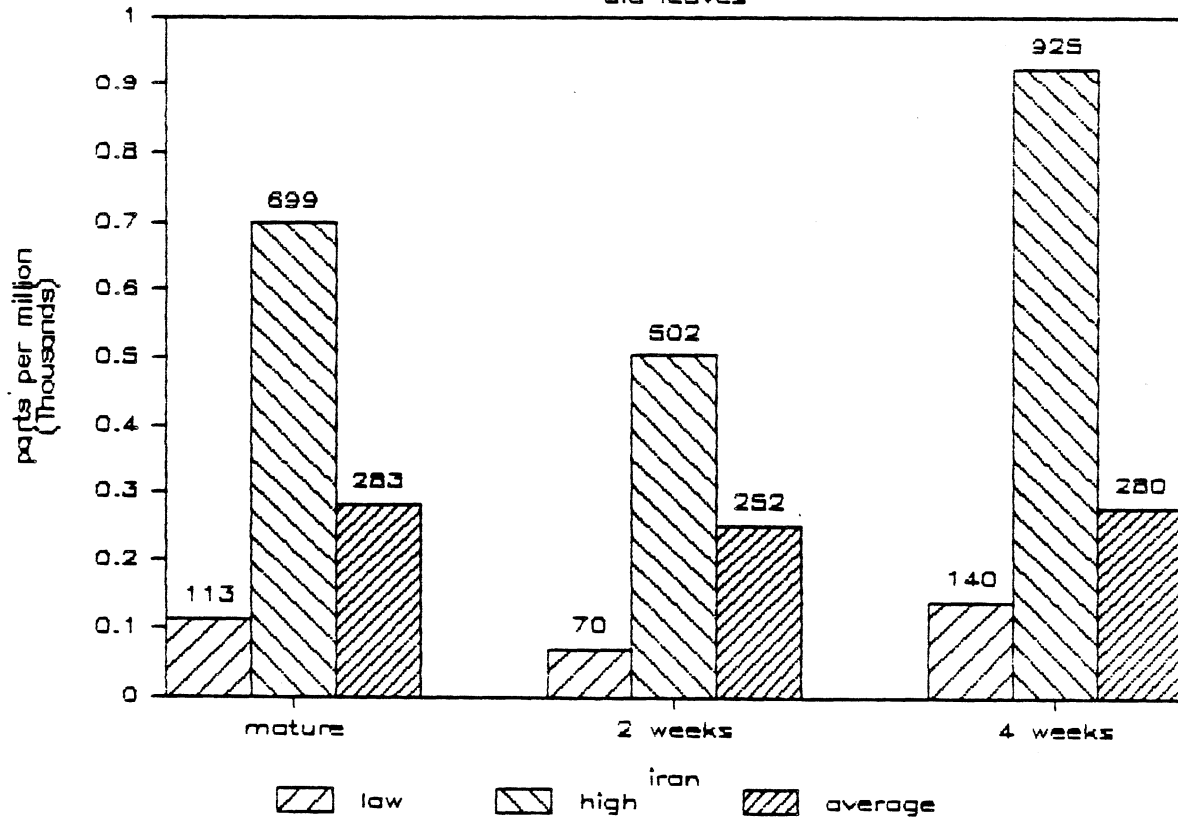


ENDIVE

old leaves

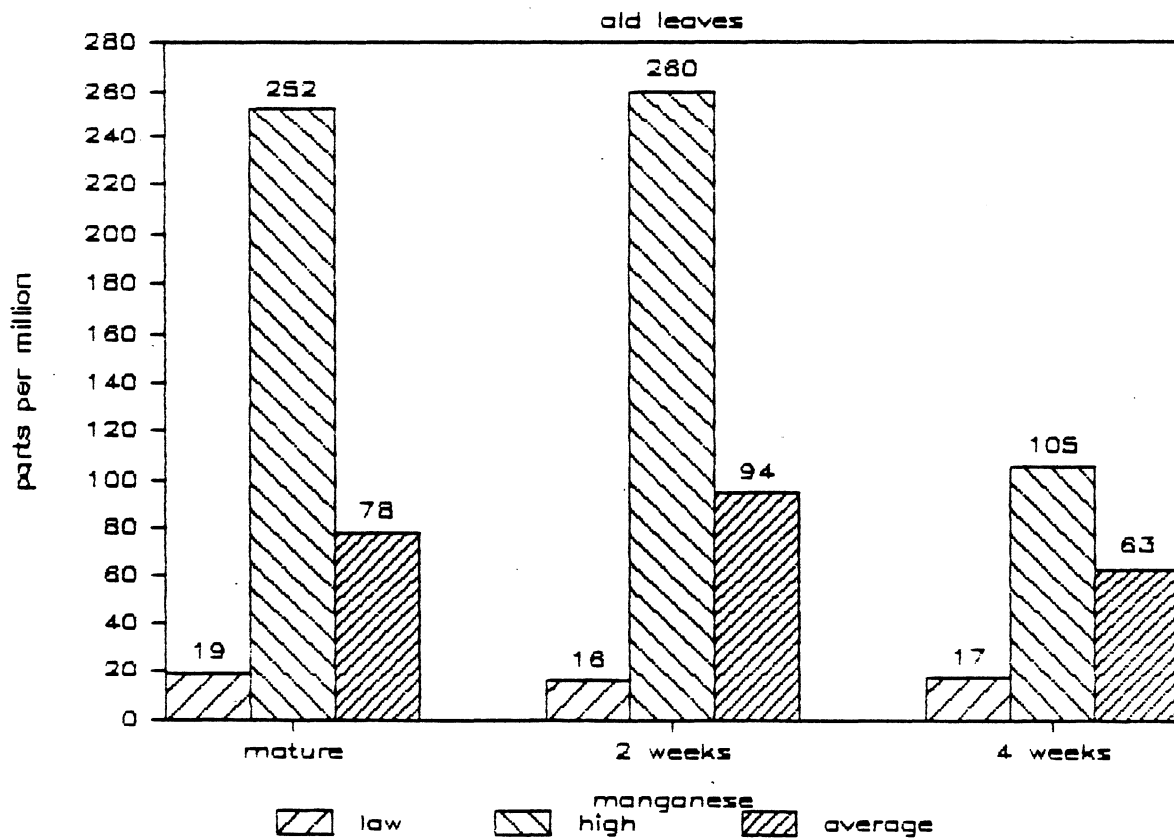
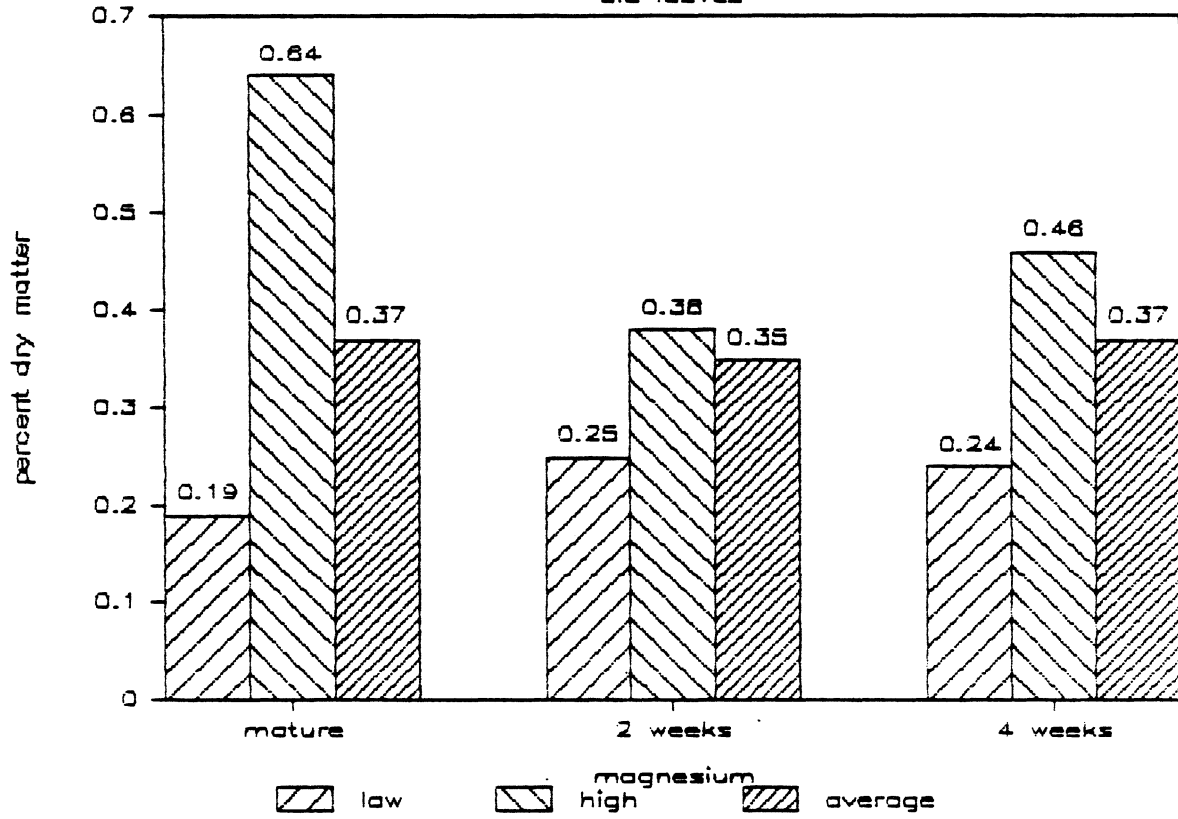


old leaves

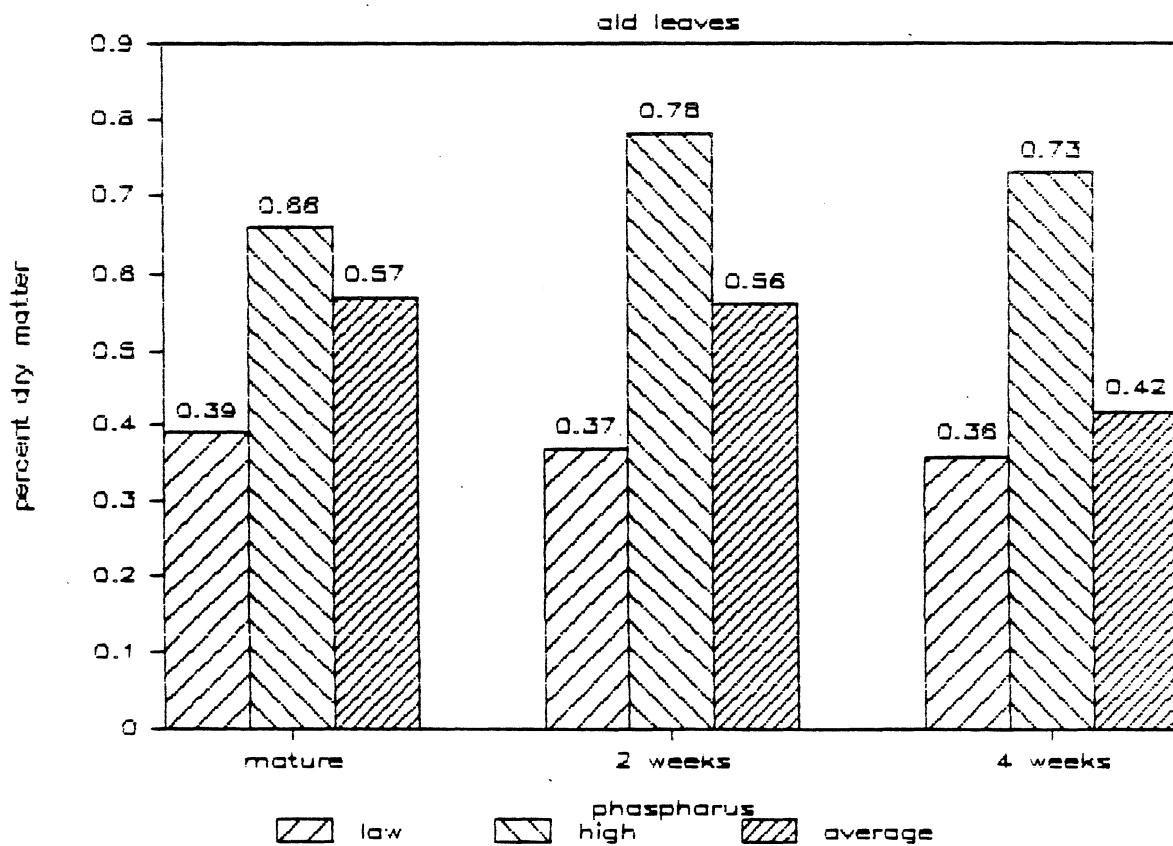
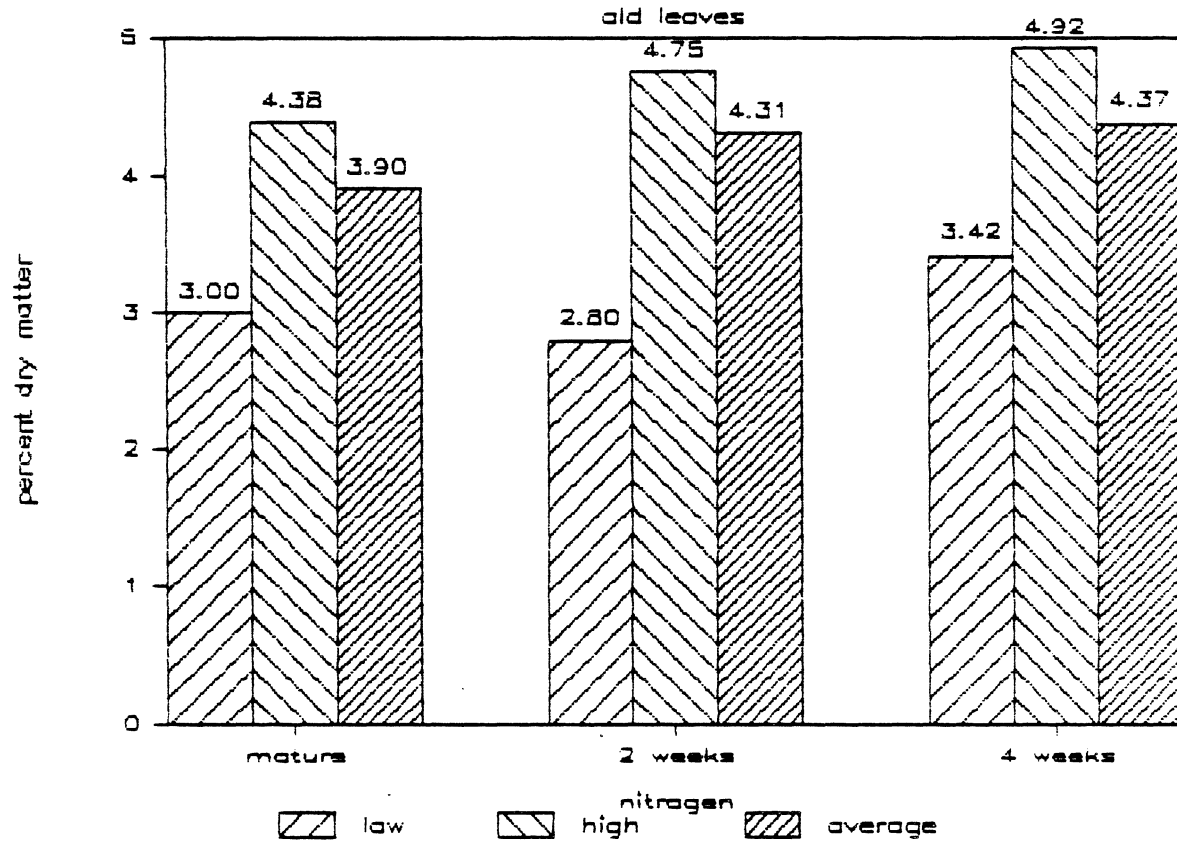


ENDIVE

old leaves

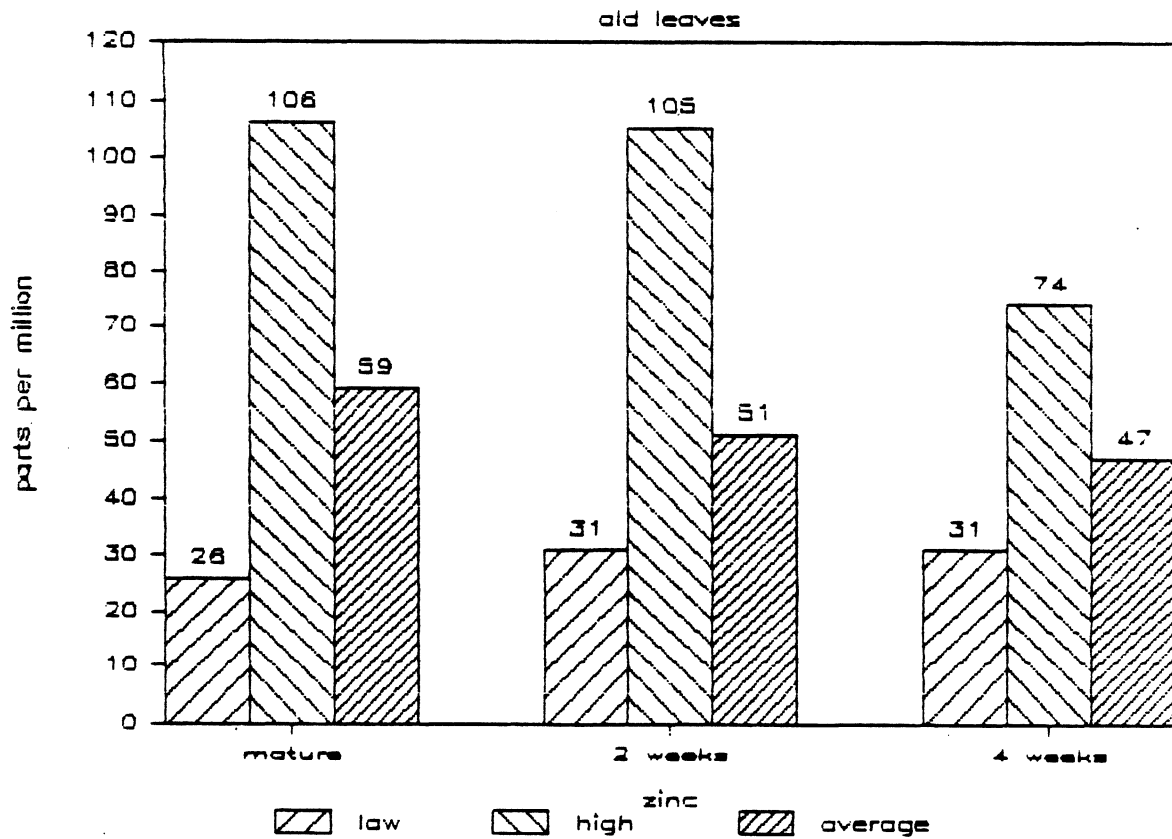
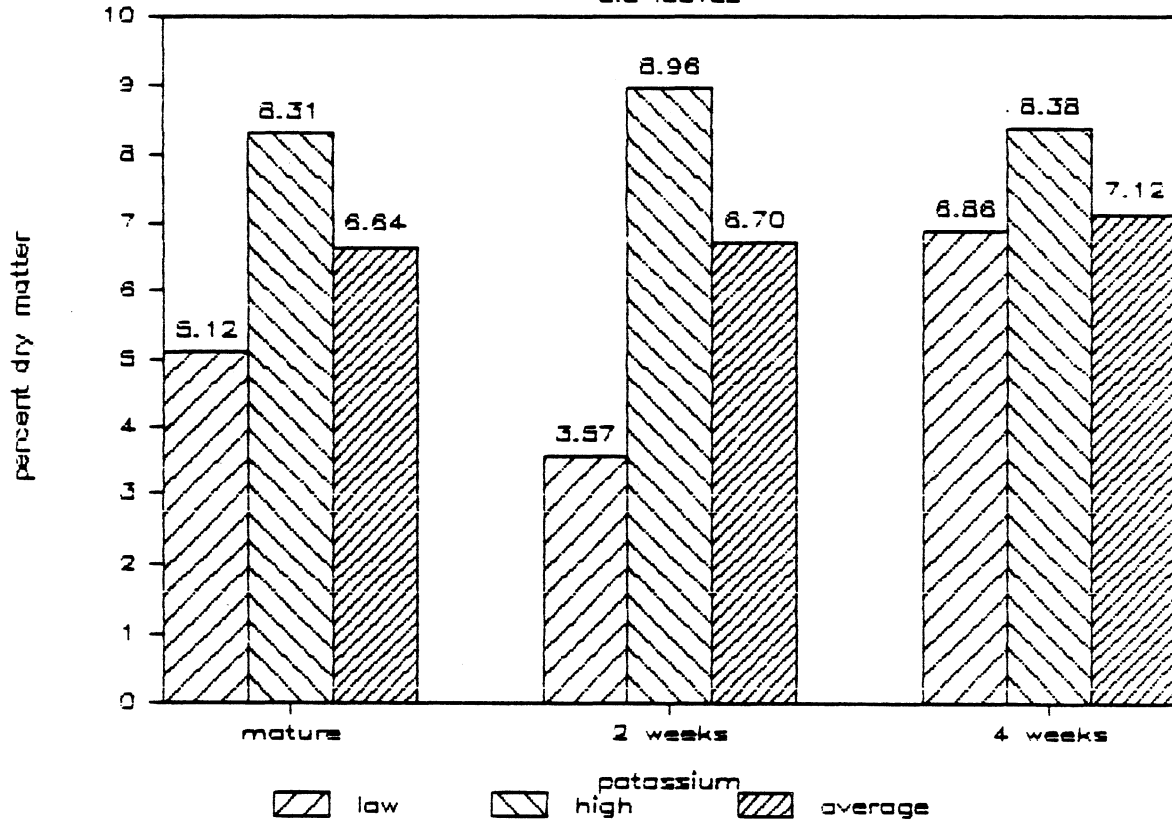


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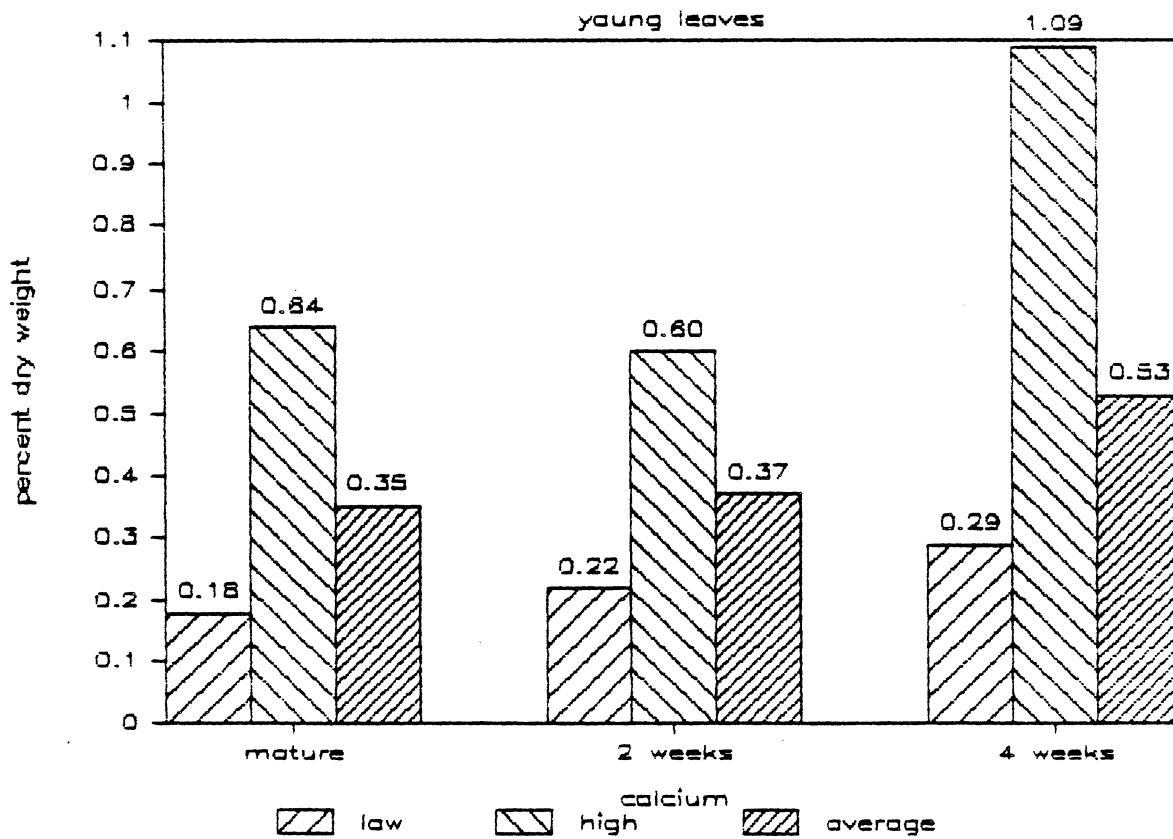
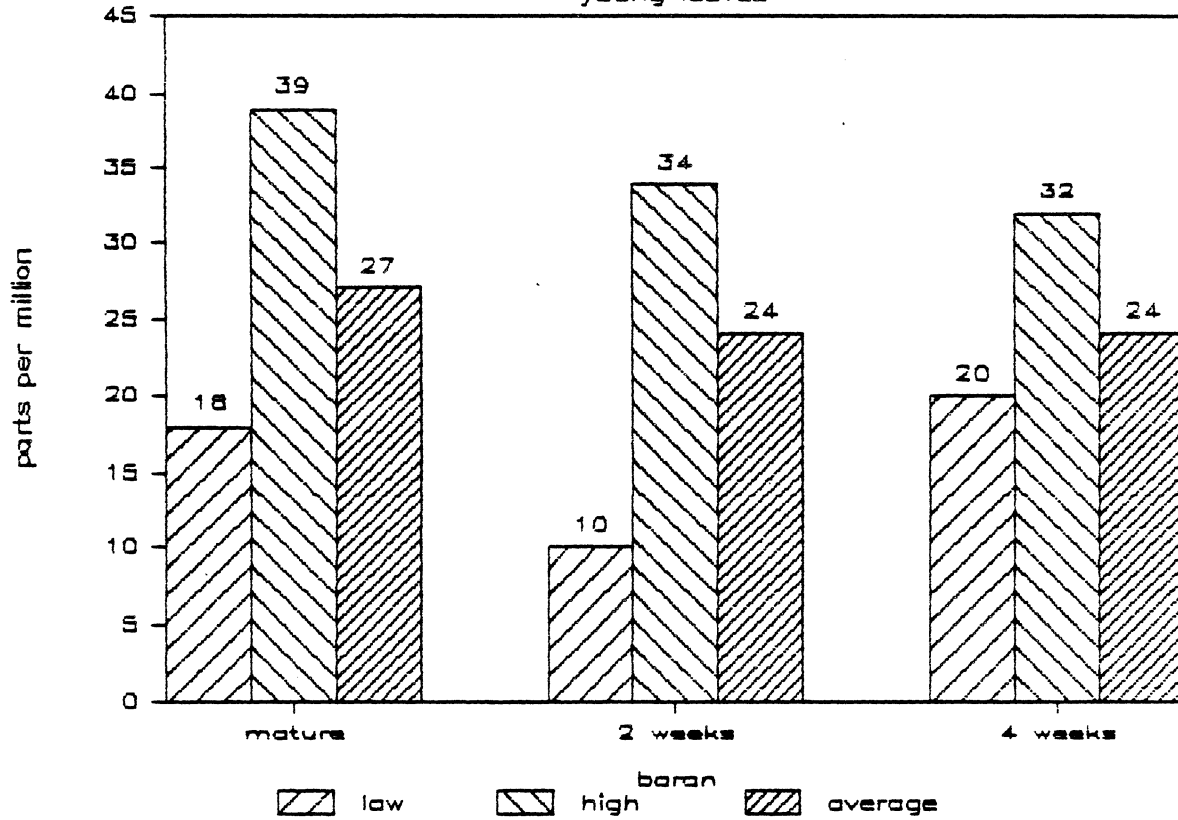
ENDIVE

old leaves



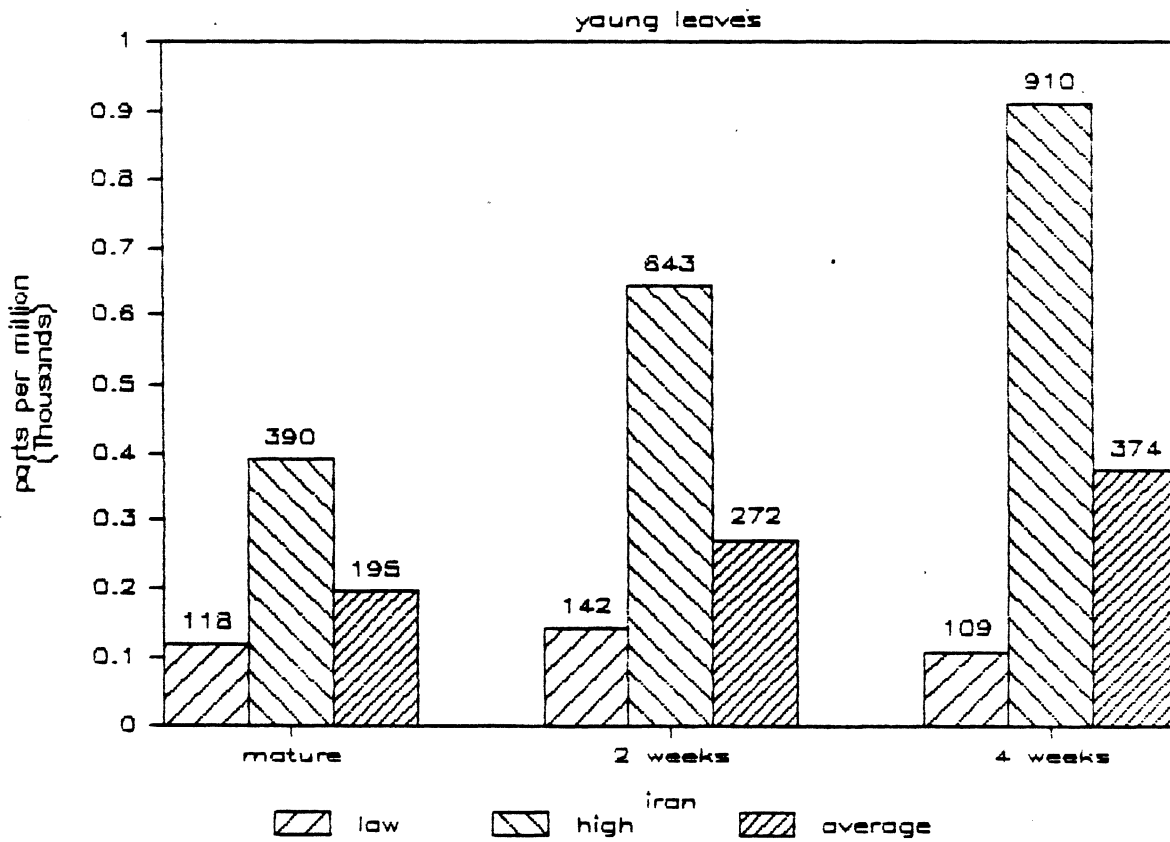
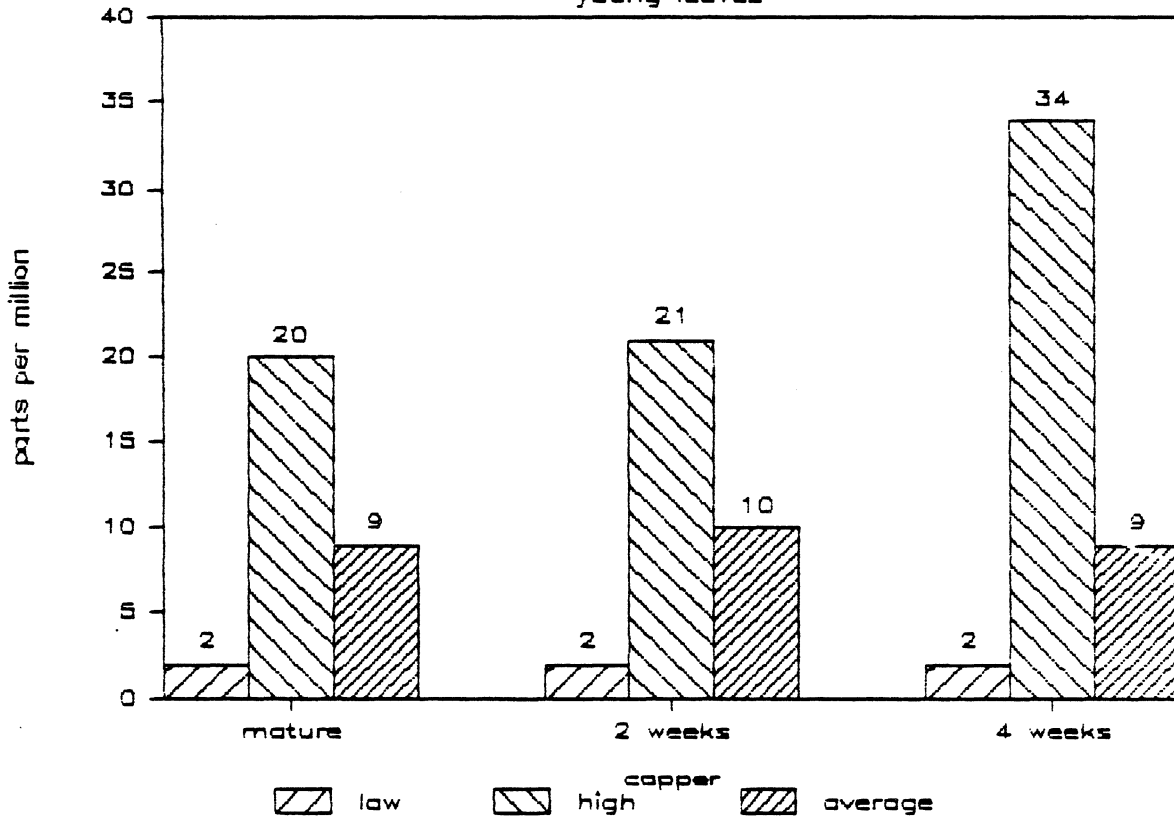
ENDIVE

young leaves



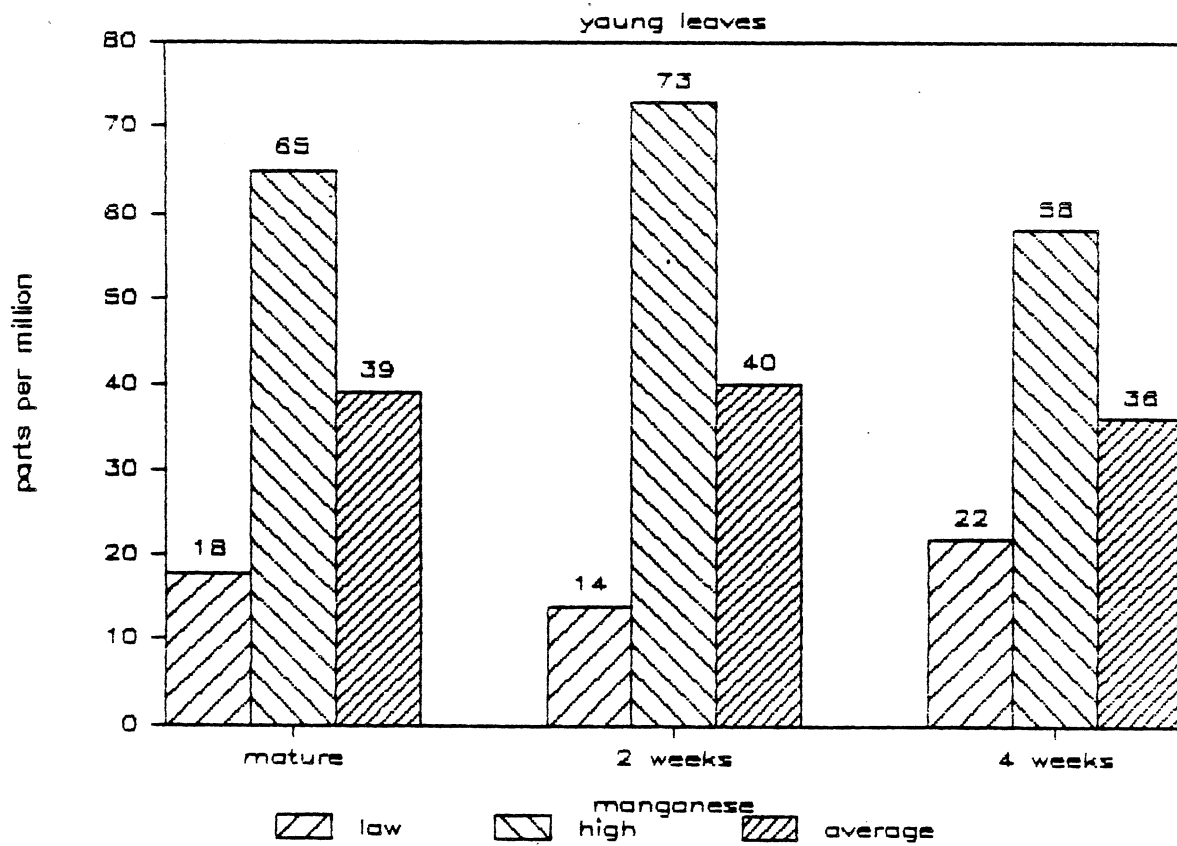
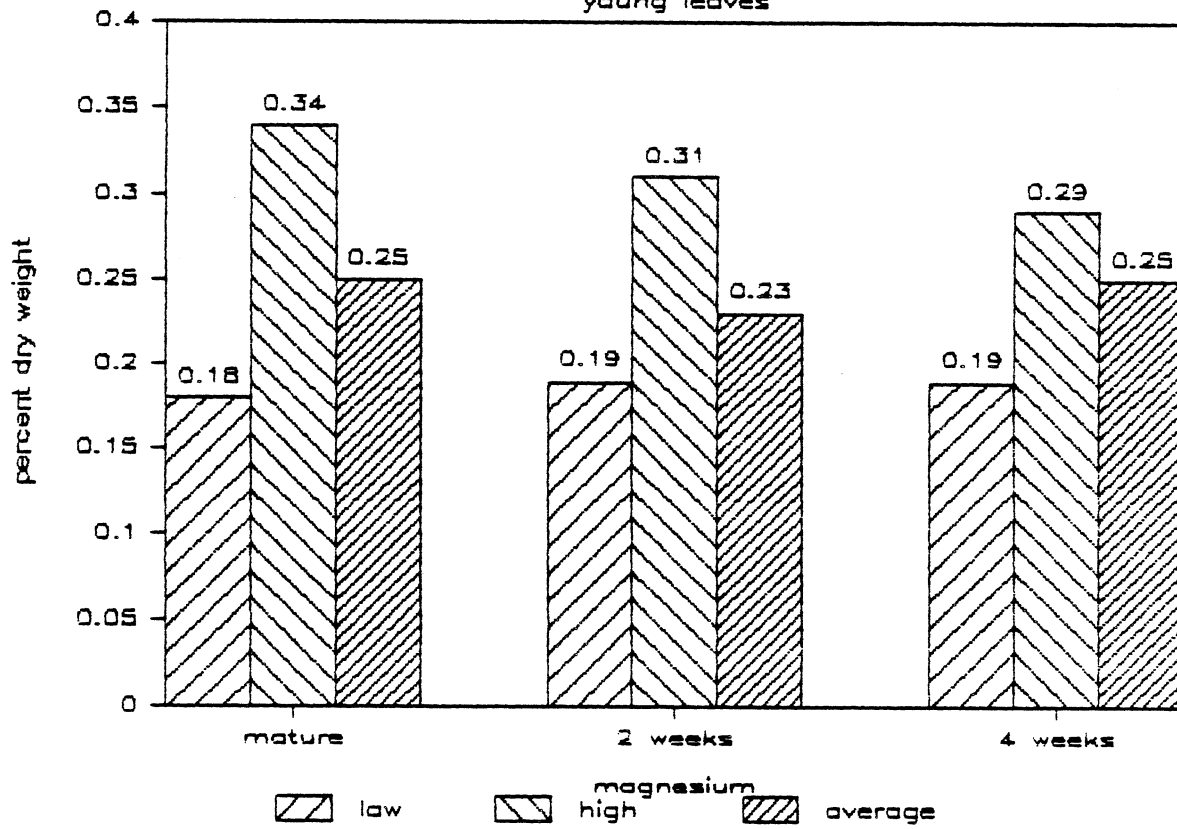
ENDIVE

young leaves



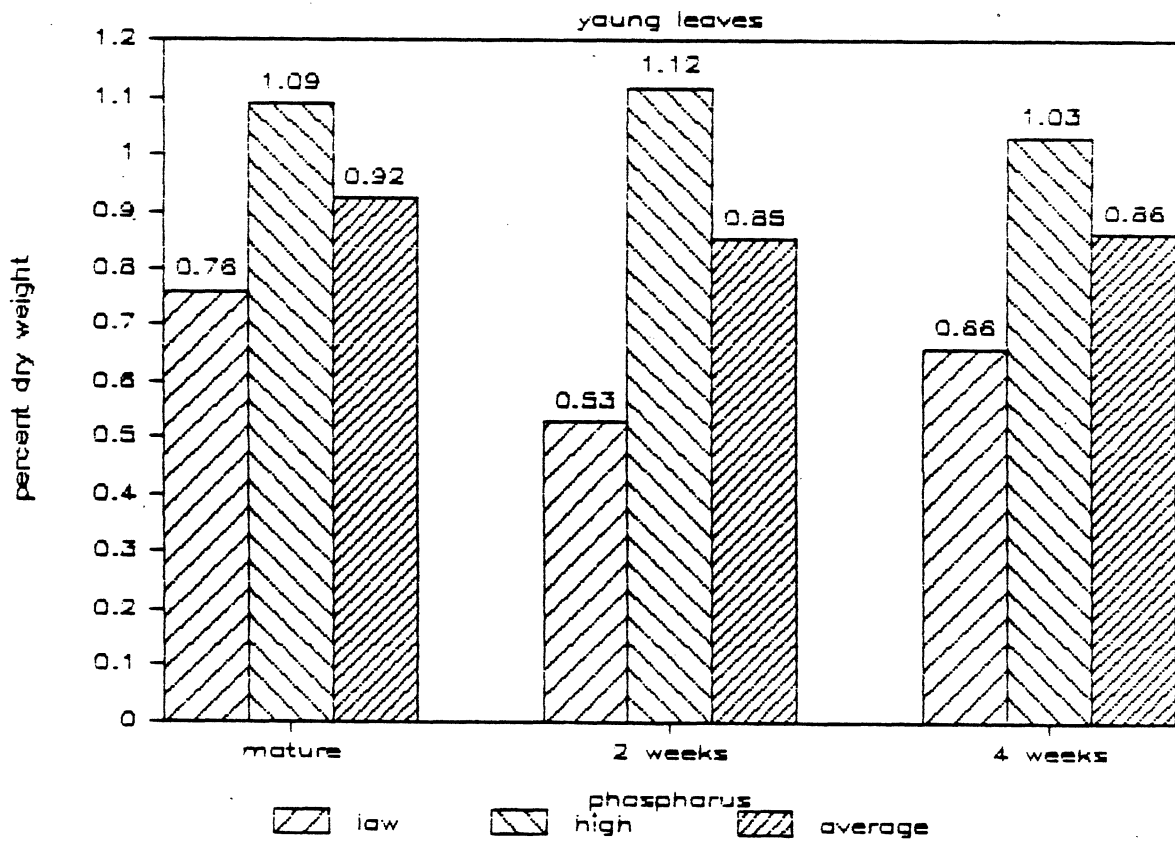
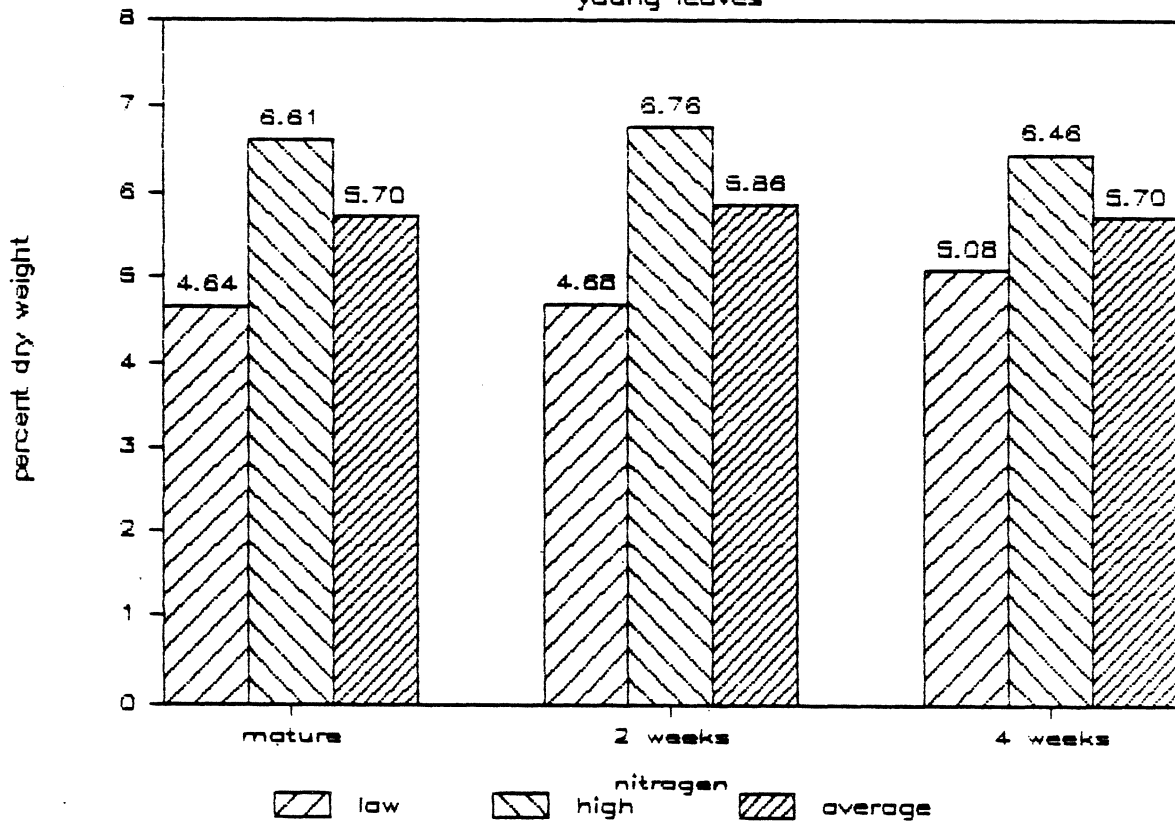
ENDIVE

young leaves



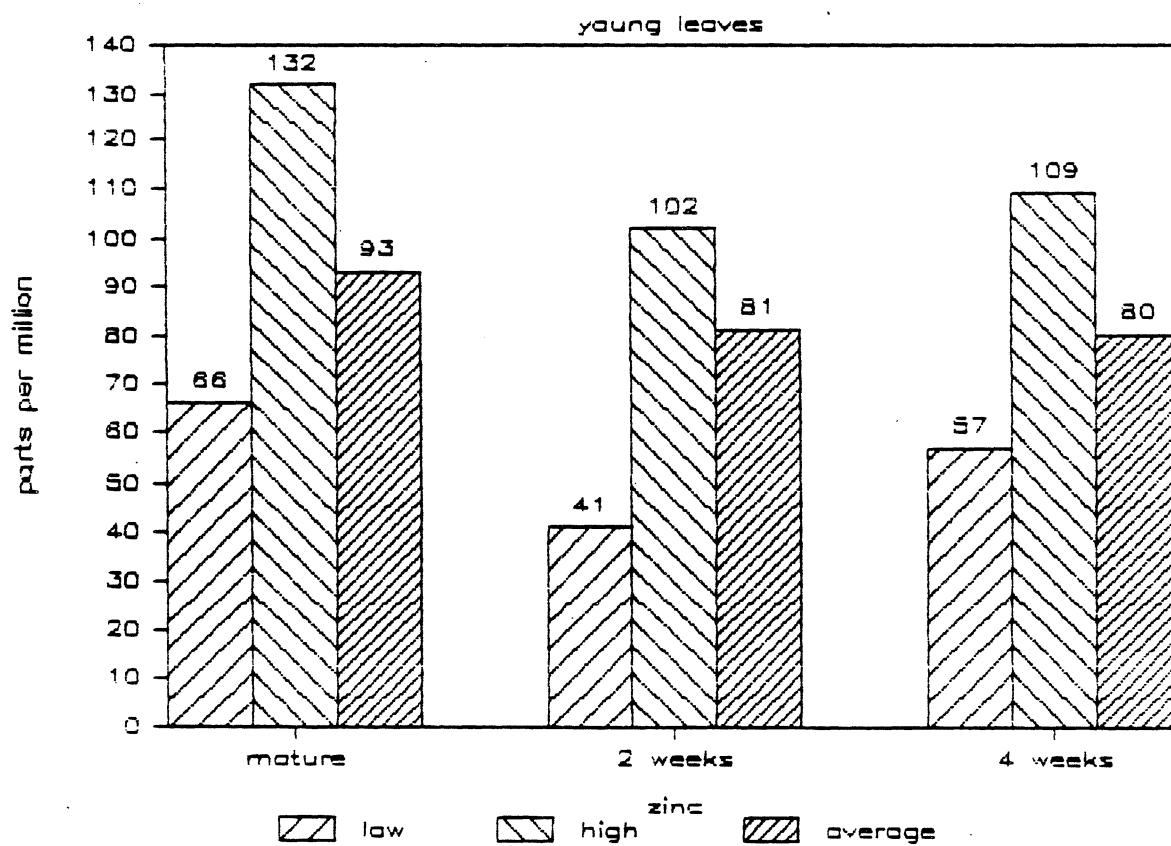
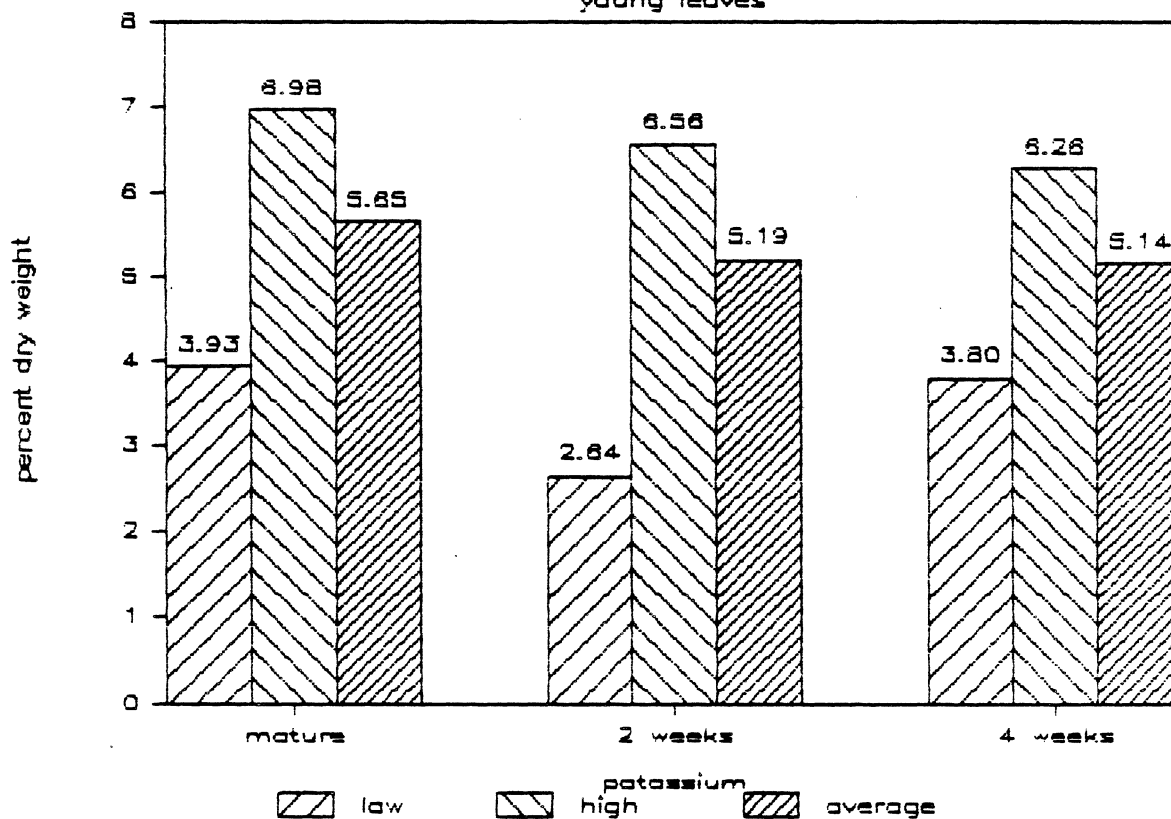
ENDIVE

young leaves



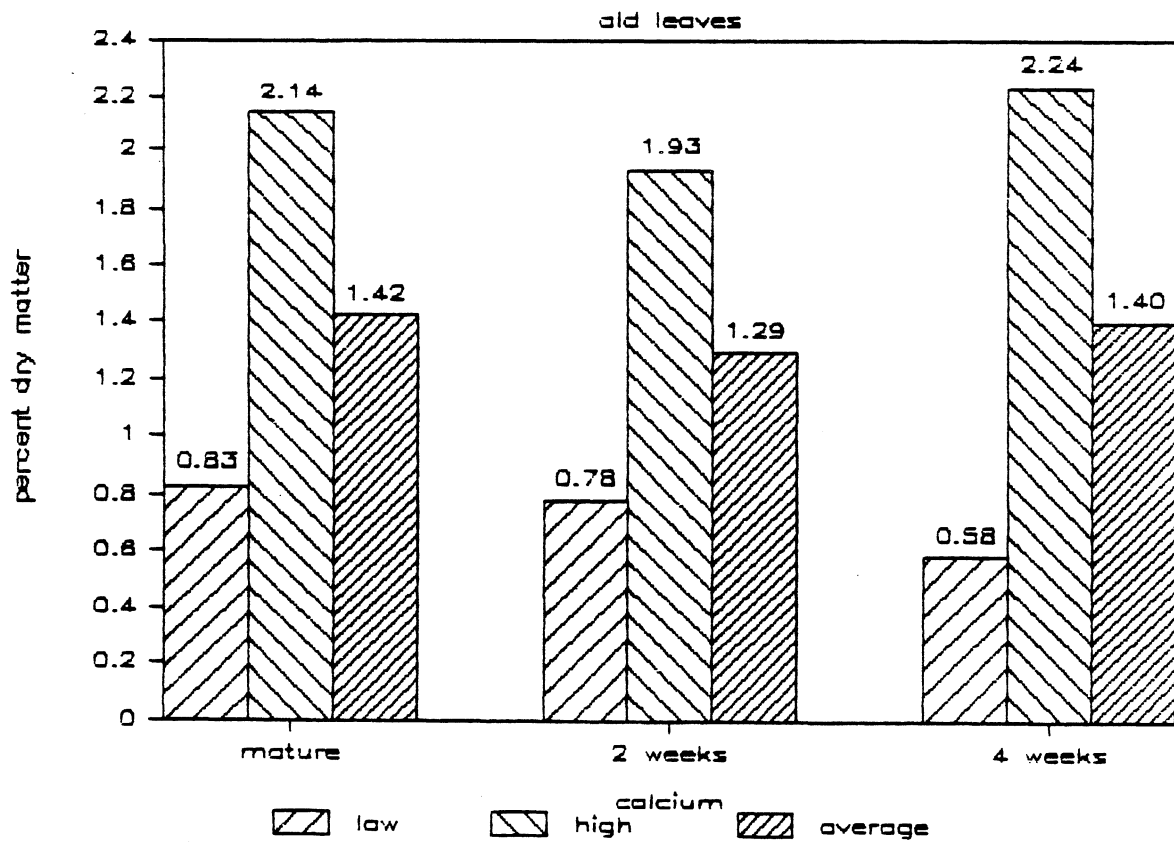
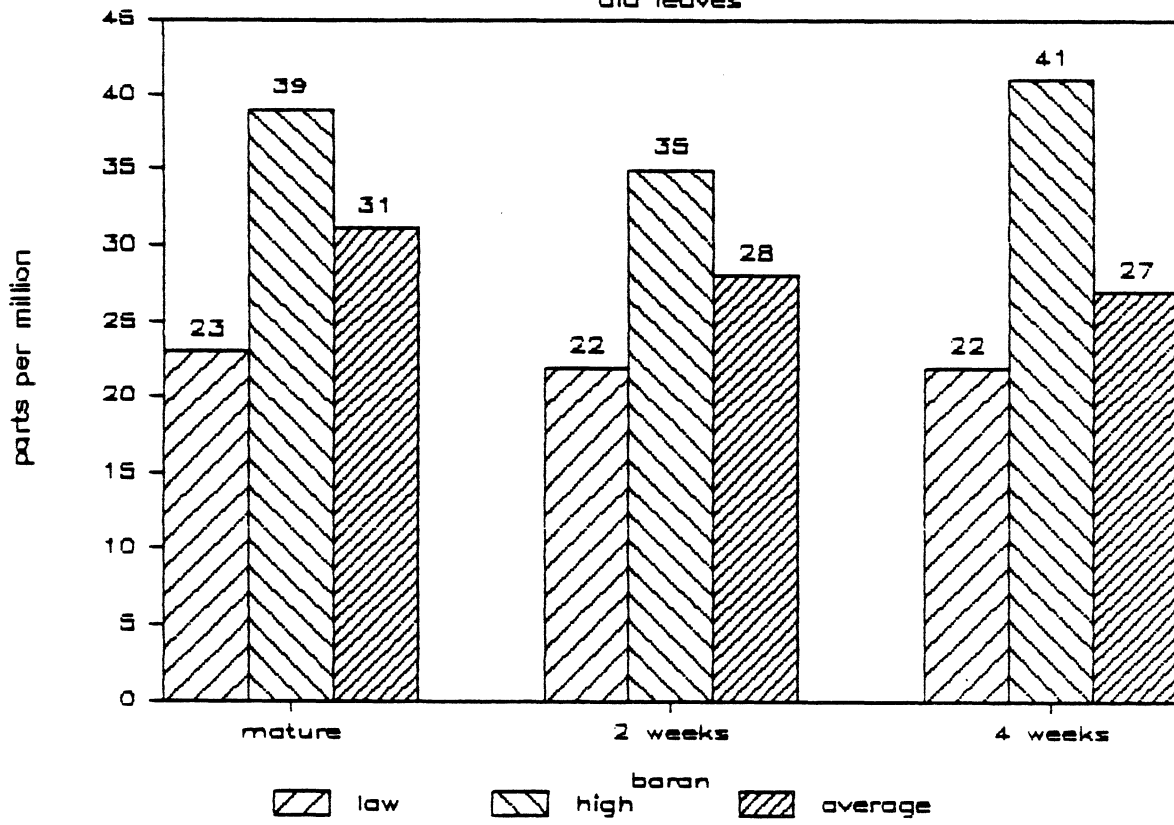
ENDIVE

young leaves



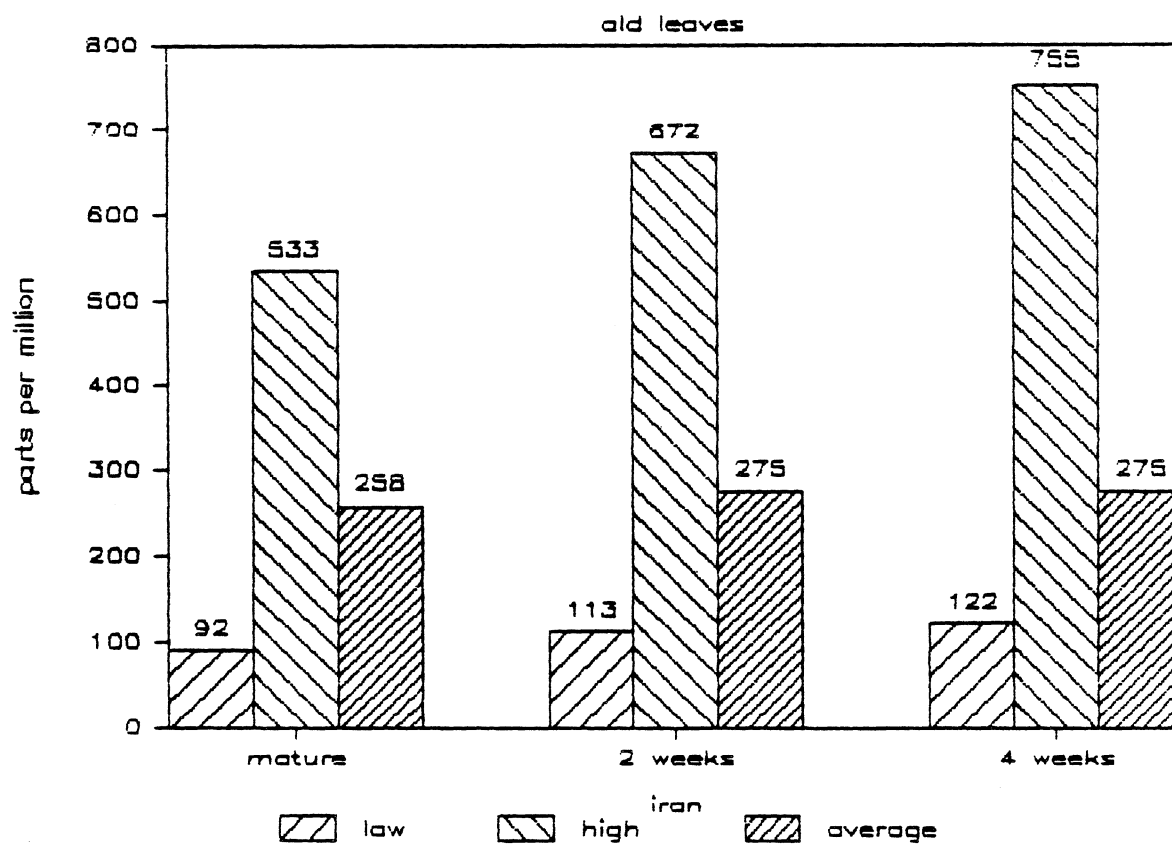
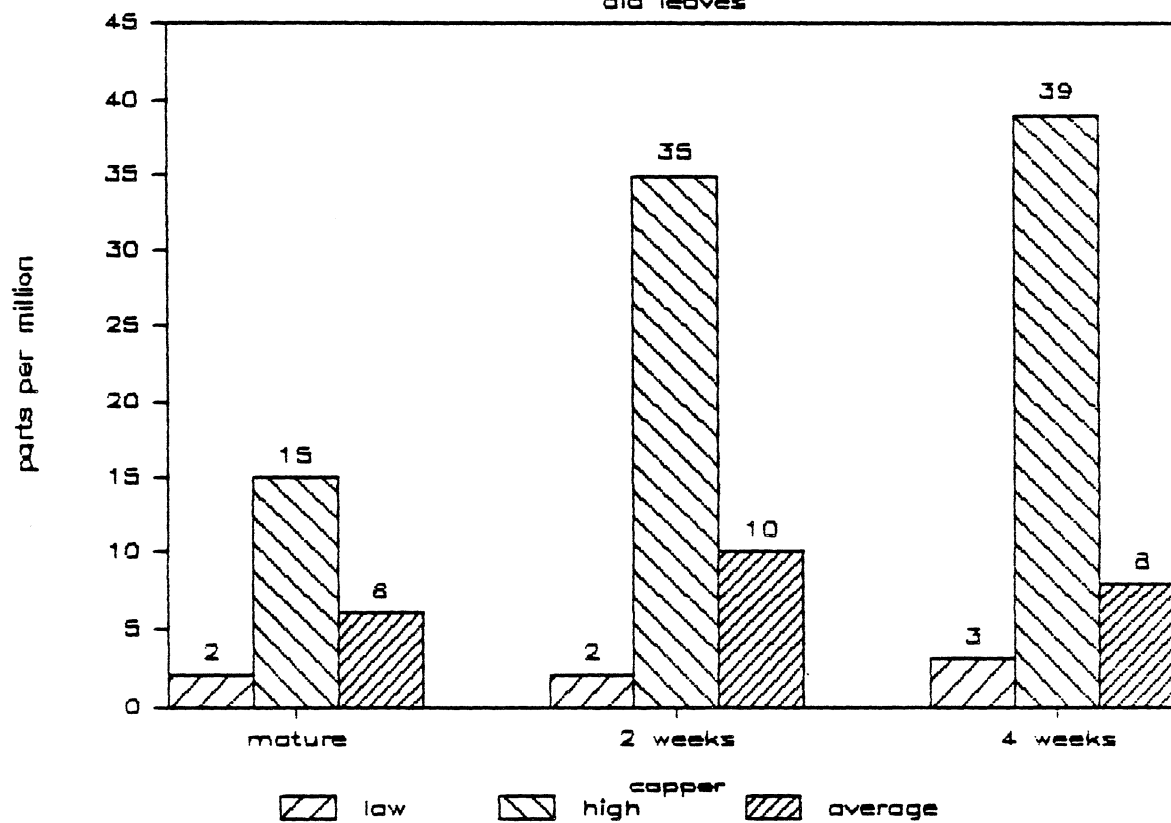
ESCAROLE

aid leaves



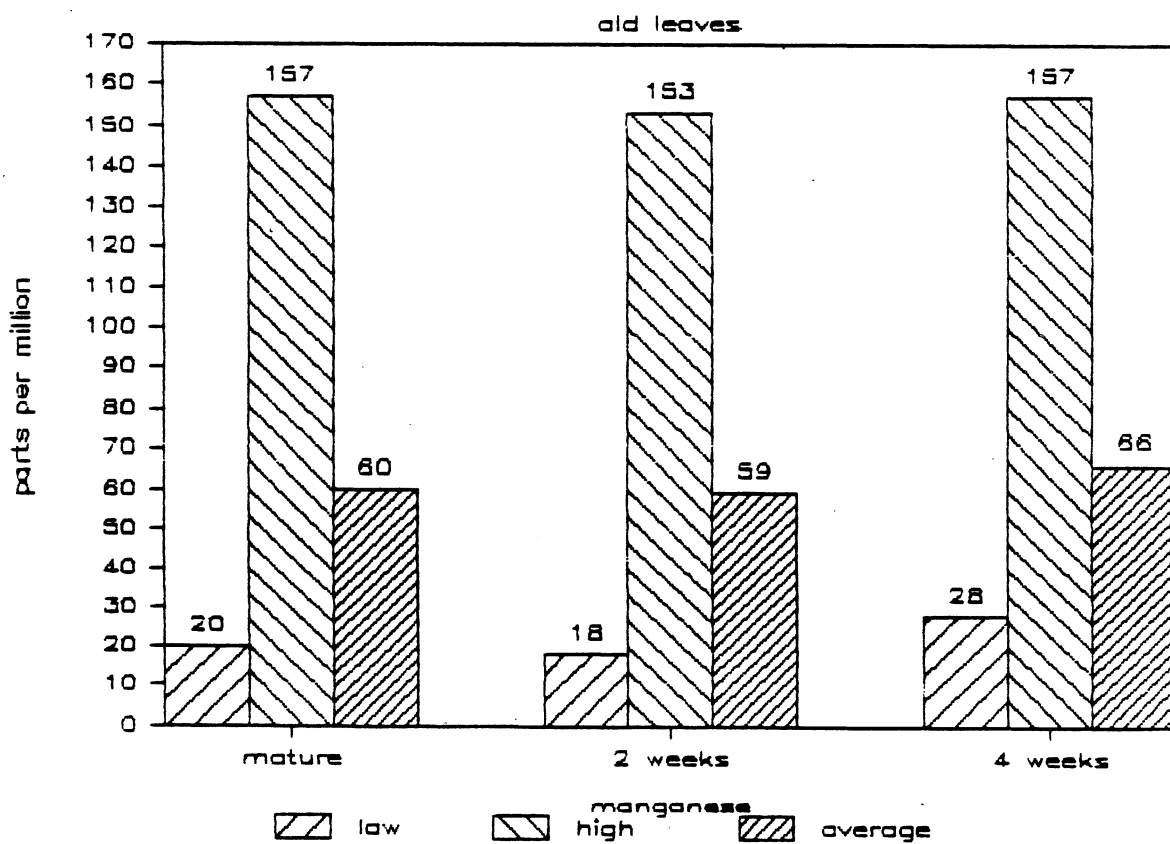
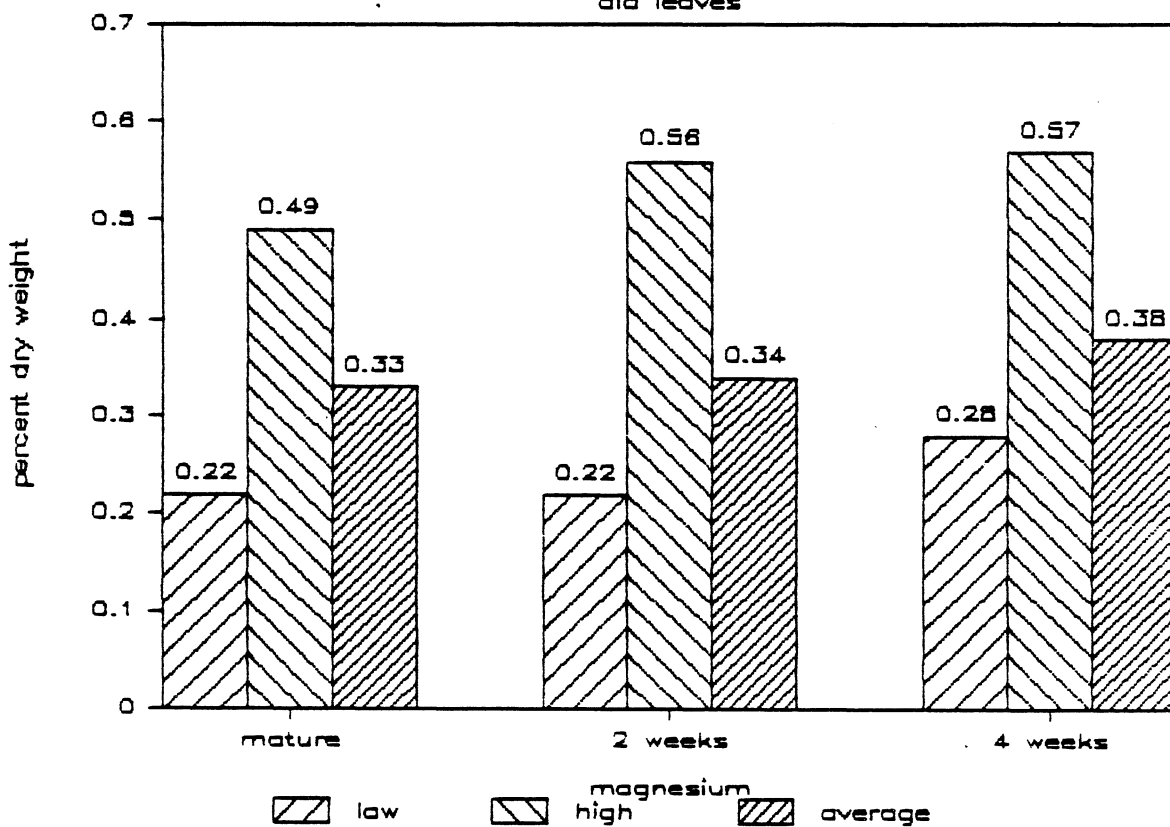
ESCAROLE

old leaves



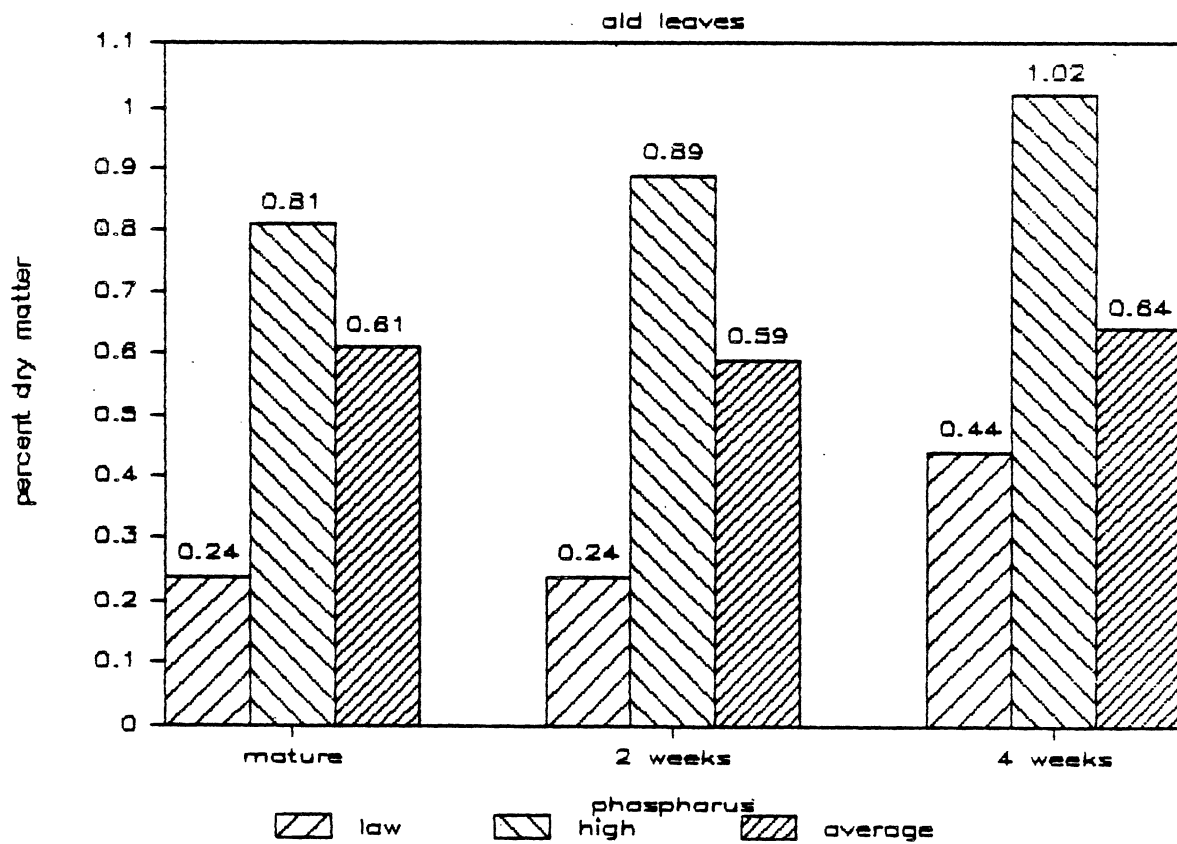
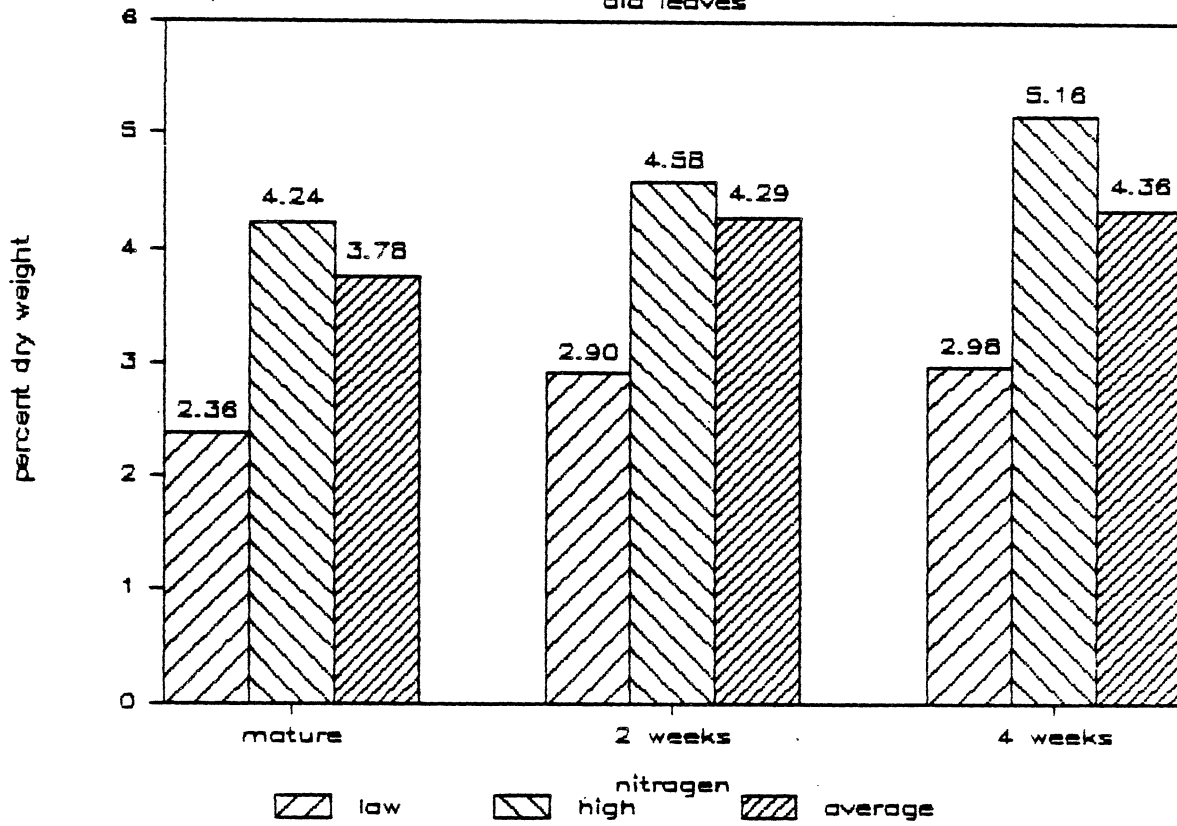
ESCAROLE

old leaves



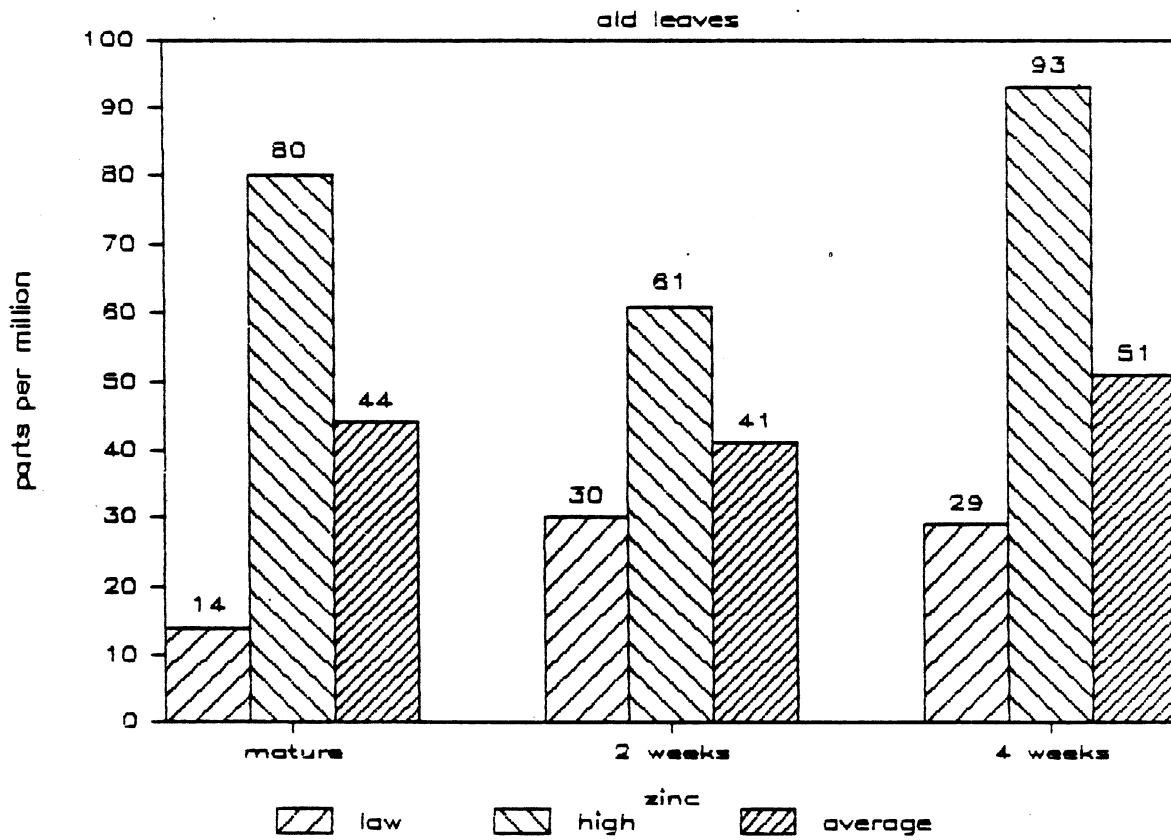
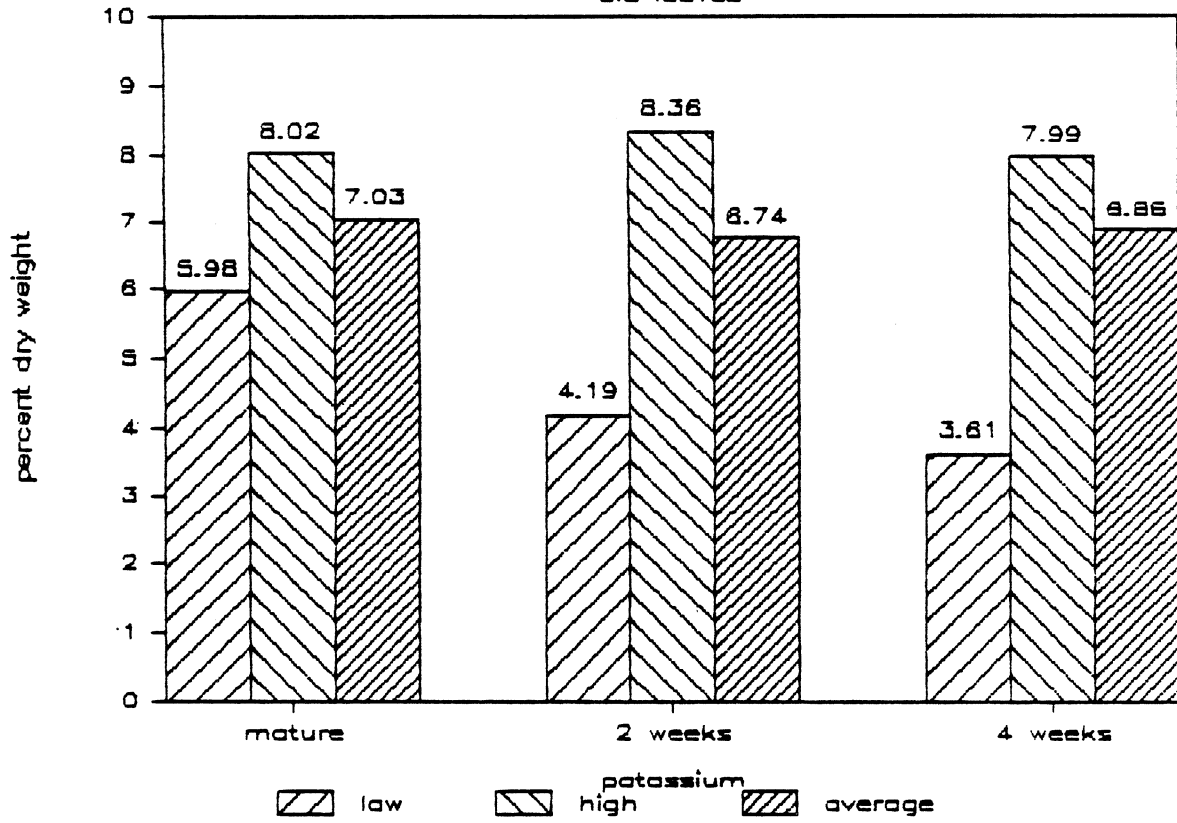
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old leaves



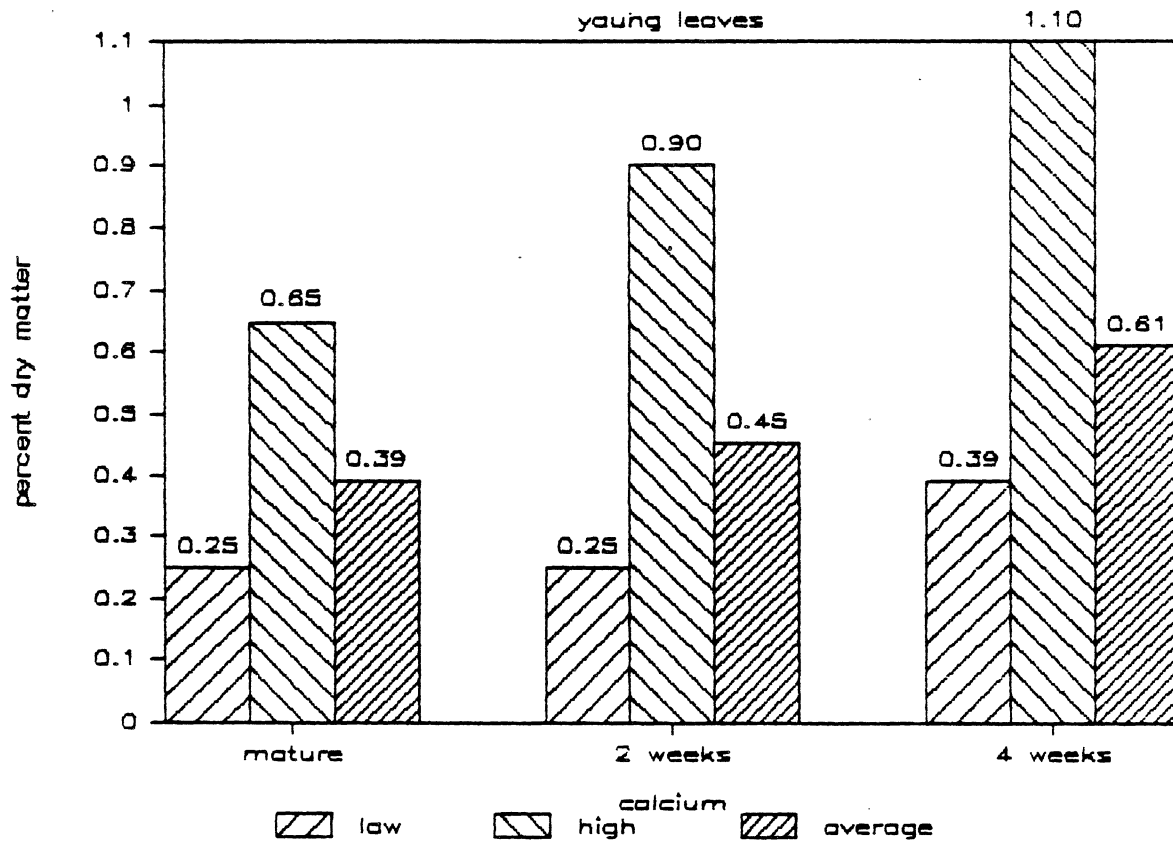
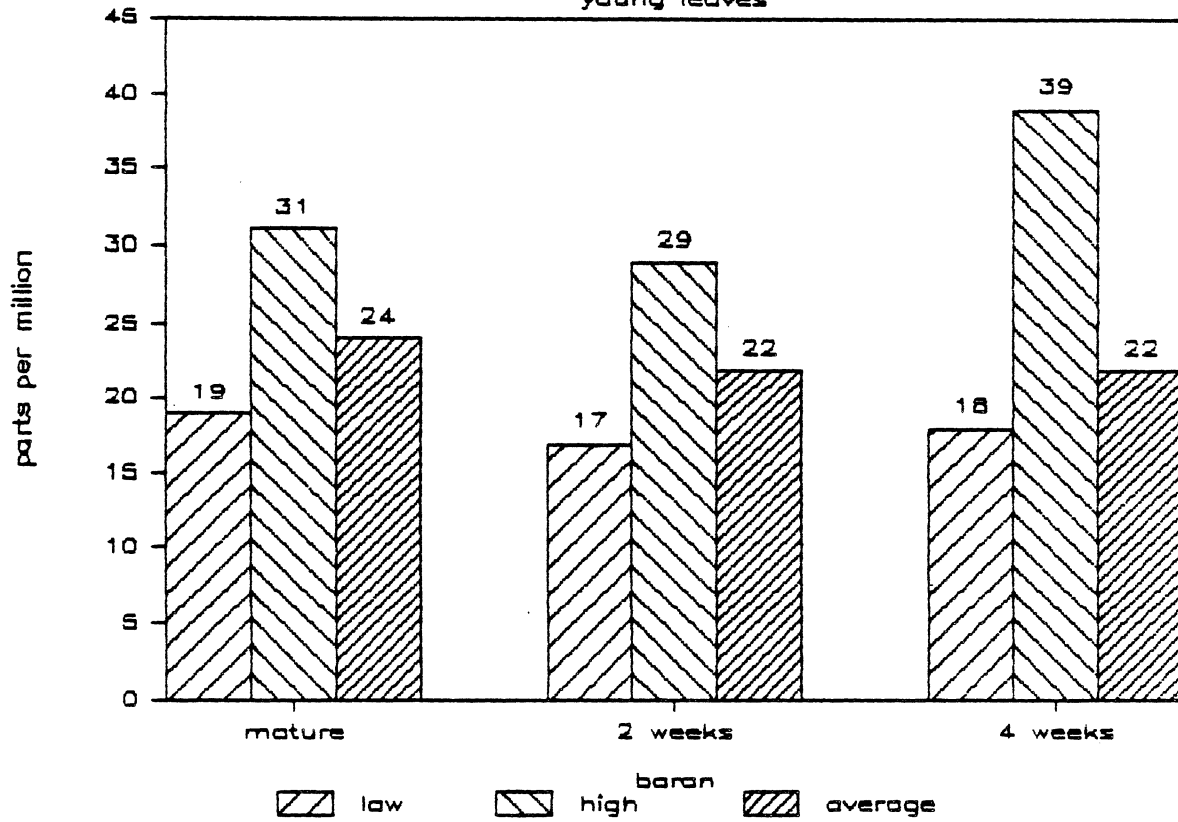
ESCAROLE

old leaves



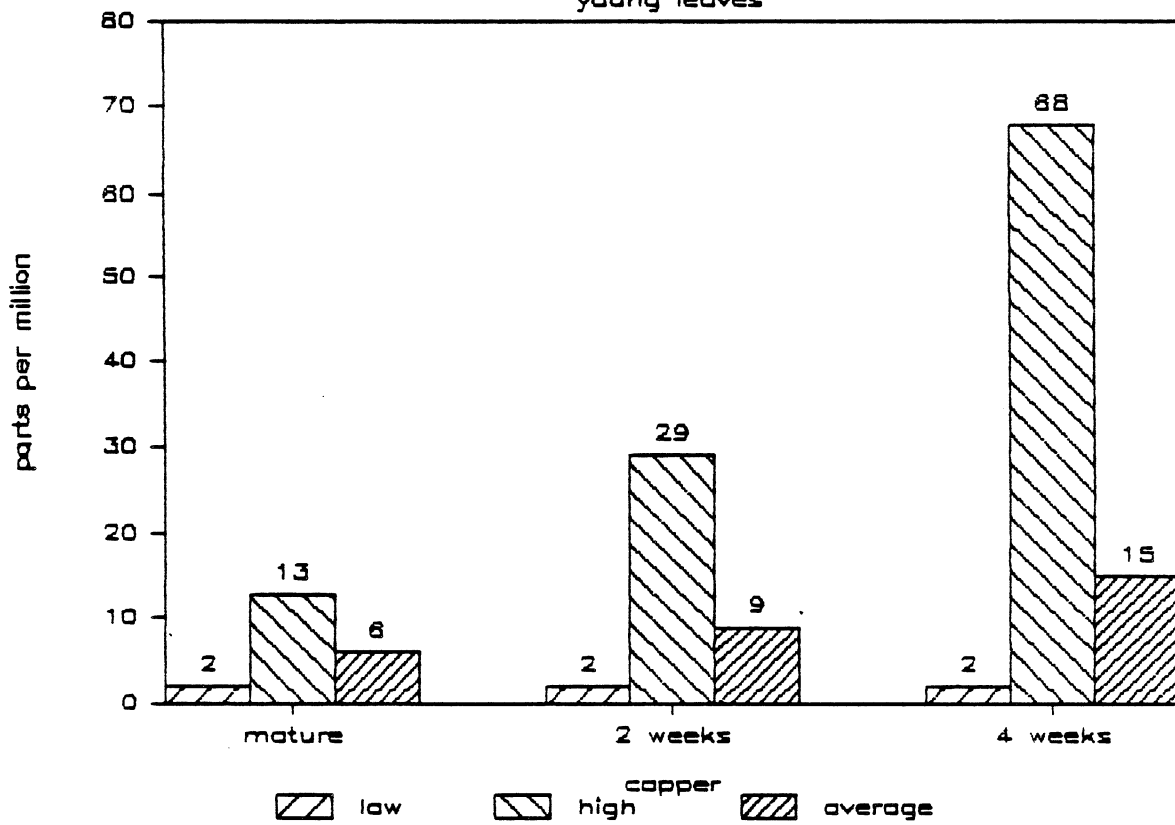
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young leaves

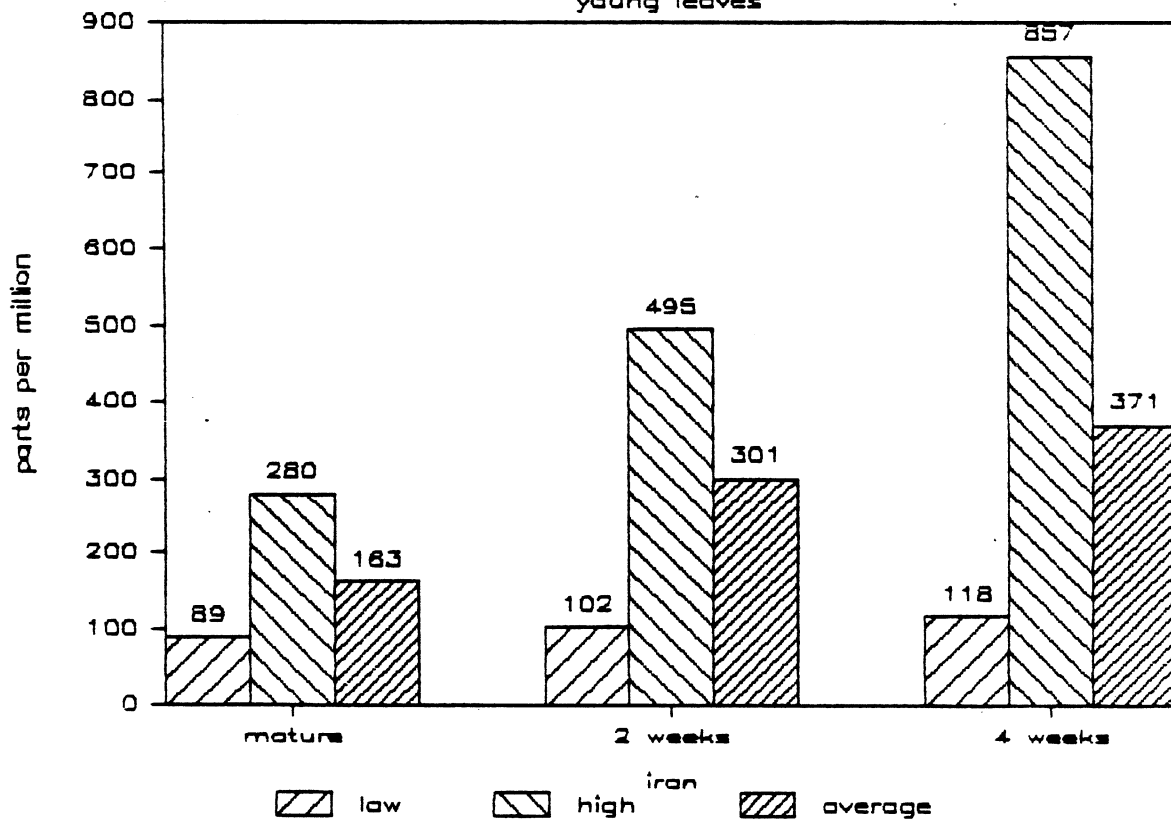


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young leaves

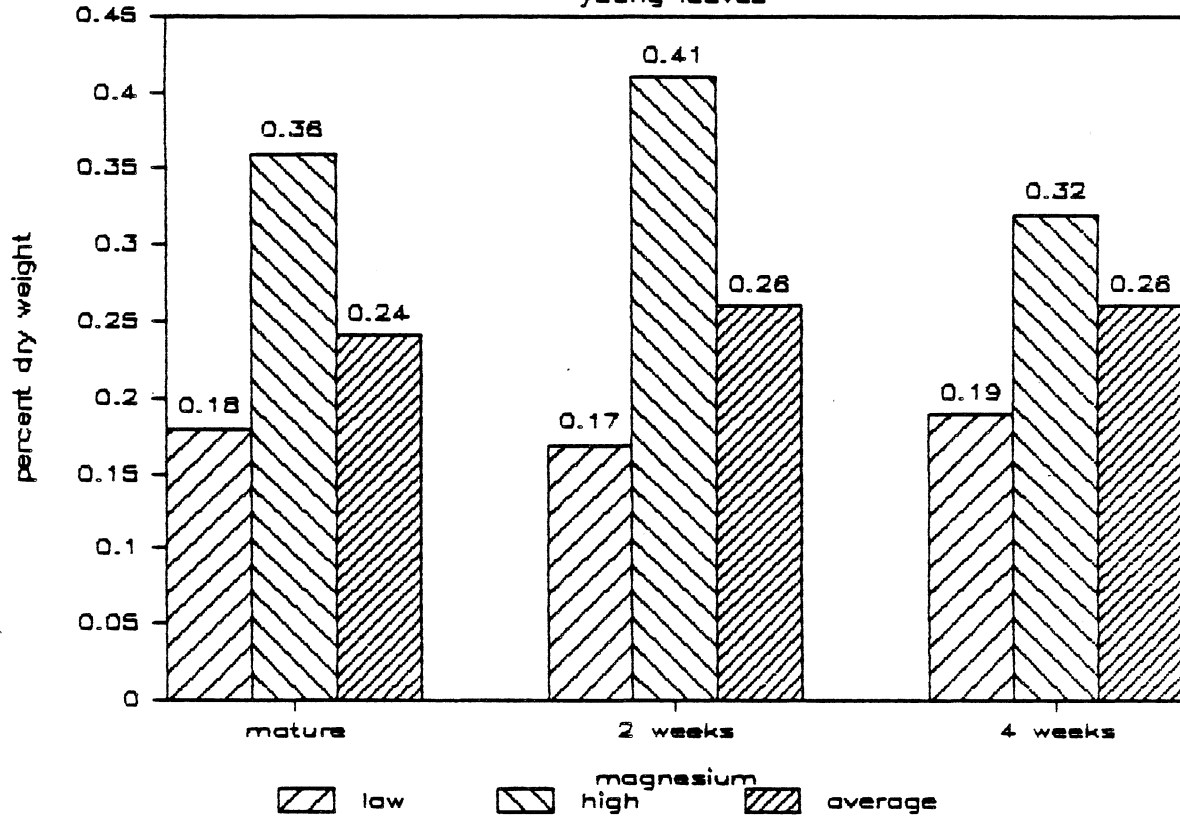


young leaves

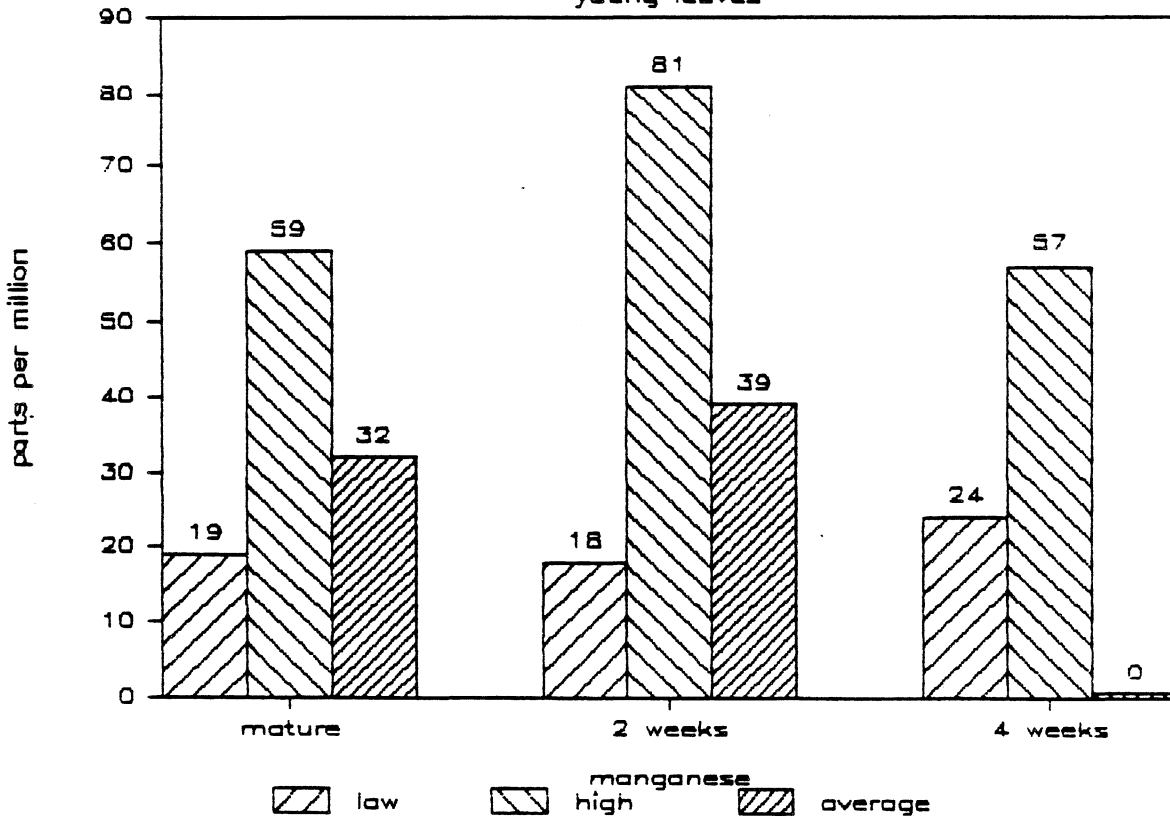


ESCAROLE

young leaves

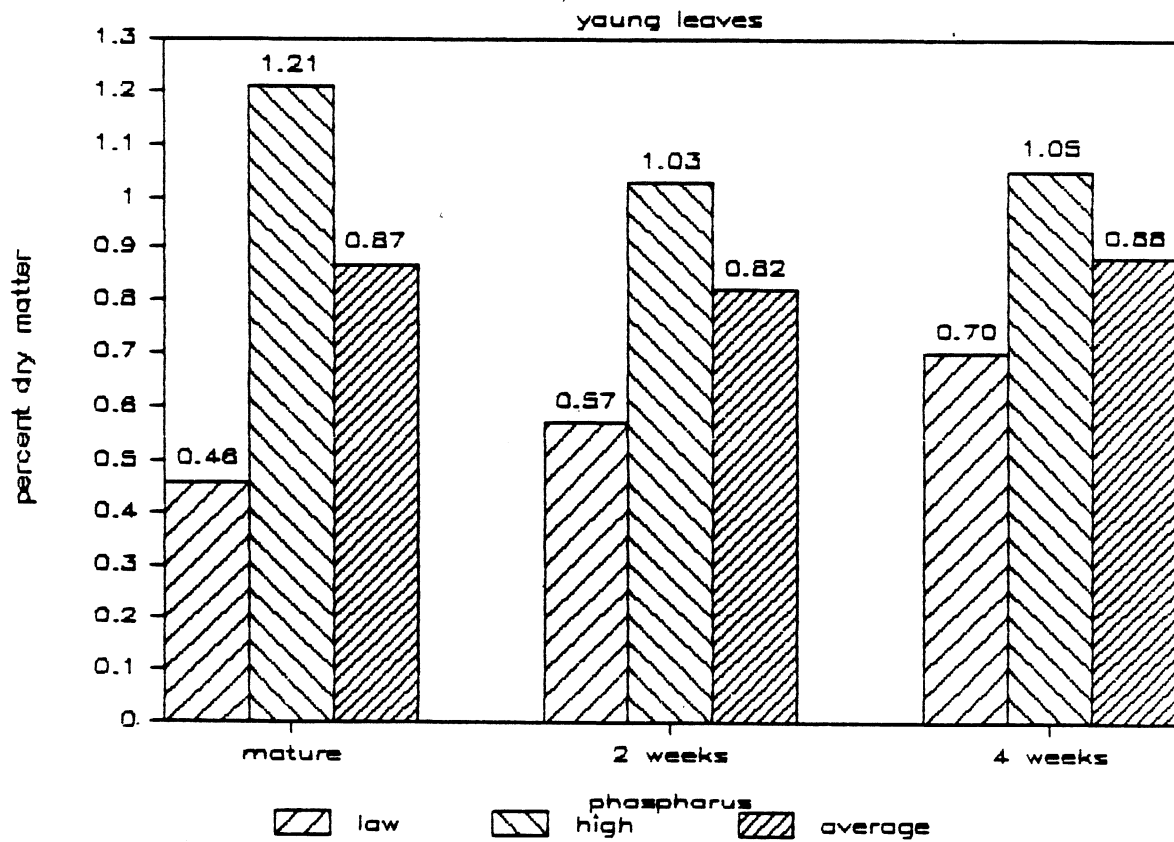
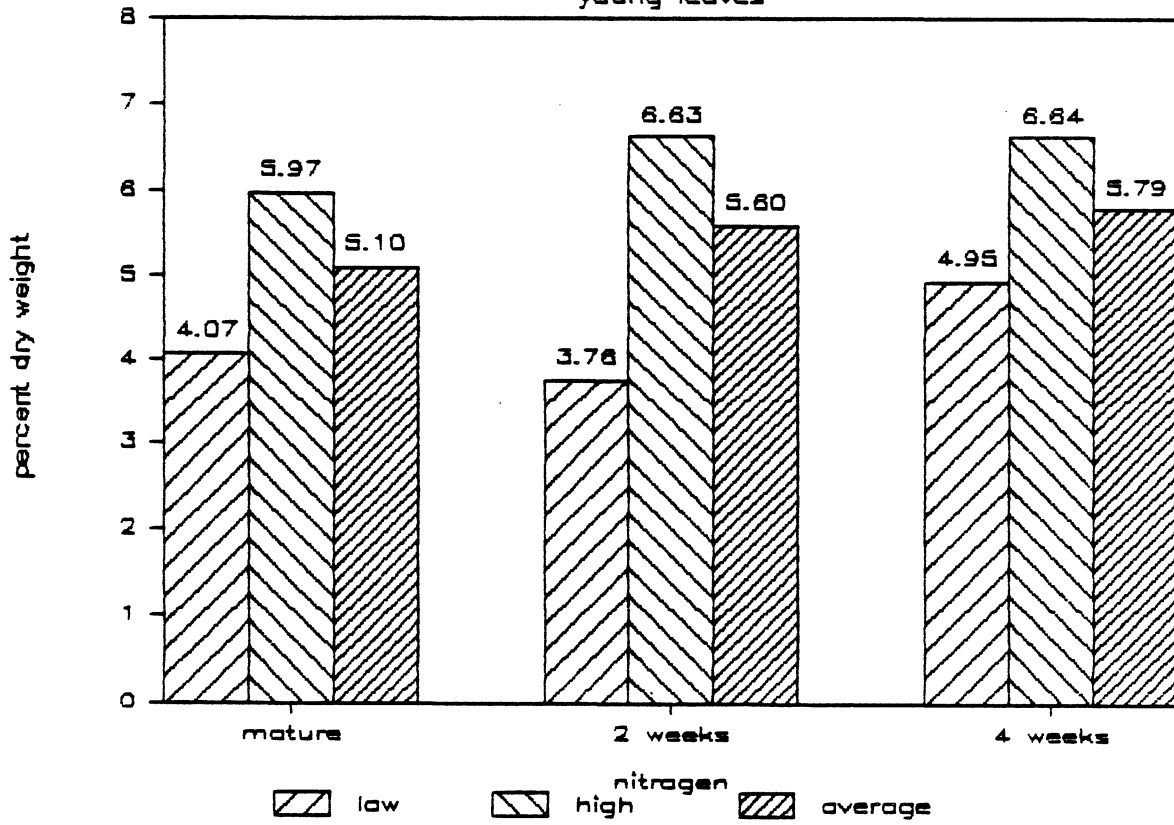


young leaves



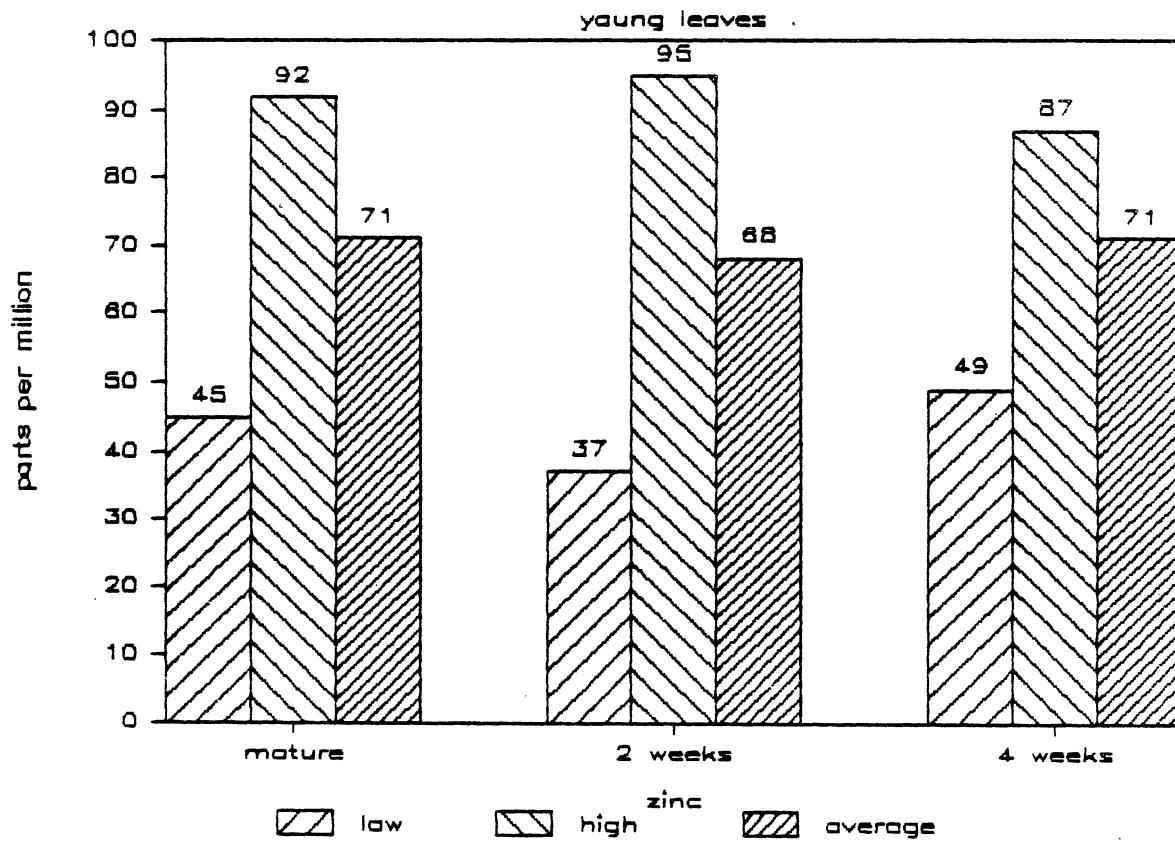
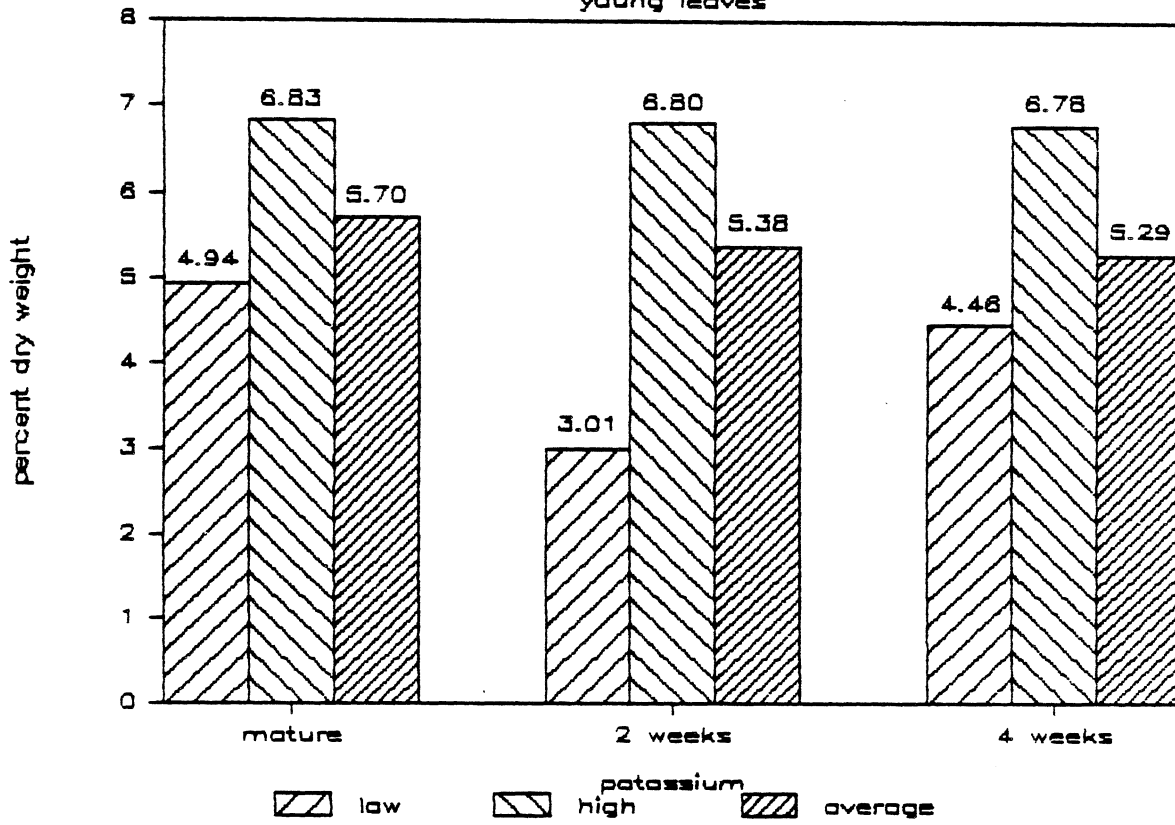
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young leaves



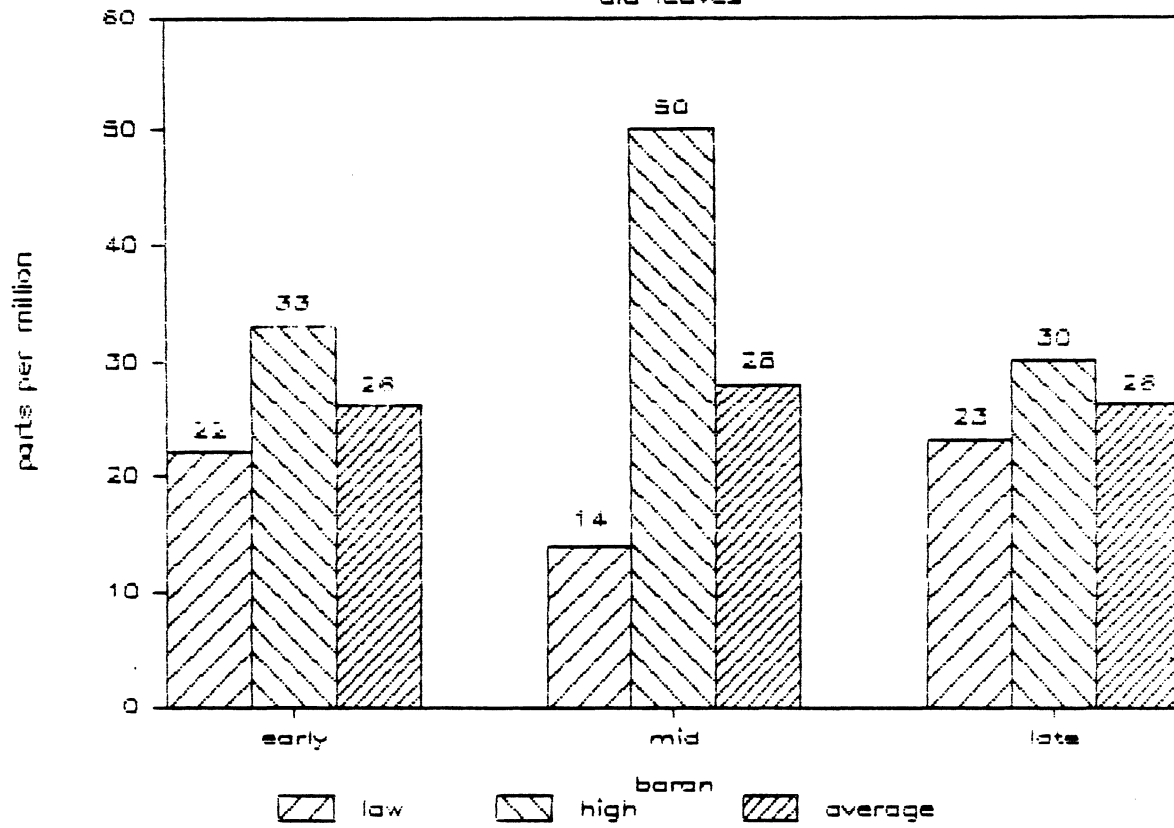
ESCAROLE

young leaves

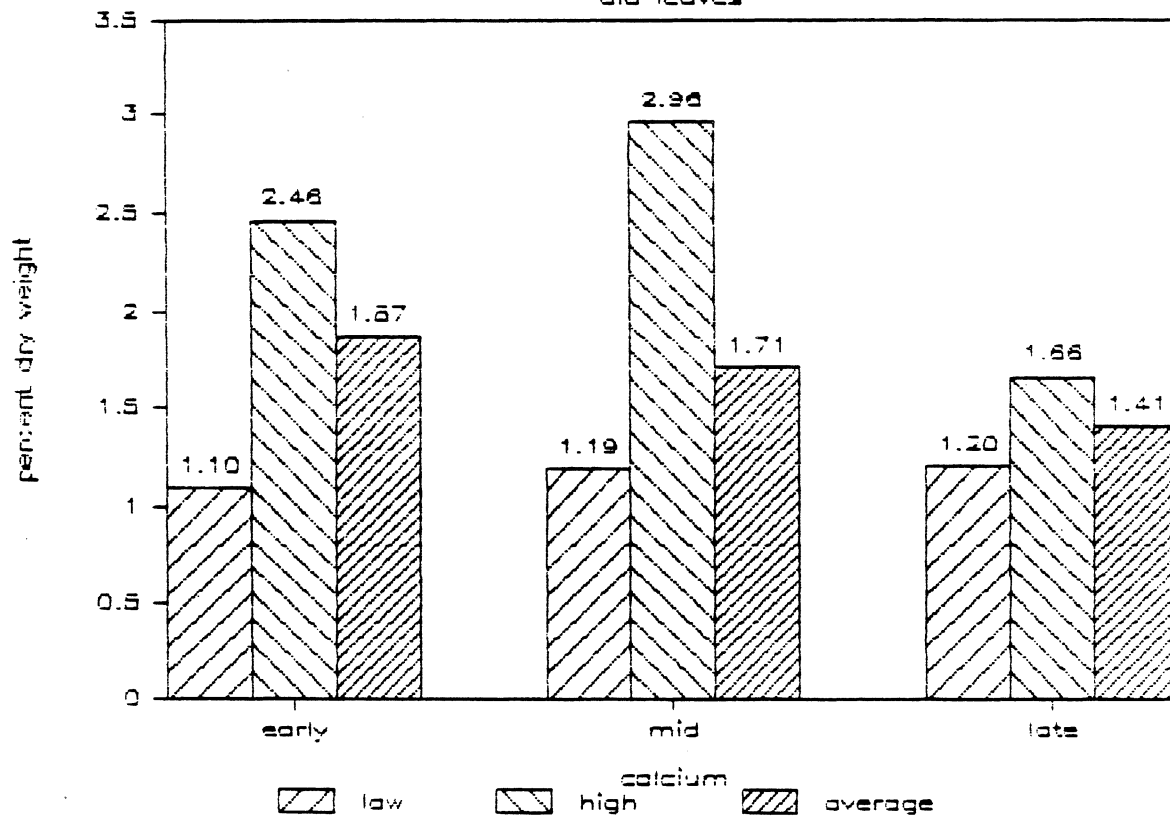


DRY ONION

old leaves

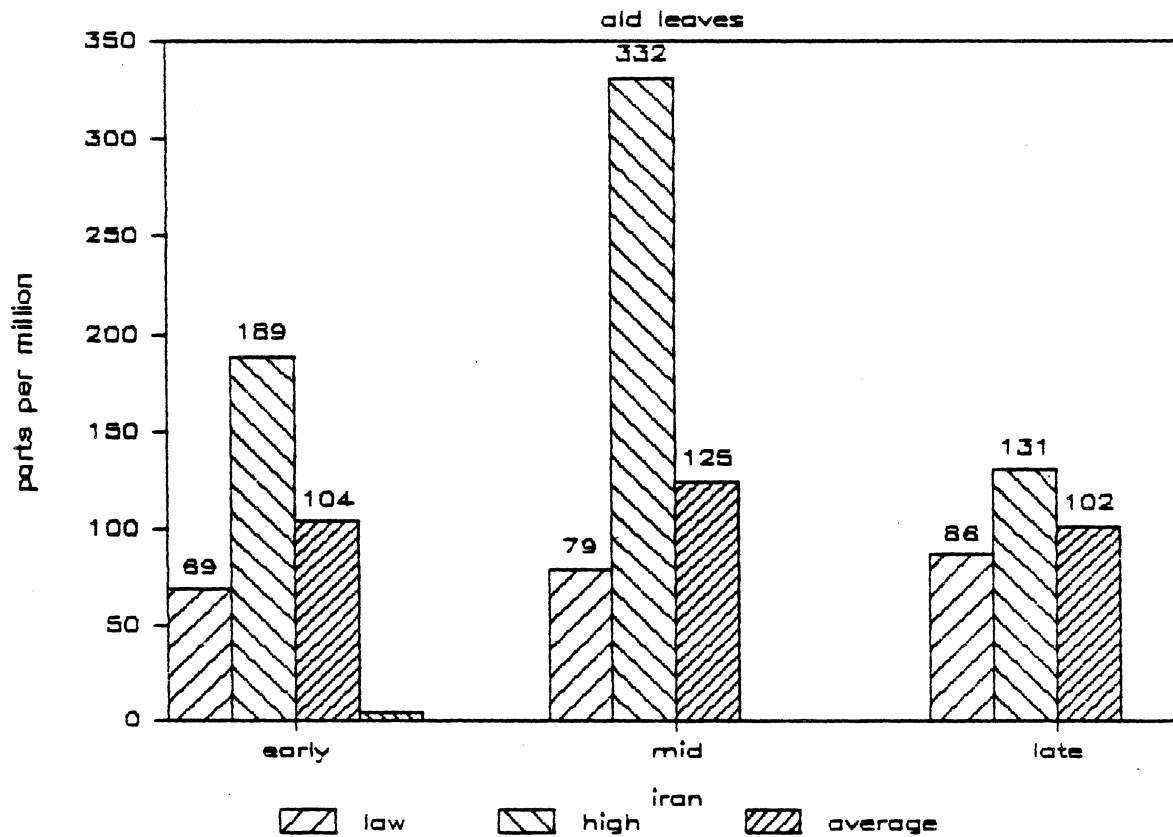
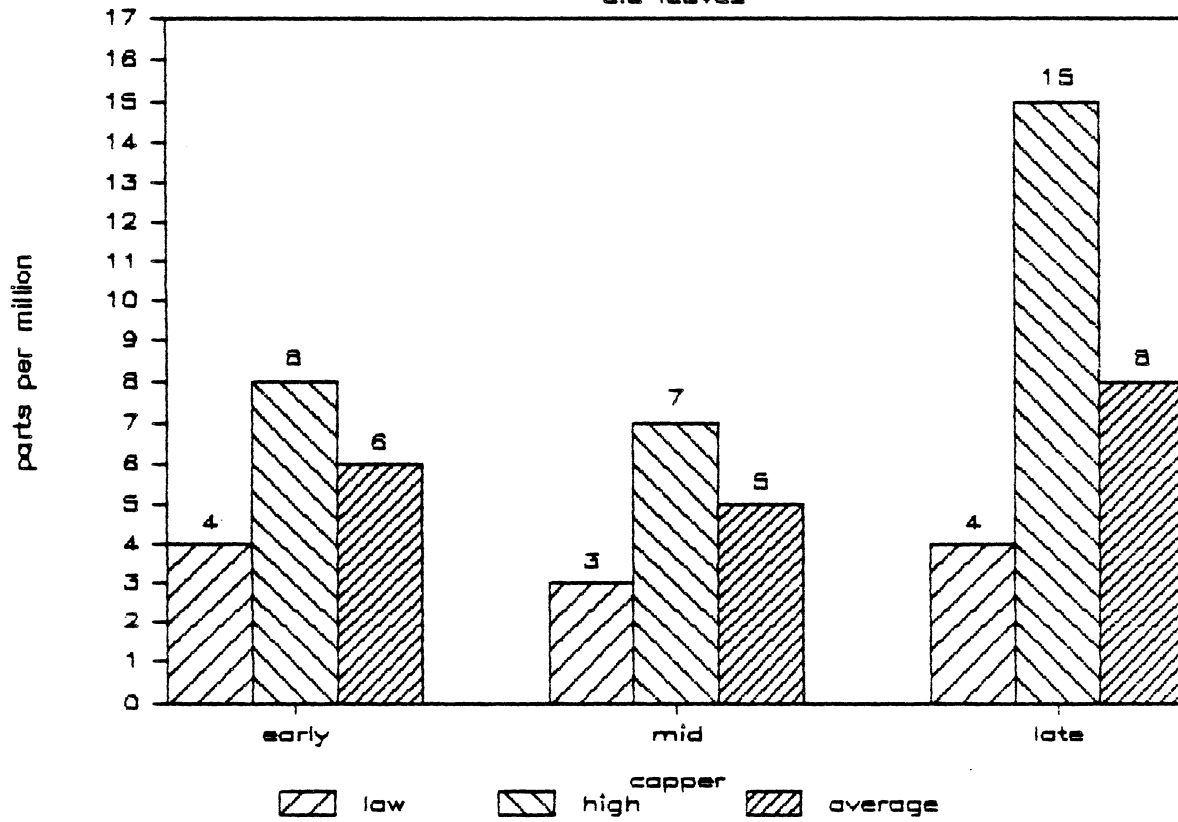


old leaves

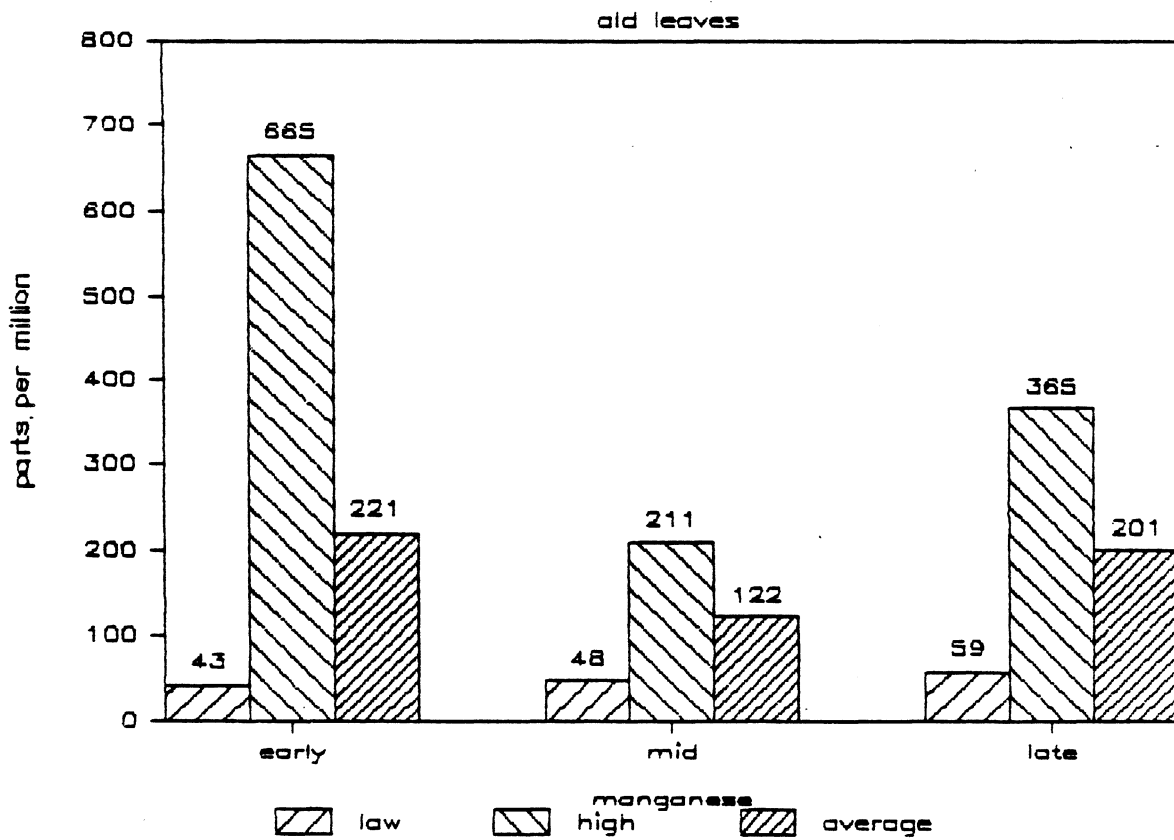
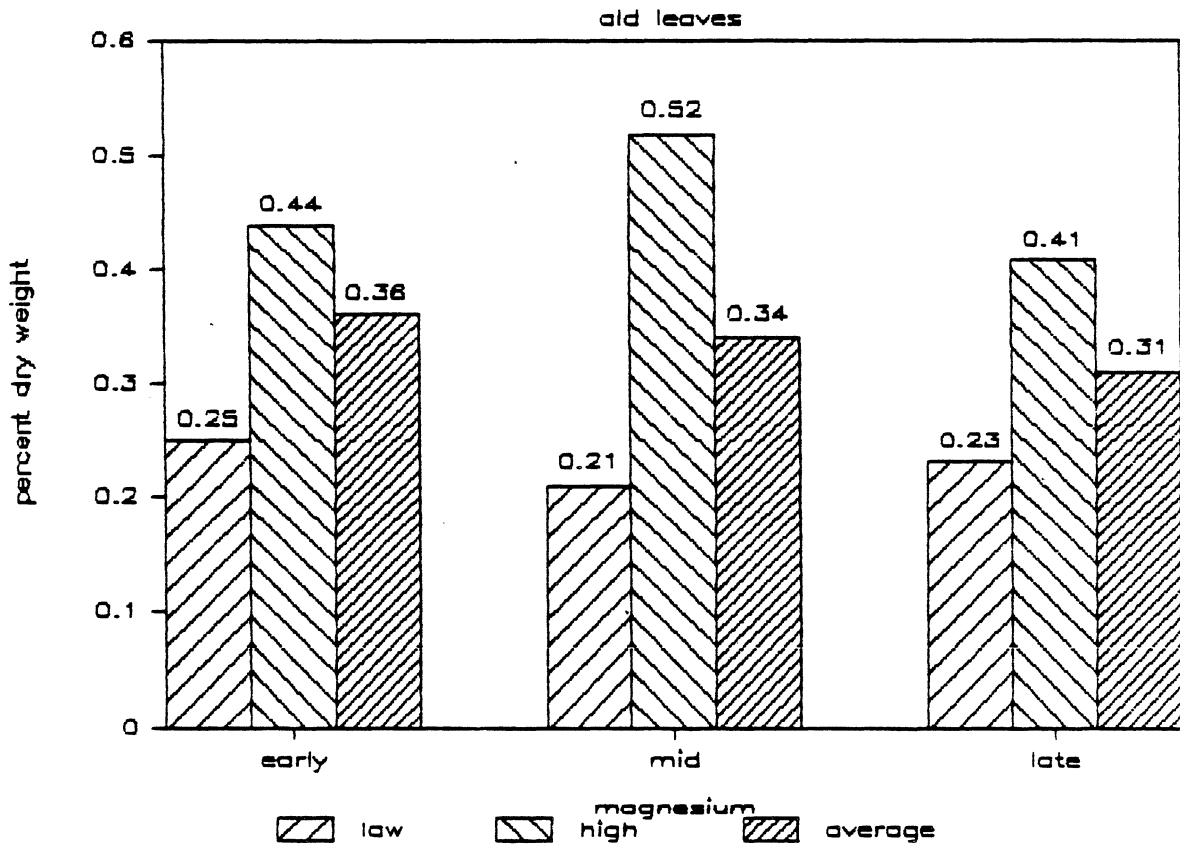


DRY ONION

old leaves

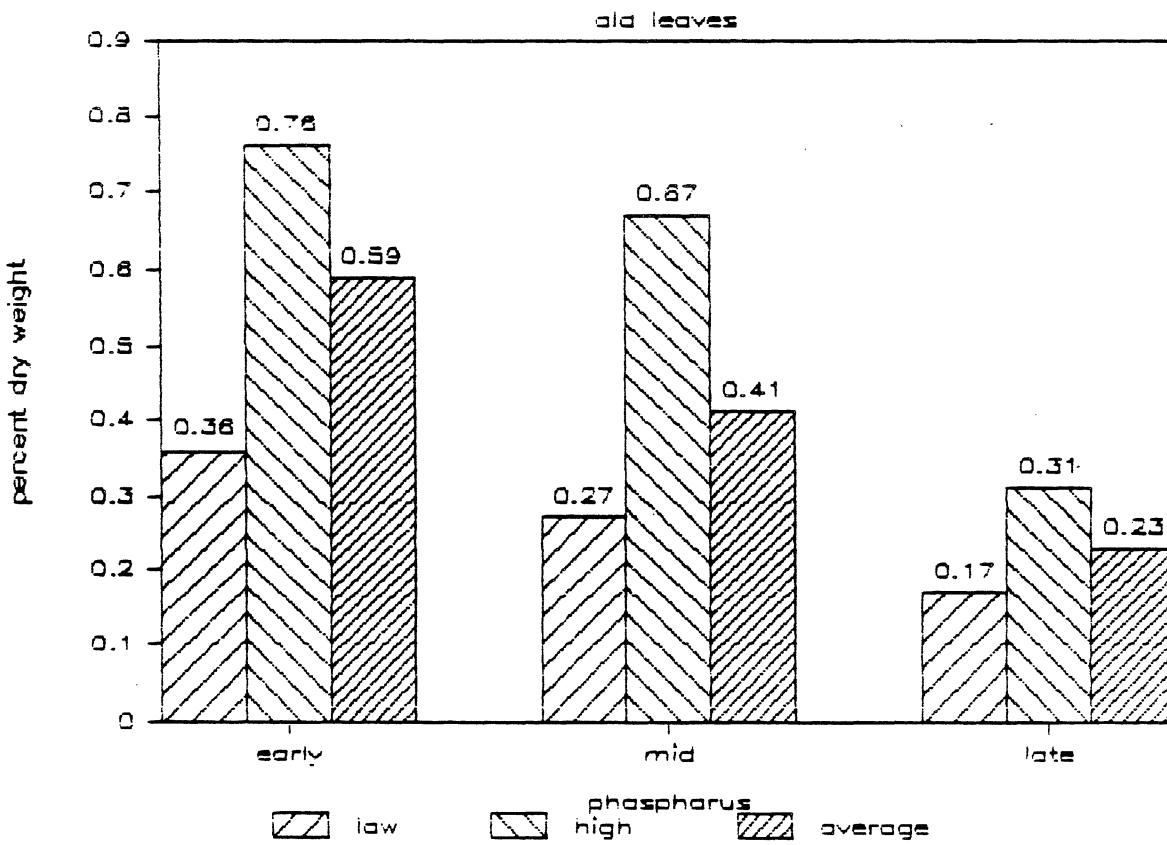
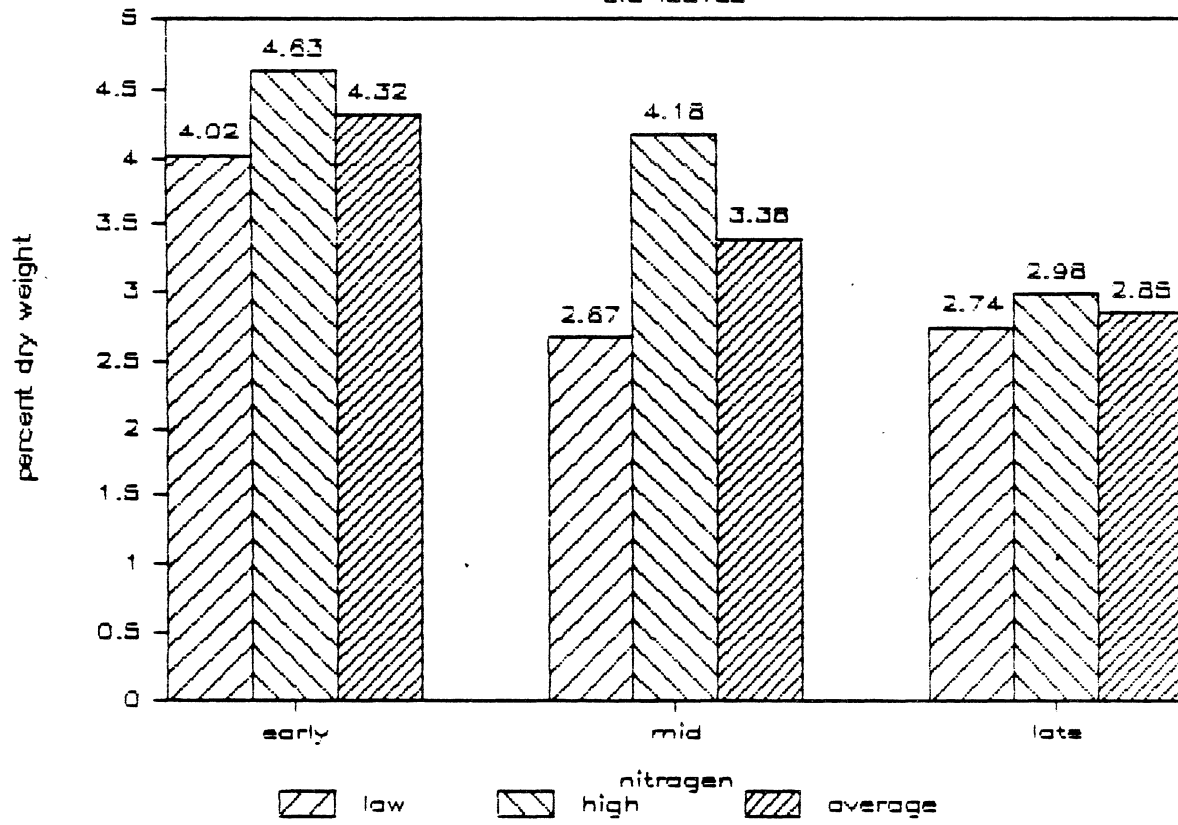


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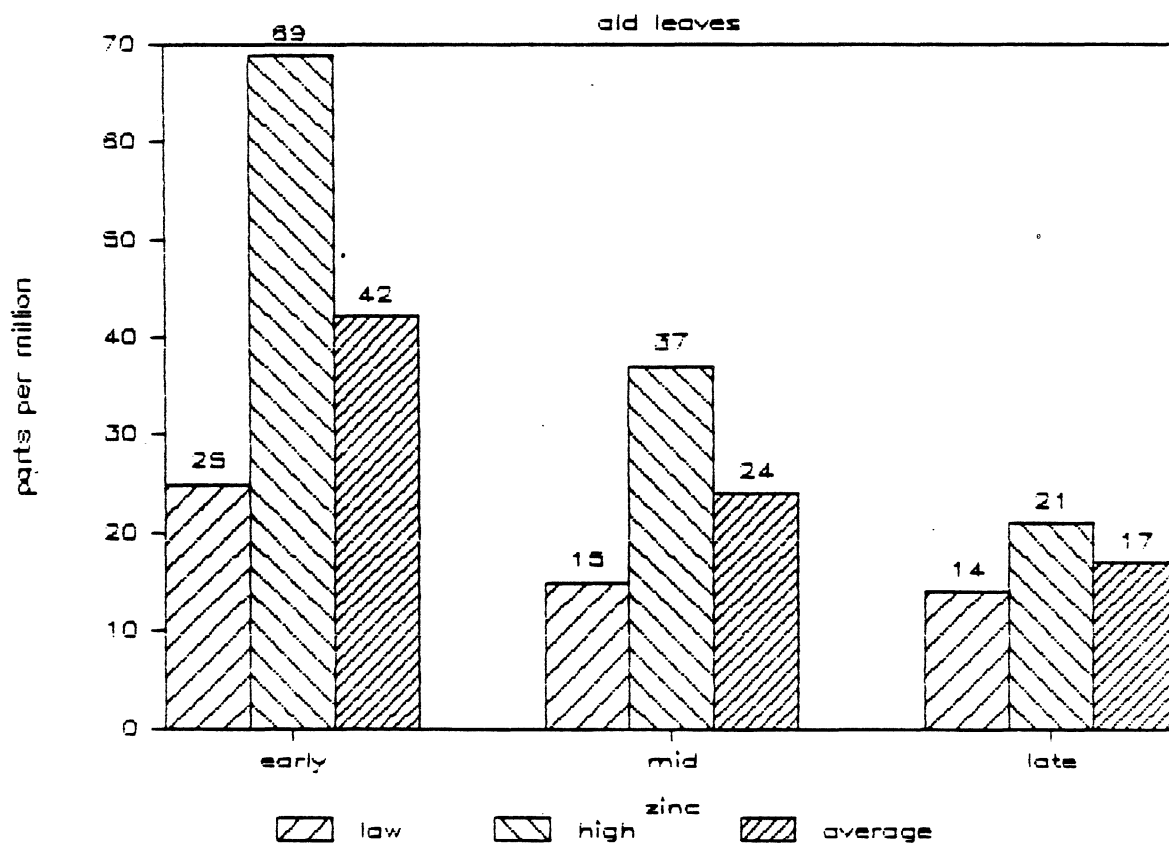
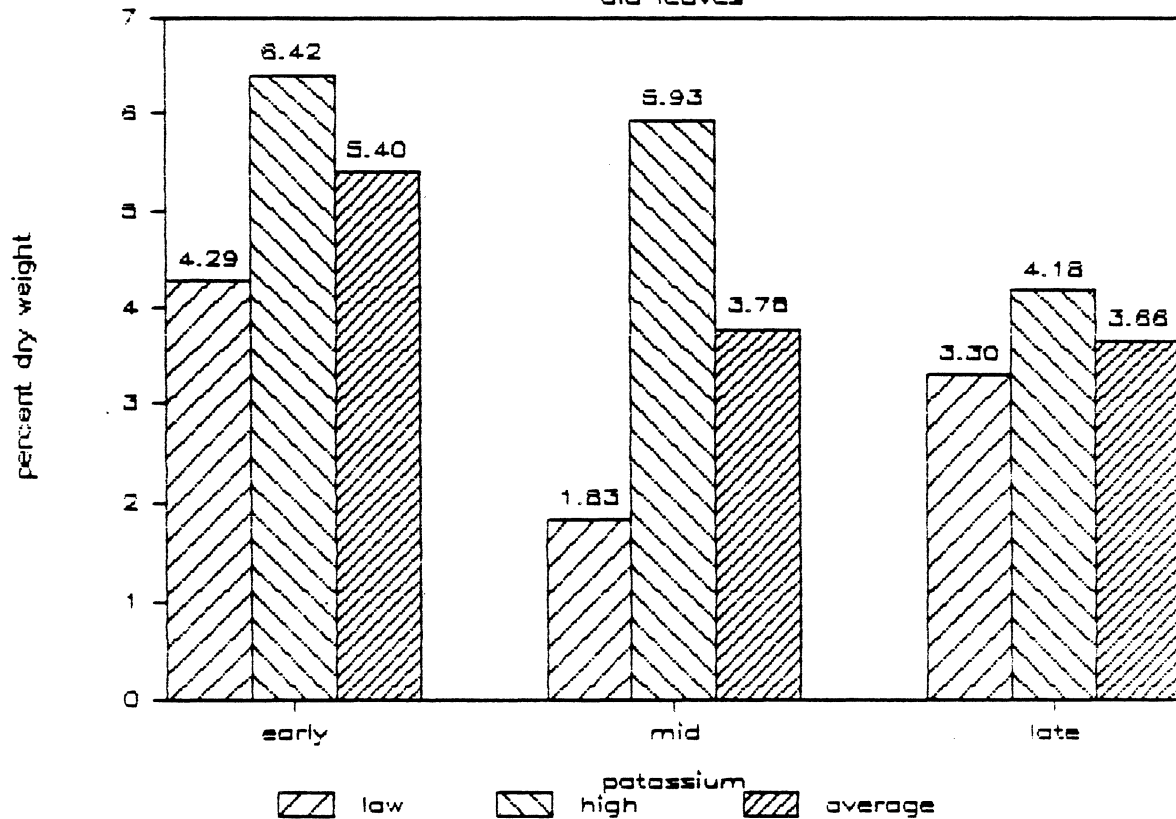
DRY ONION

old leaves



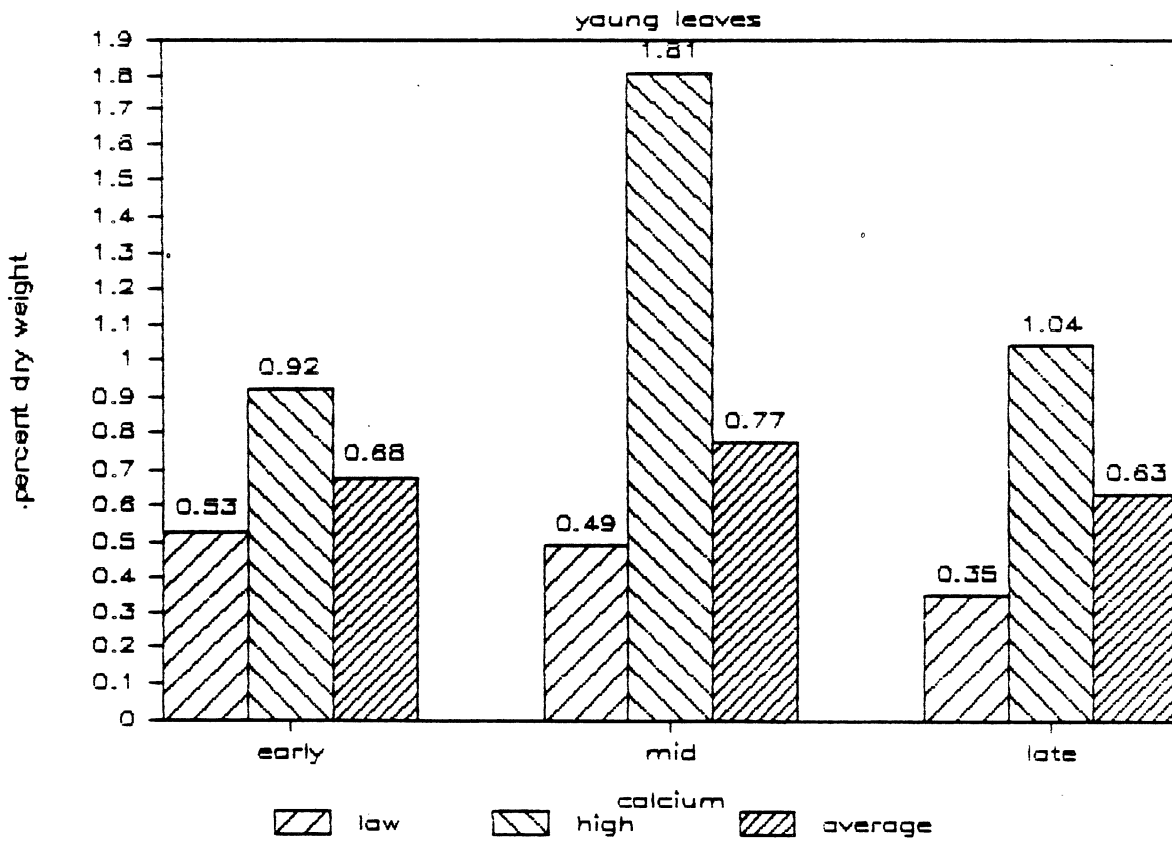
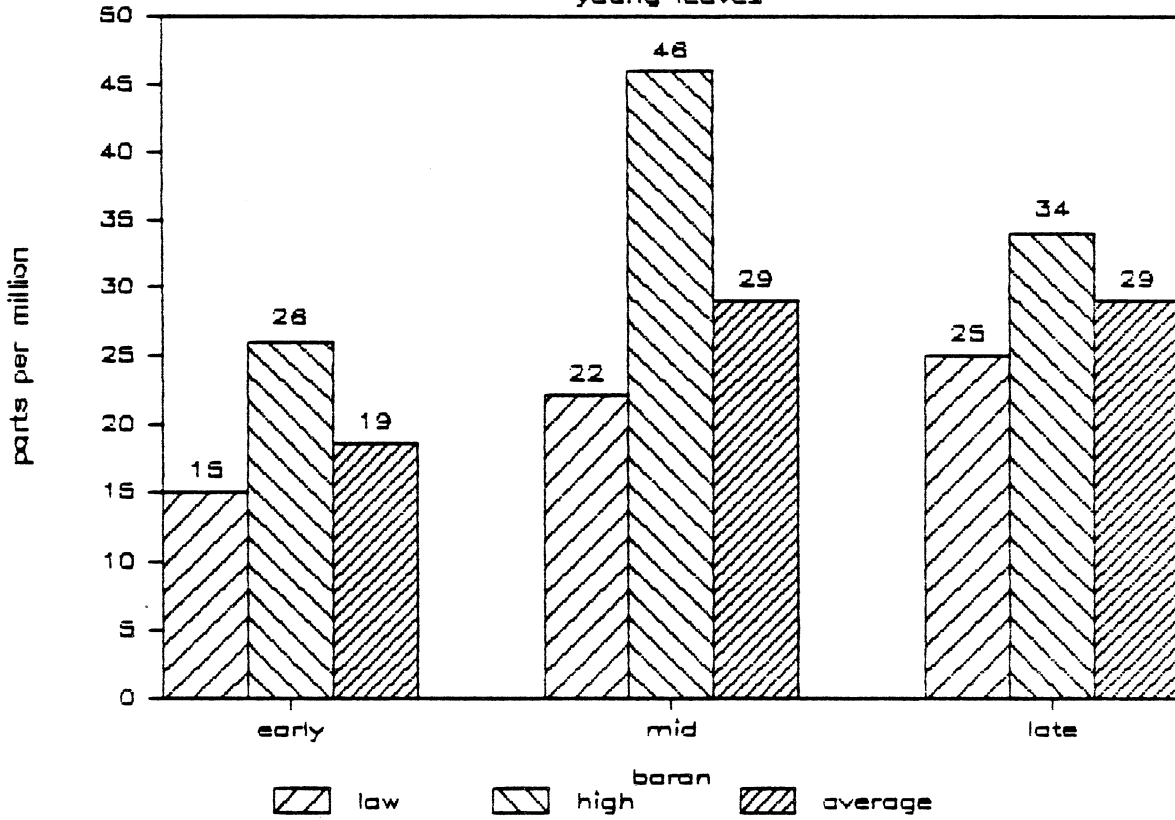
DRY ONION

old leaves



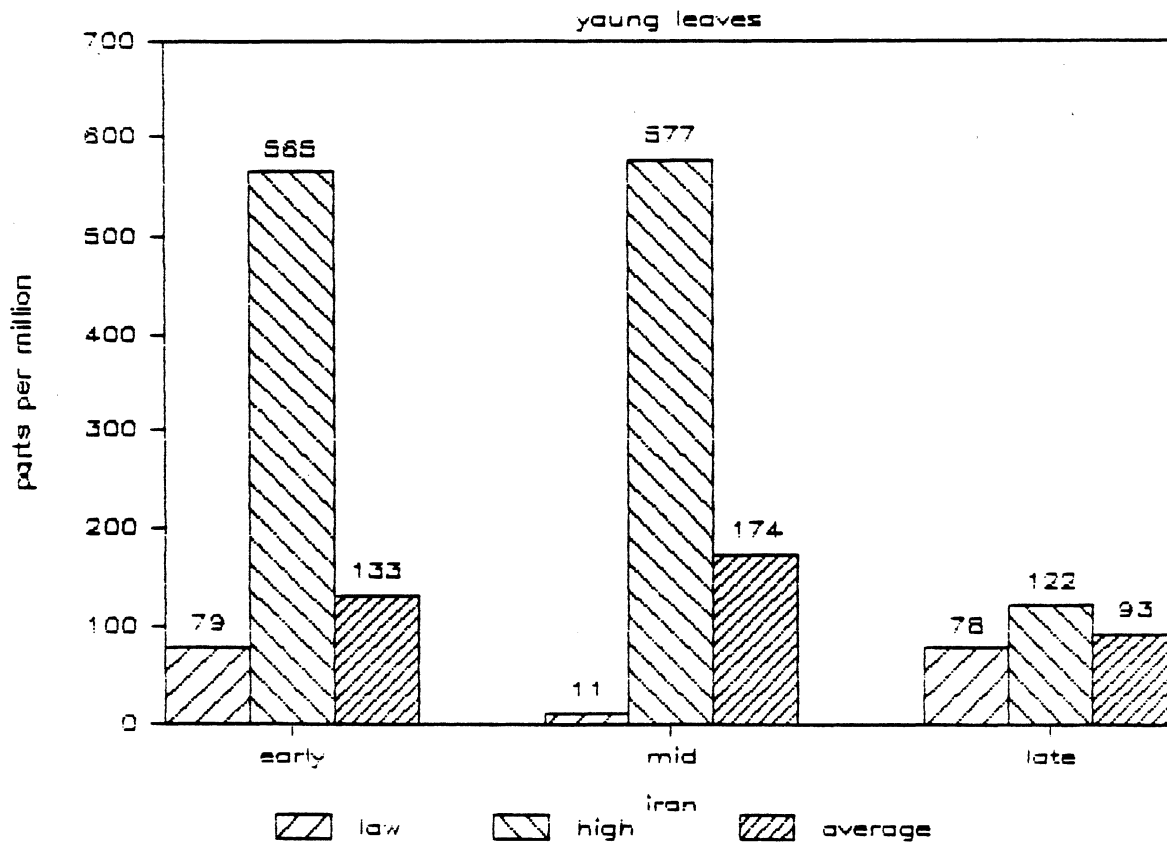
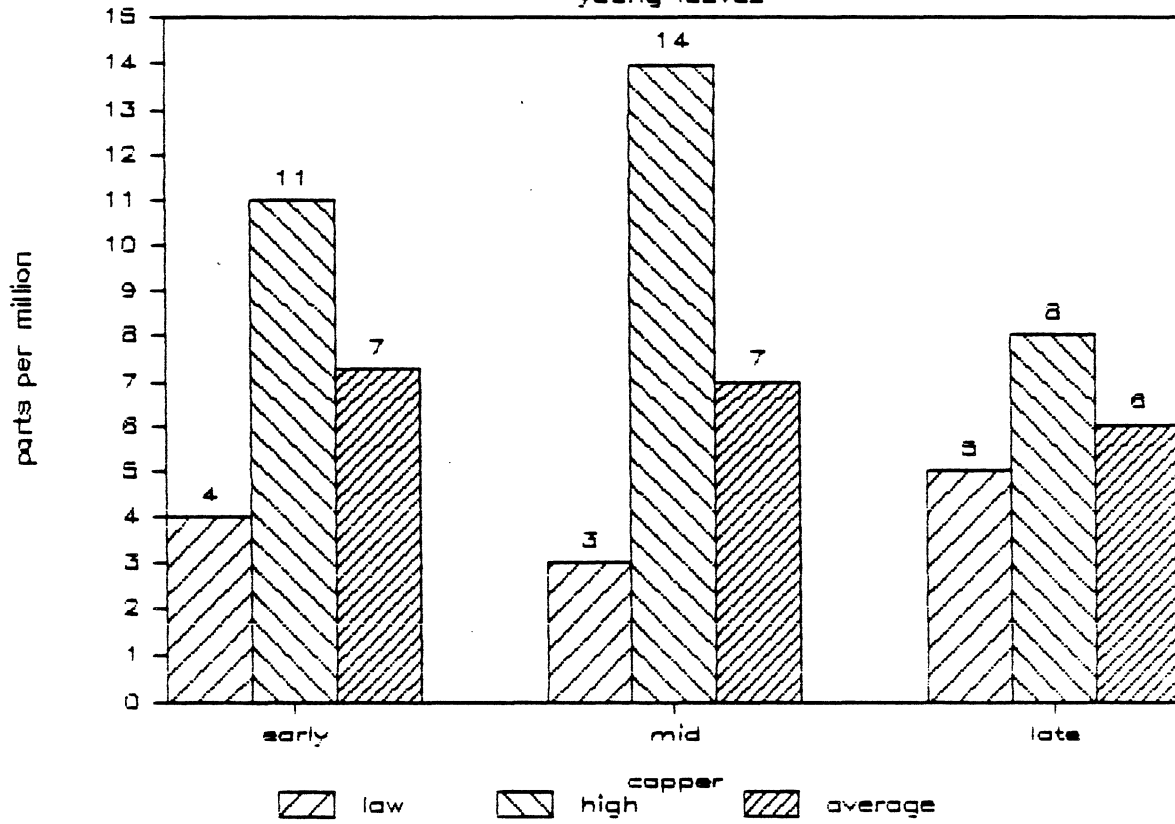
DRY ONION

young leaves



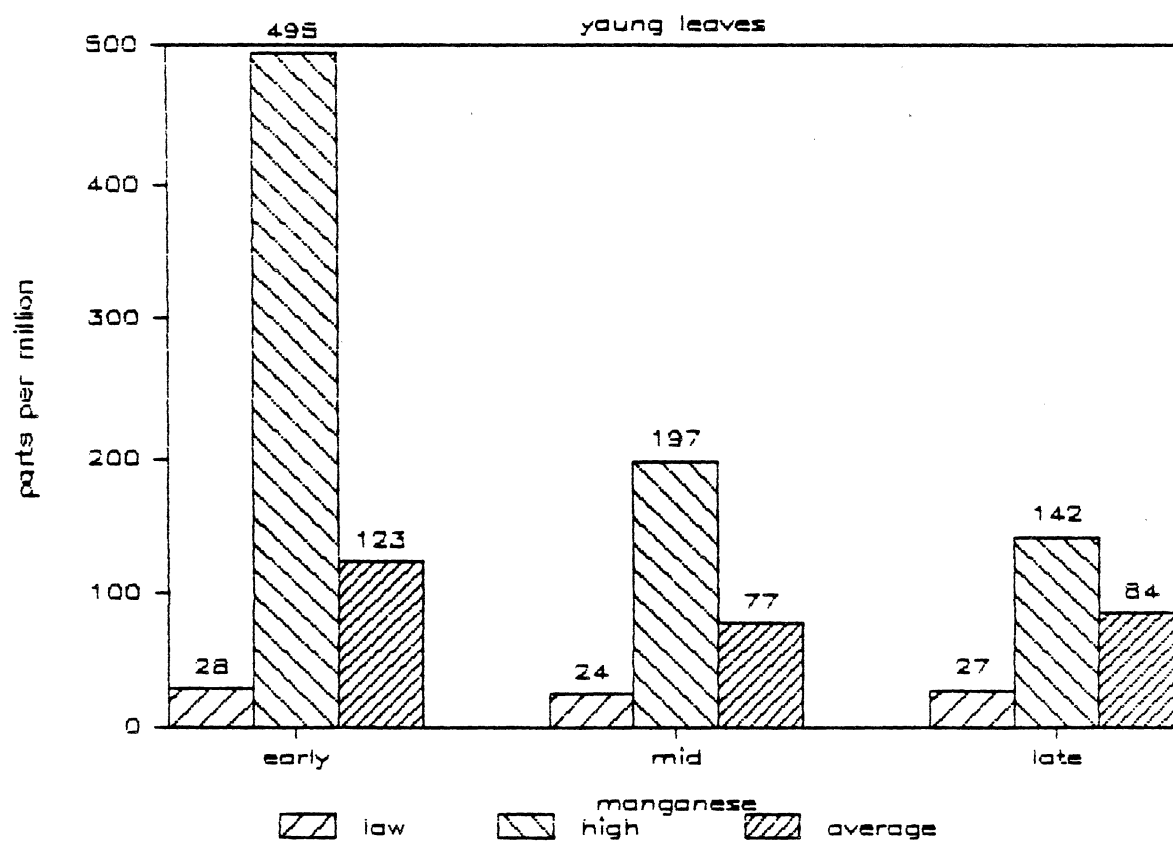
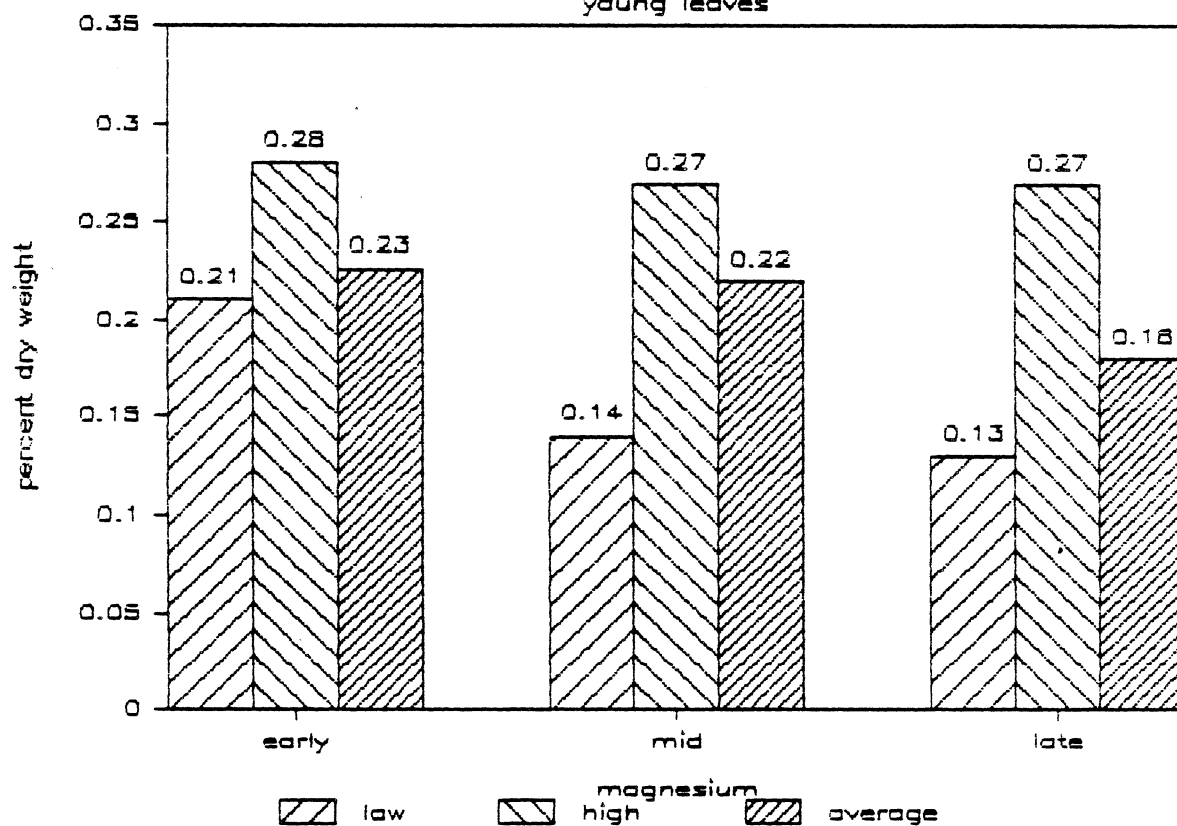
DRY ONION

young leaves



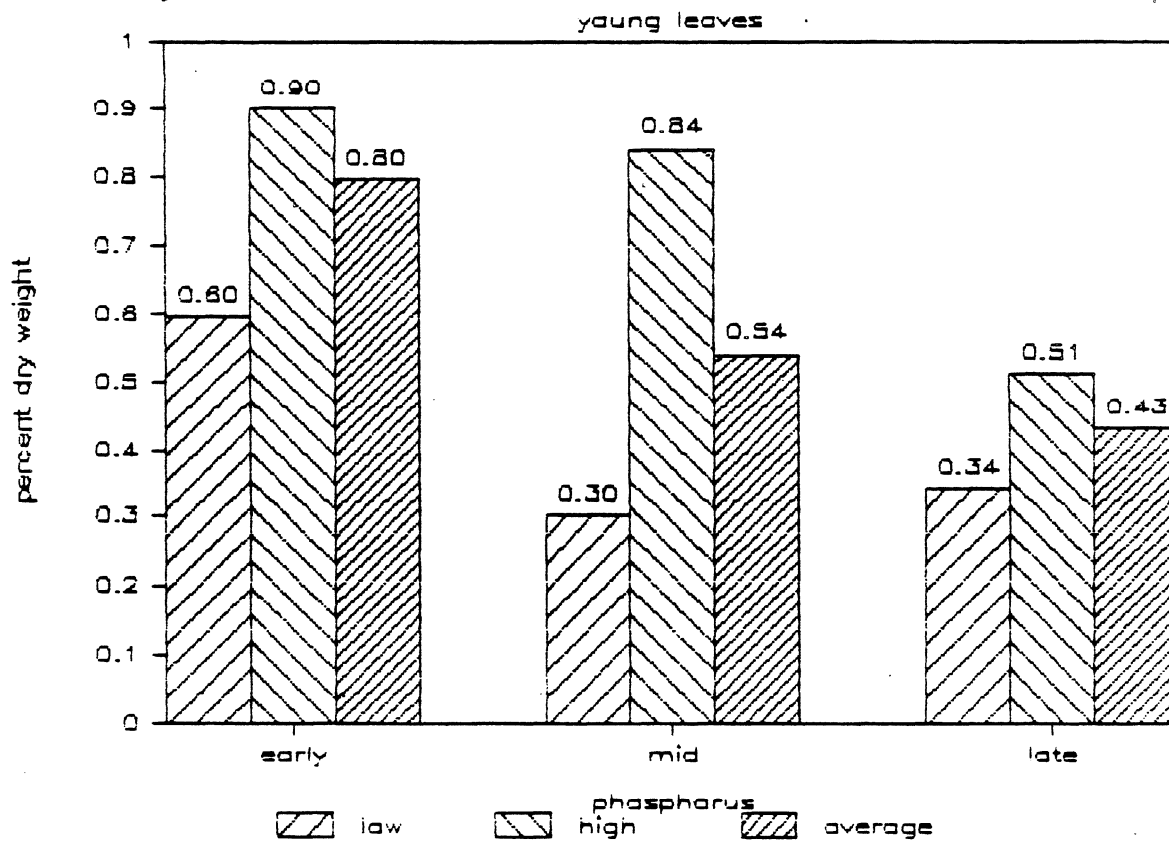
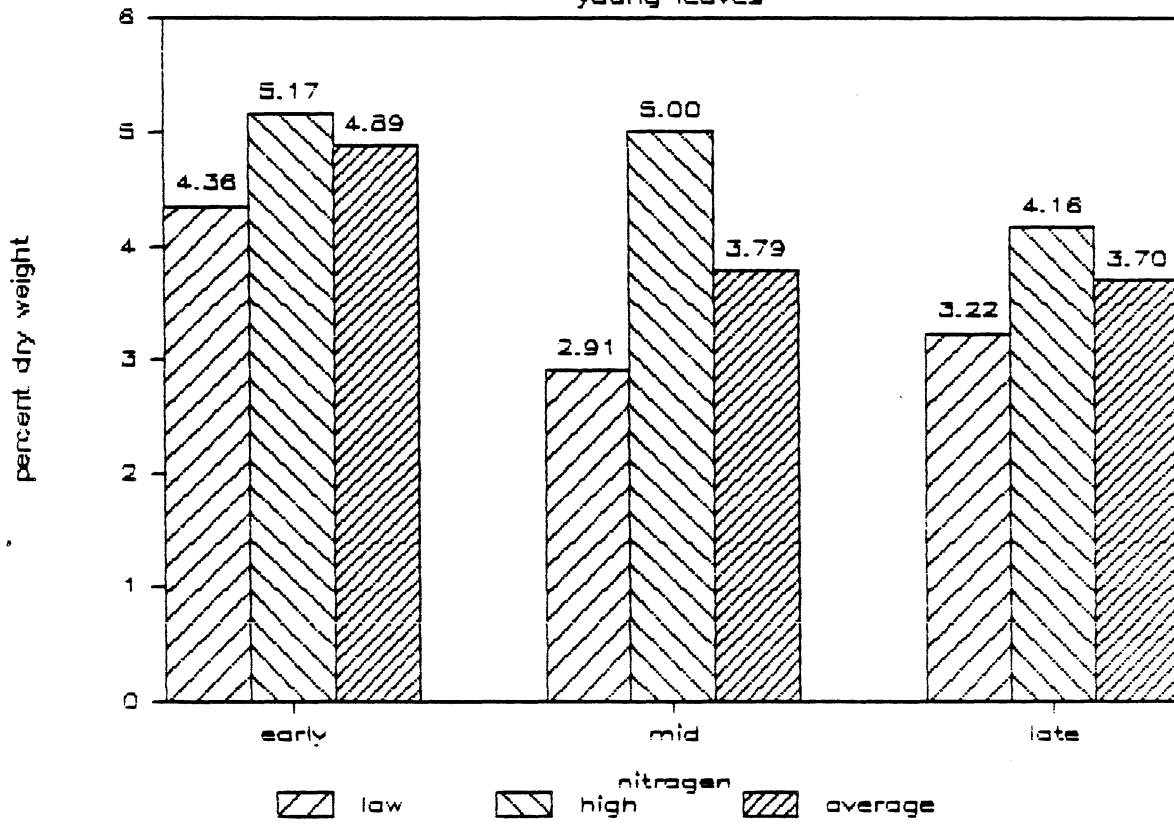
DRY ONION

young leaves



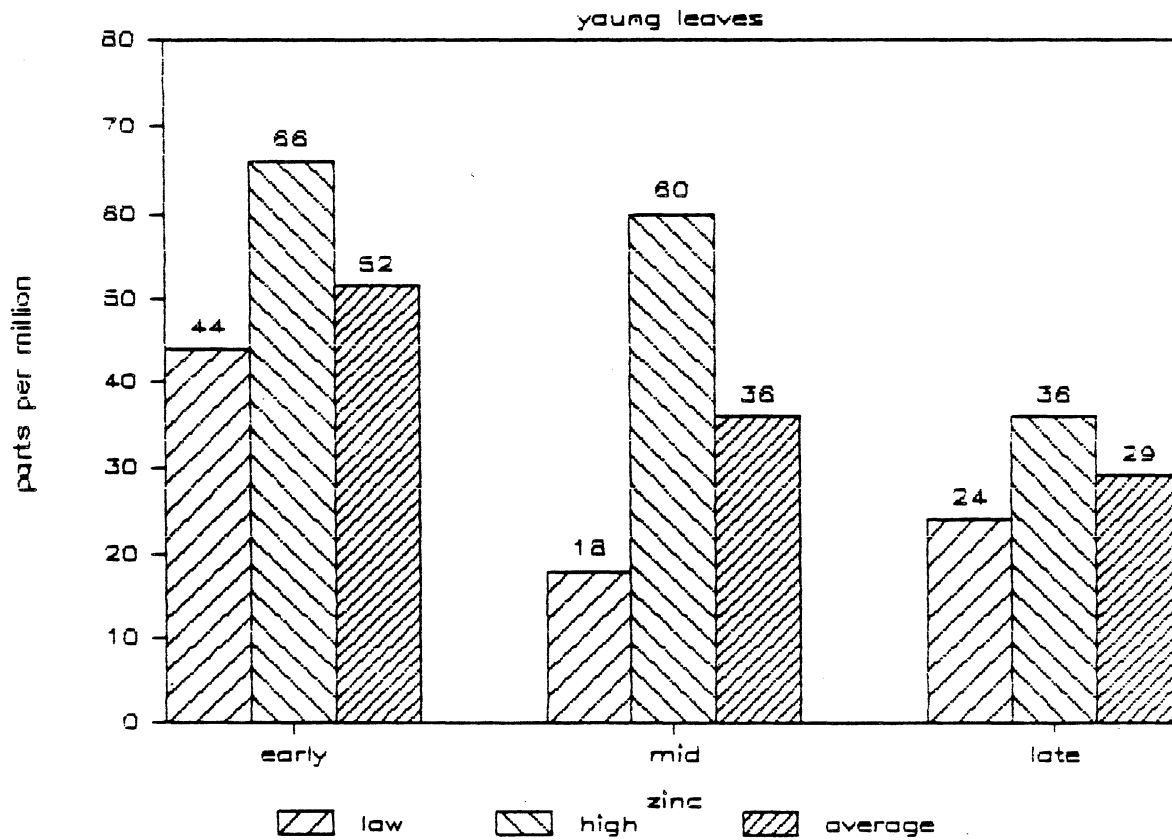
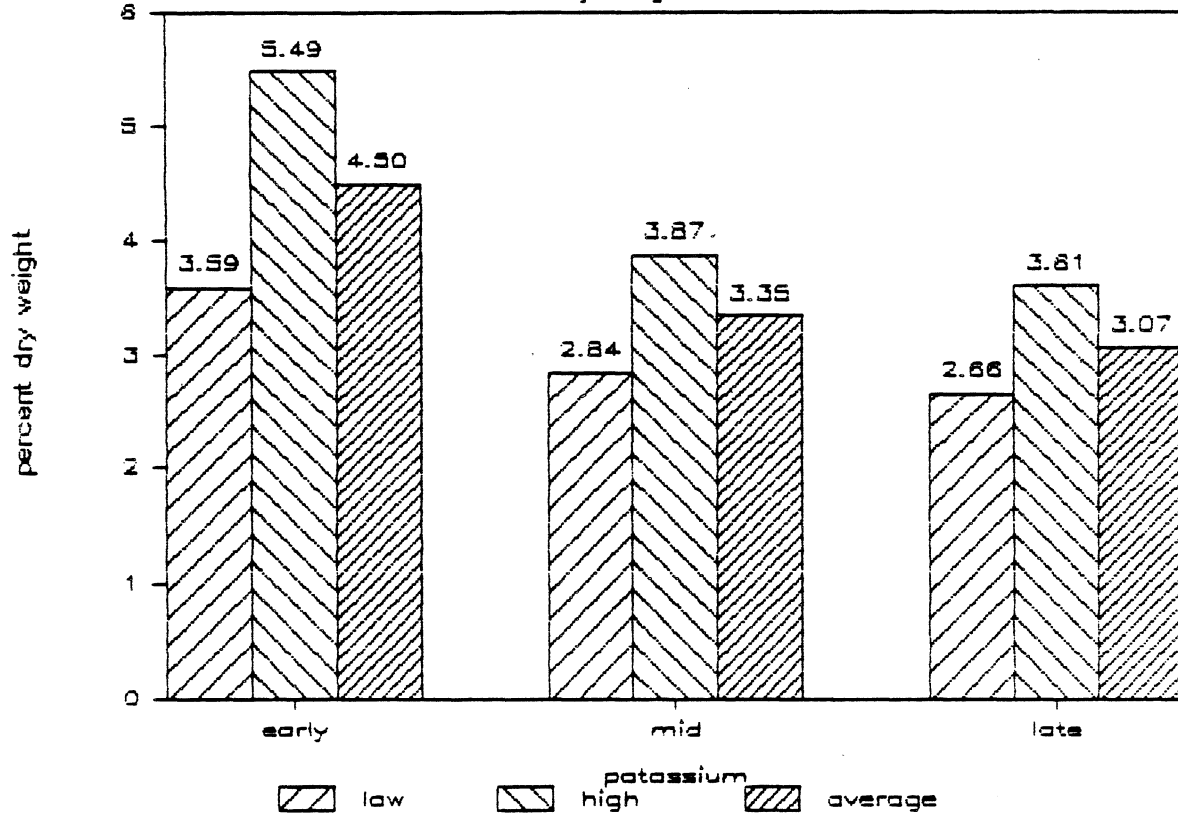
DRY ONION

young leaves



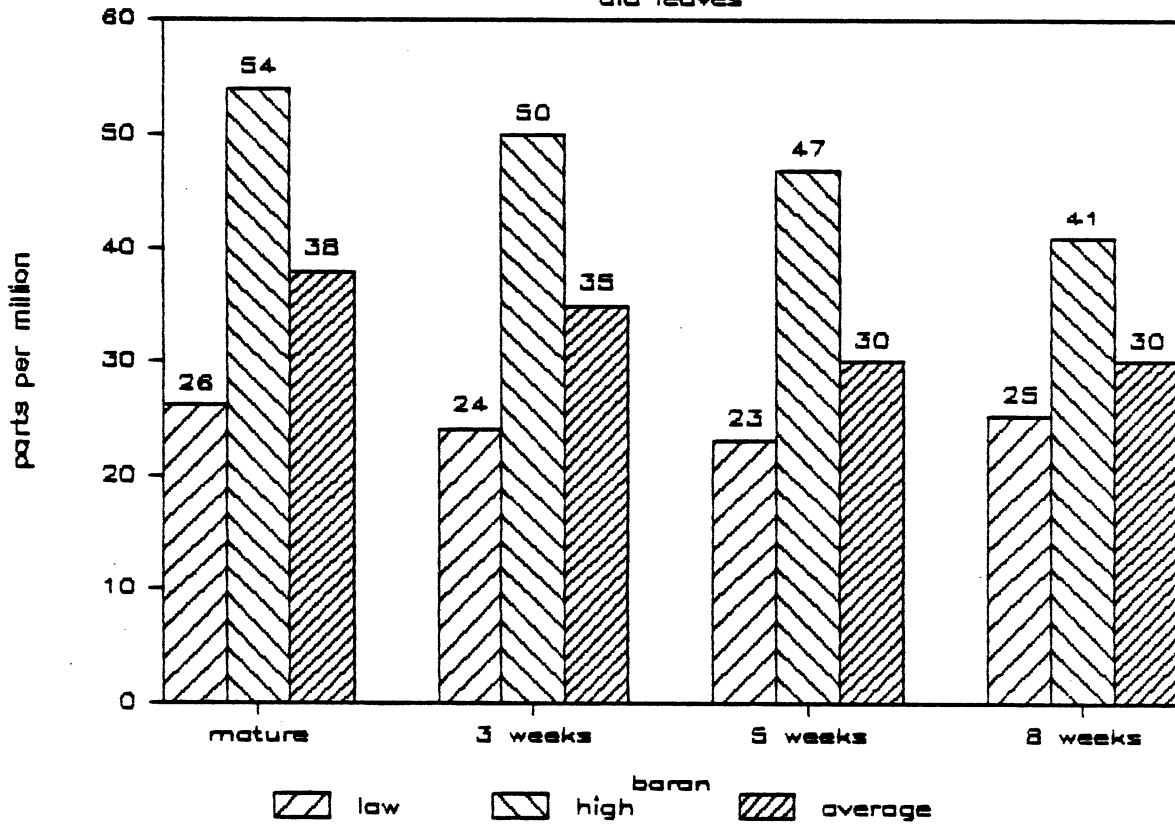
DRY ONION

young leaves

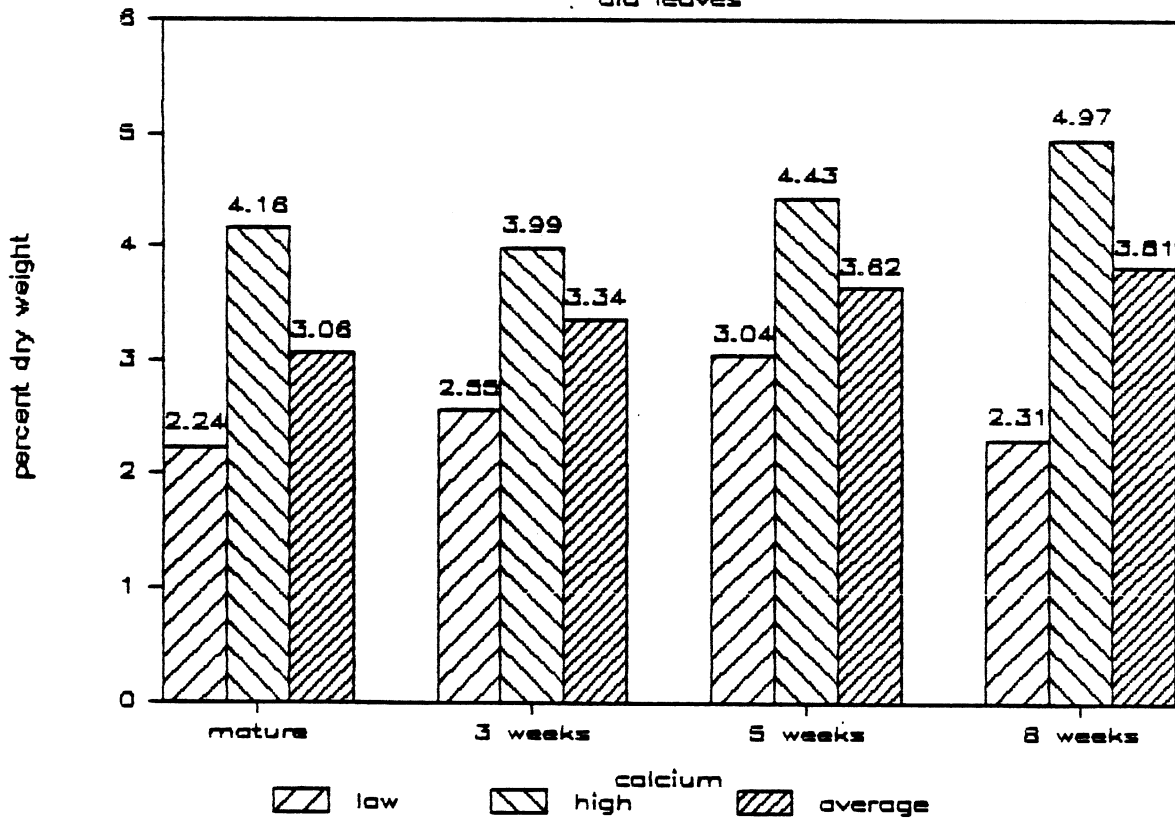


BROCCOLI

old leaves

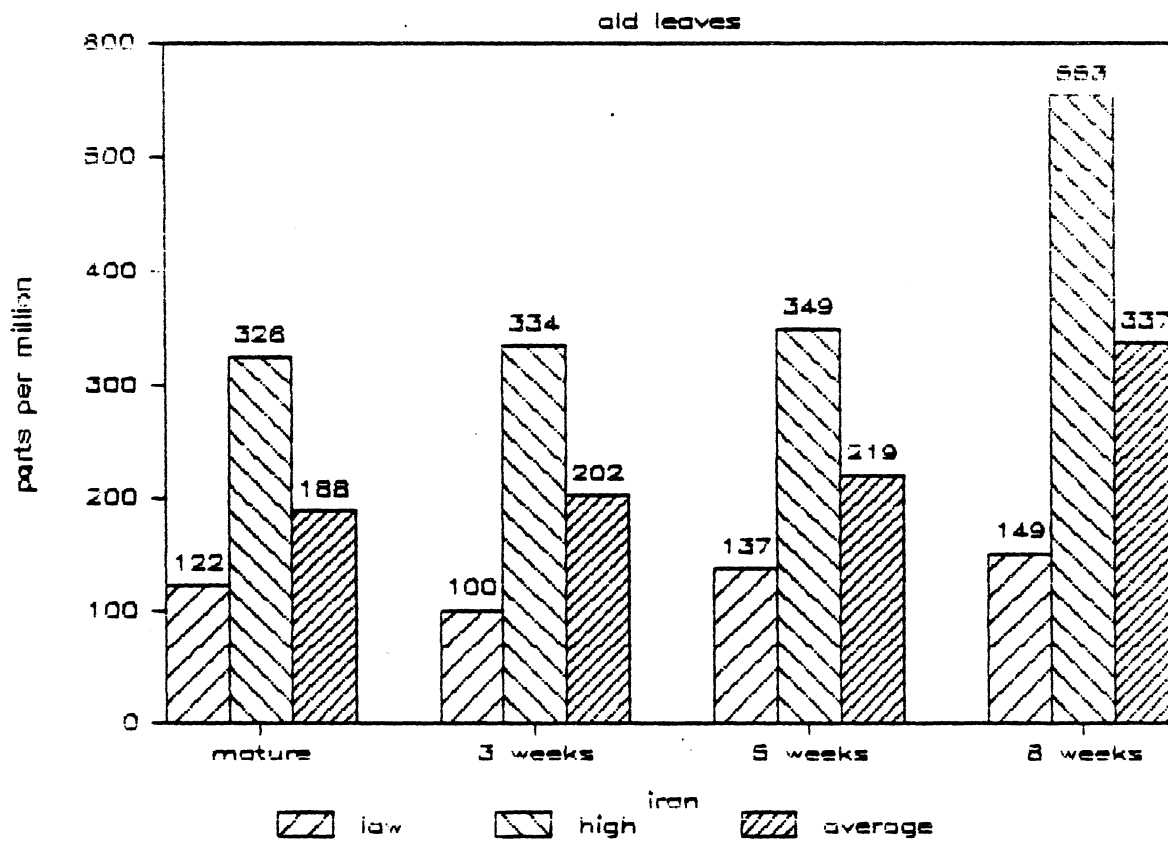
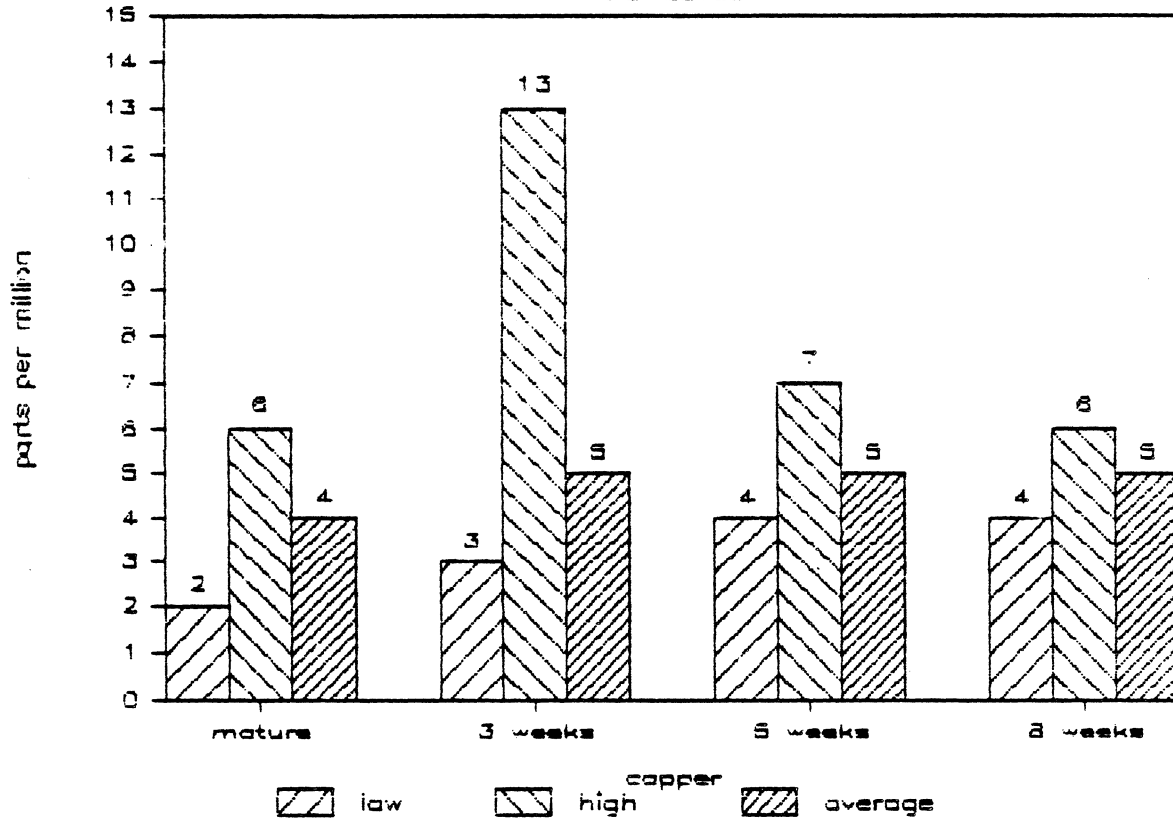


old leaves



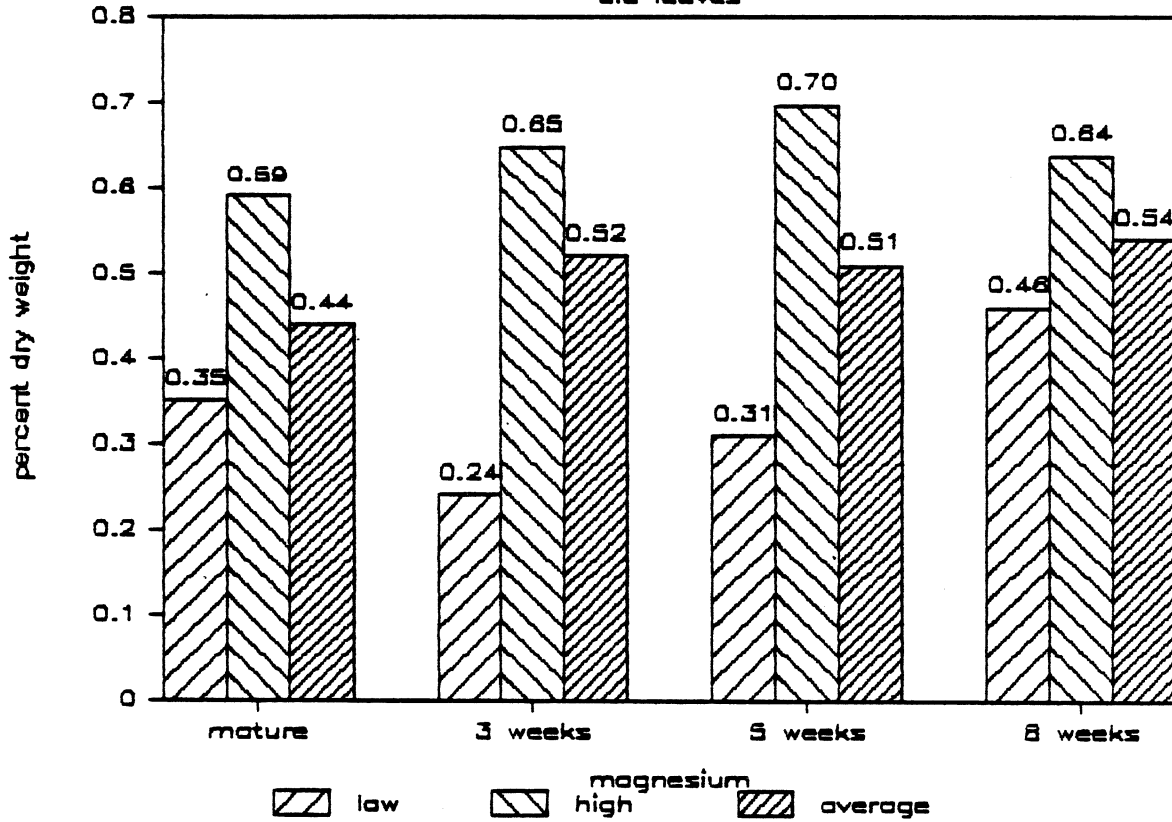
BROCCOLI

old leaves

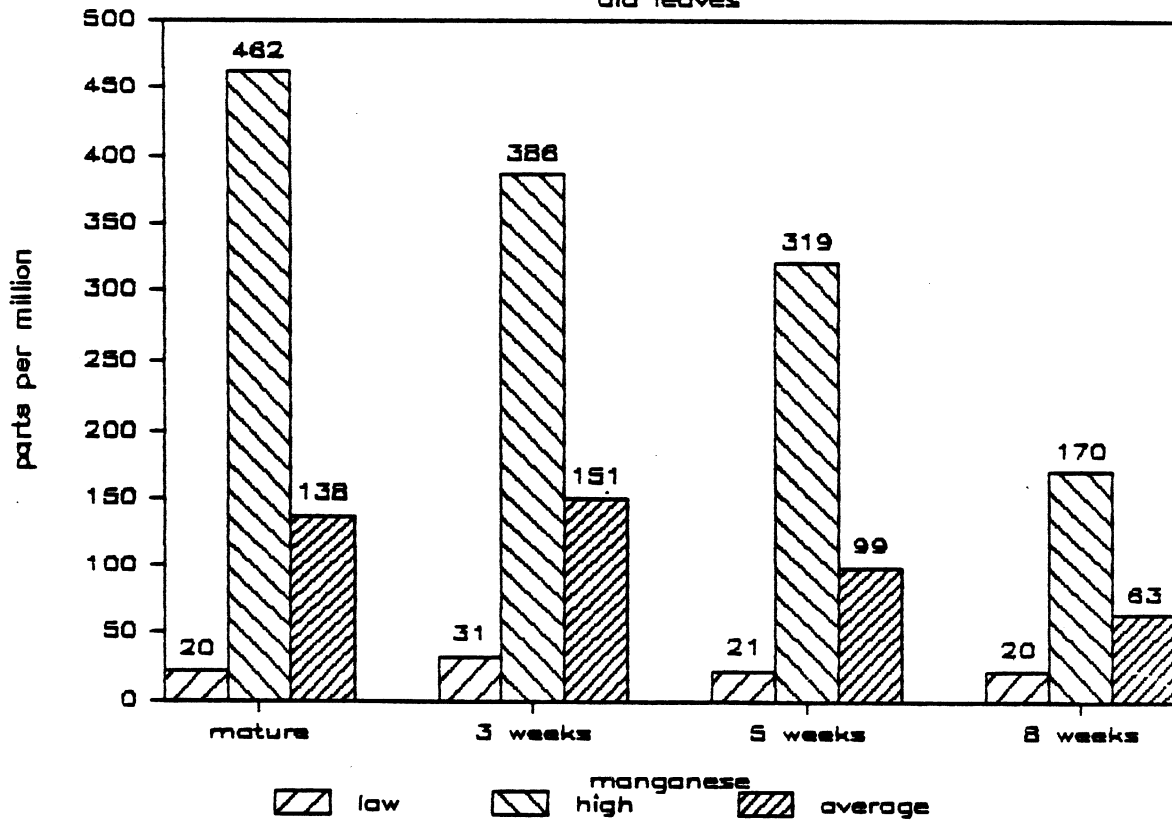


BROCCOLI

old leaves

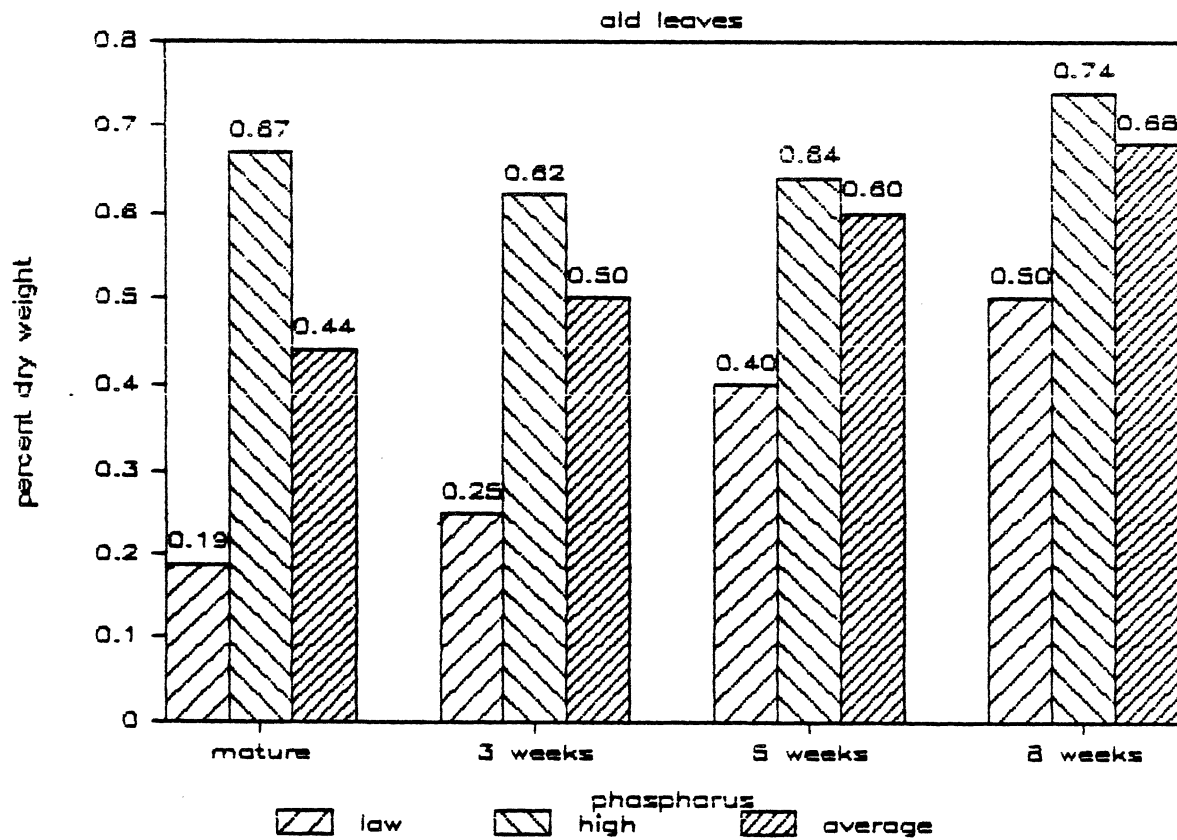
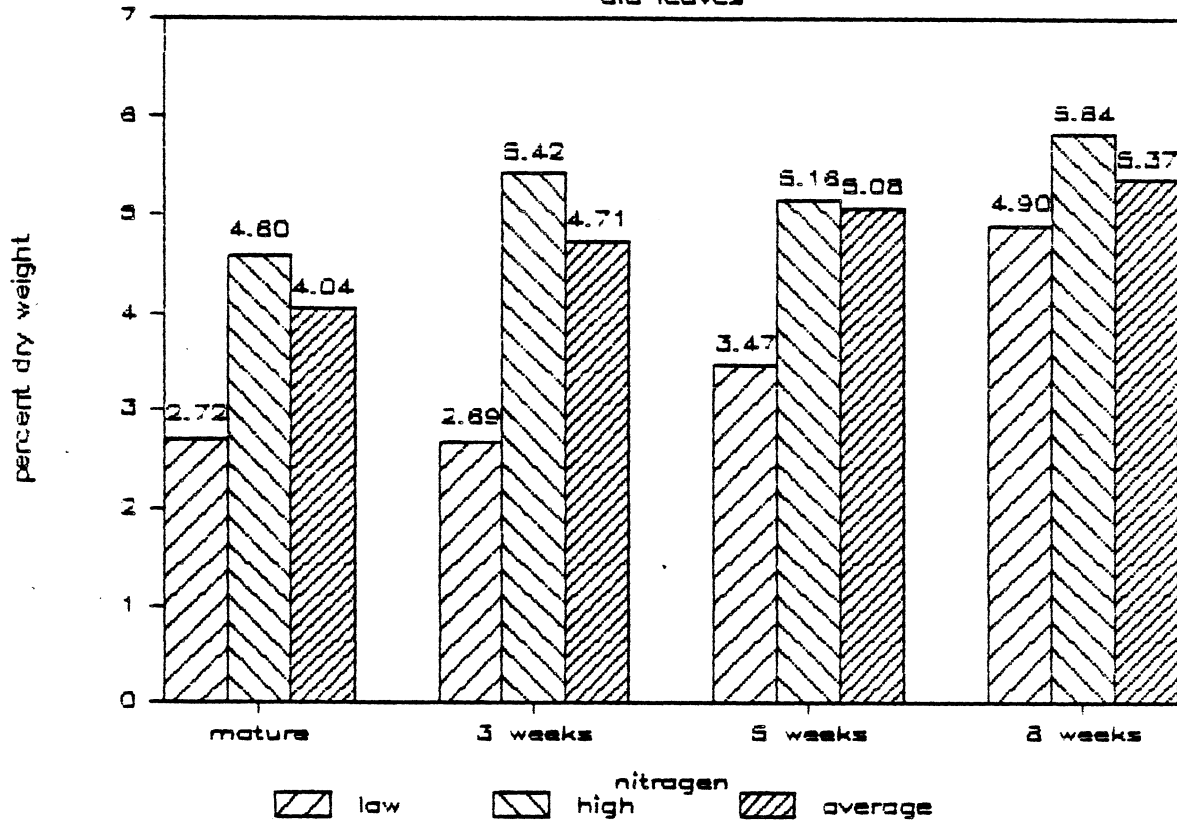


old leaves



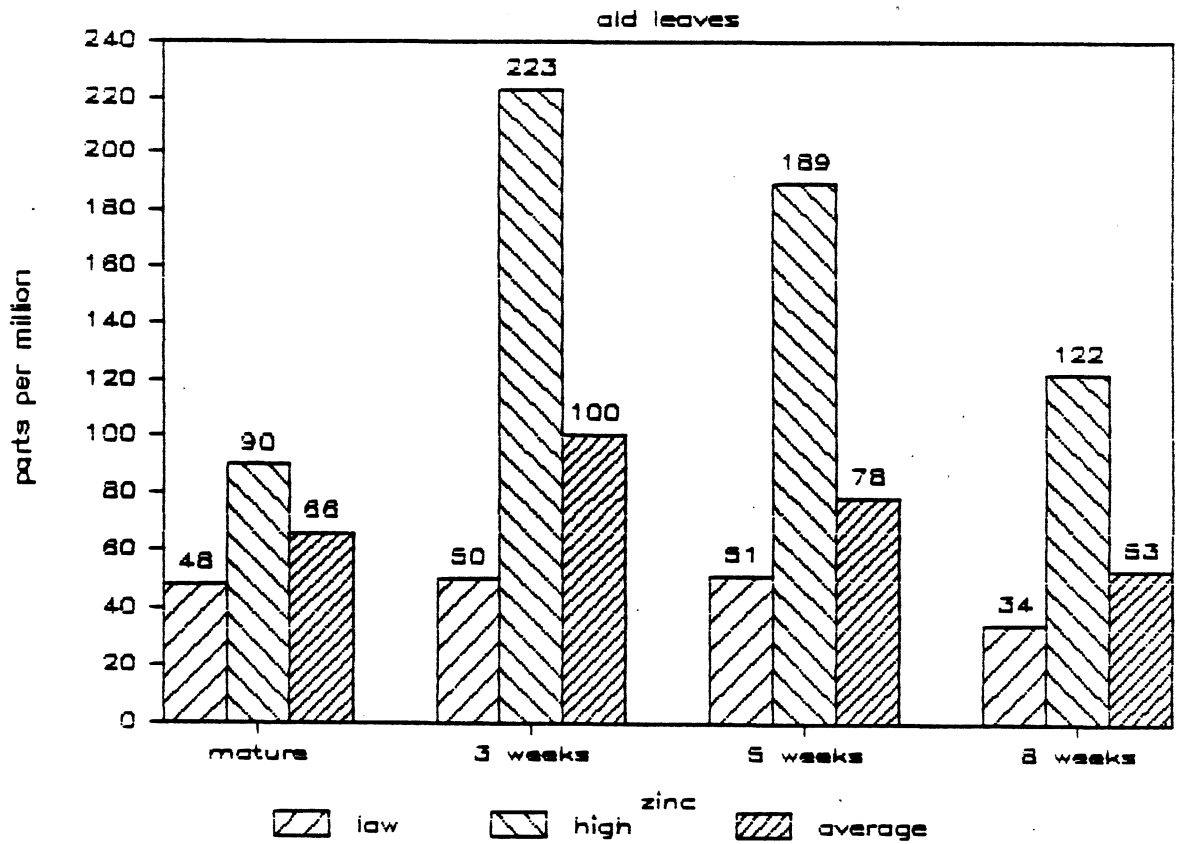
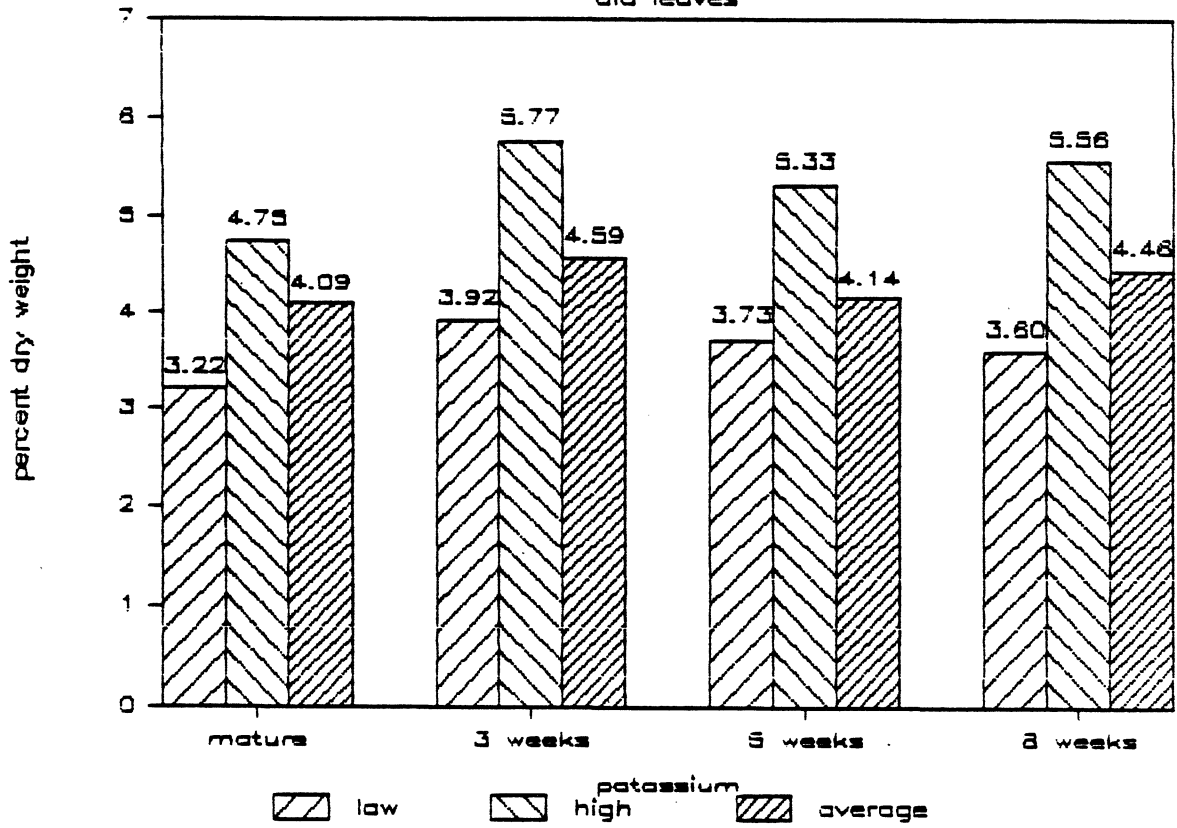
BROCCOLI

old leaves



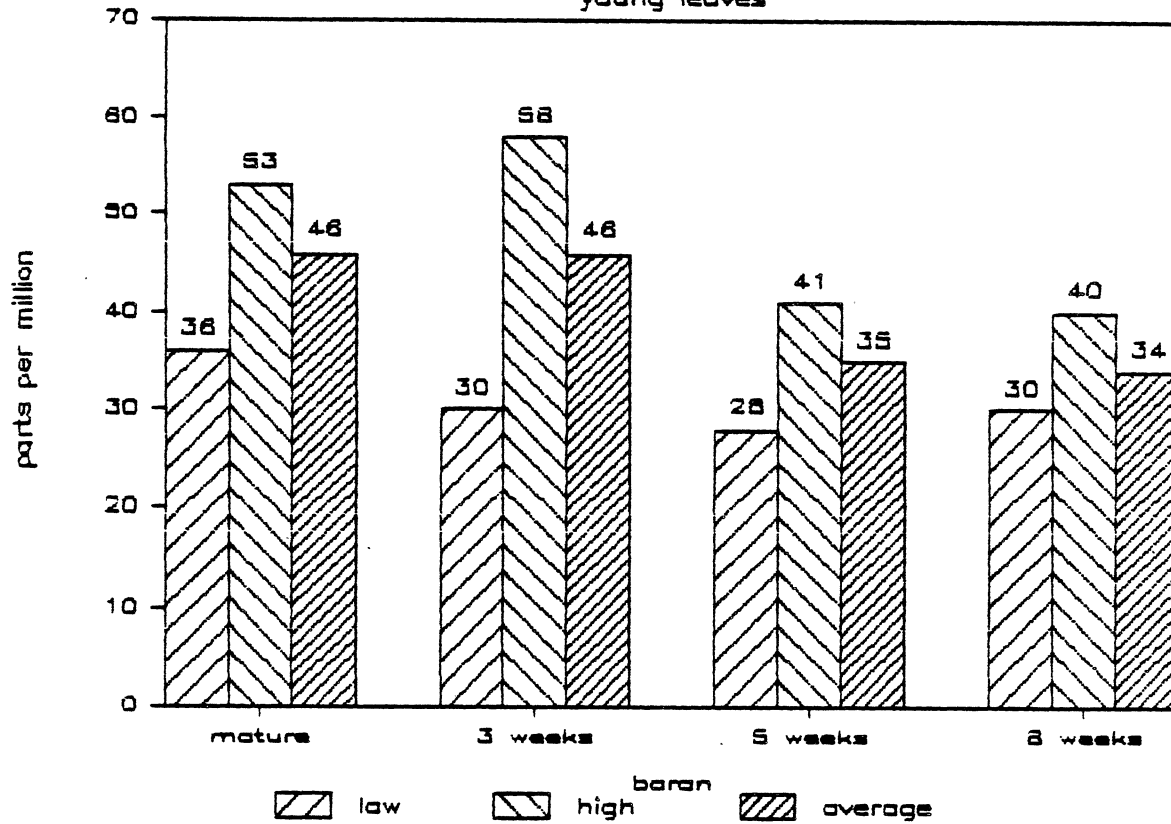
BROCCOLI

aid leaves

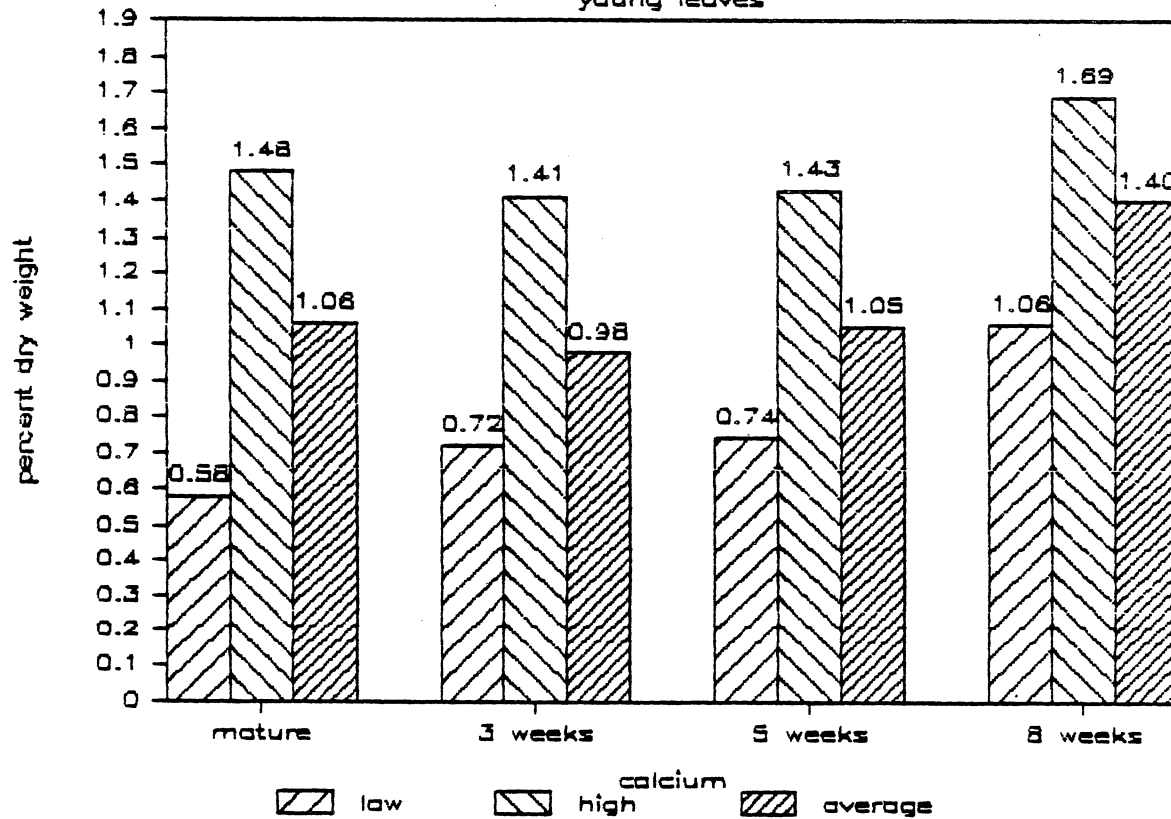


BROCCOLI

young leaves

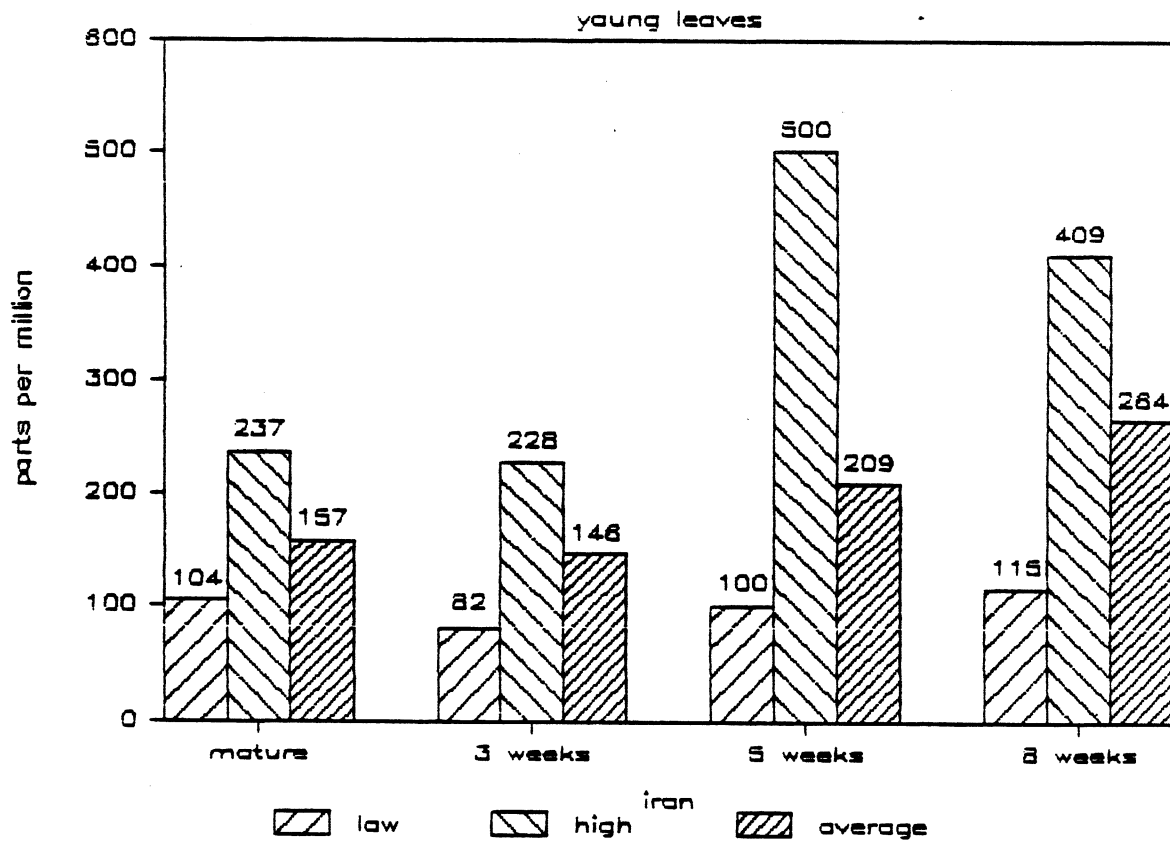
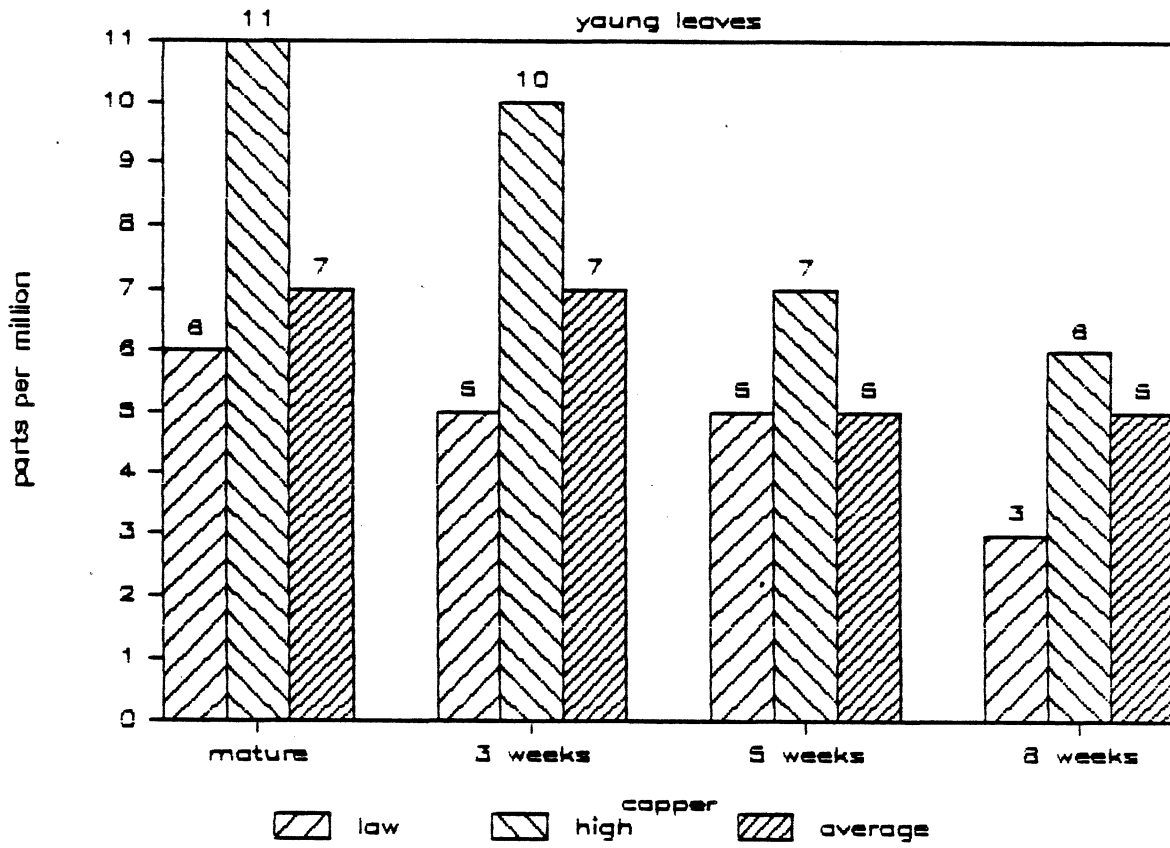


young leaves



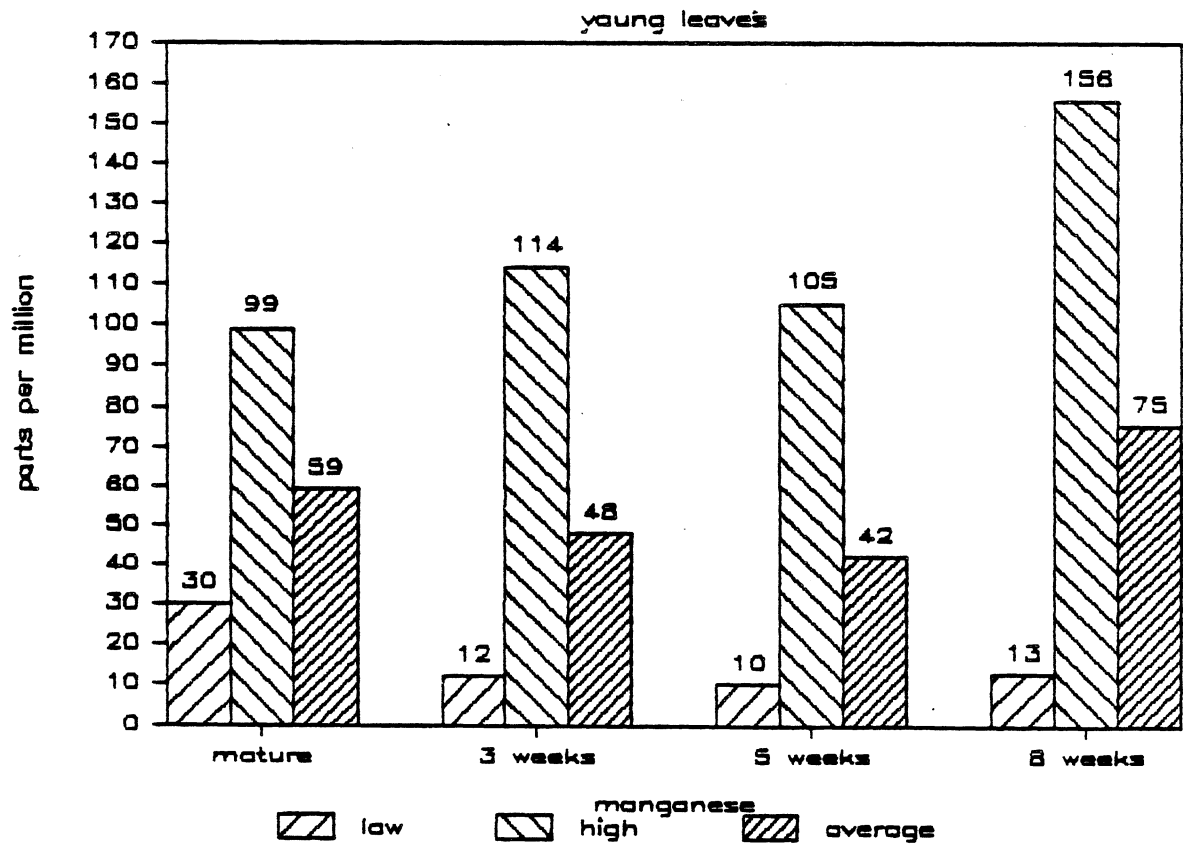
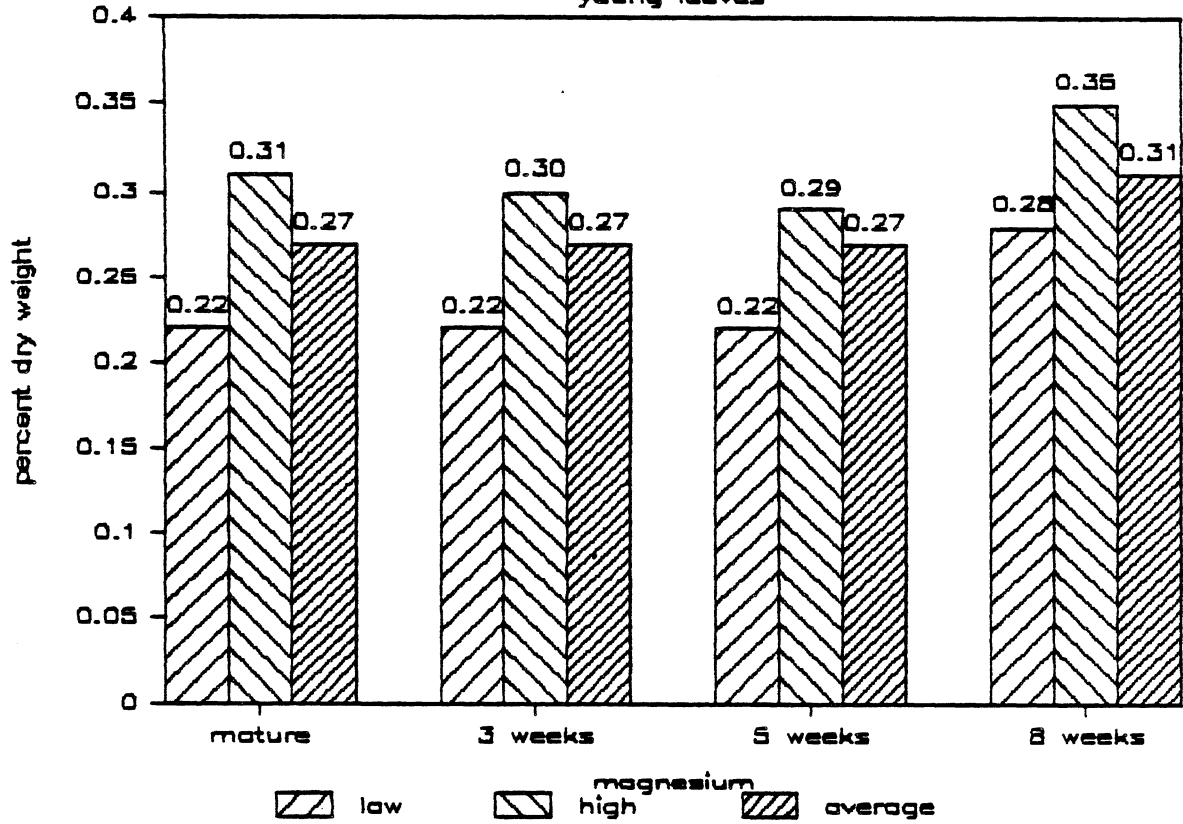
BROCCOLI

young leaves



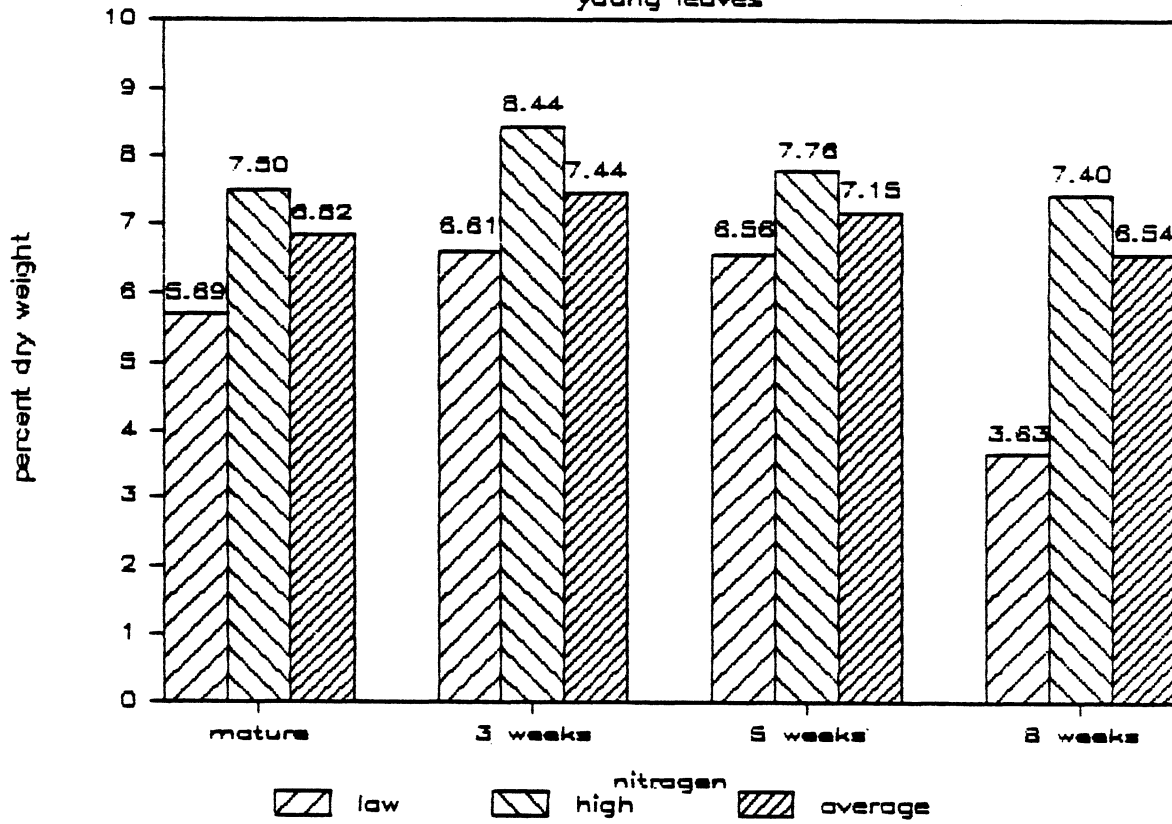
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young leaves

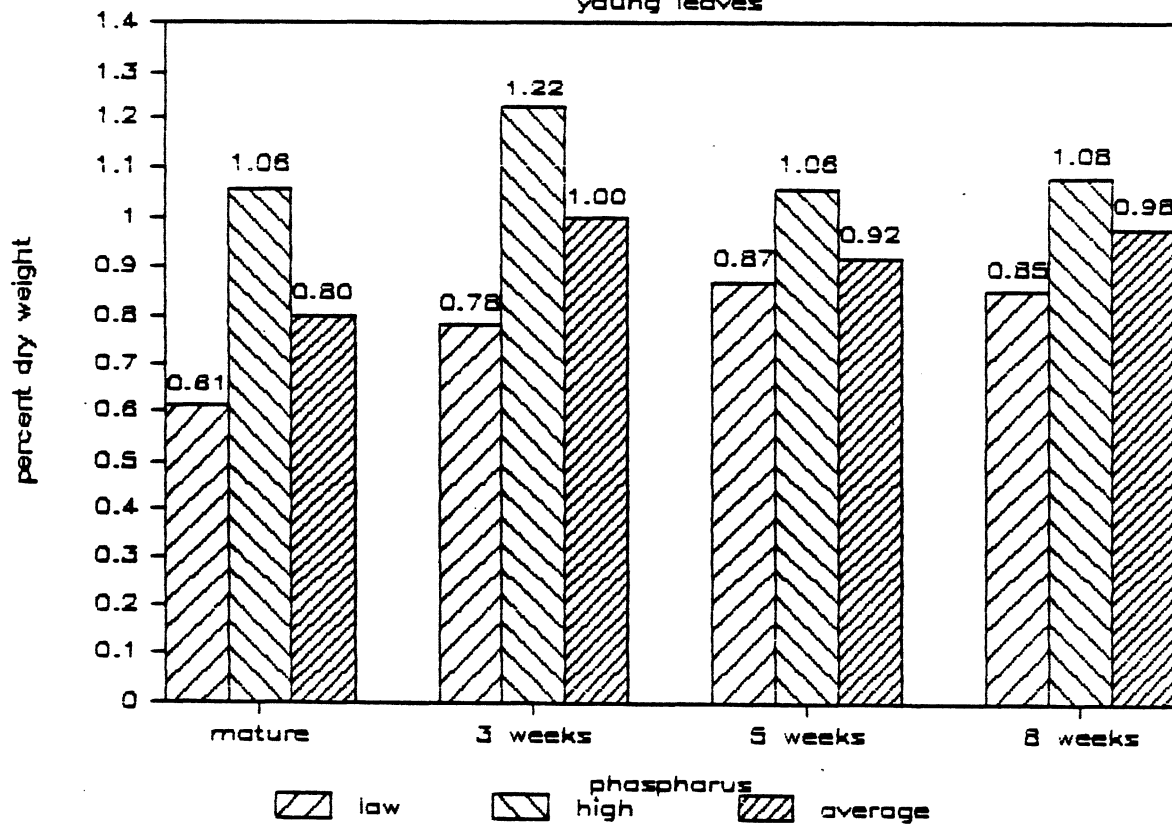


BROCCOLI

young leaves

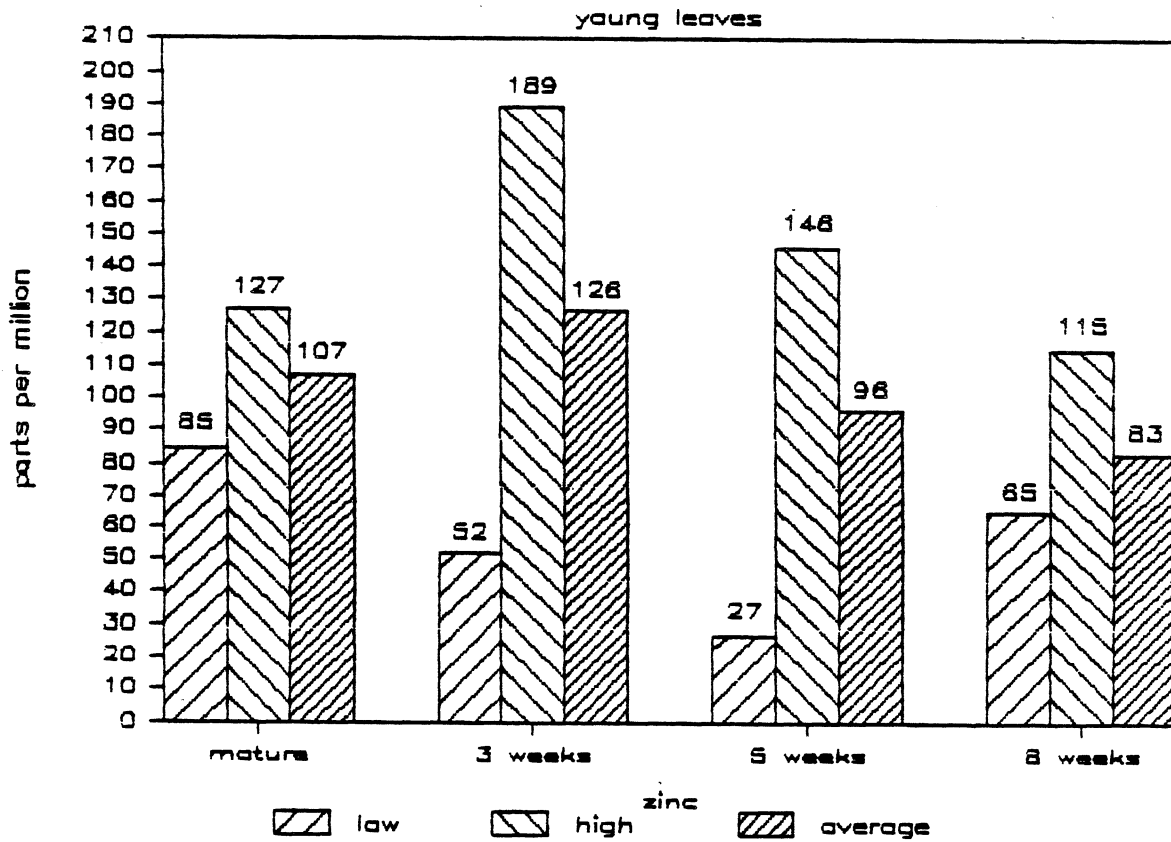
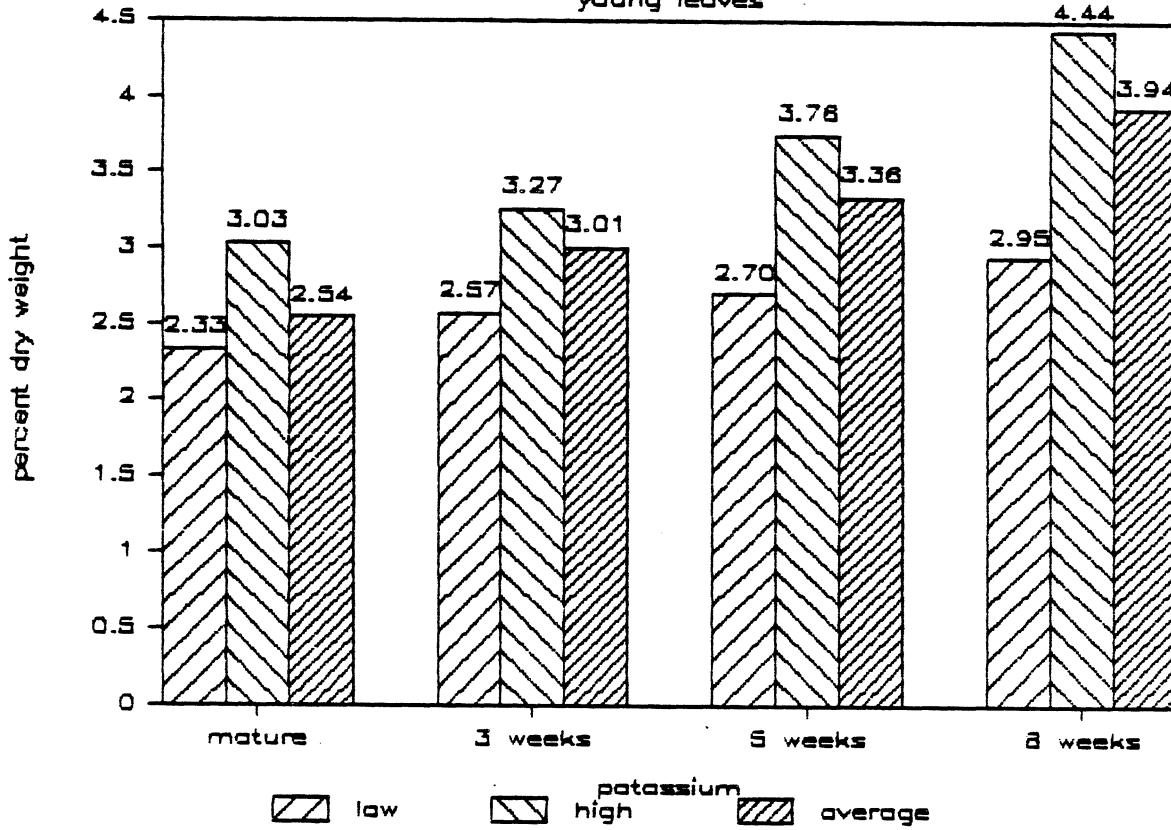


young leaves



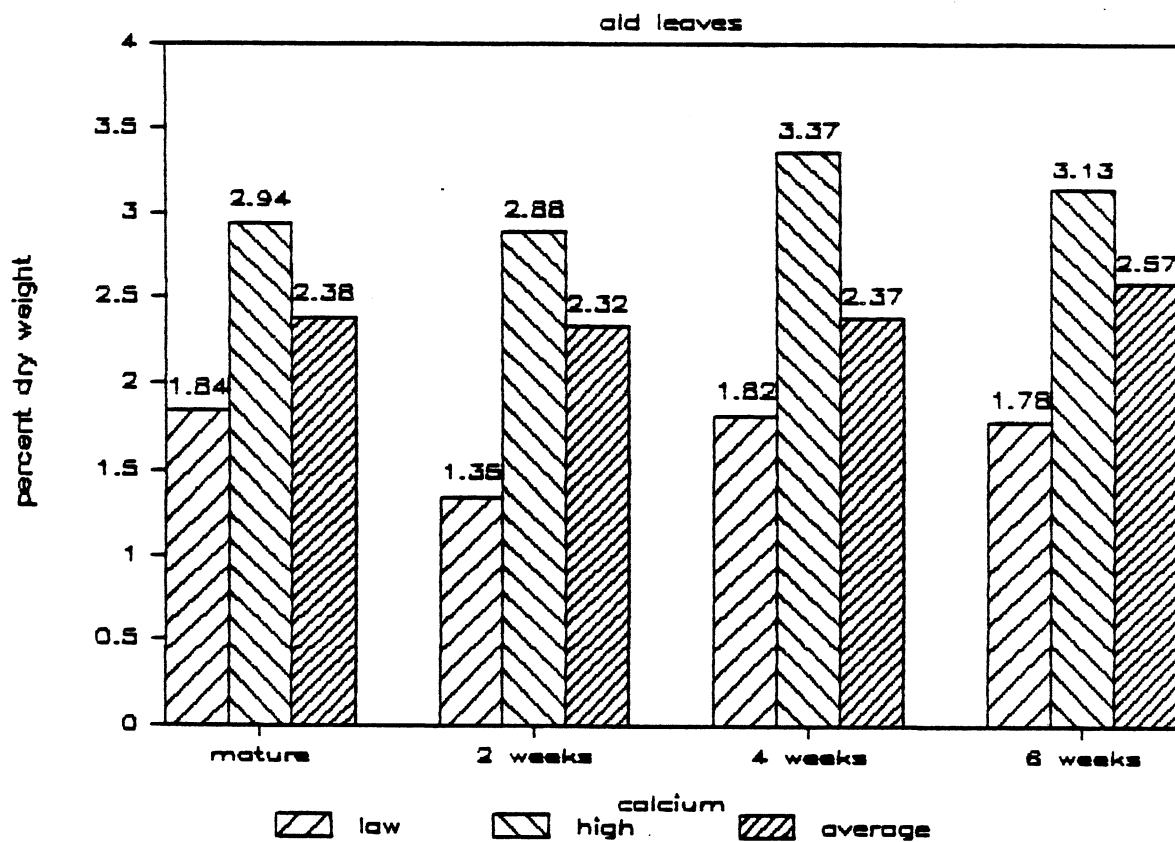
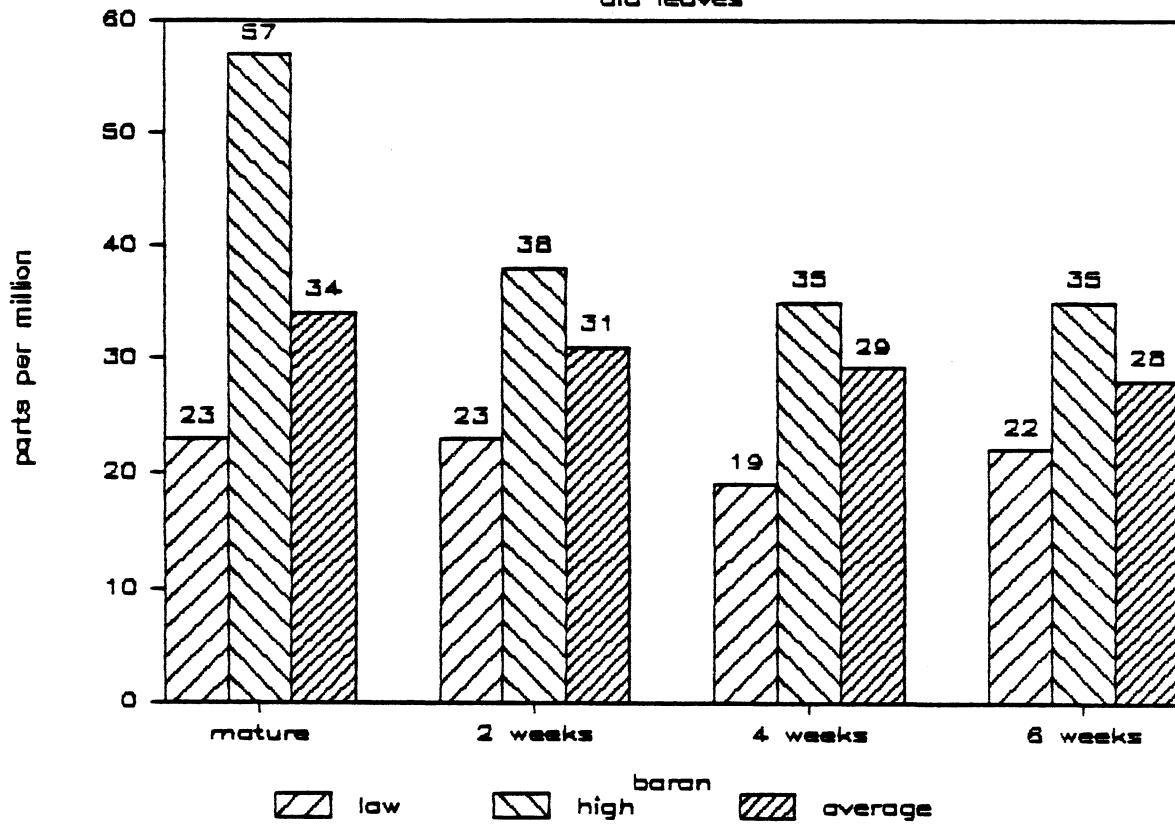
BROCCOLI

young leaves



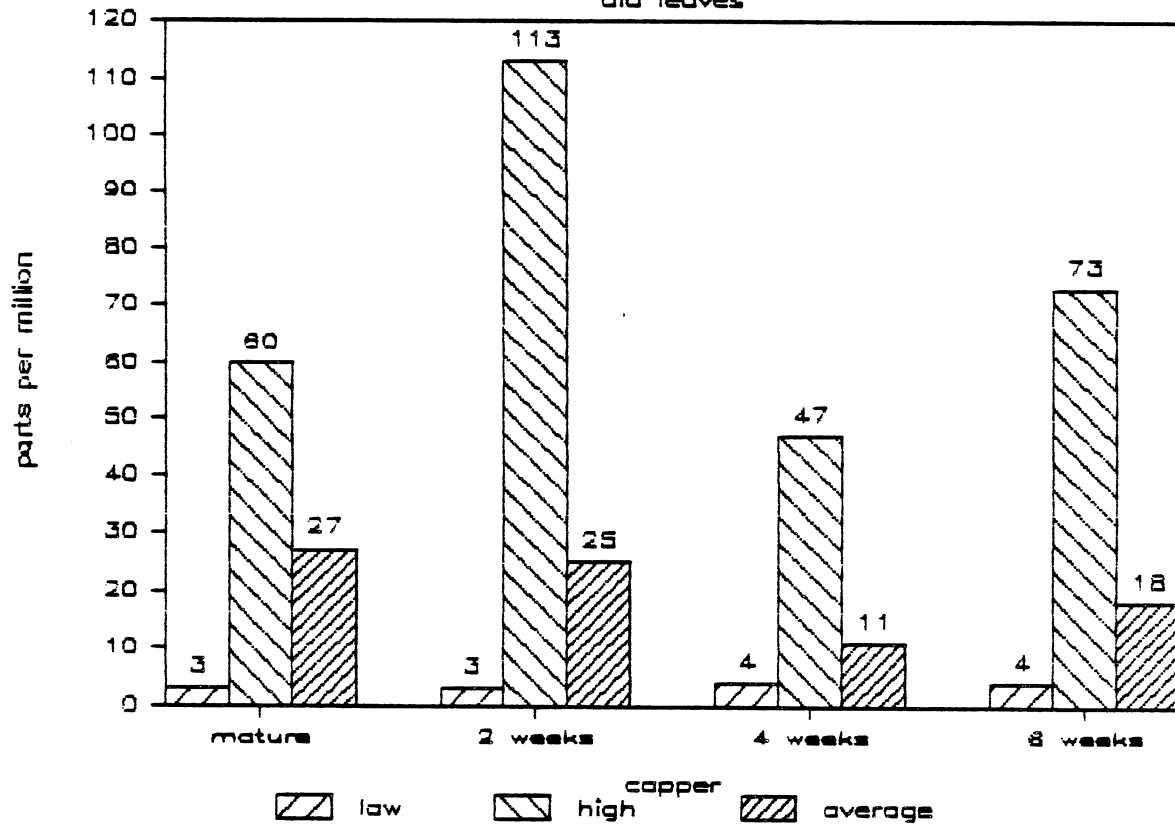
CELERY

old leaves

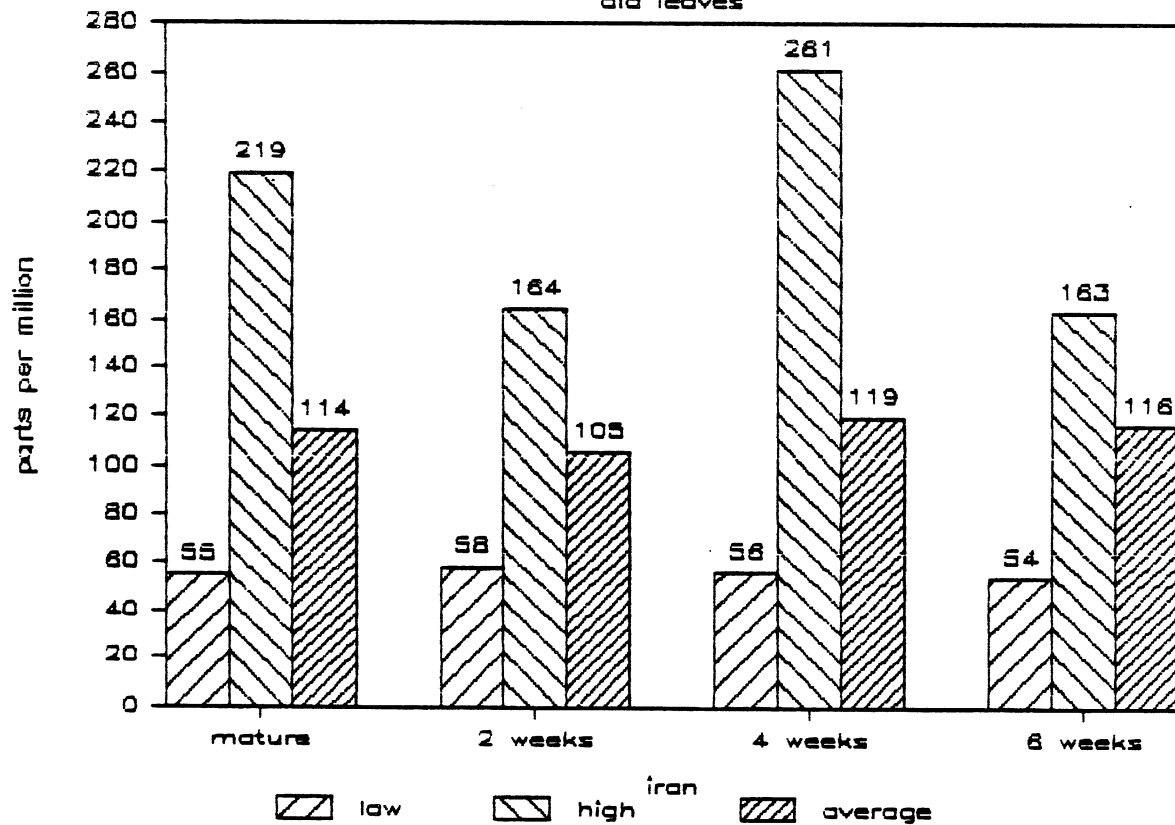


CELERY

old leaves

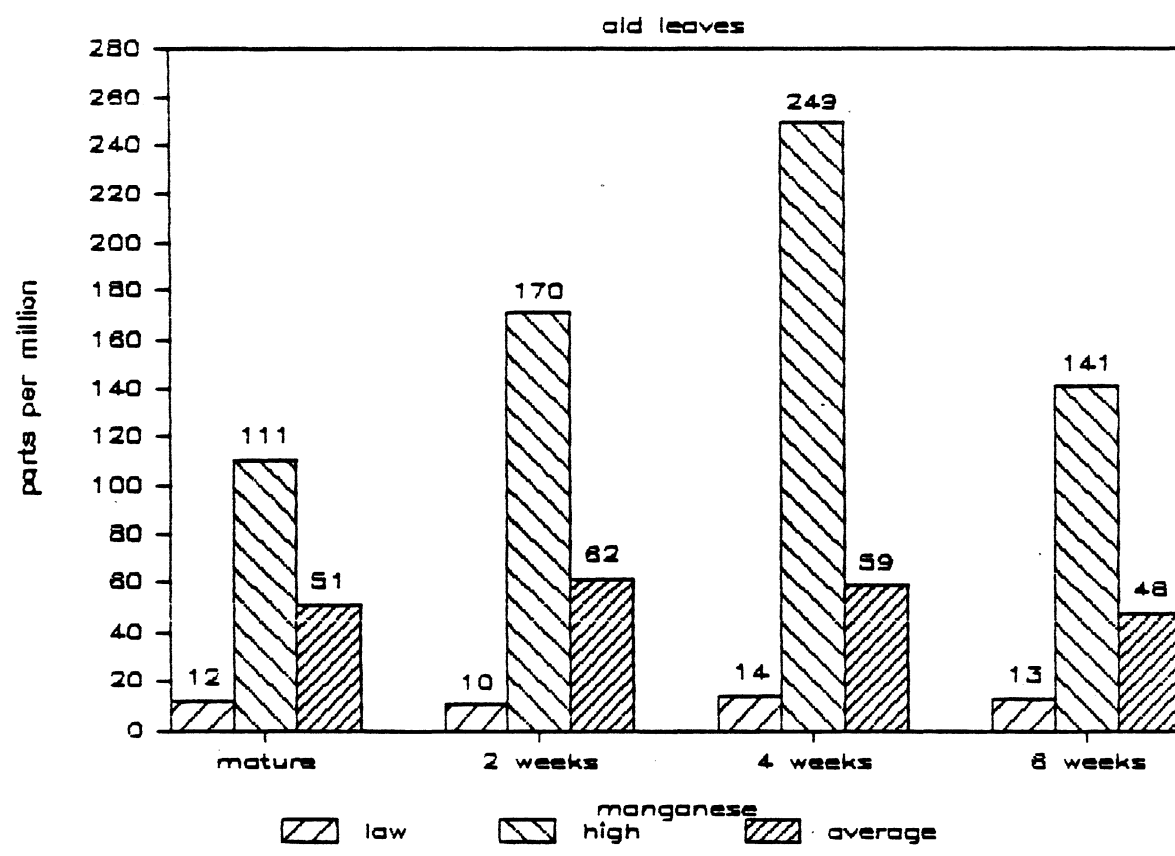
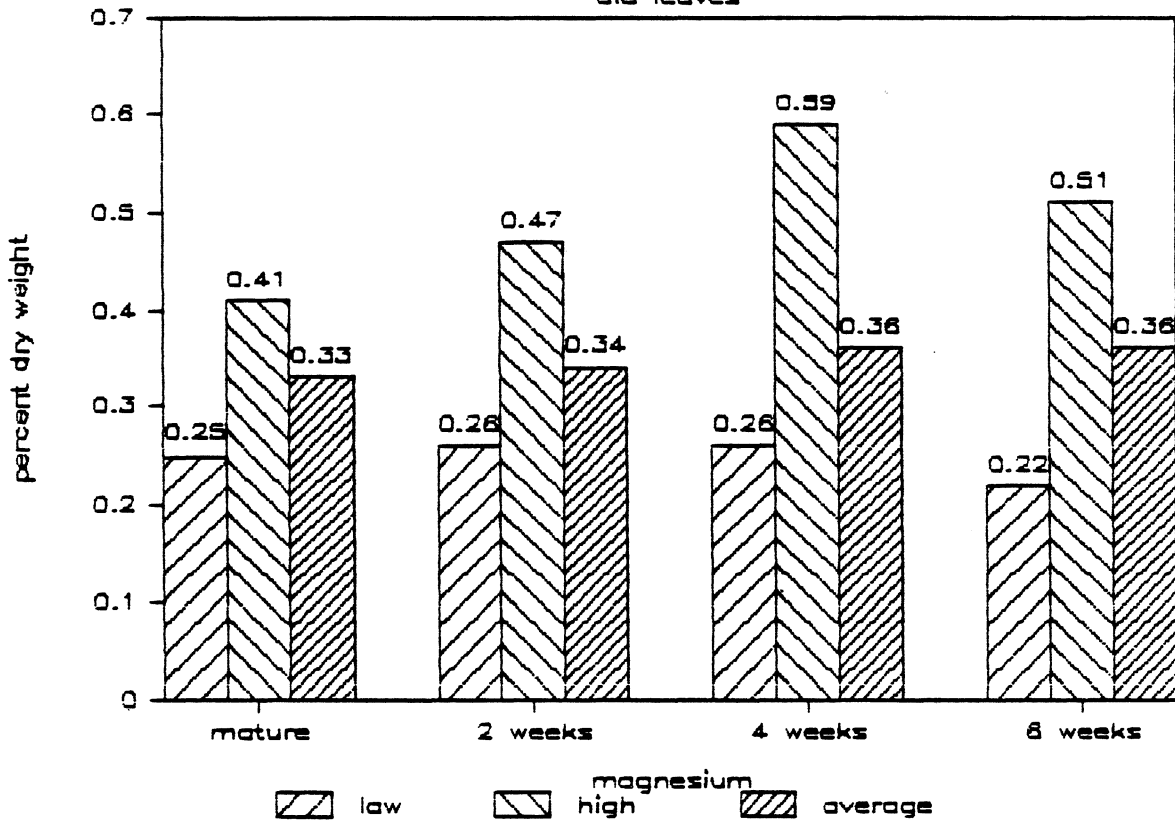


old leaves



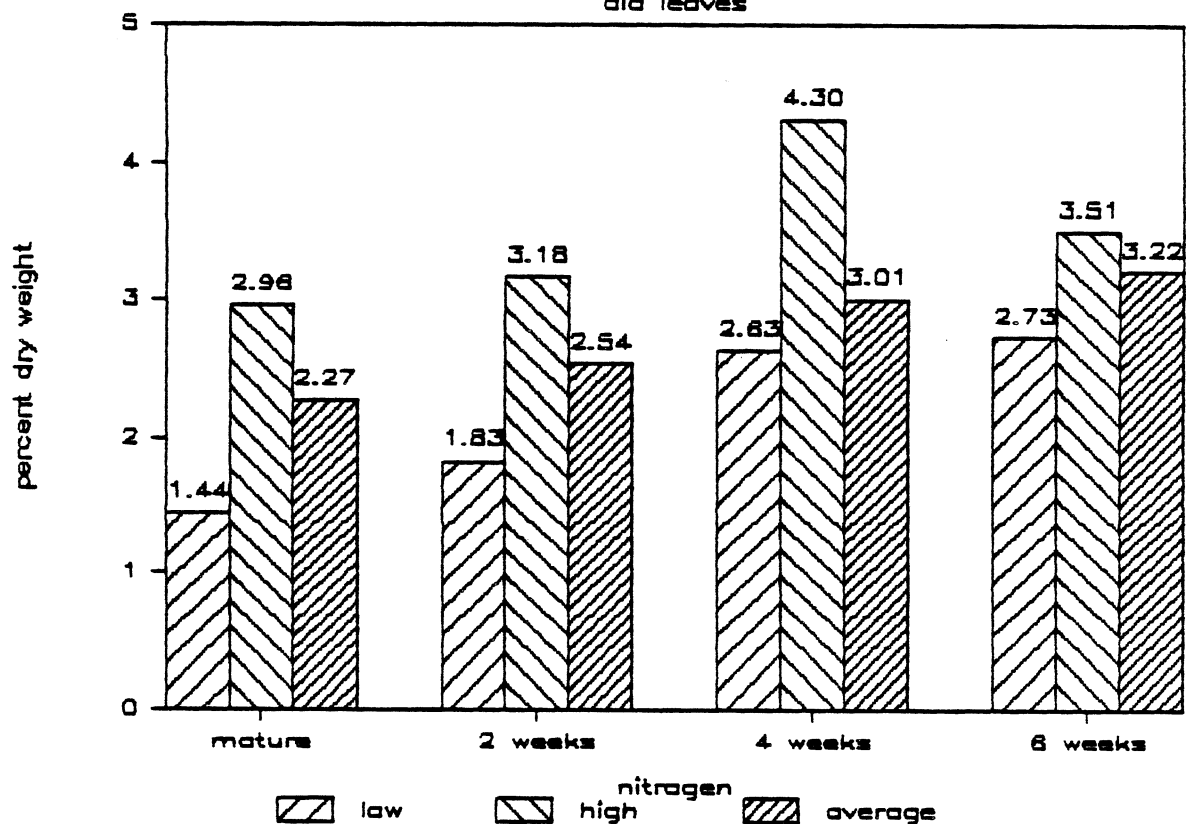
CELERY

aid leaves

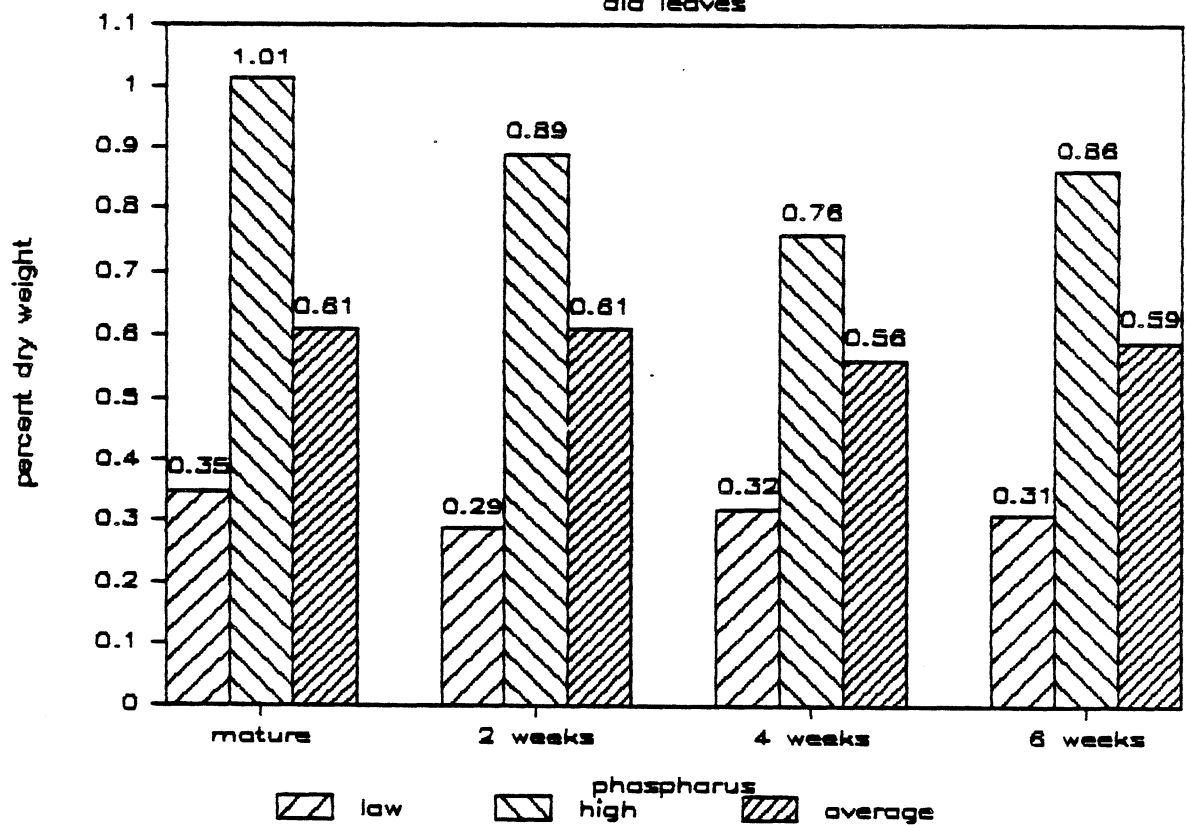


CELERY

old leaves

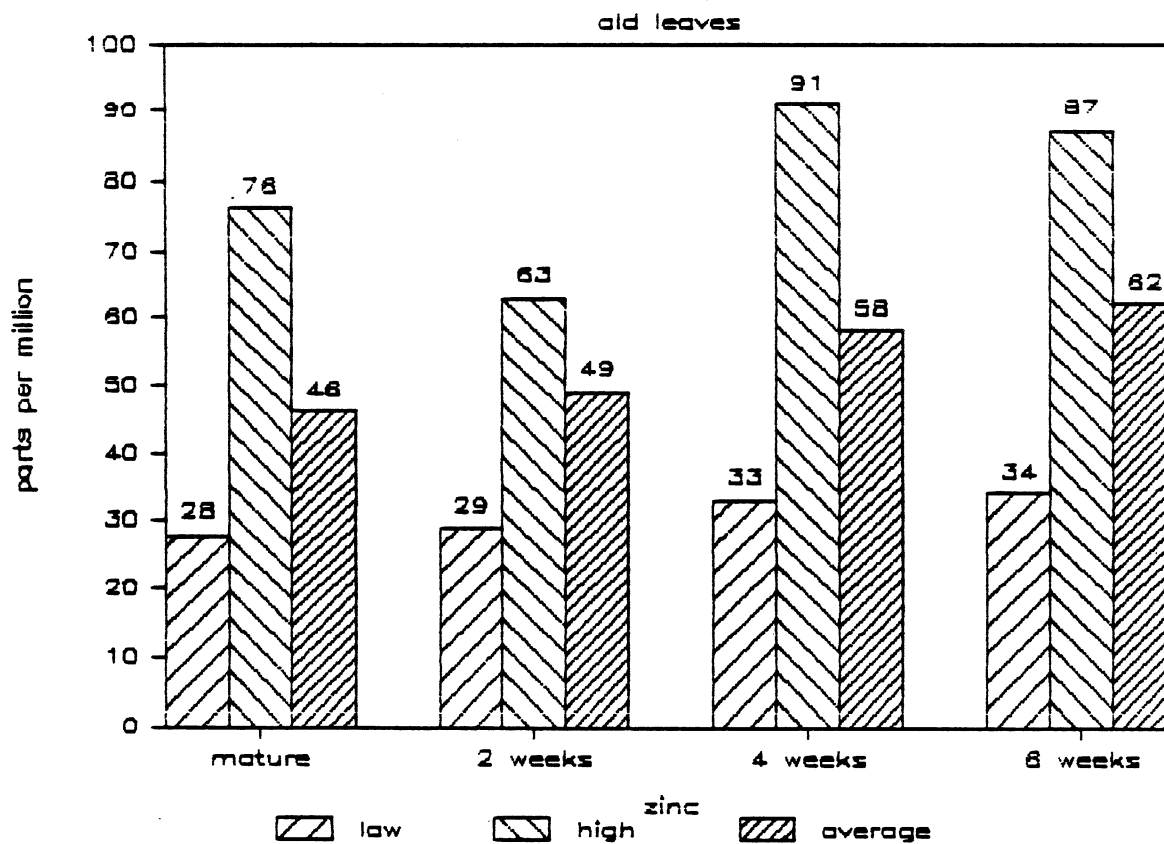
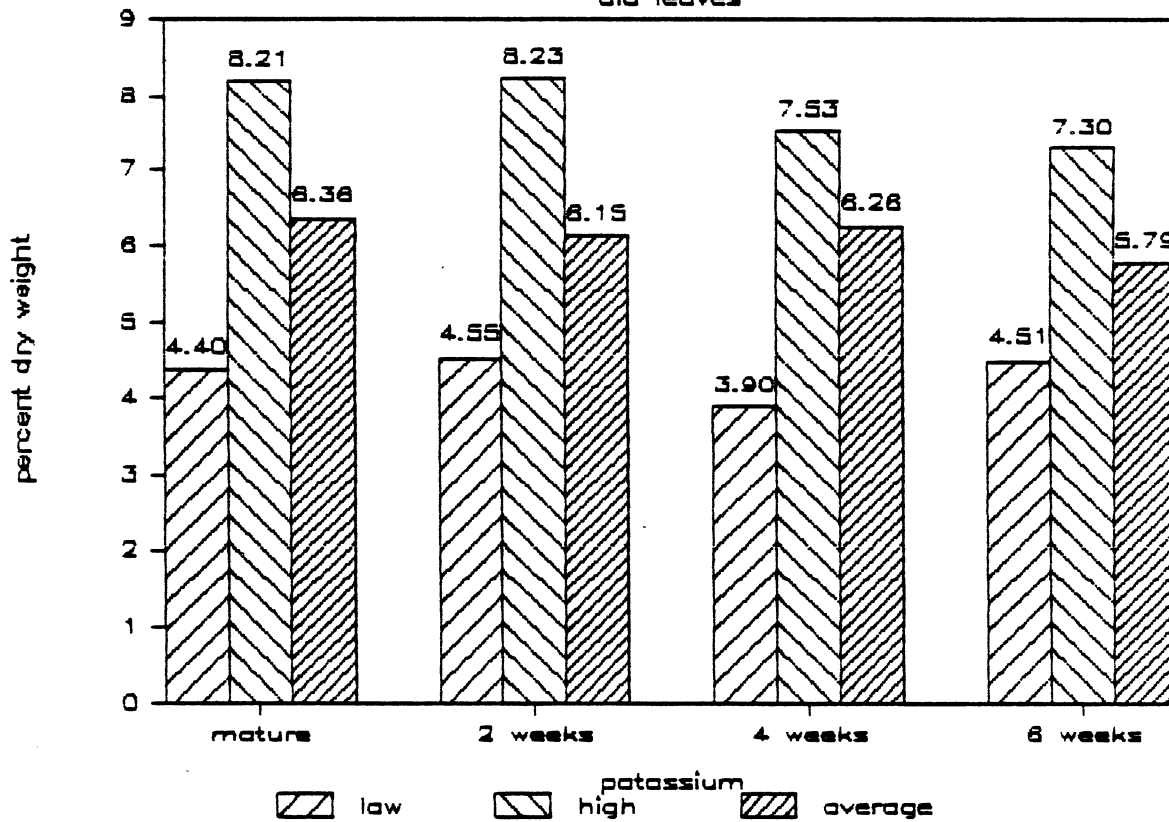


old leaves



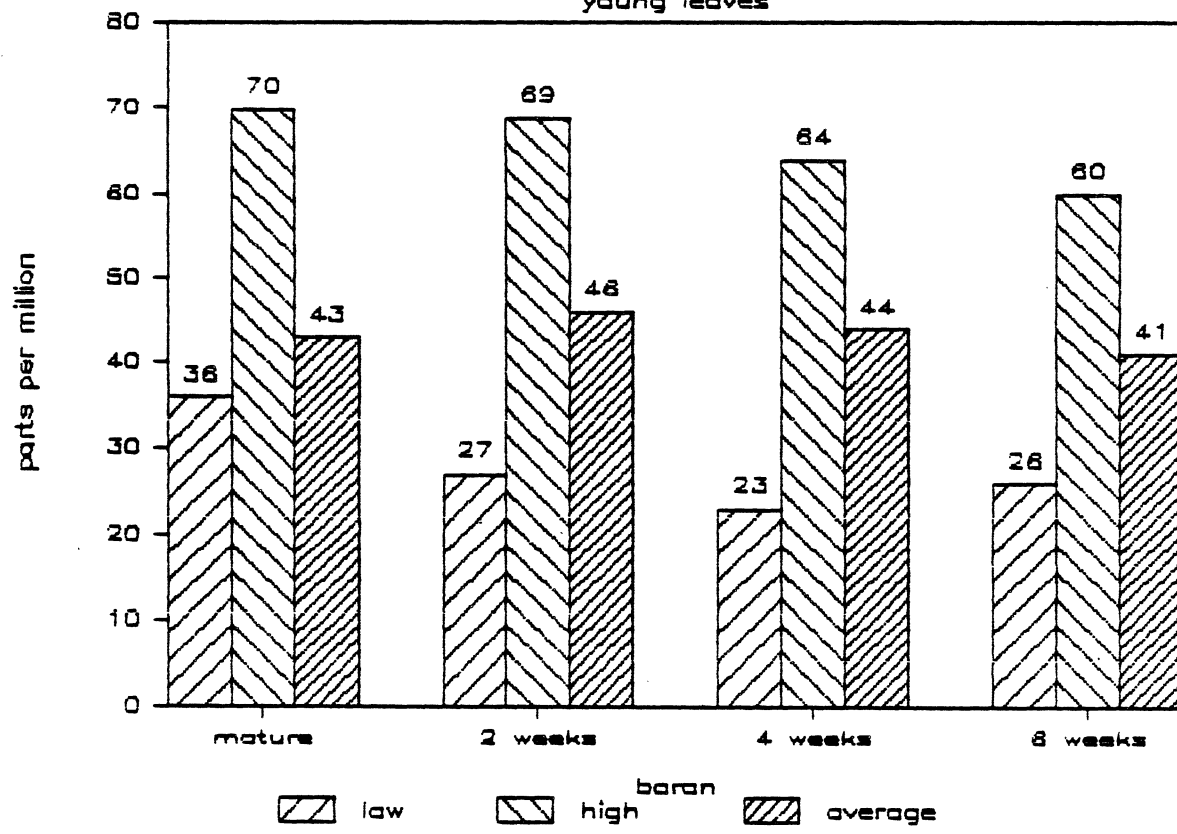
CELERY

old leaves

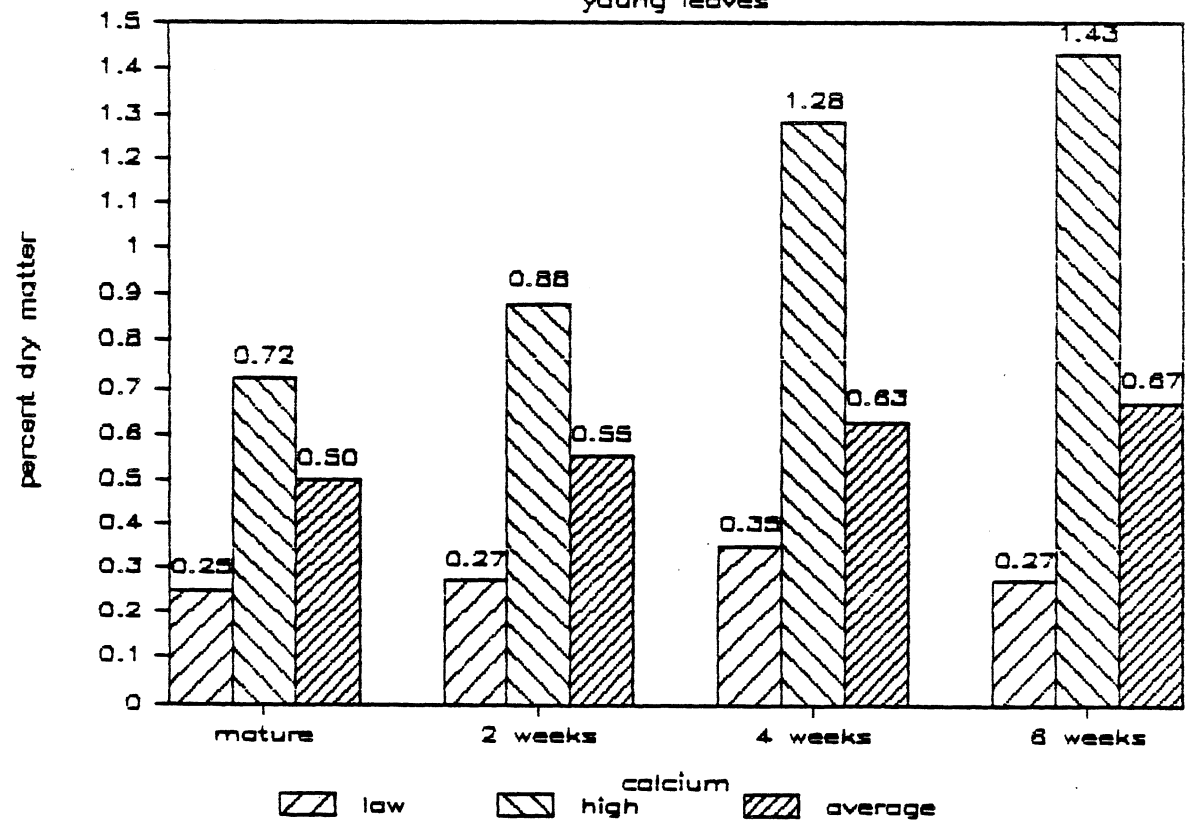


CELERY

young leaves

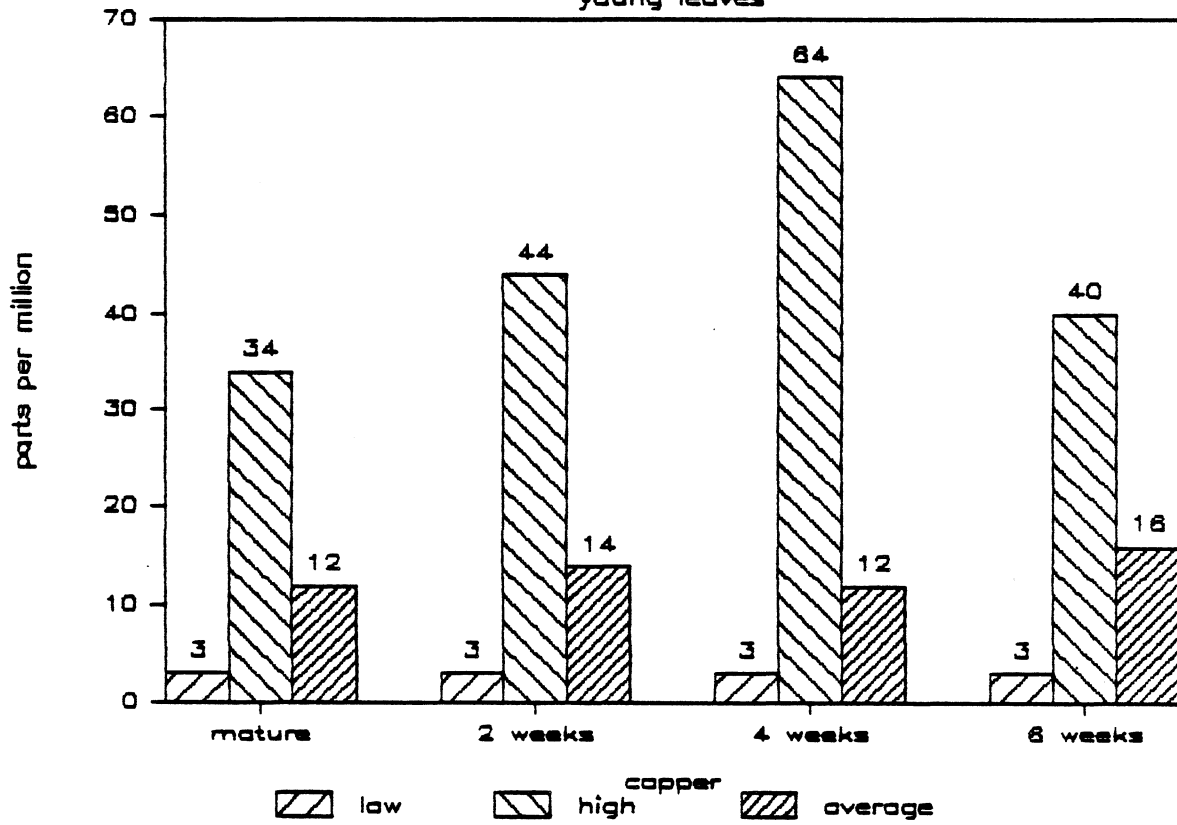


young leaves

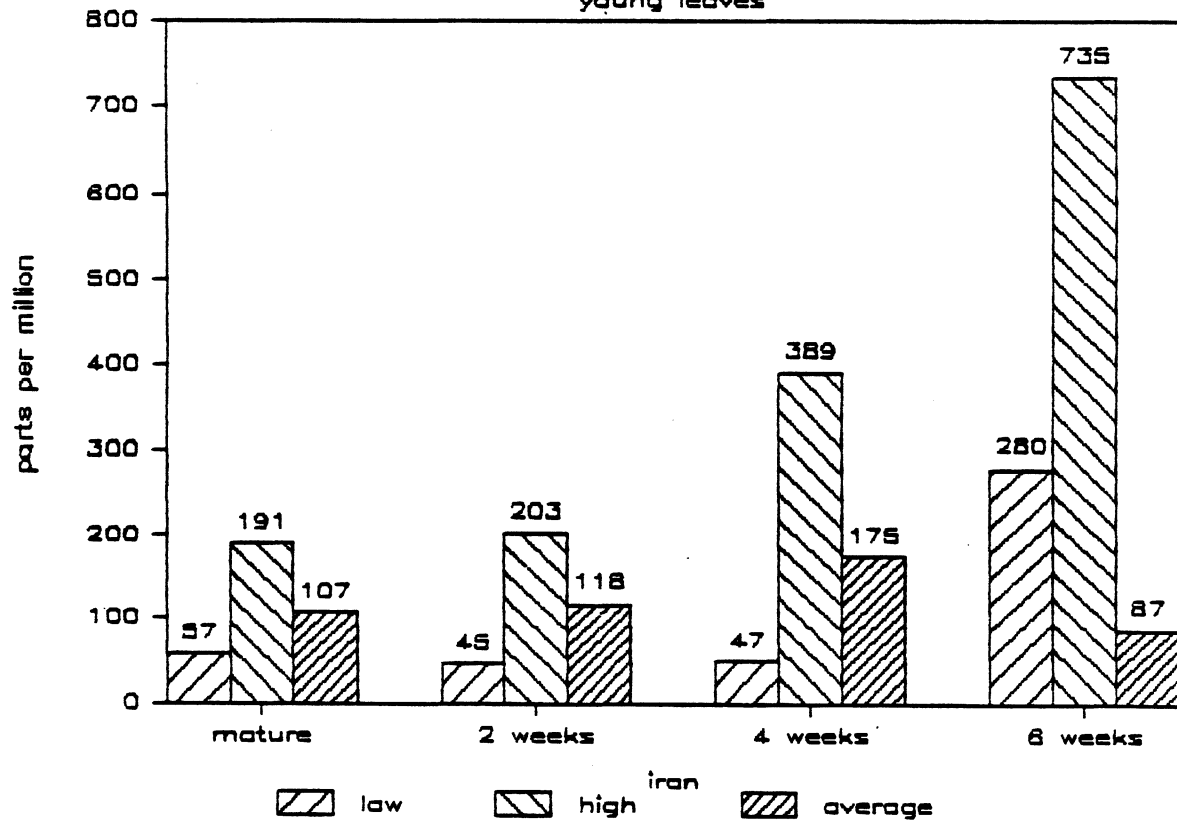


CELERY

young leaves

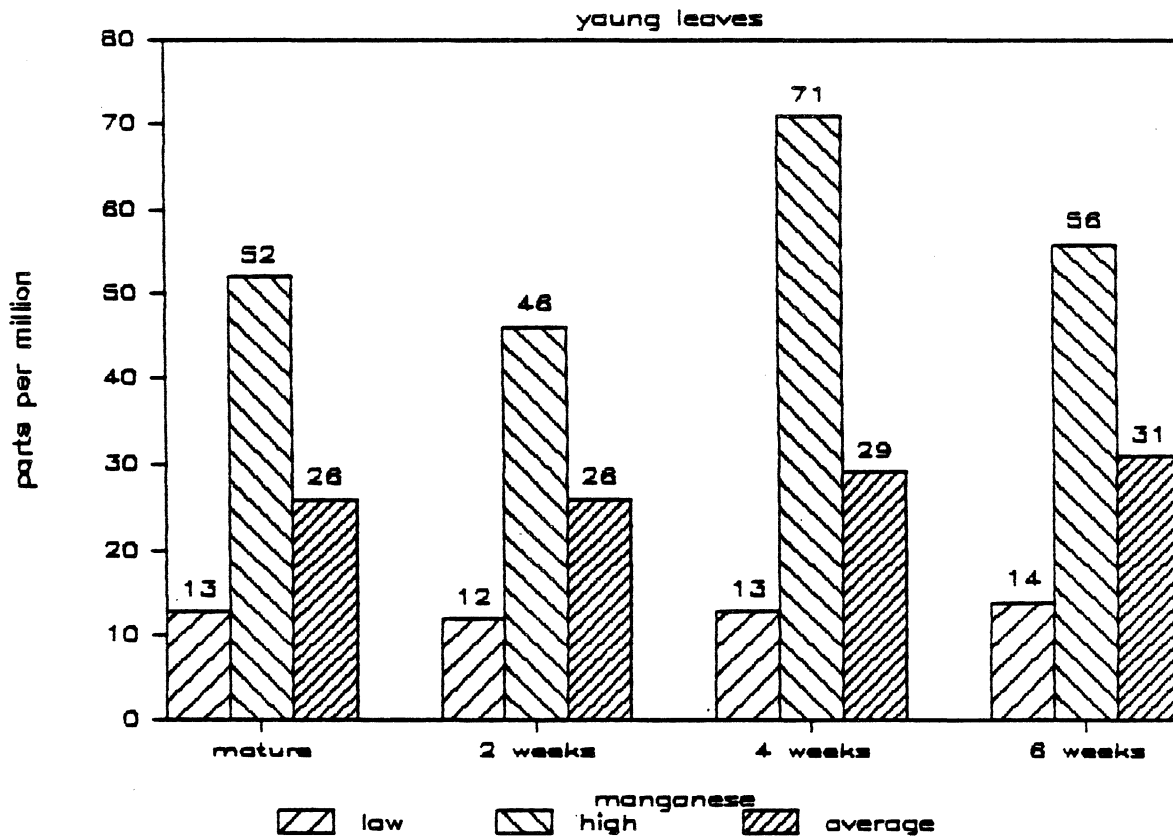
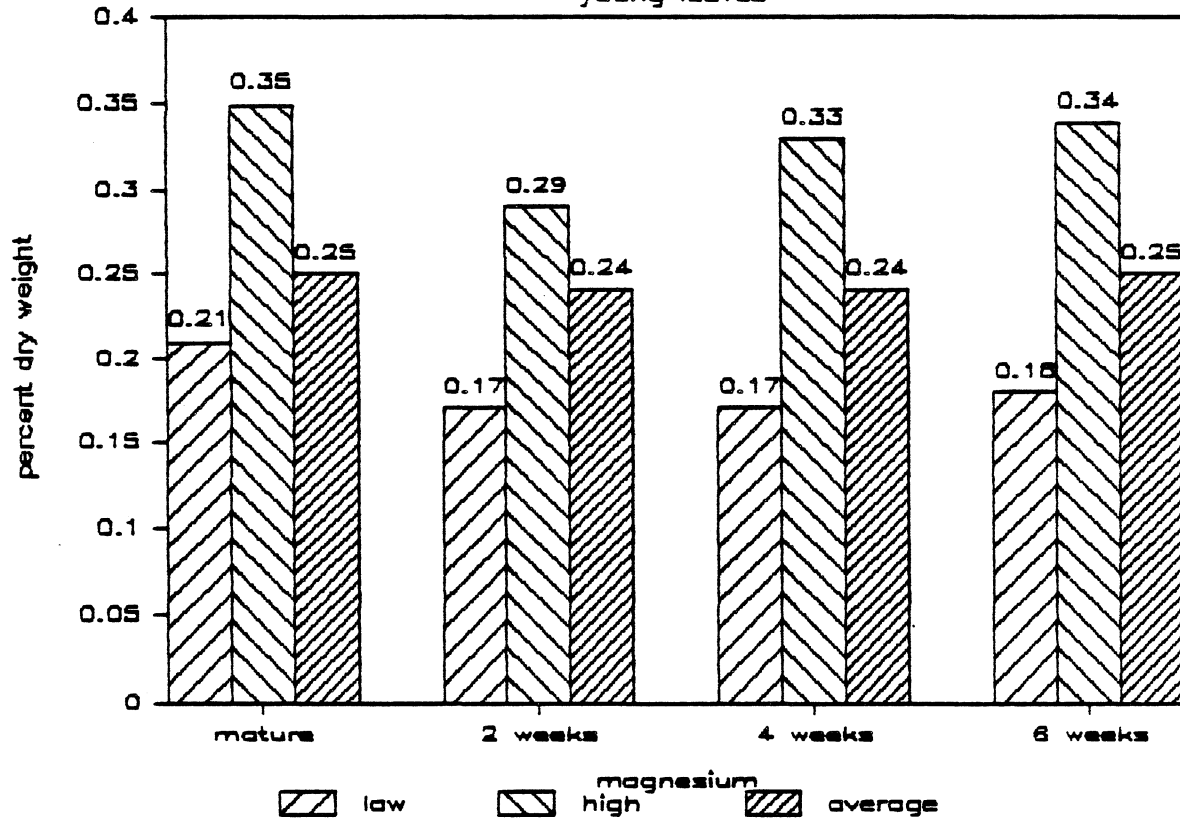


young leaves



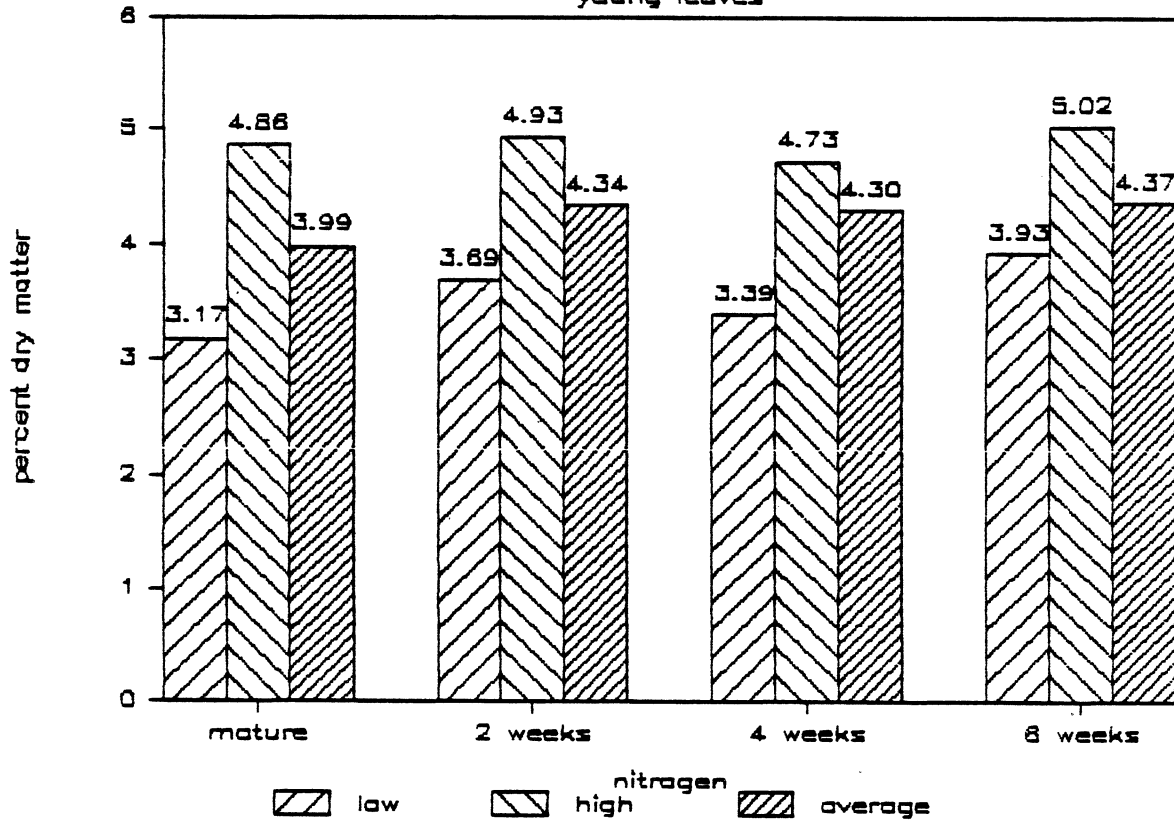
CELERY

young leaves



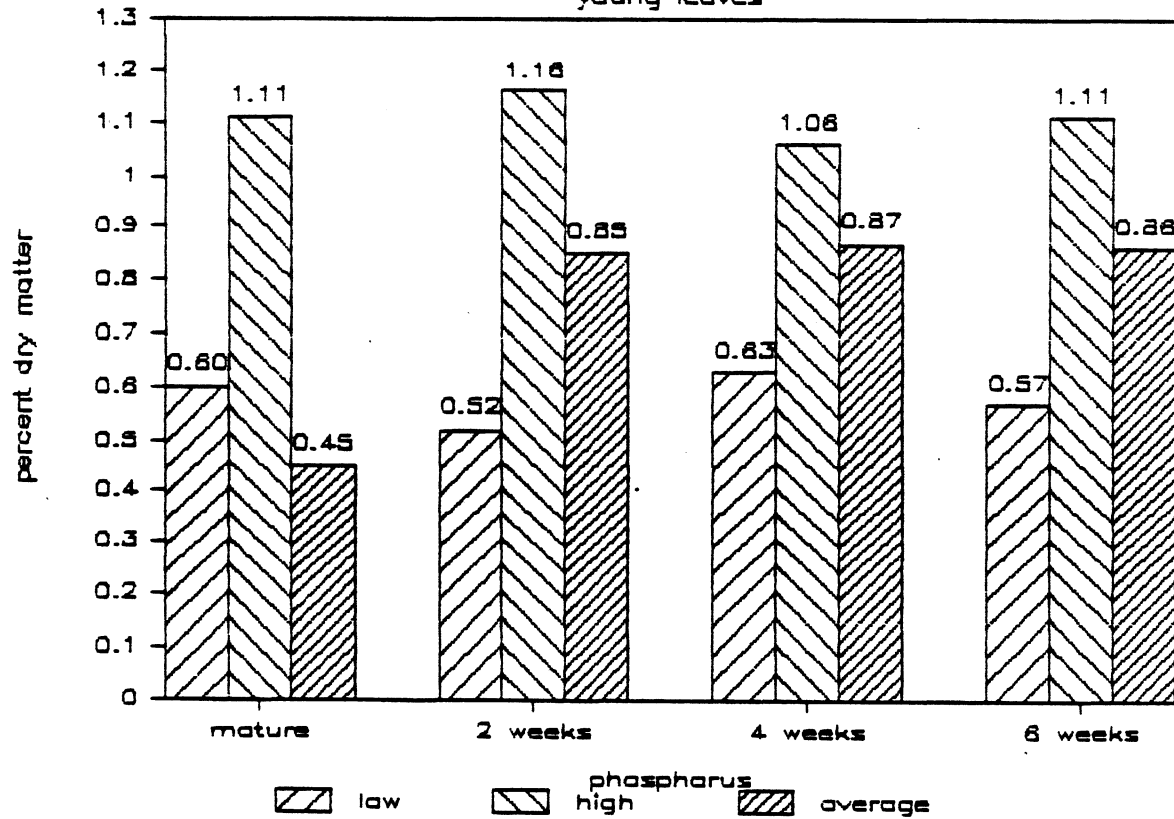
CELERY

young leaves



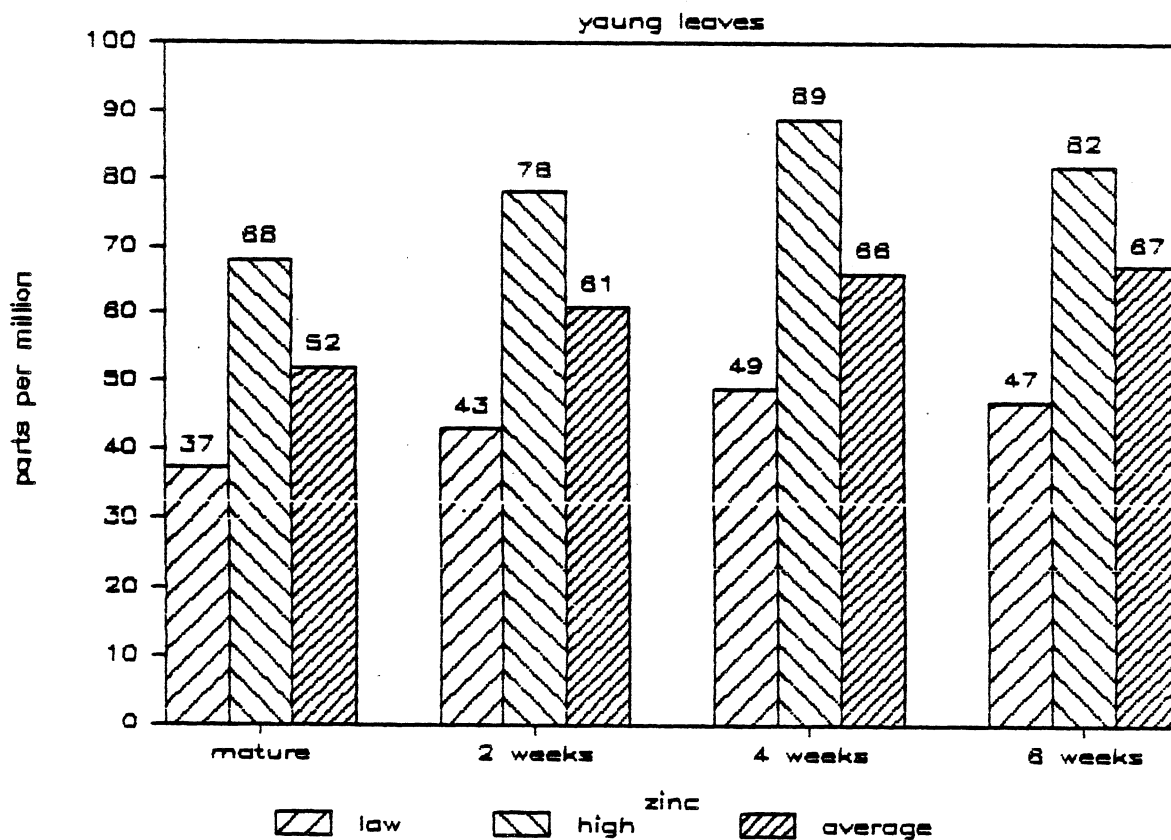
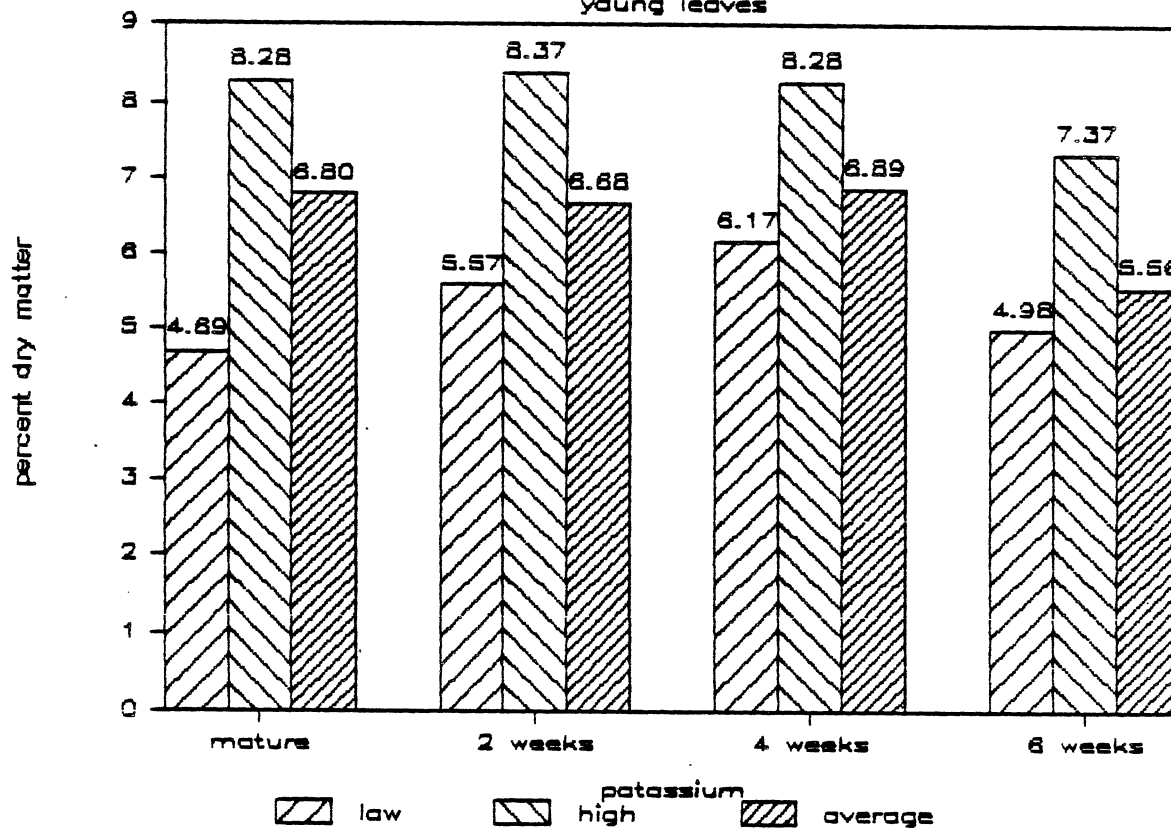
CELERY

young leaves

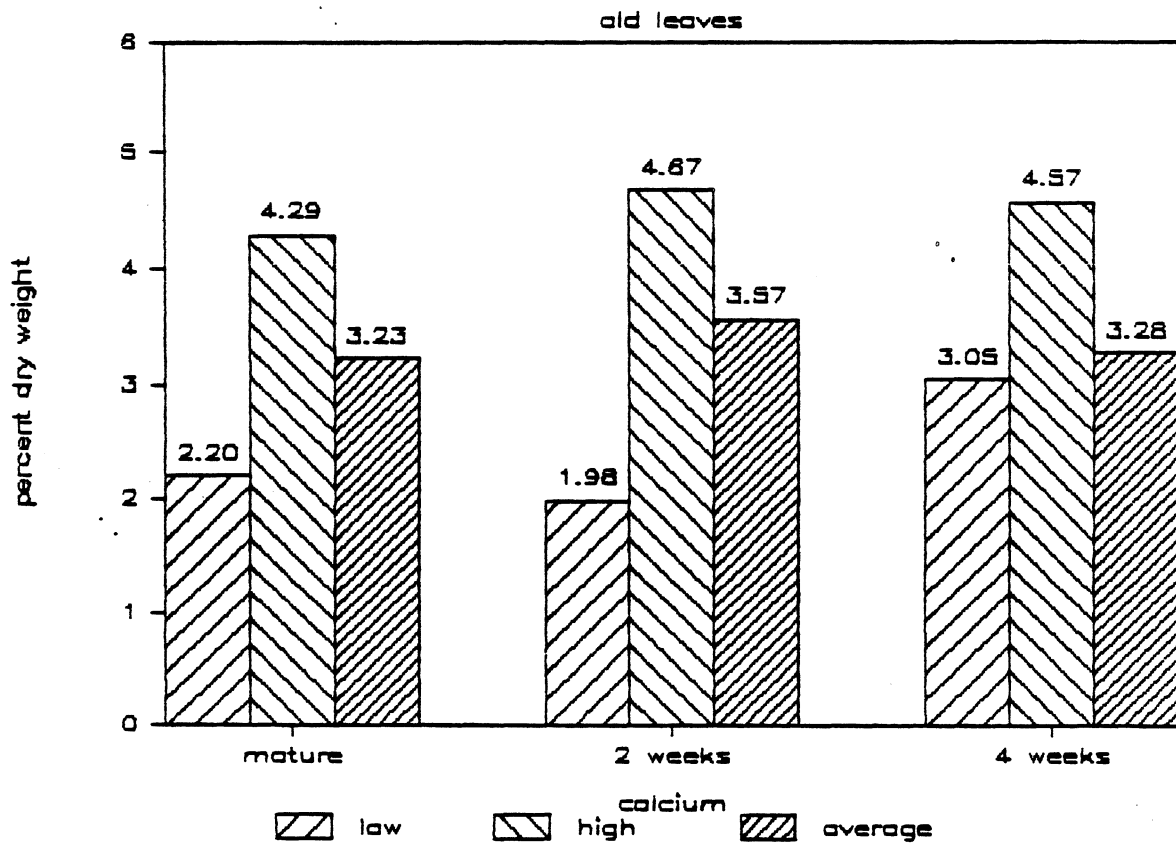
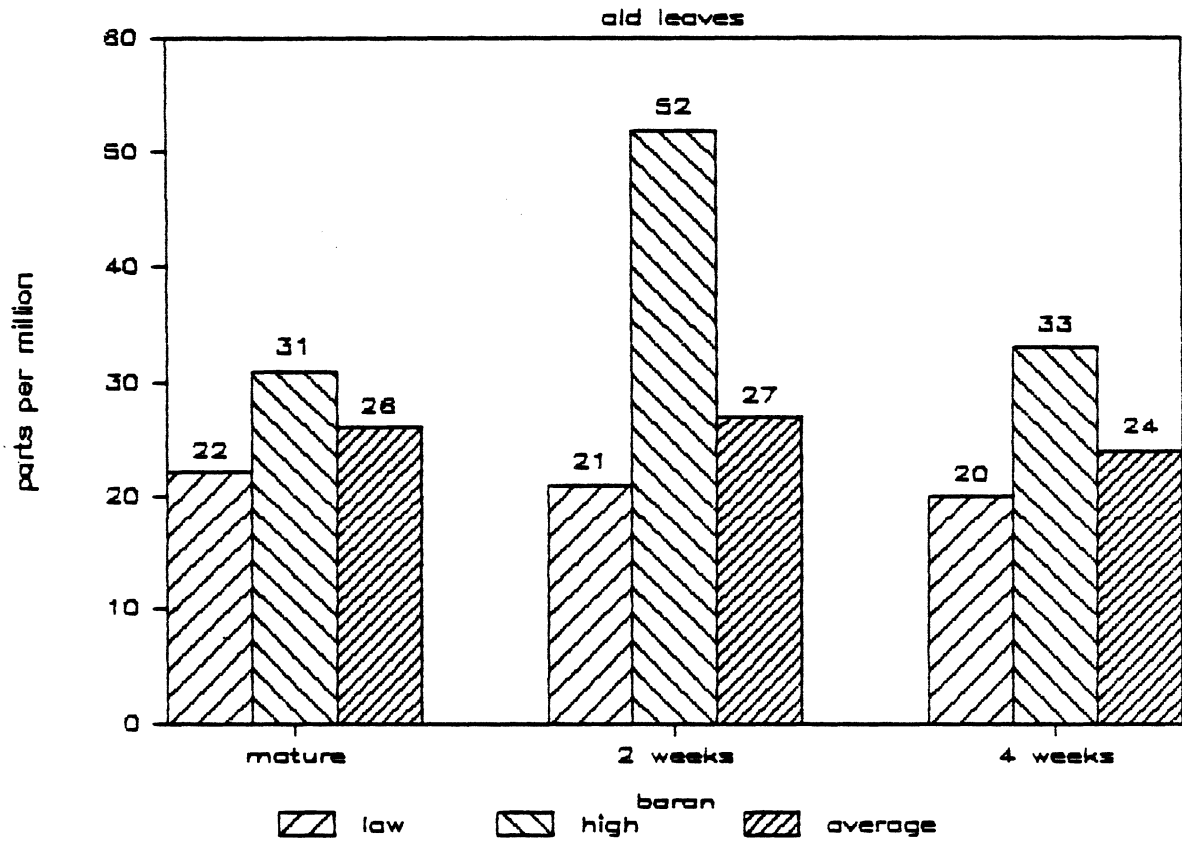


CELERY

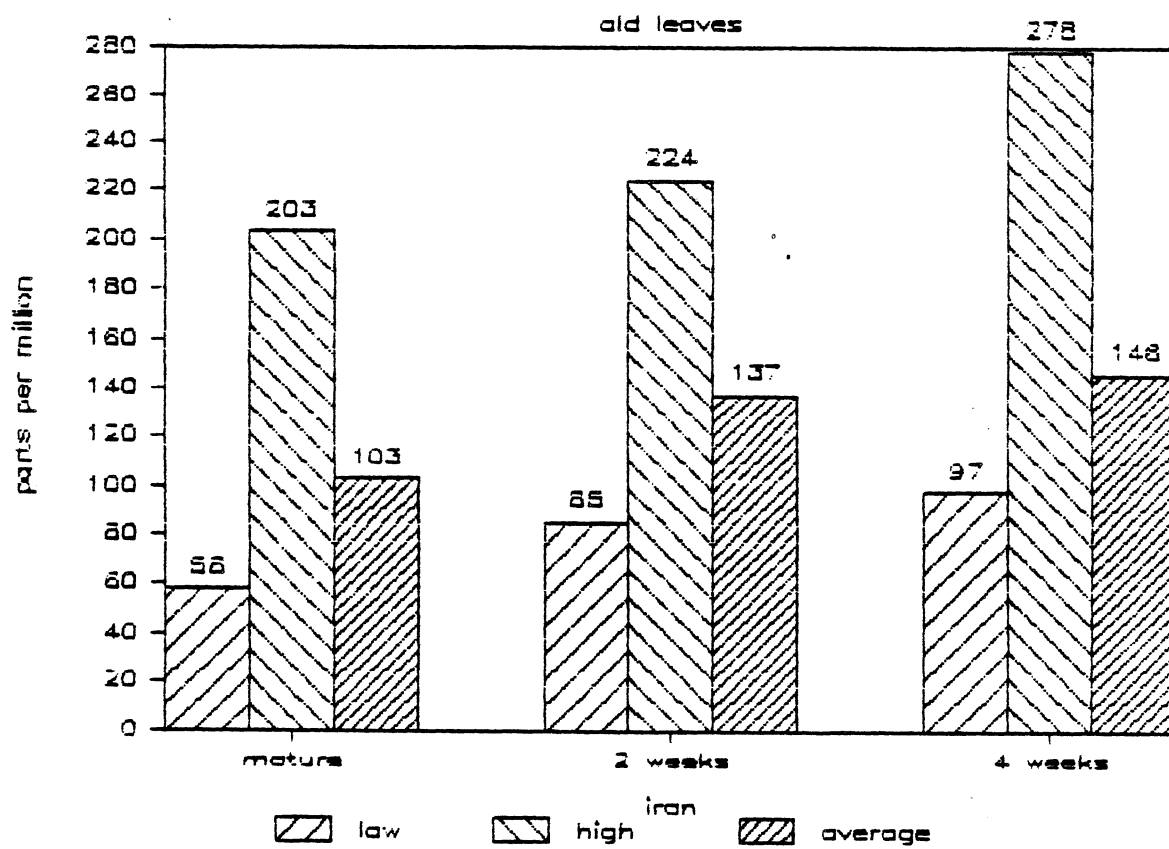
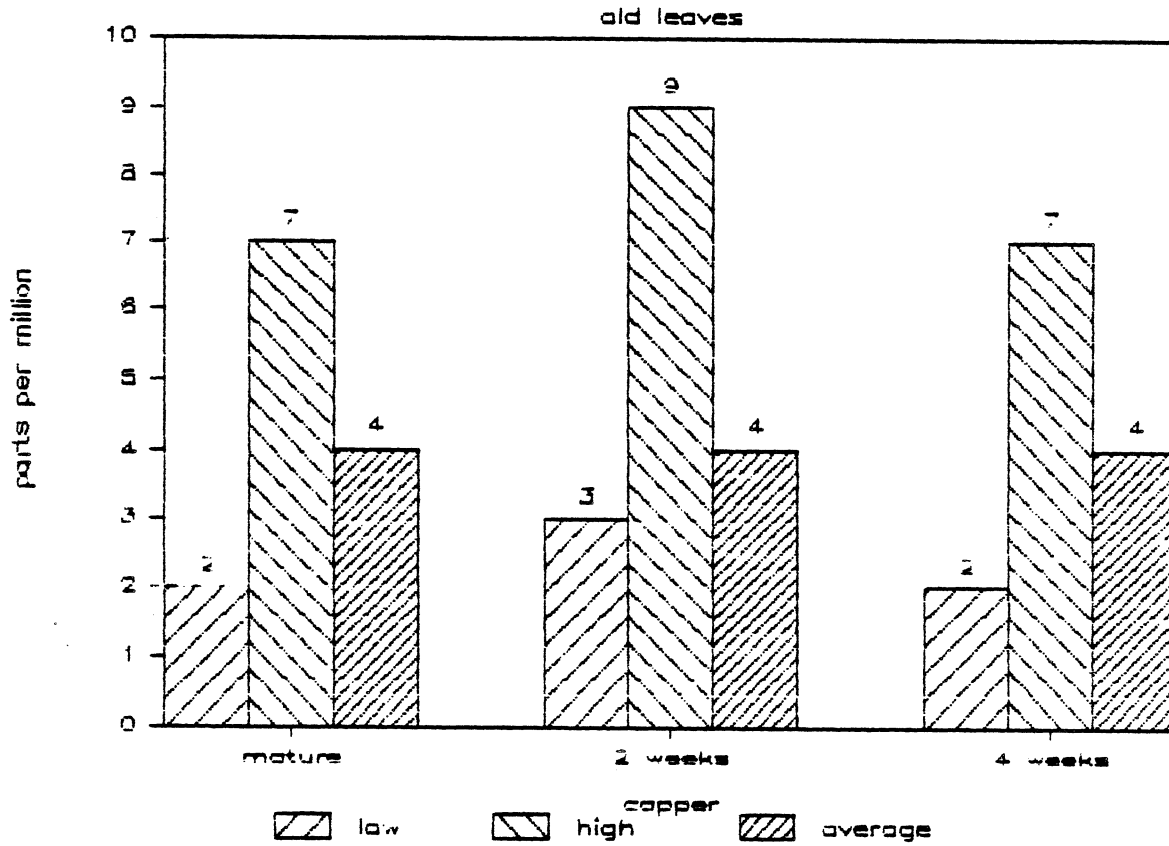
young leaves



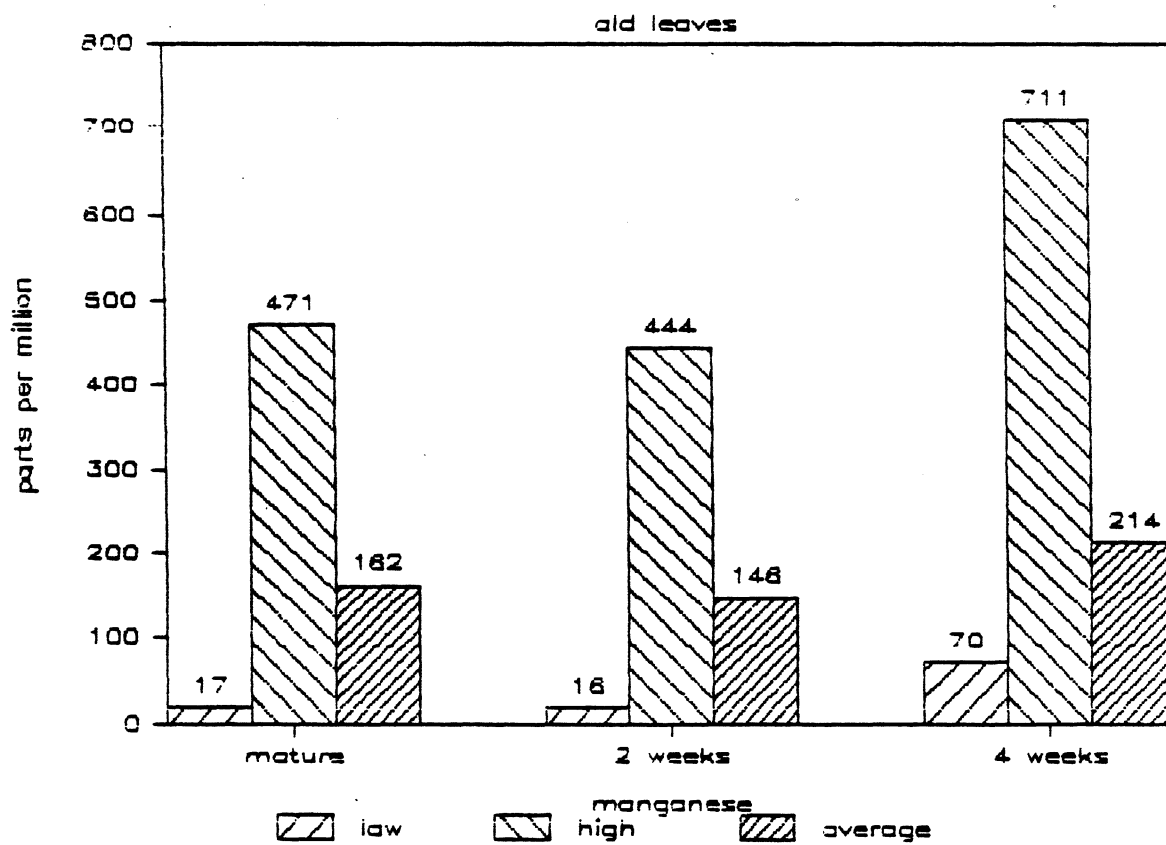
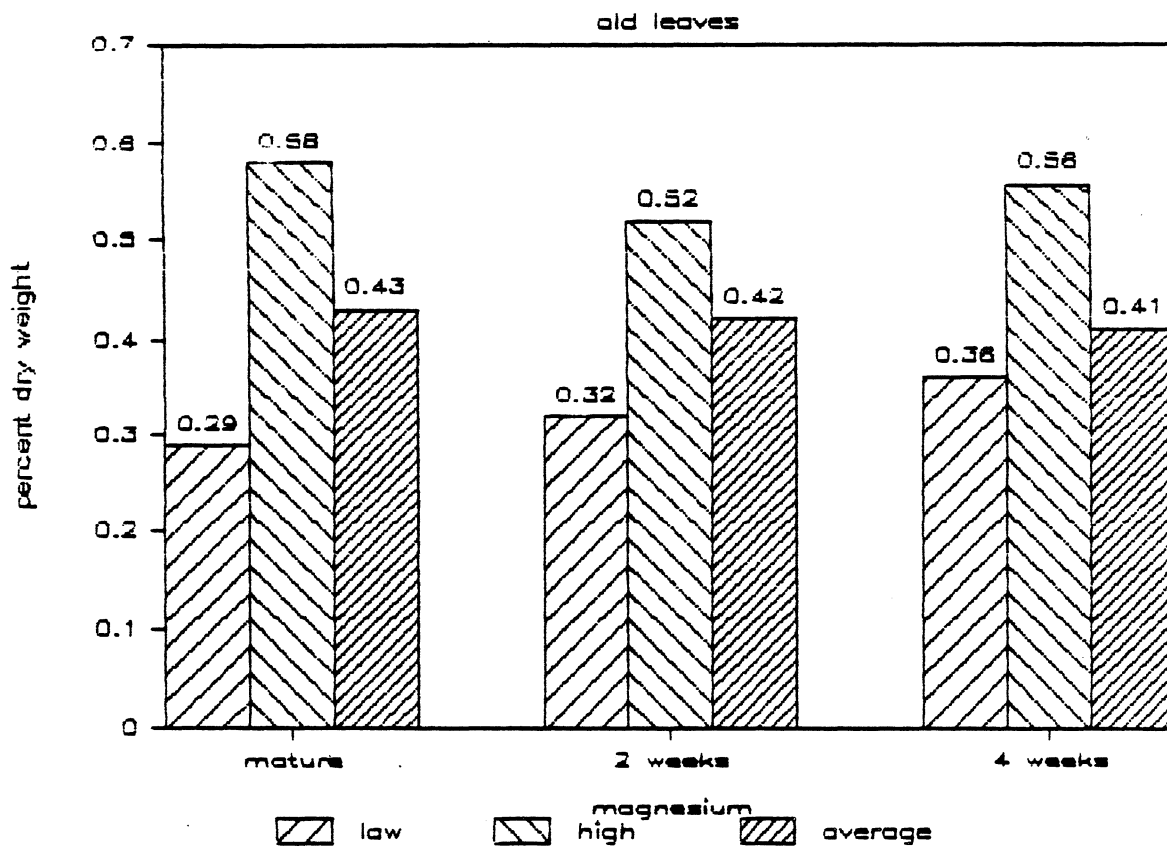
GREEN ONION



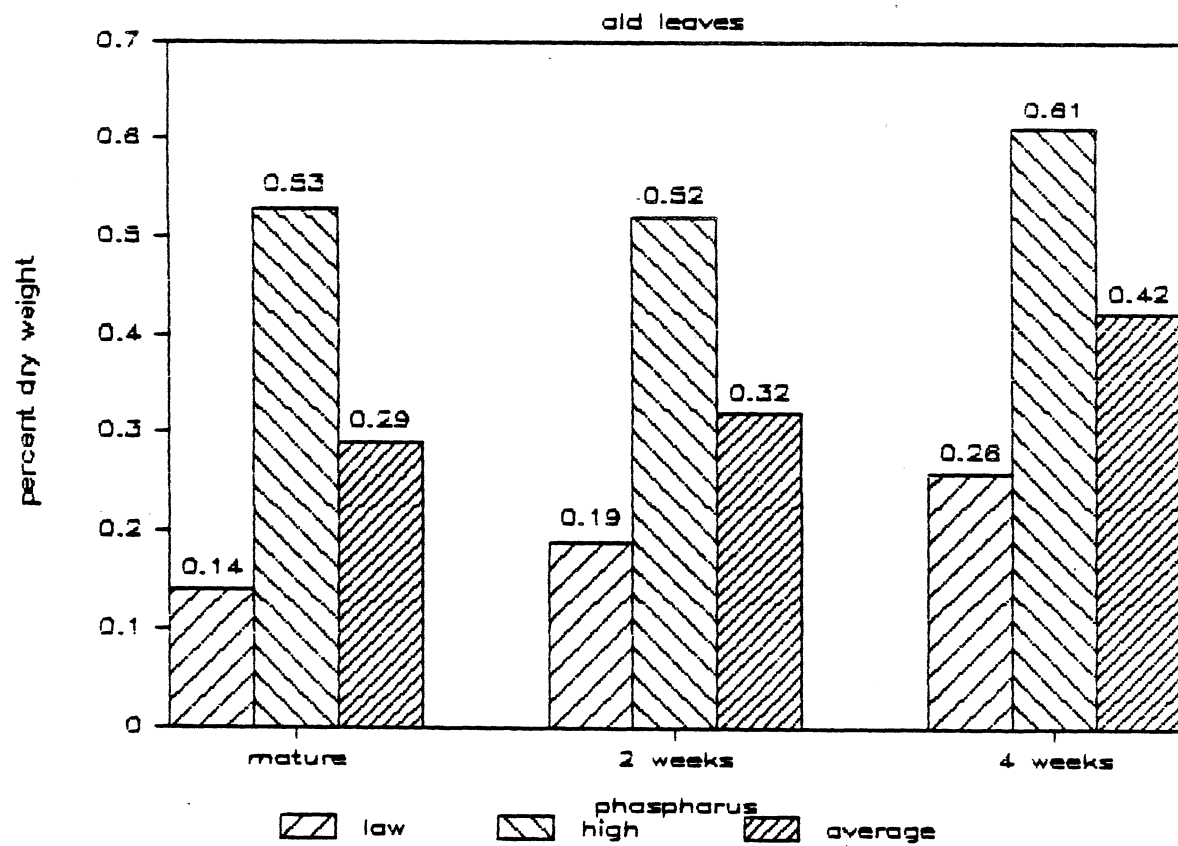
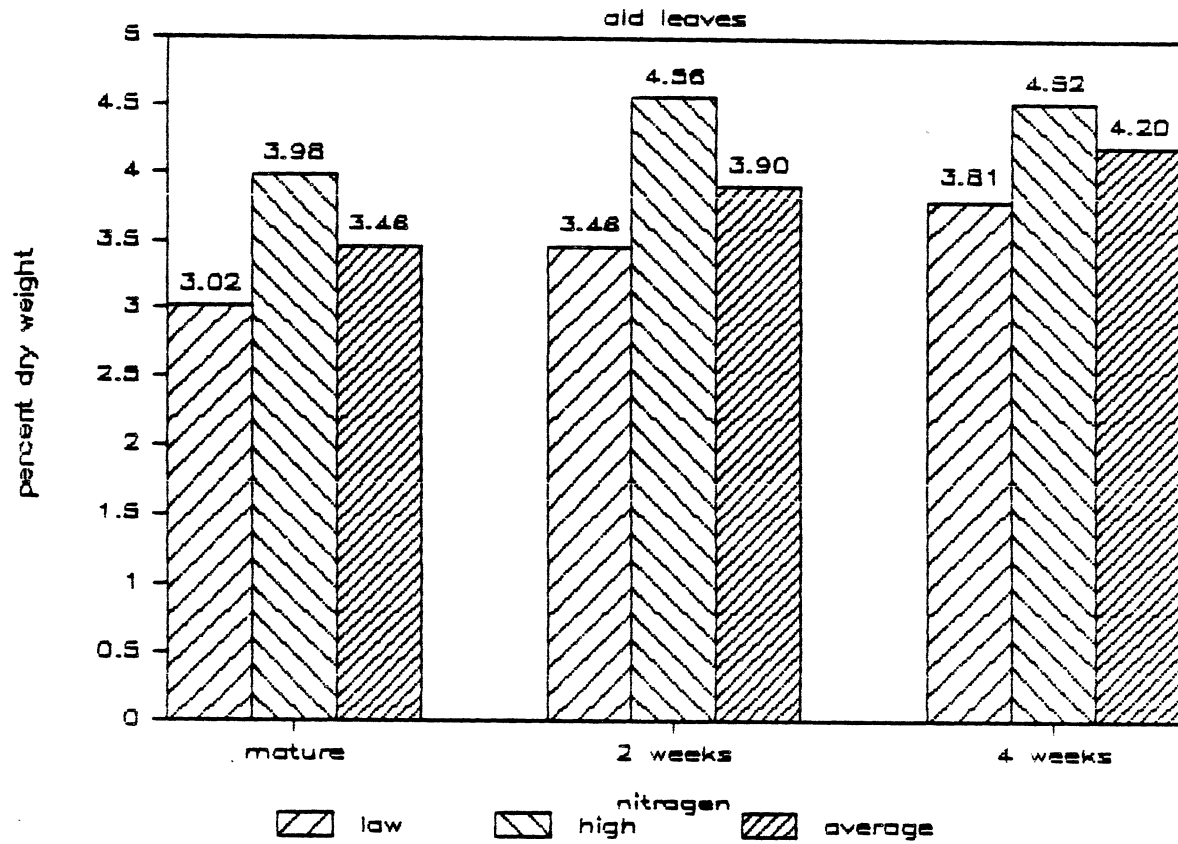
GREEN ONION



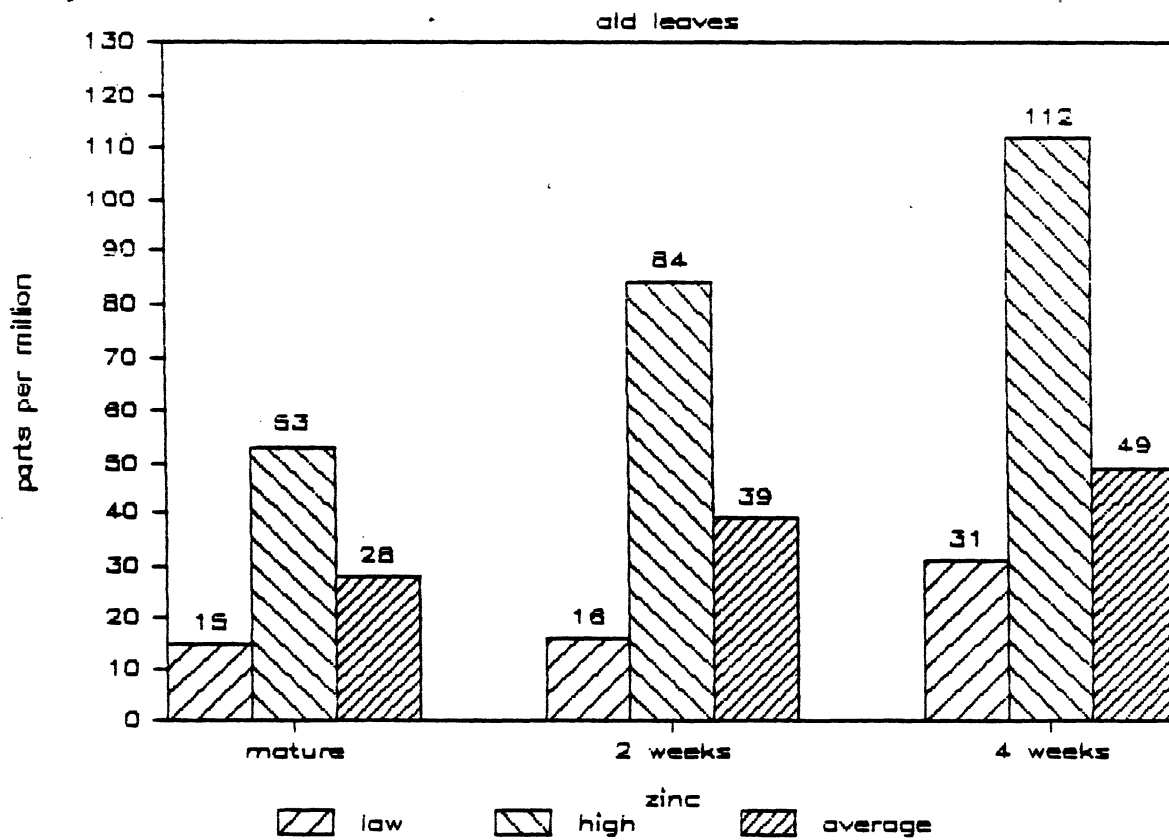
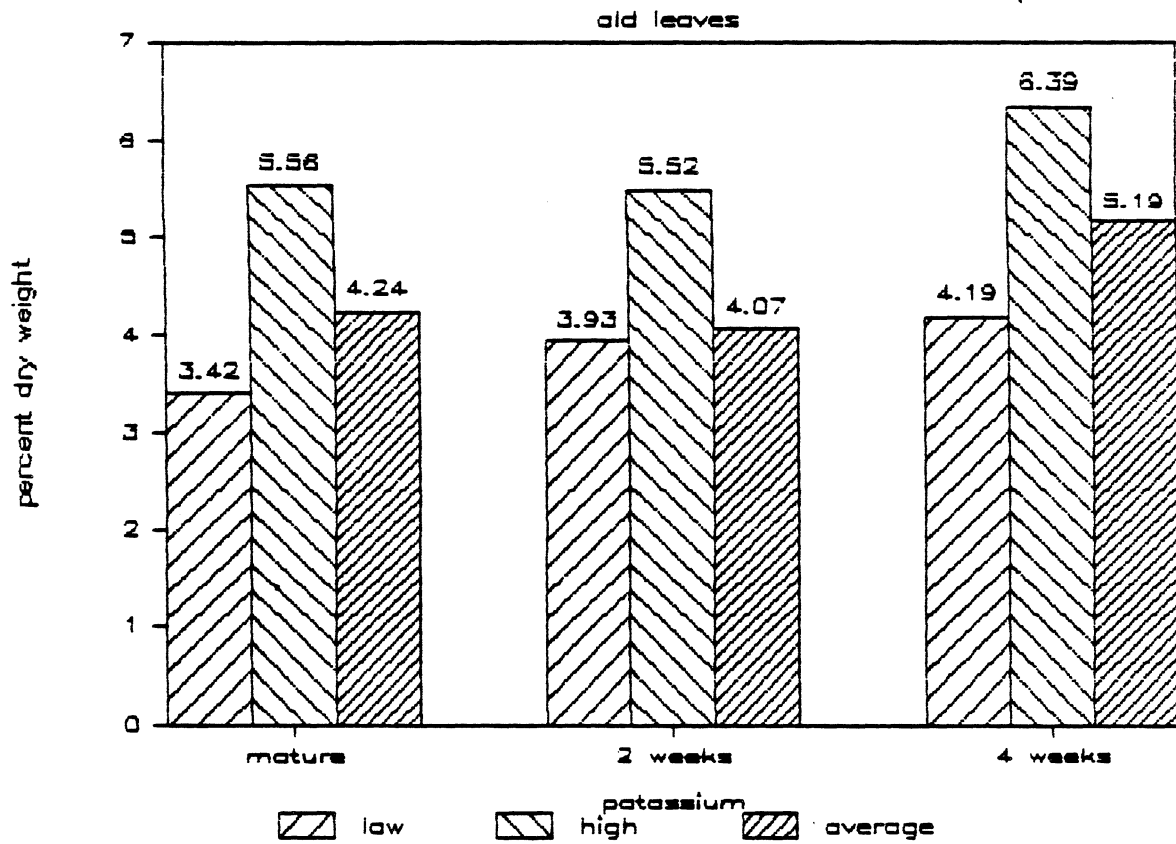
GREEN ONION



GREEN ONION

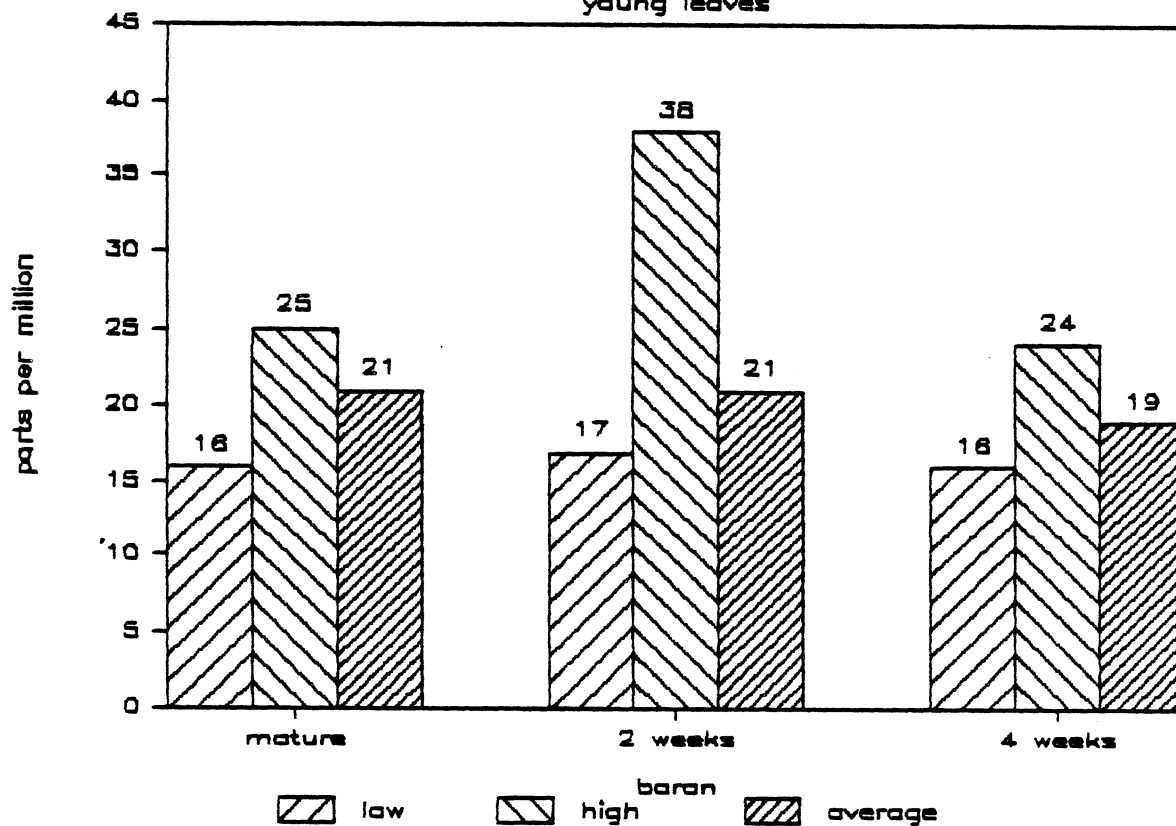


GREEN ONION

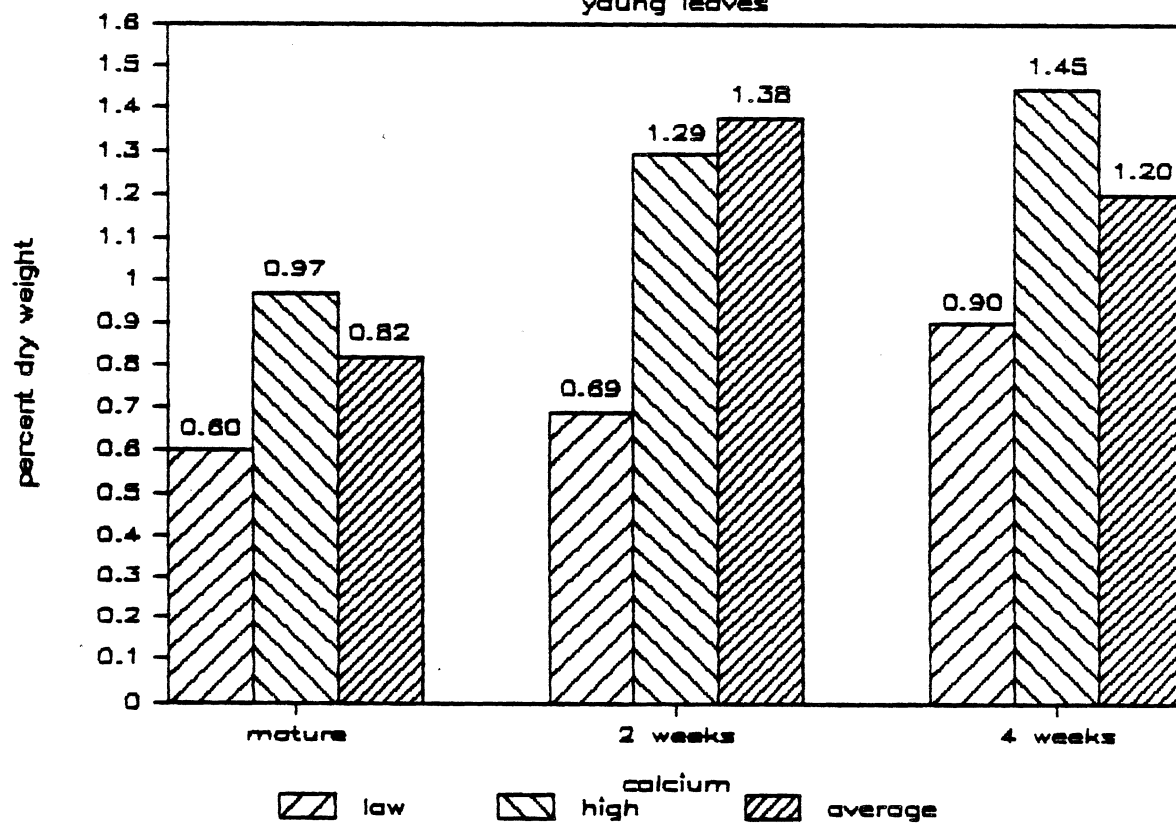


GREEN ONION

young leaves

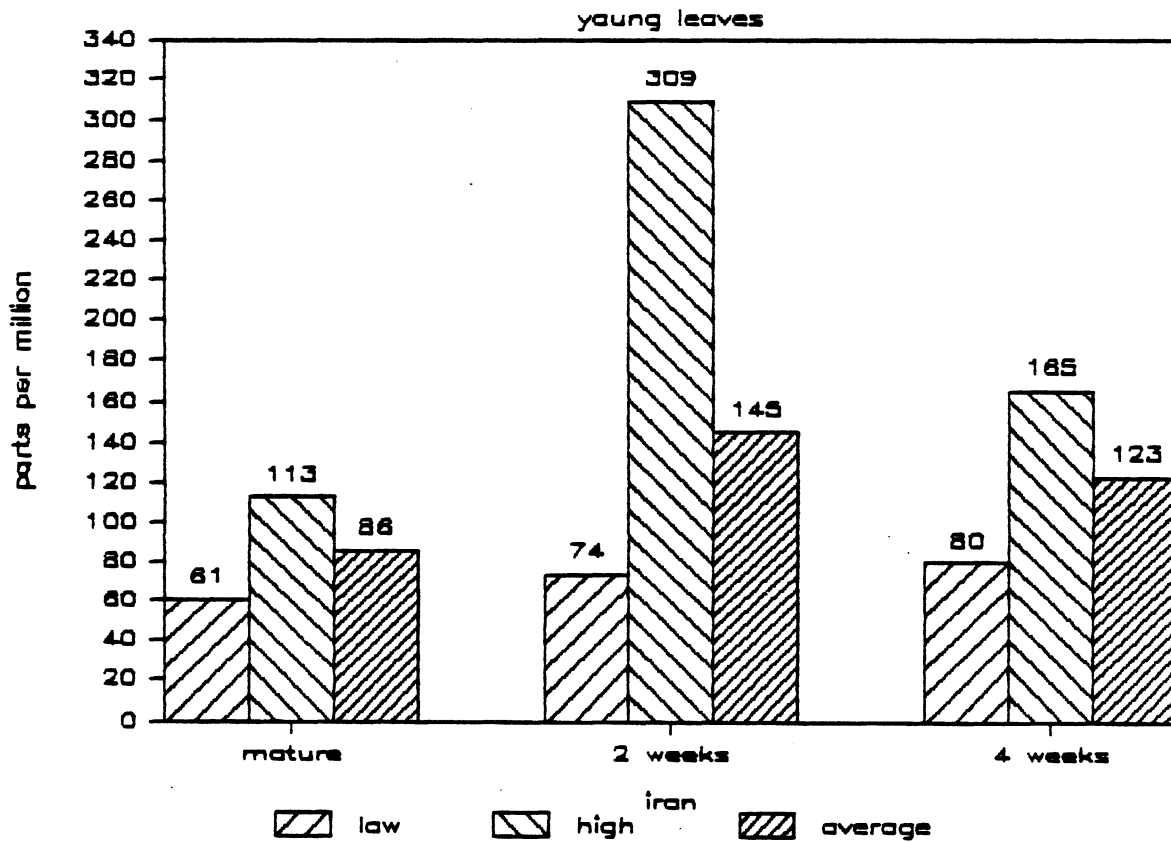
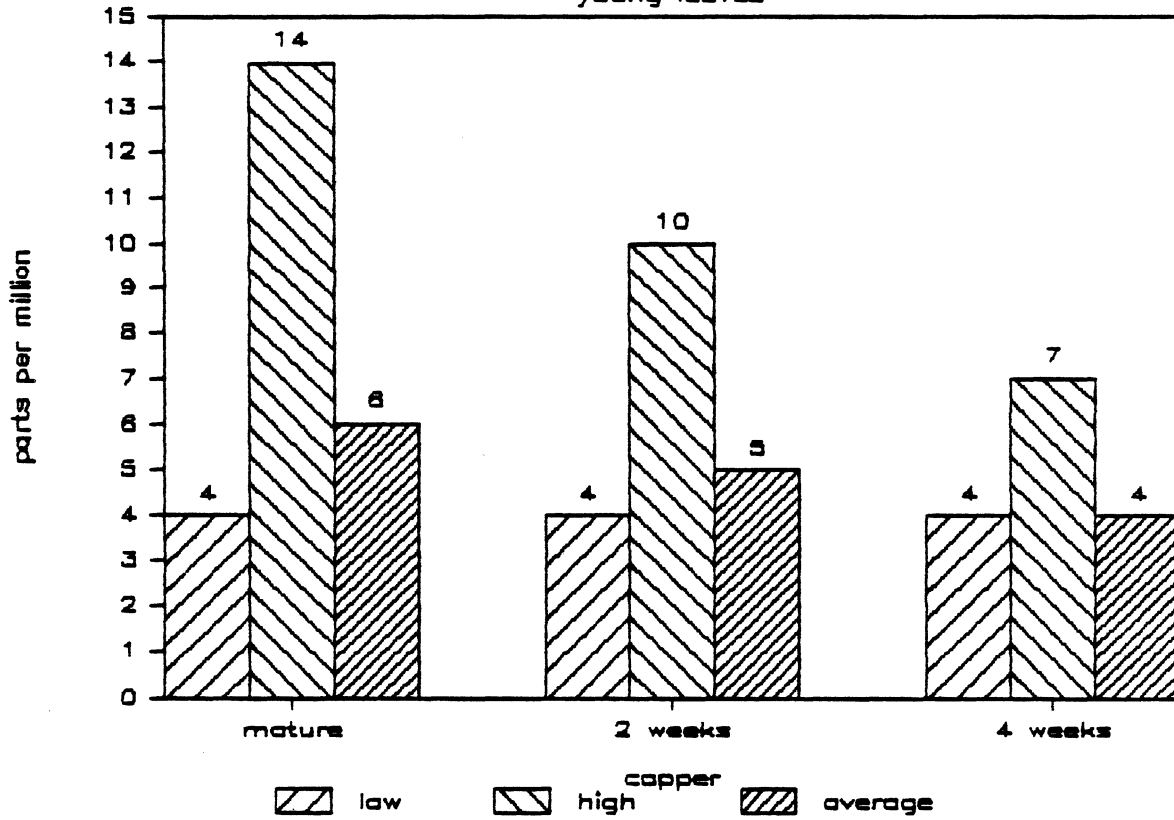


young leaves



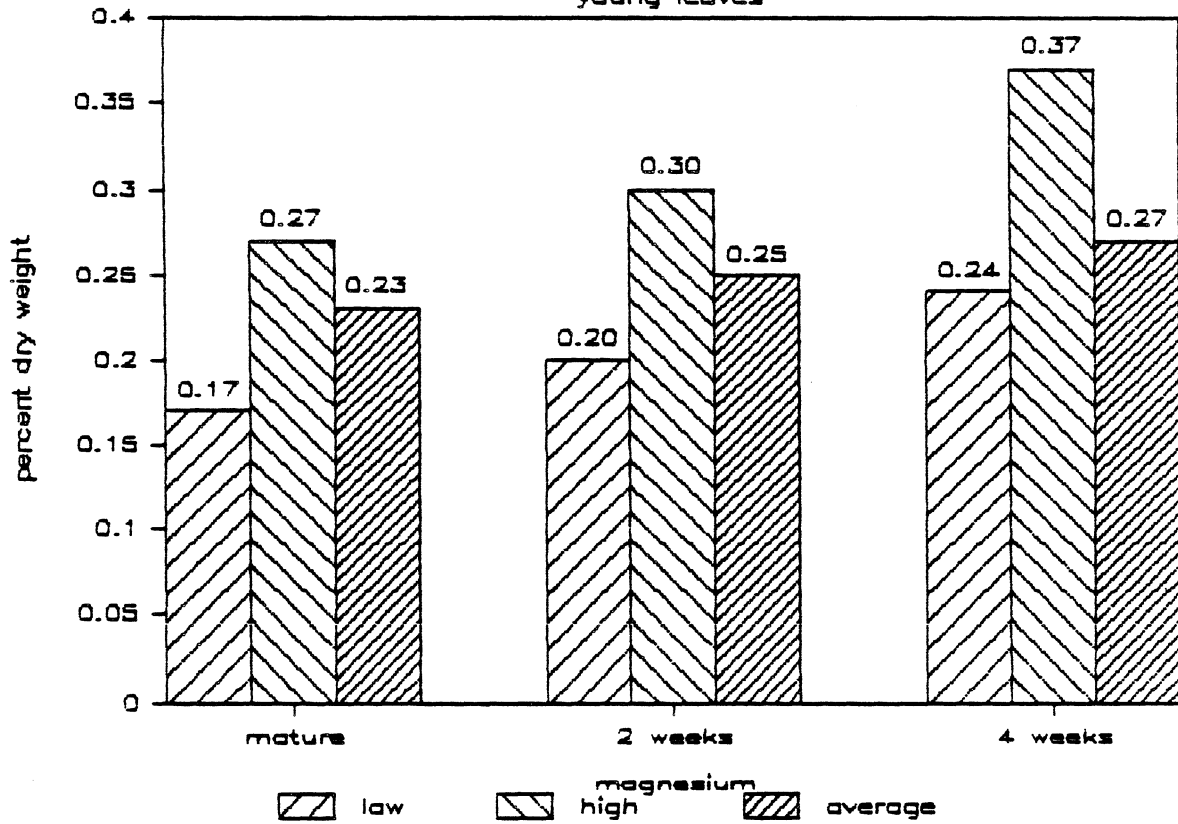
GREEN ONION

young leaves

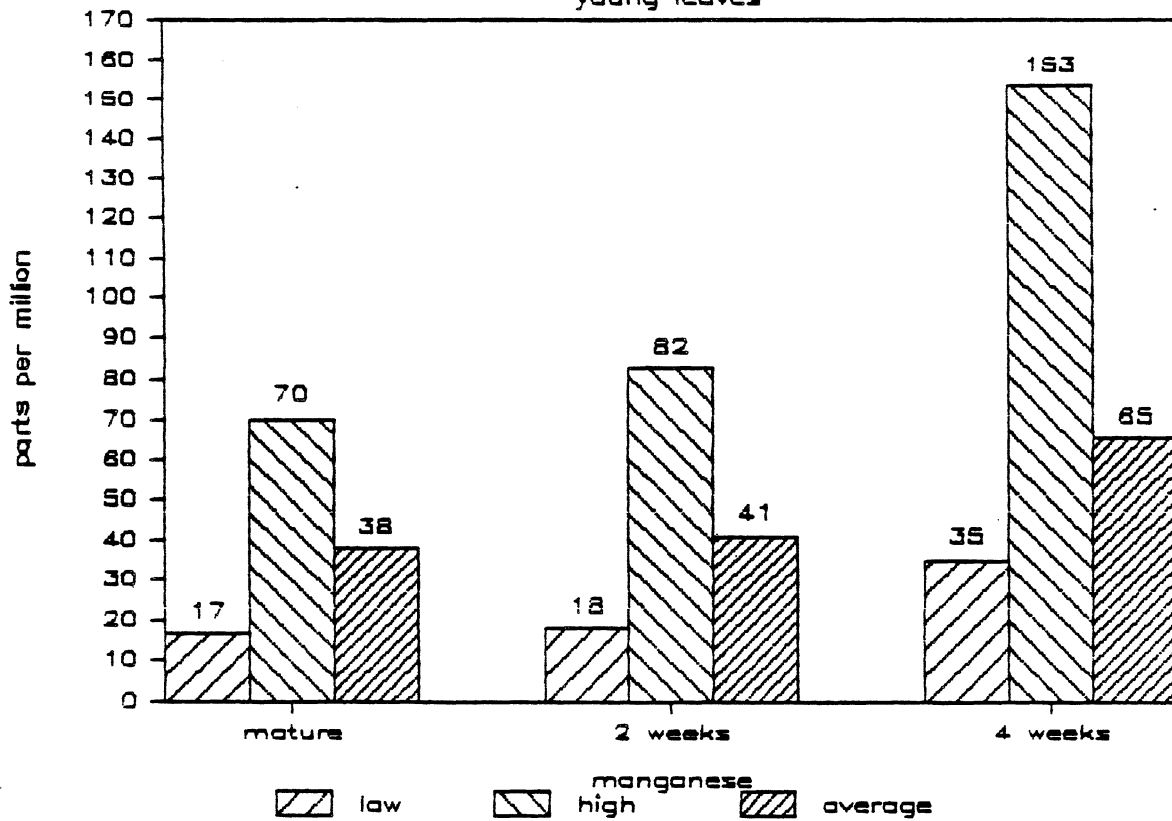


GREEN ONION

young leaves

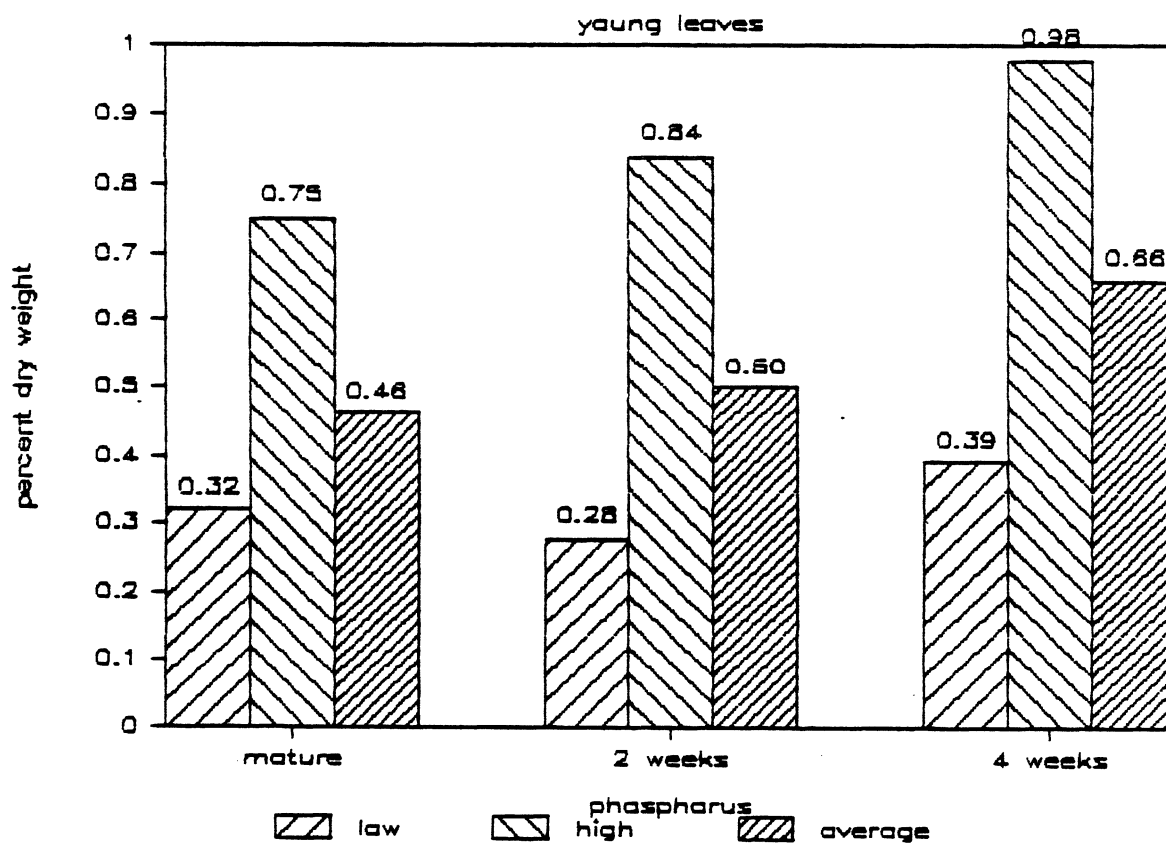
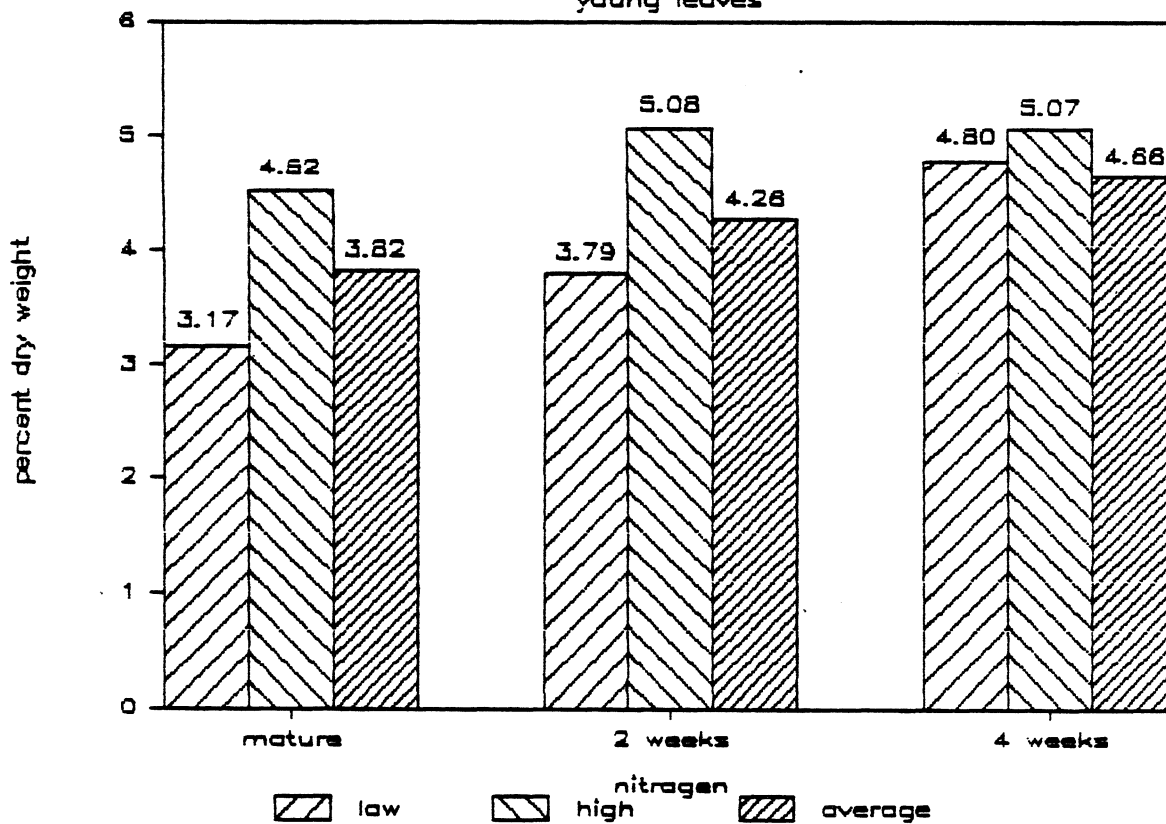


young leaves



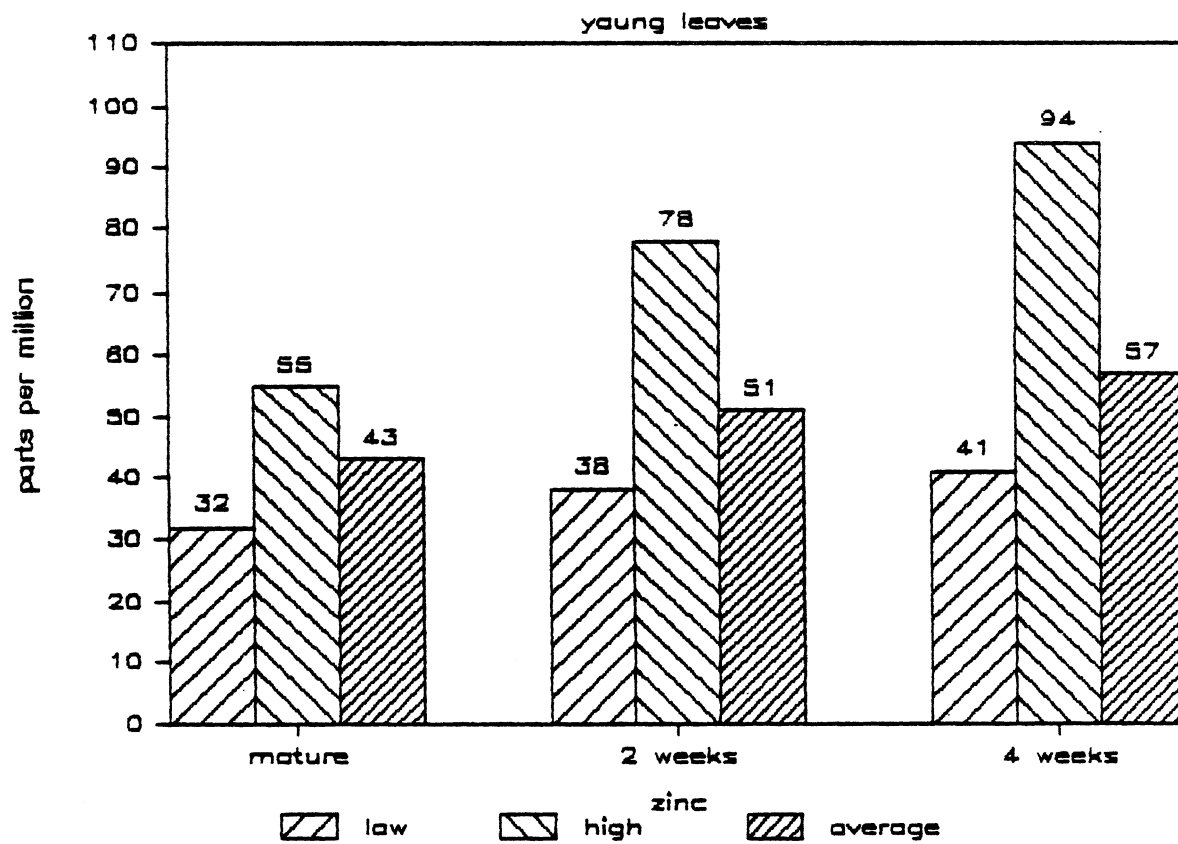
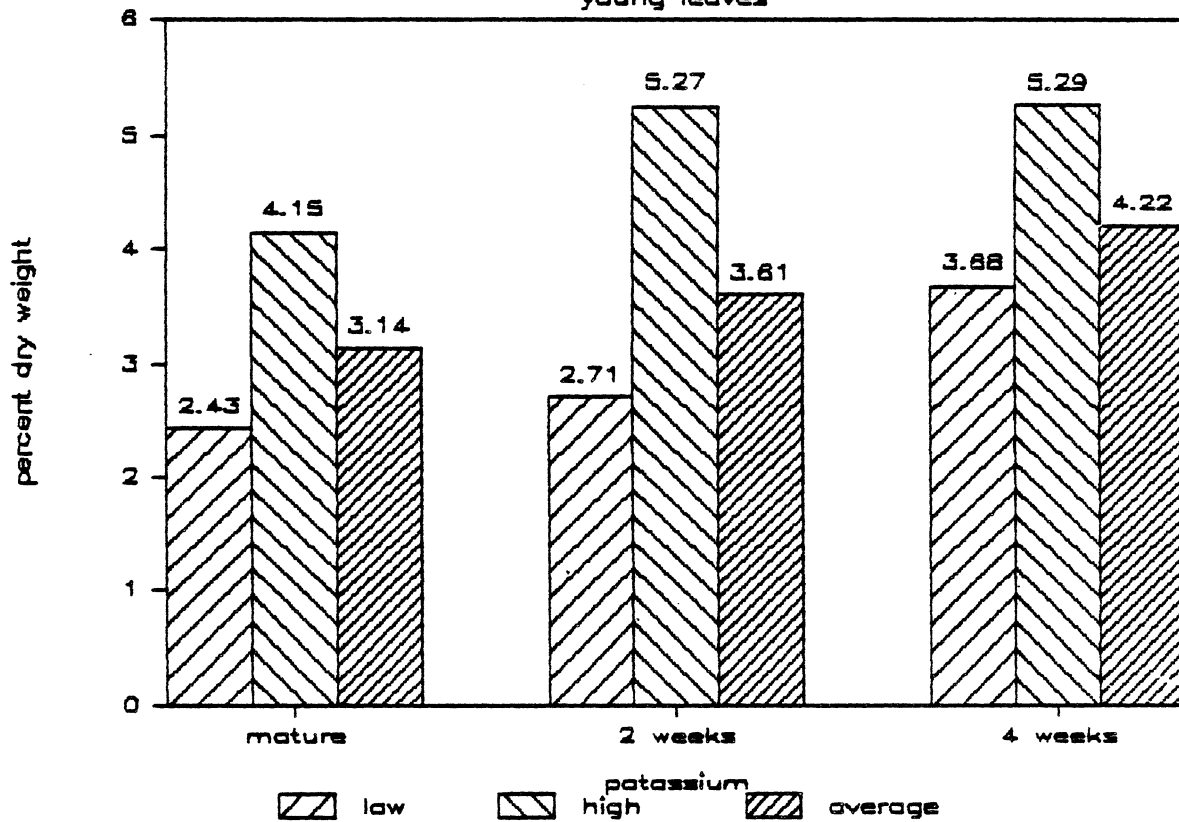
GREEN ONION

young leaves



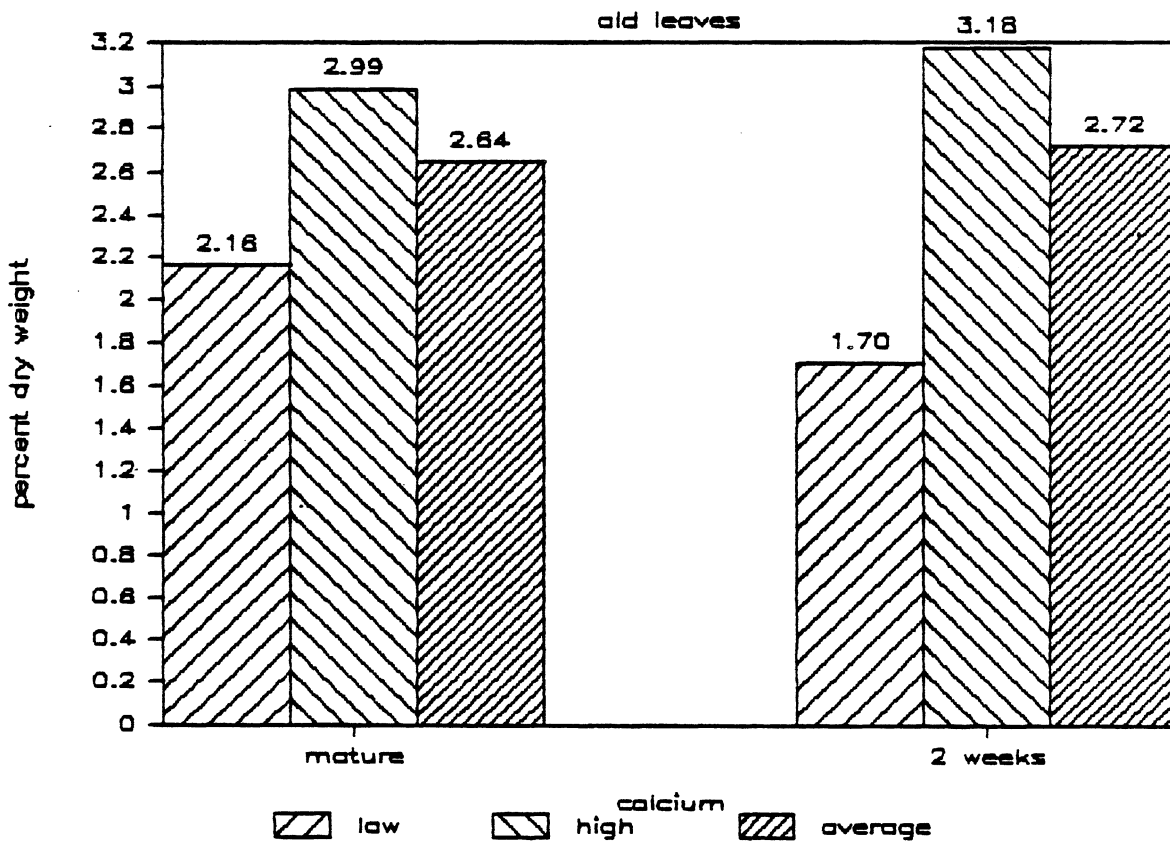
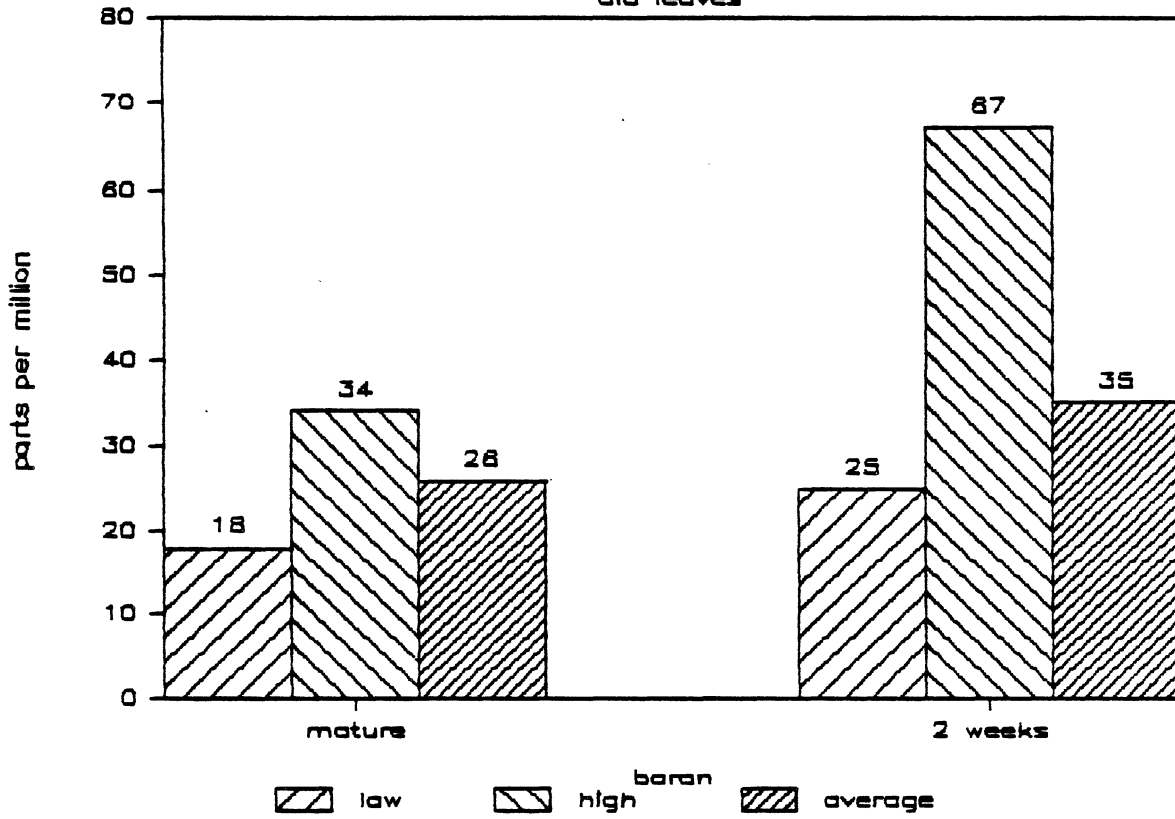
GREEN ONION

young leaves



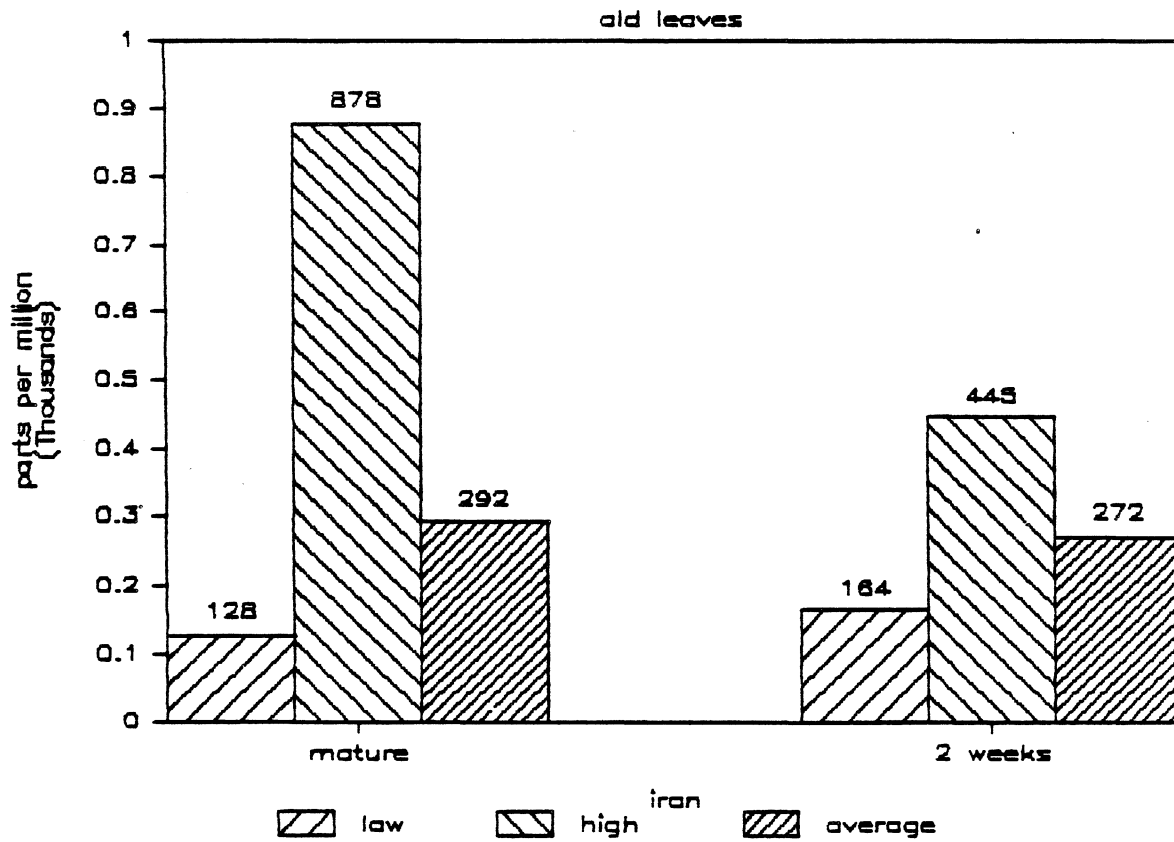
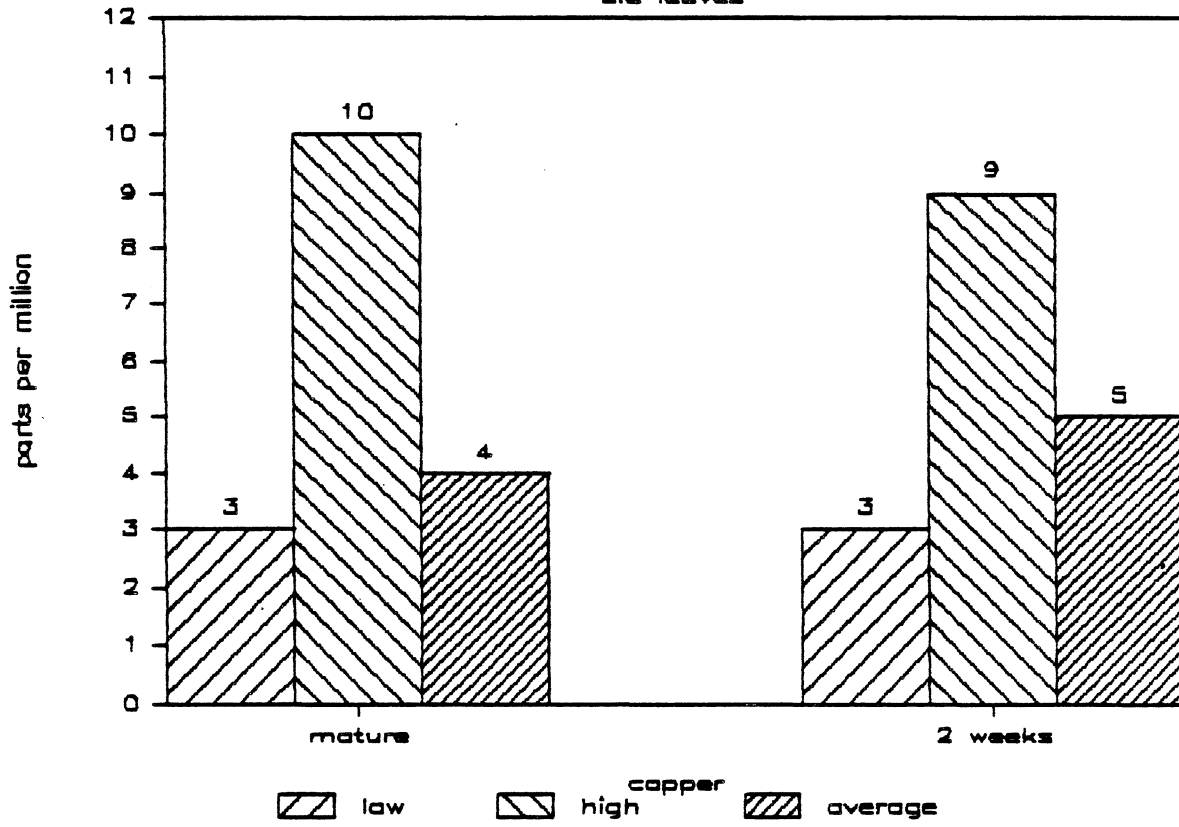
RADISH

old leaves



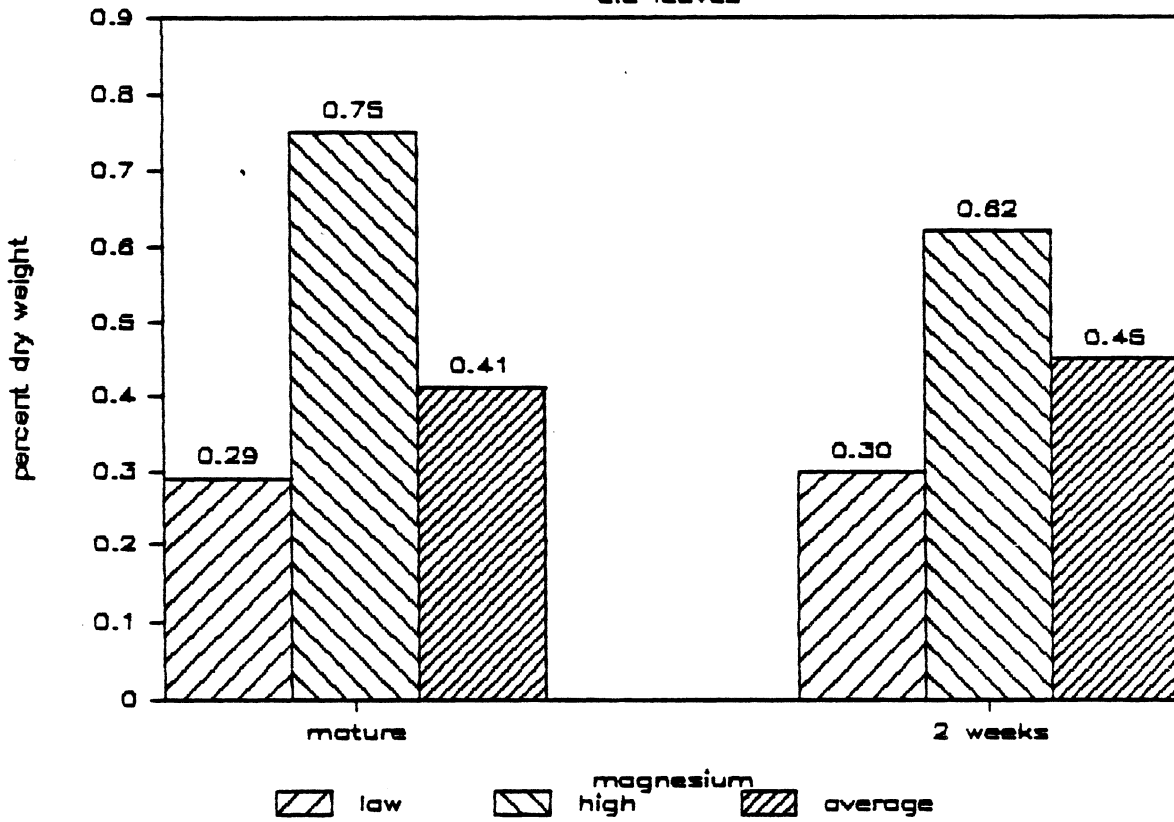
RADISH

old leaves

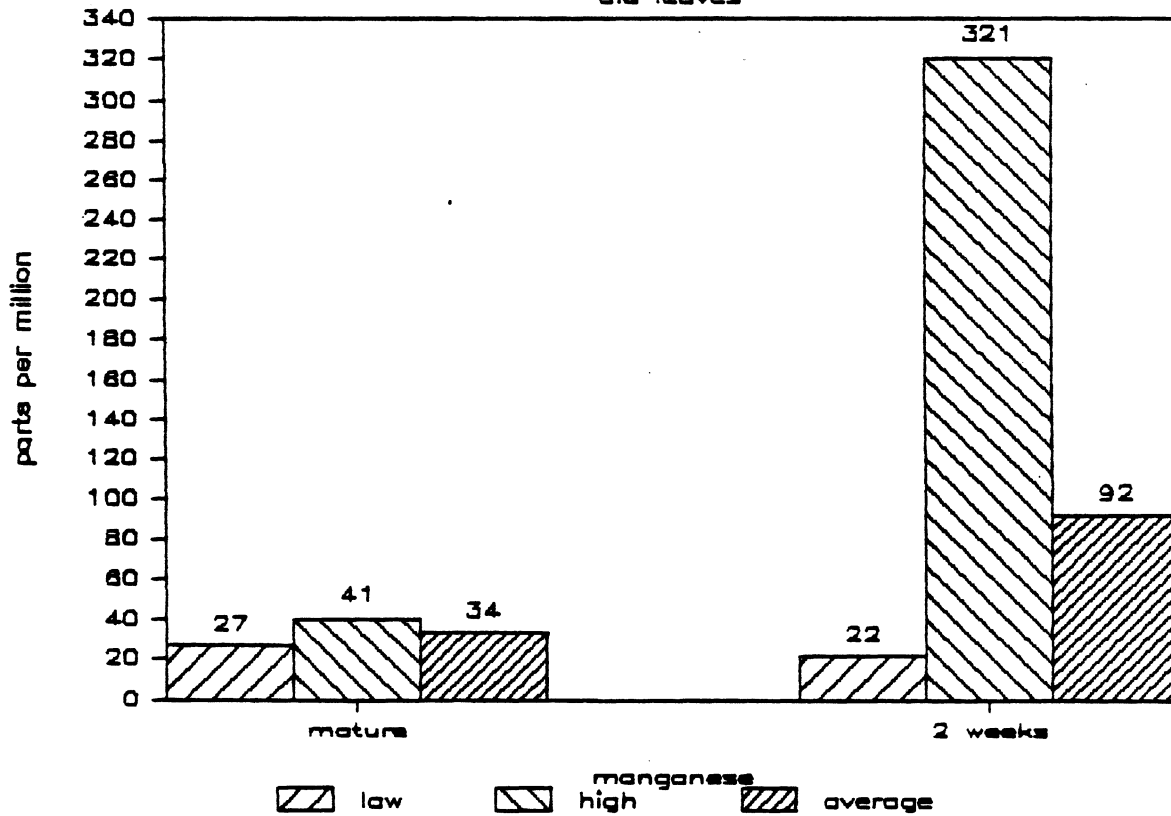


RADISH

old leaves

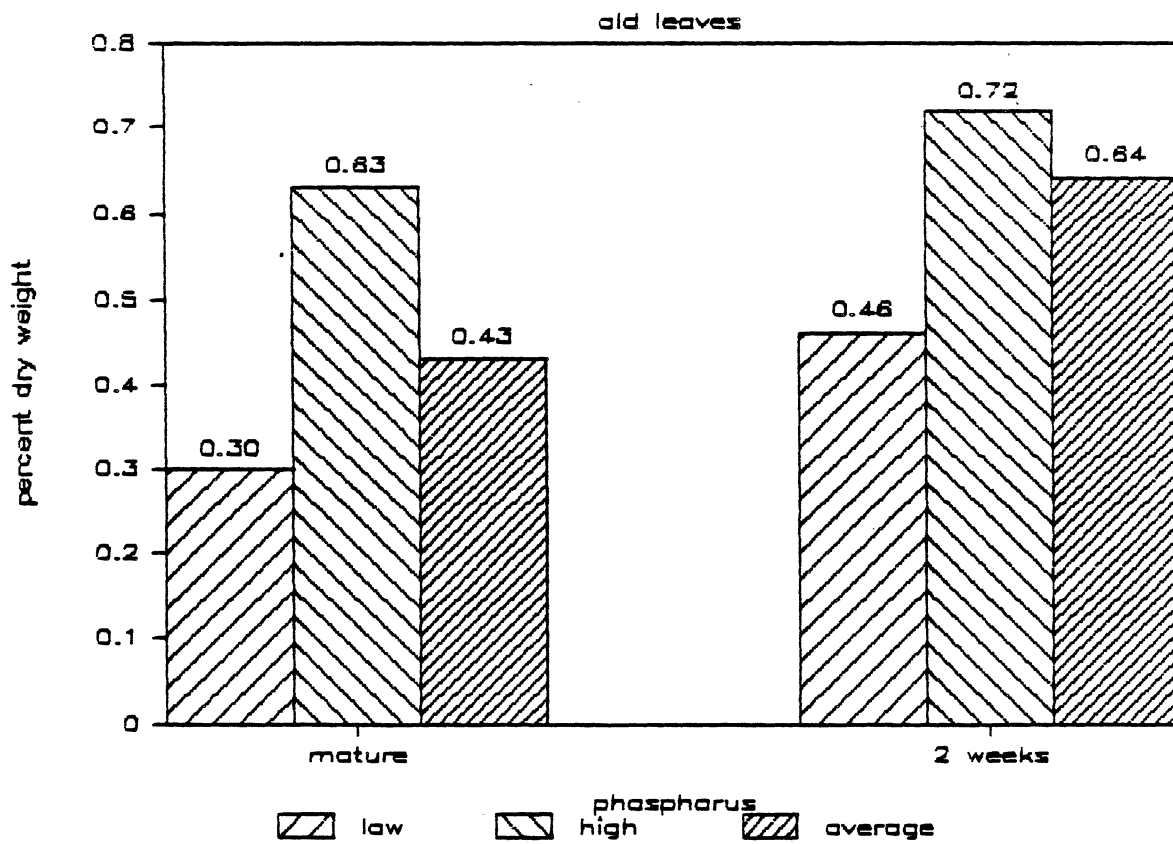
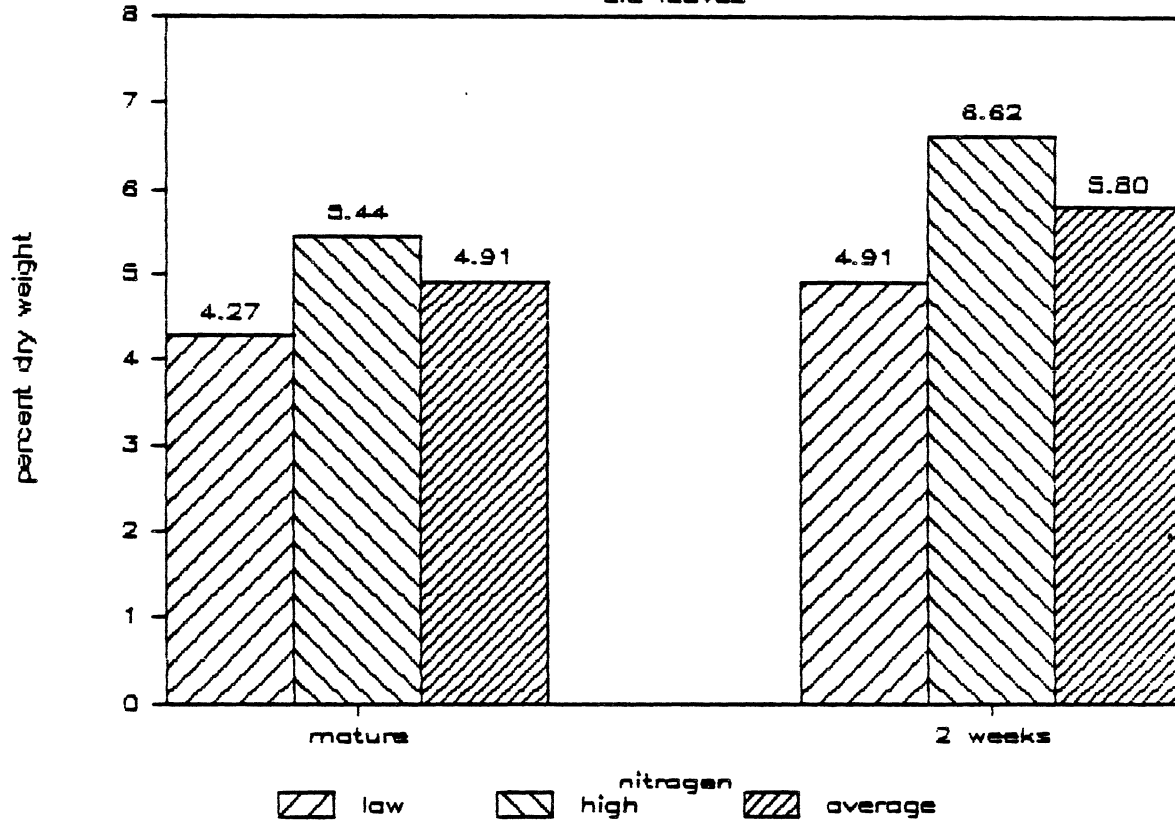


old leaves



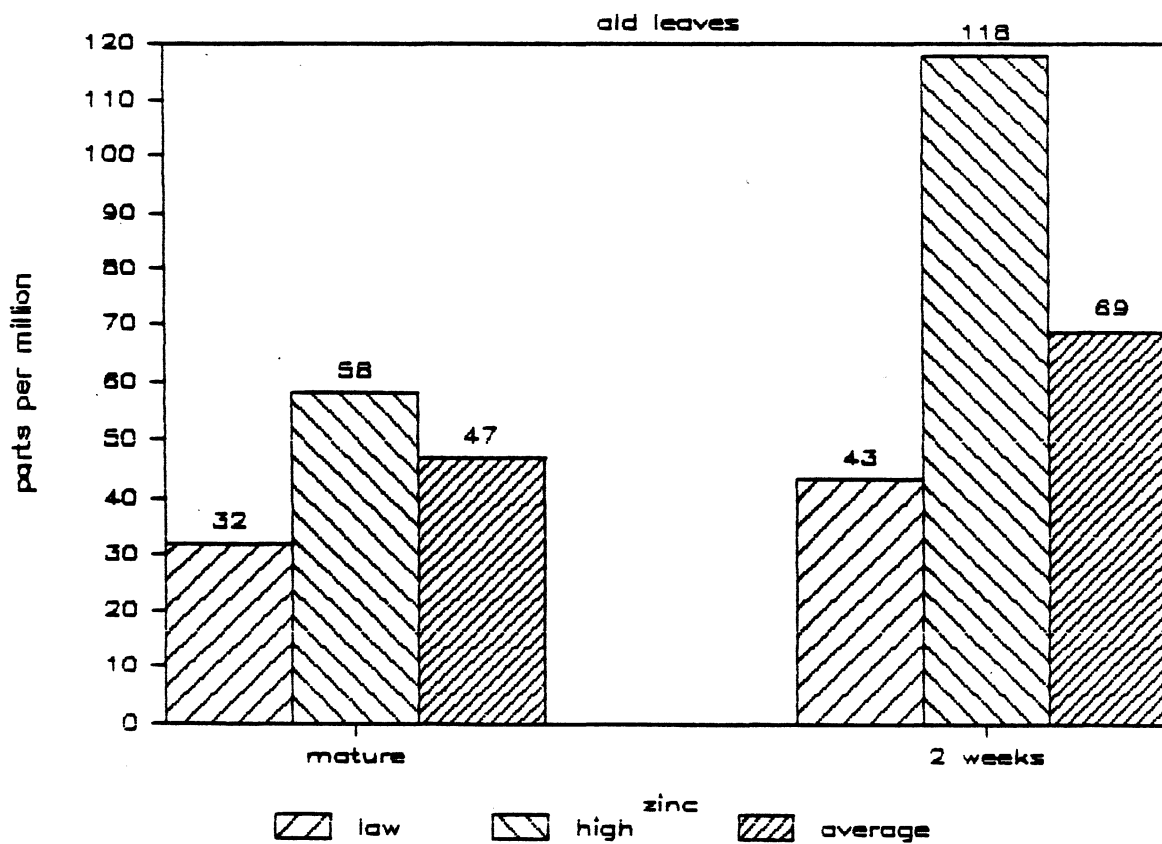
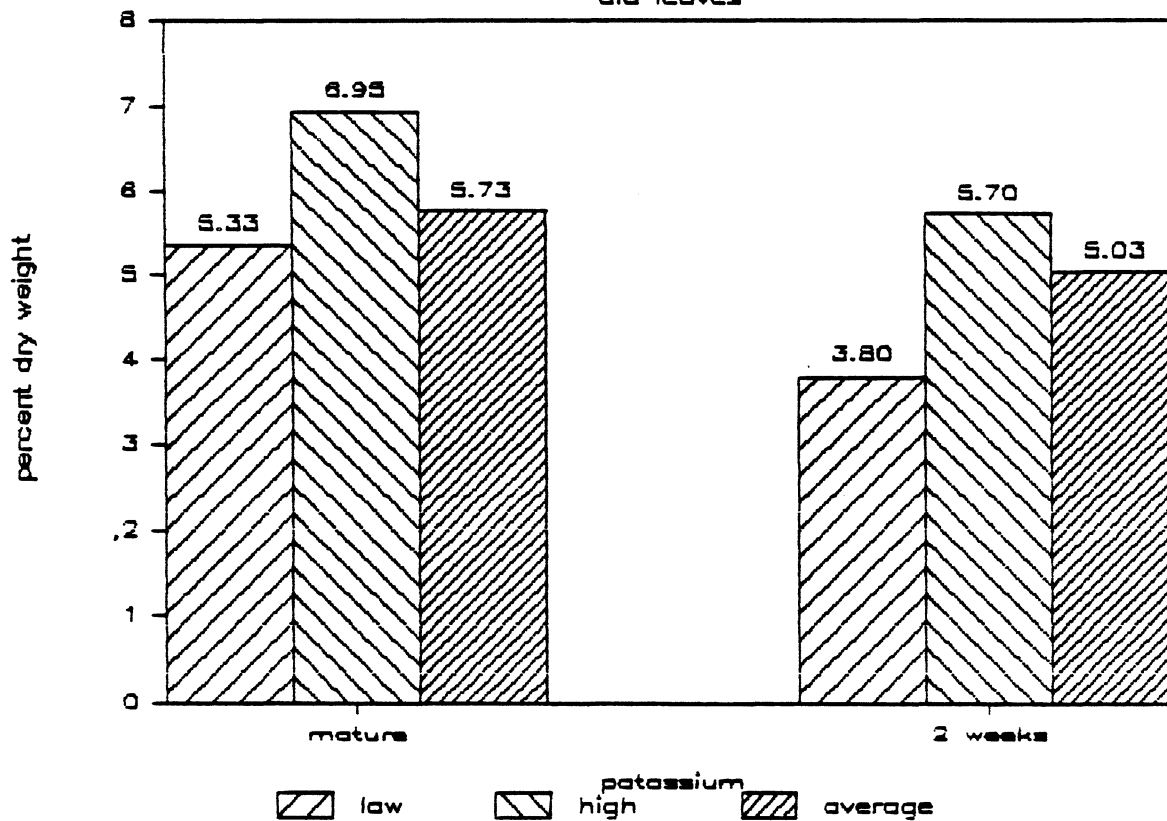
RADISH

old leaves



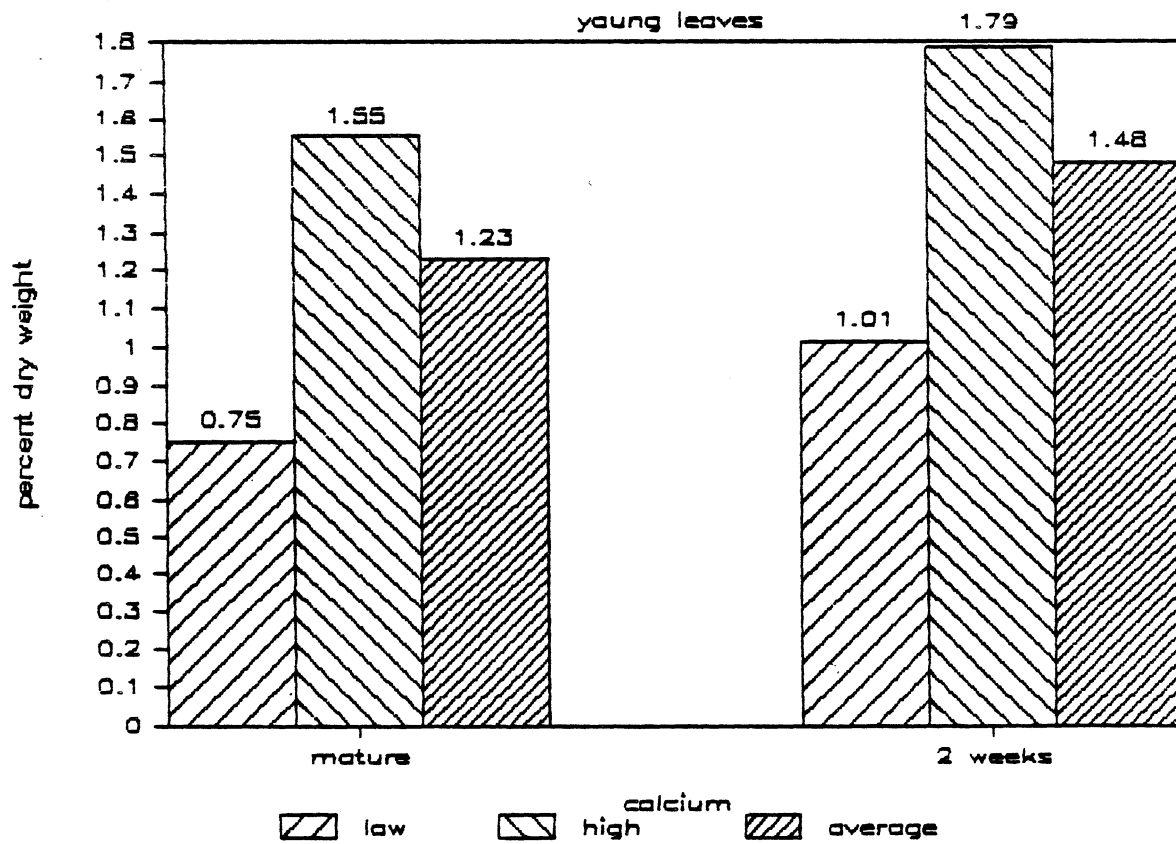
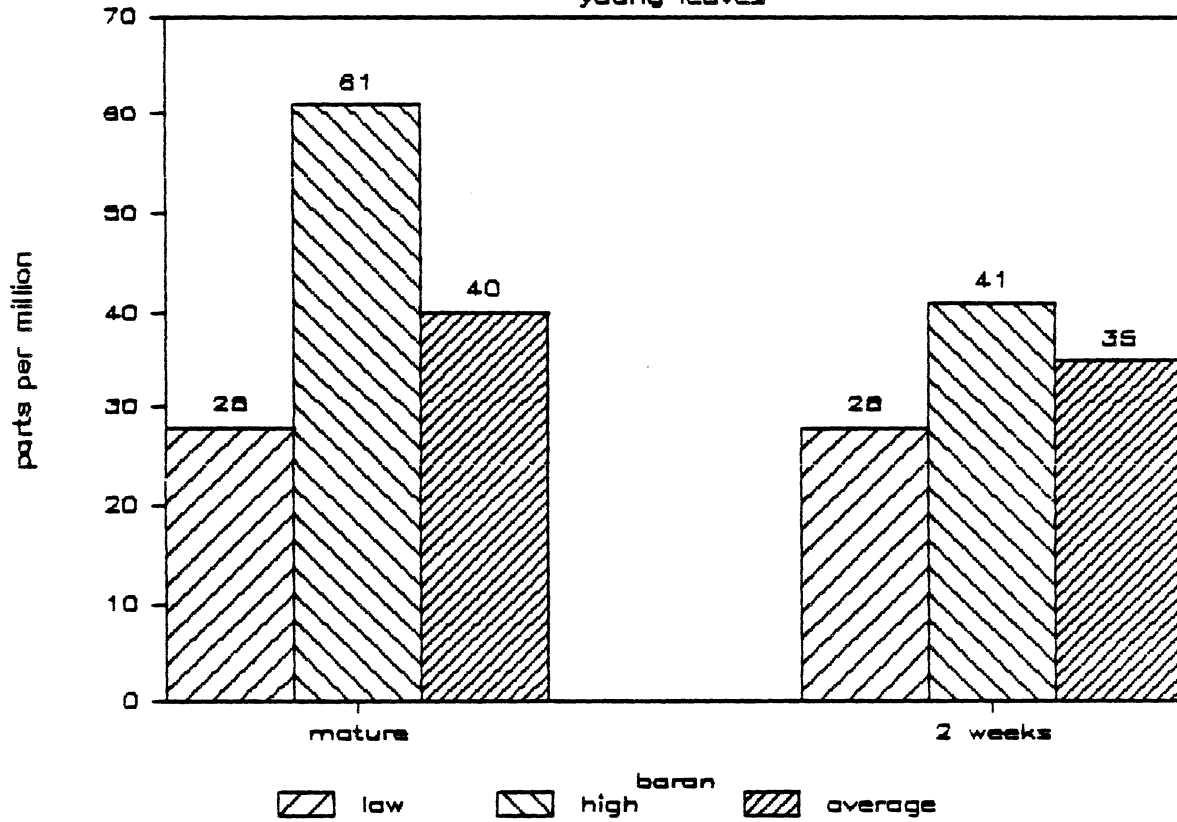
RADISH

old leaves



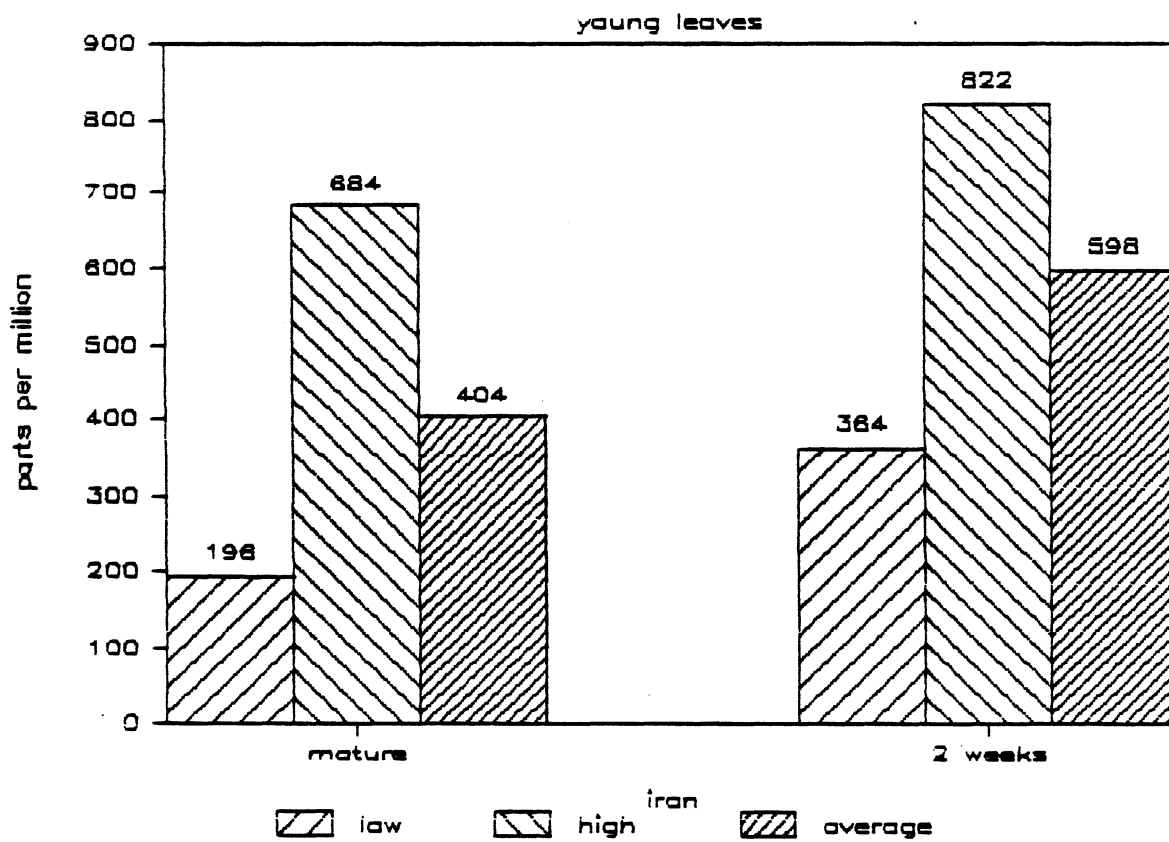
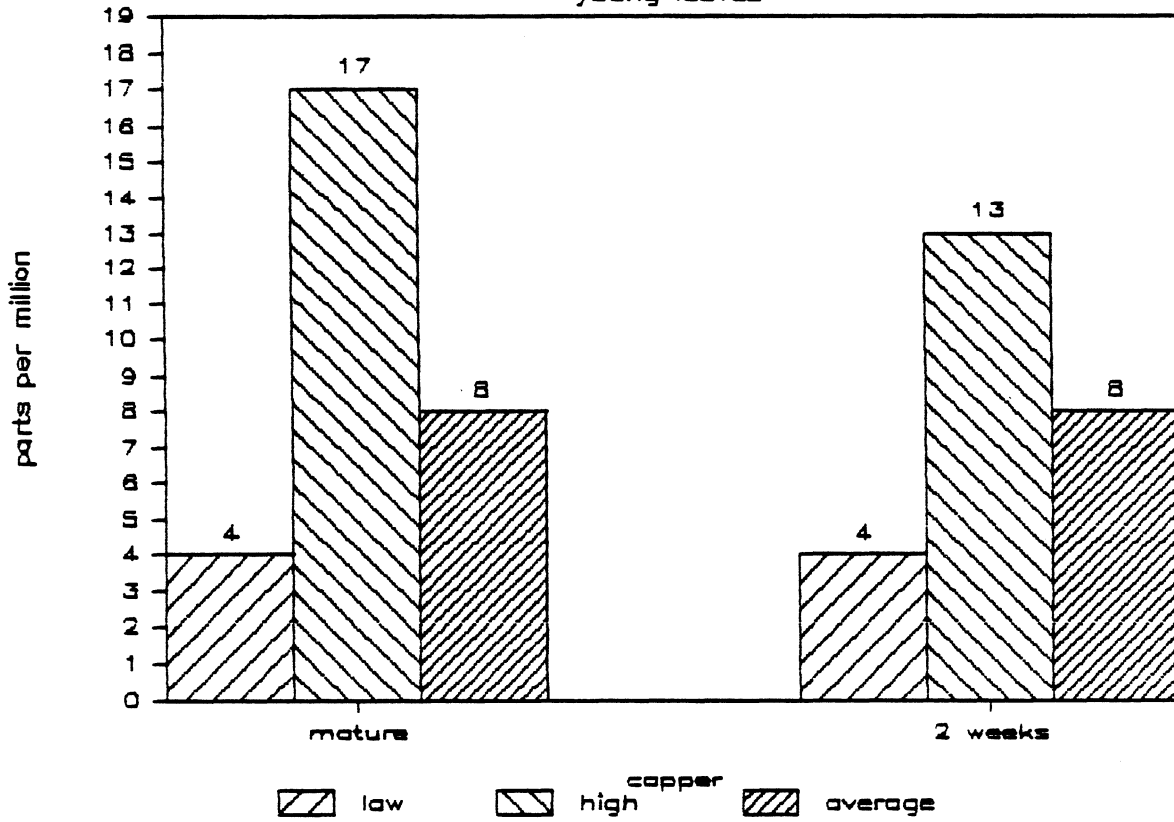
RADISH

young leaves



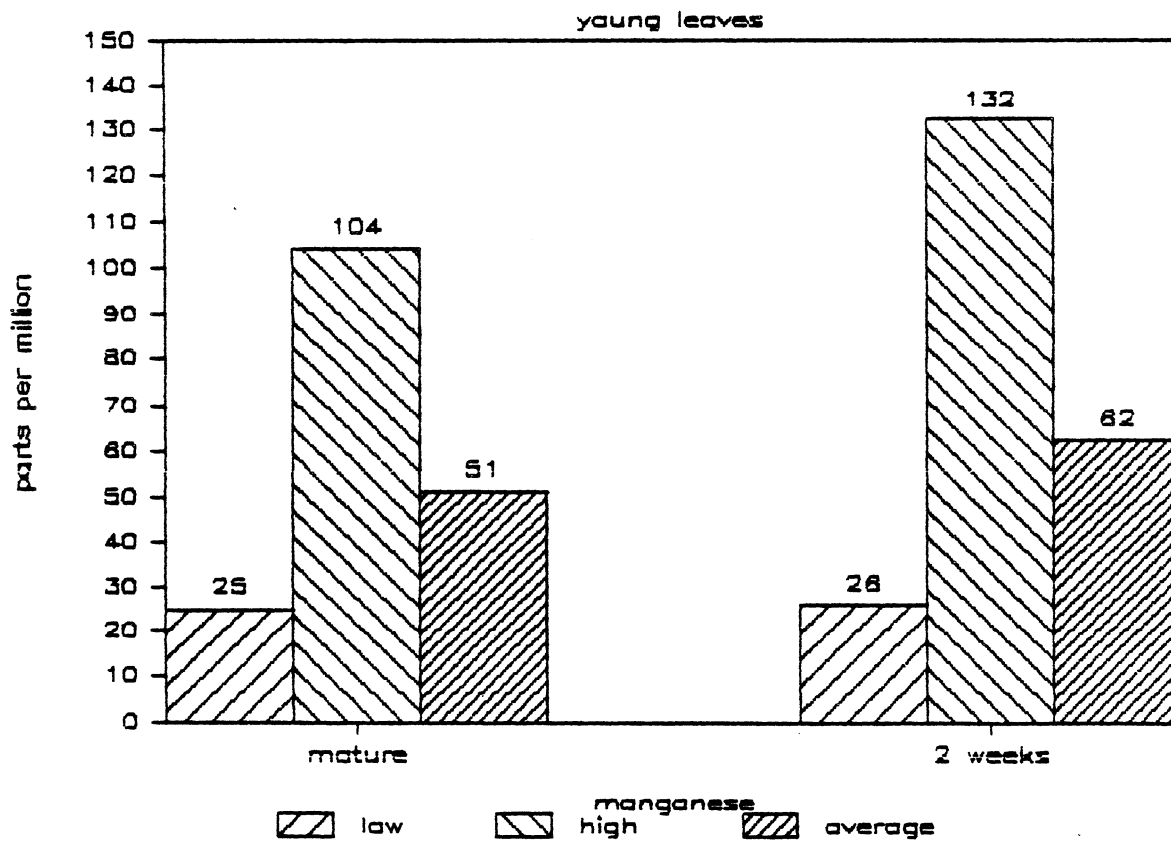
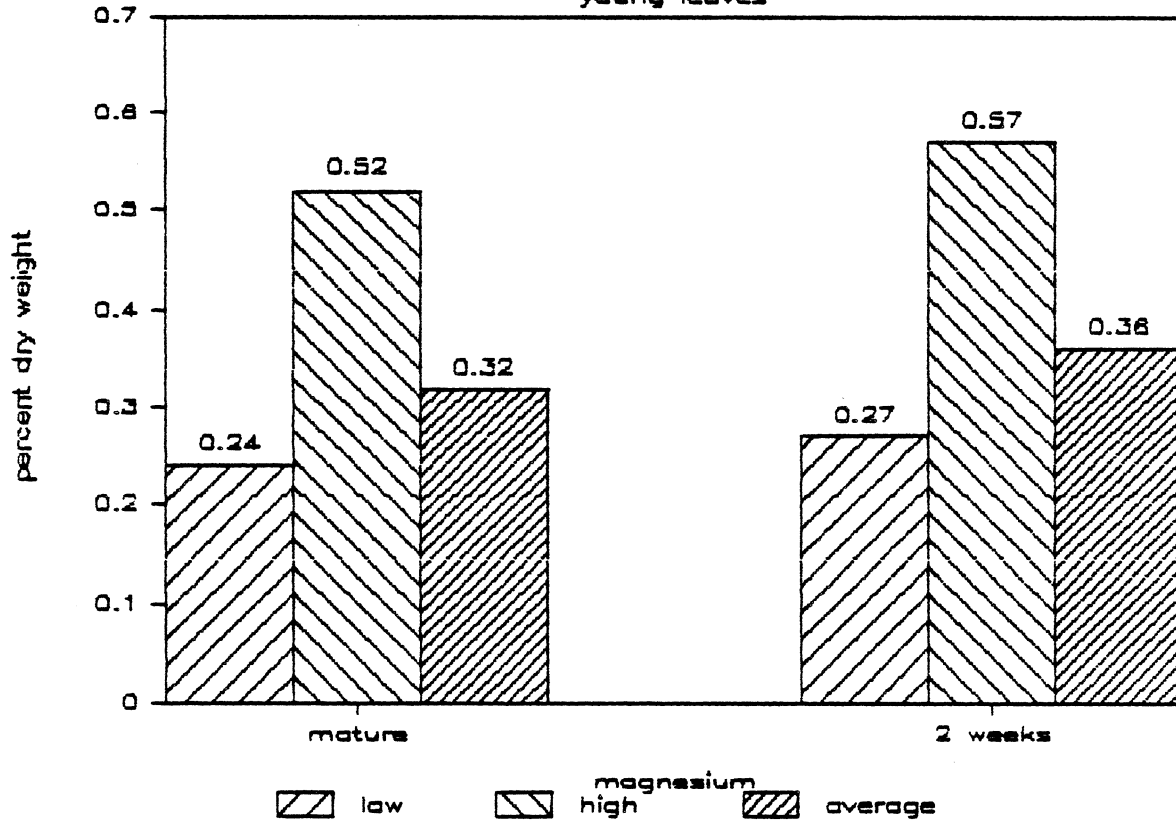
RADISH

young leaves



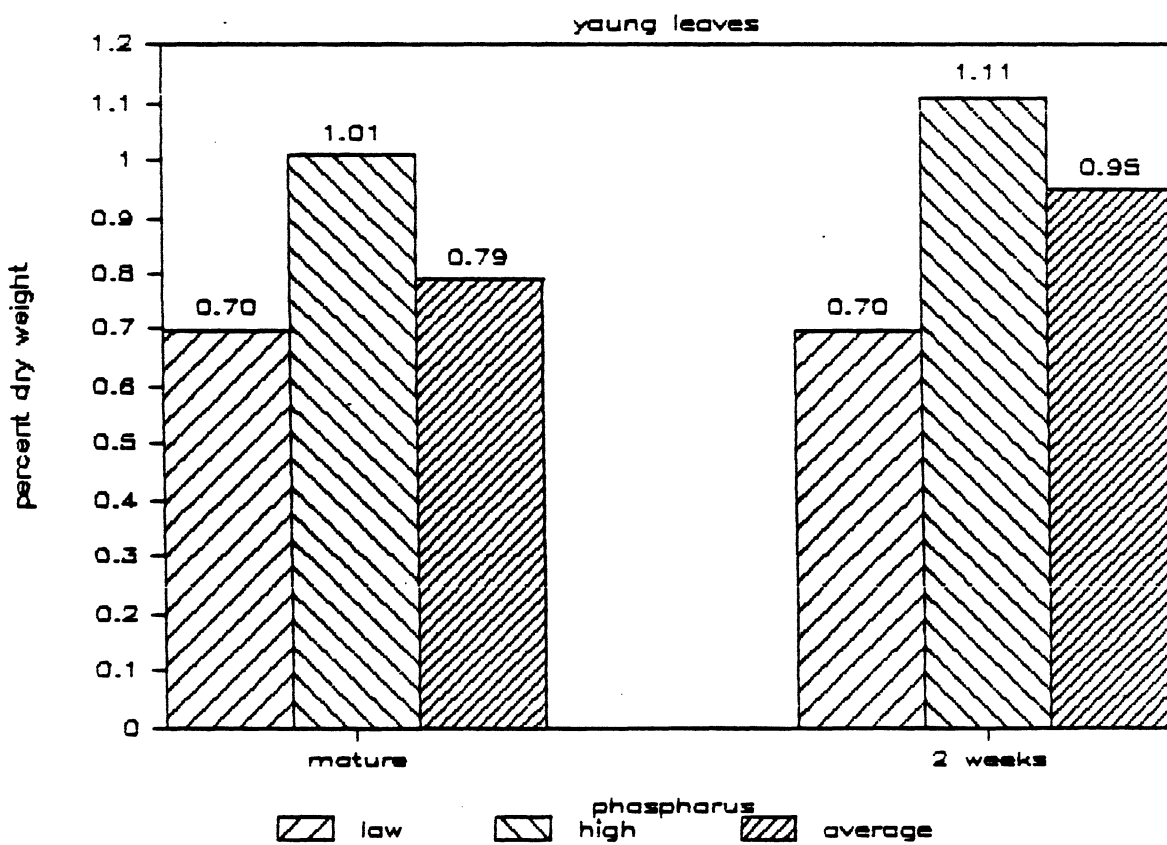
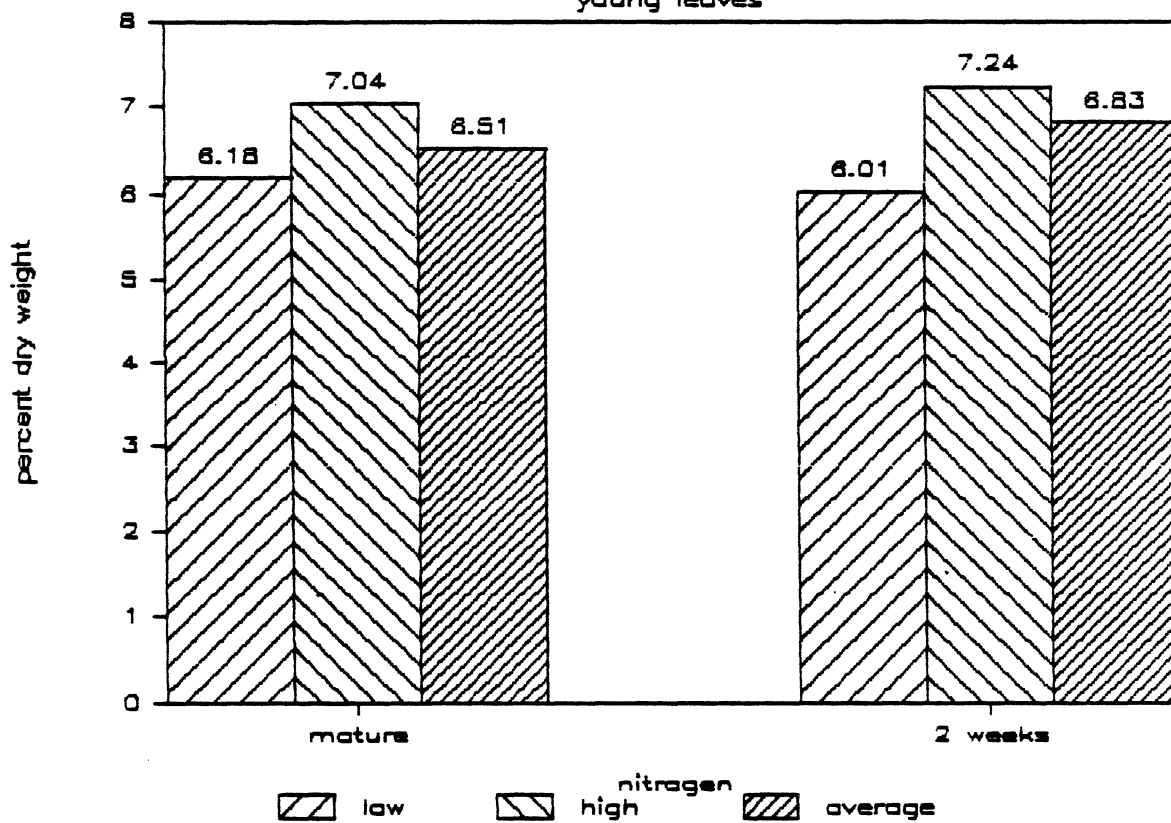
RADISH

young leaves



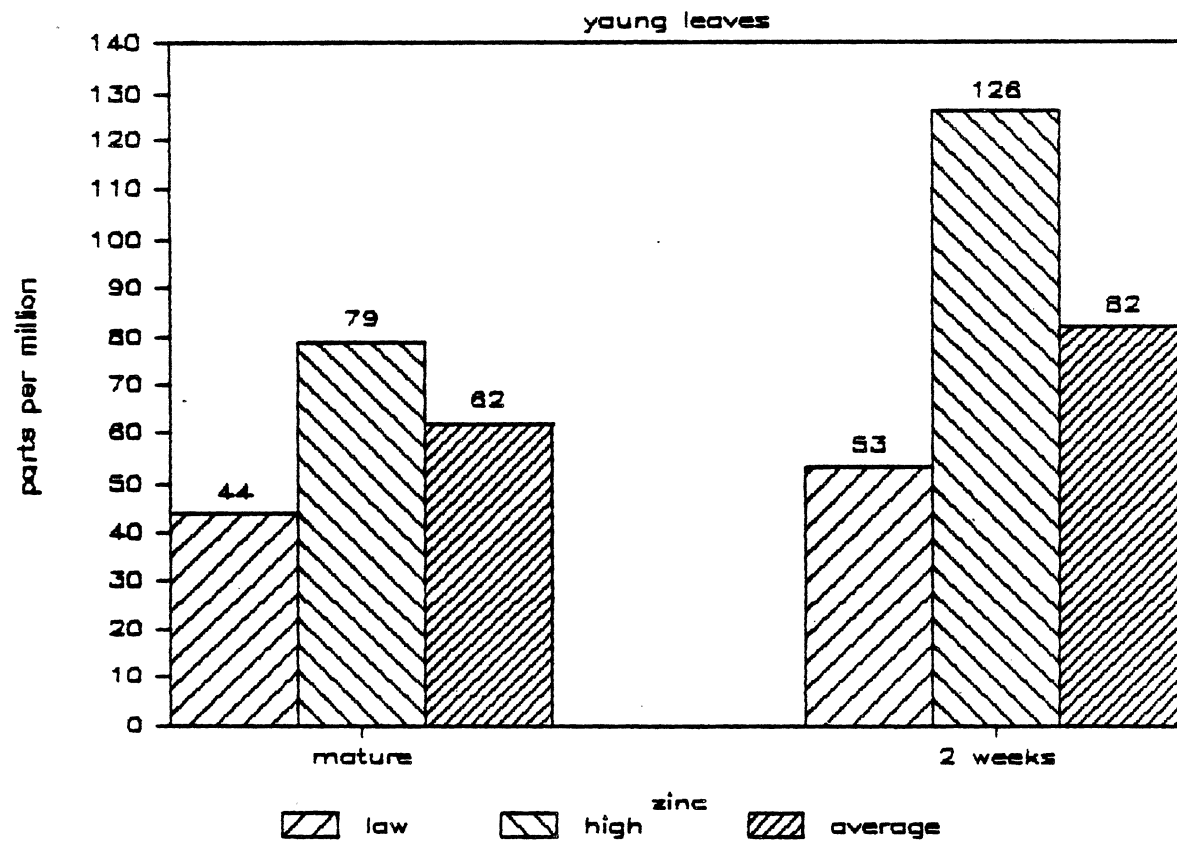
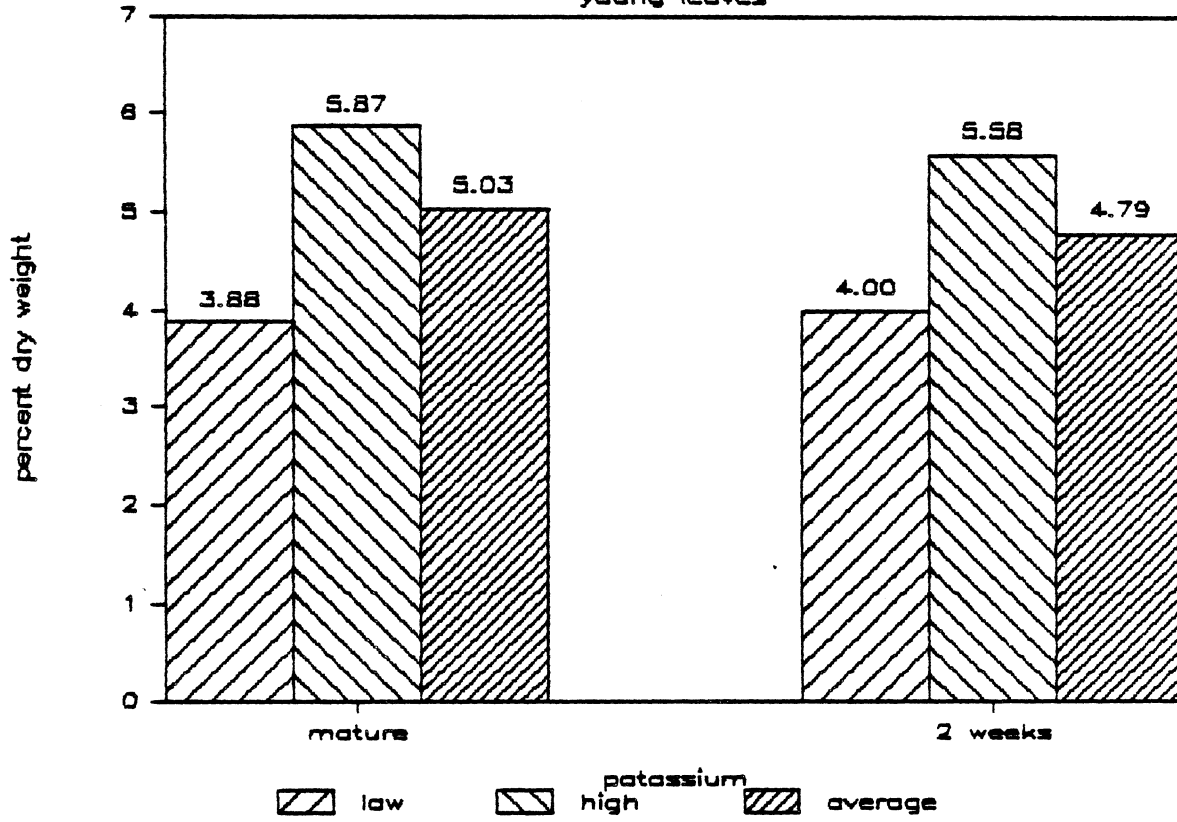
RADISH

young leaves

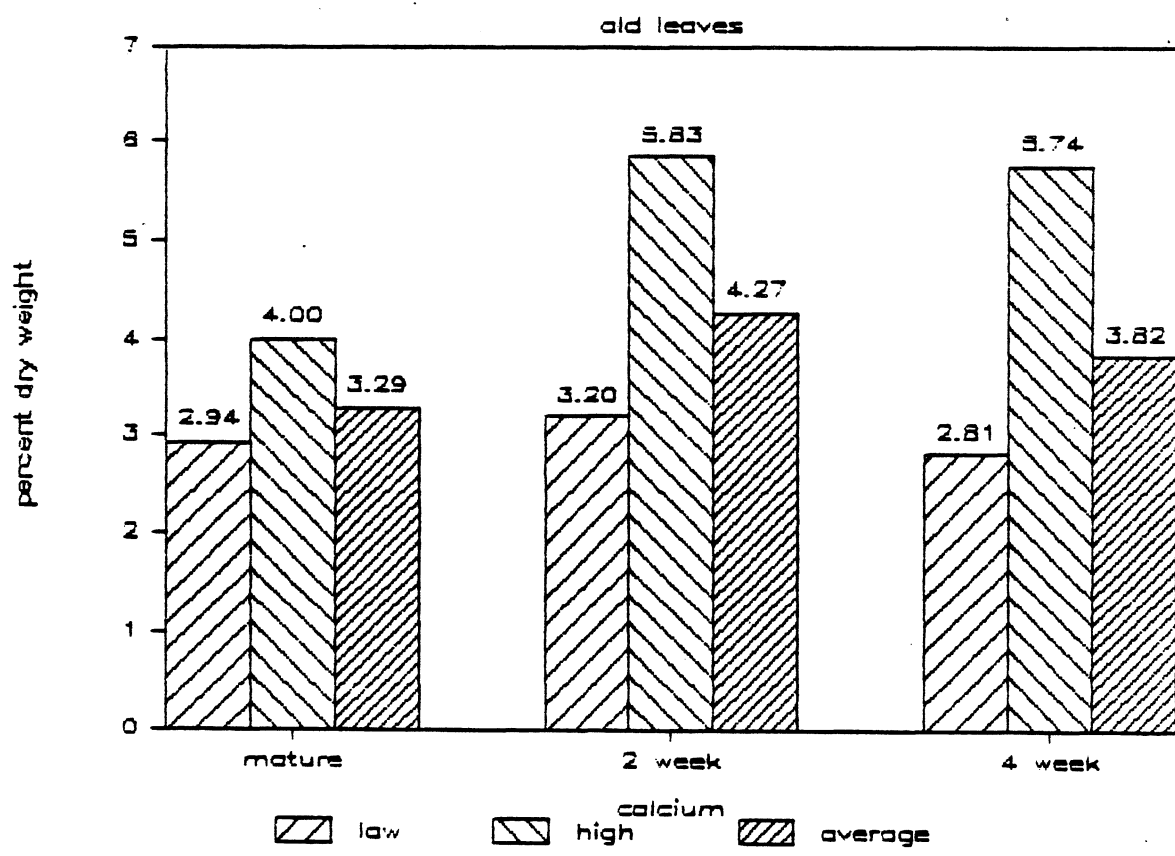
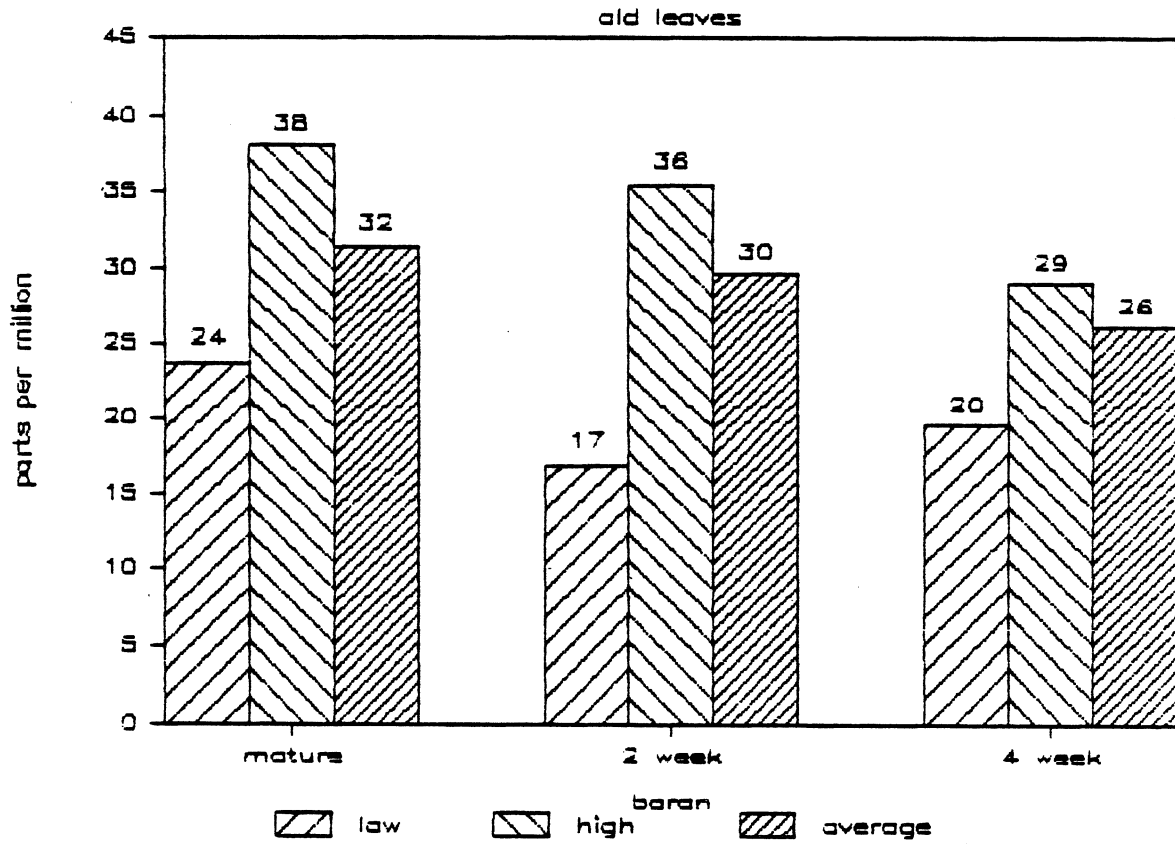


RADISH

young leaves

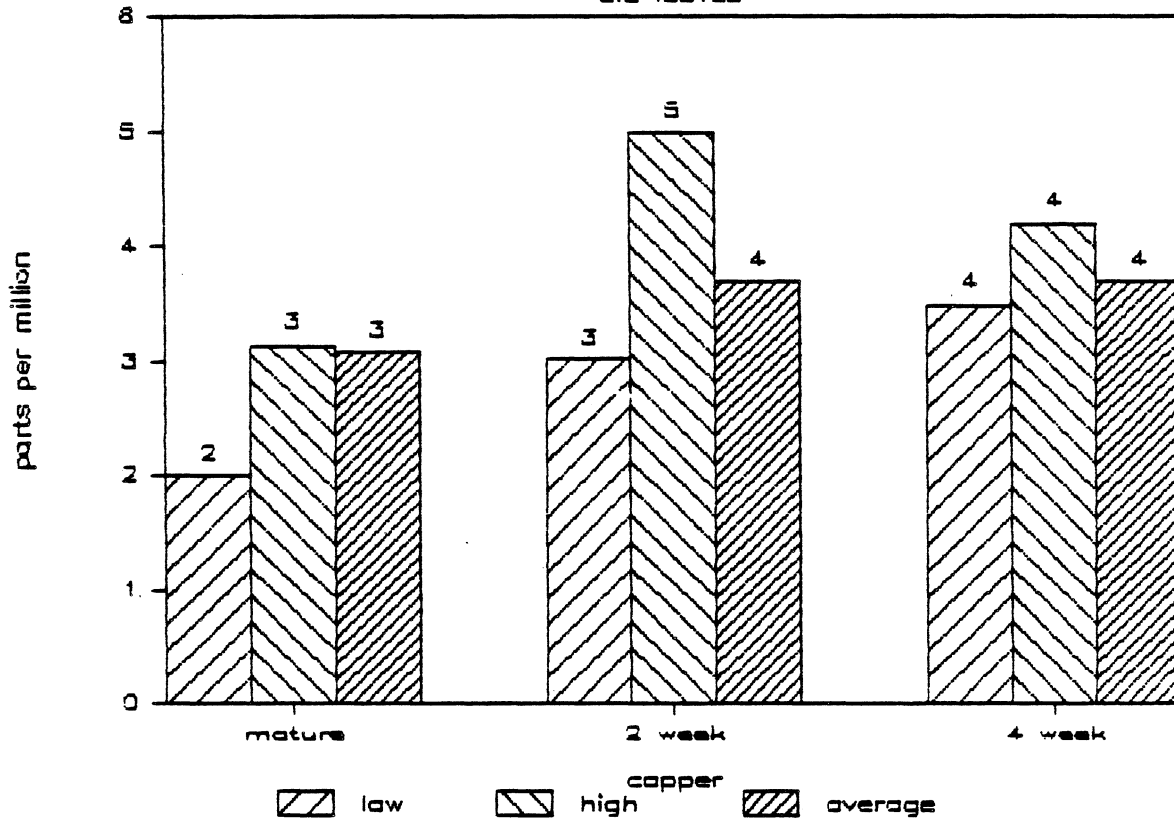


COLLARDS

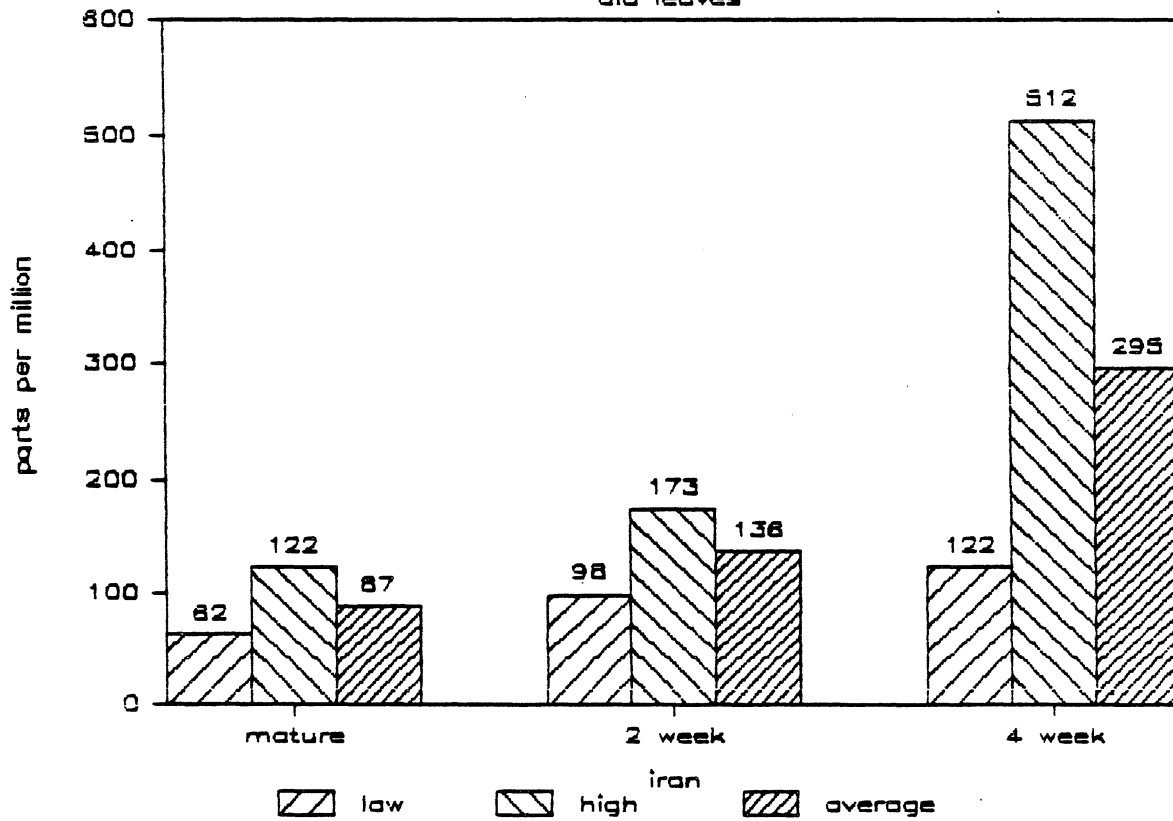


COLLARDS

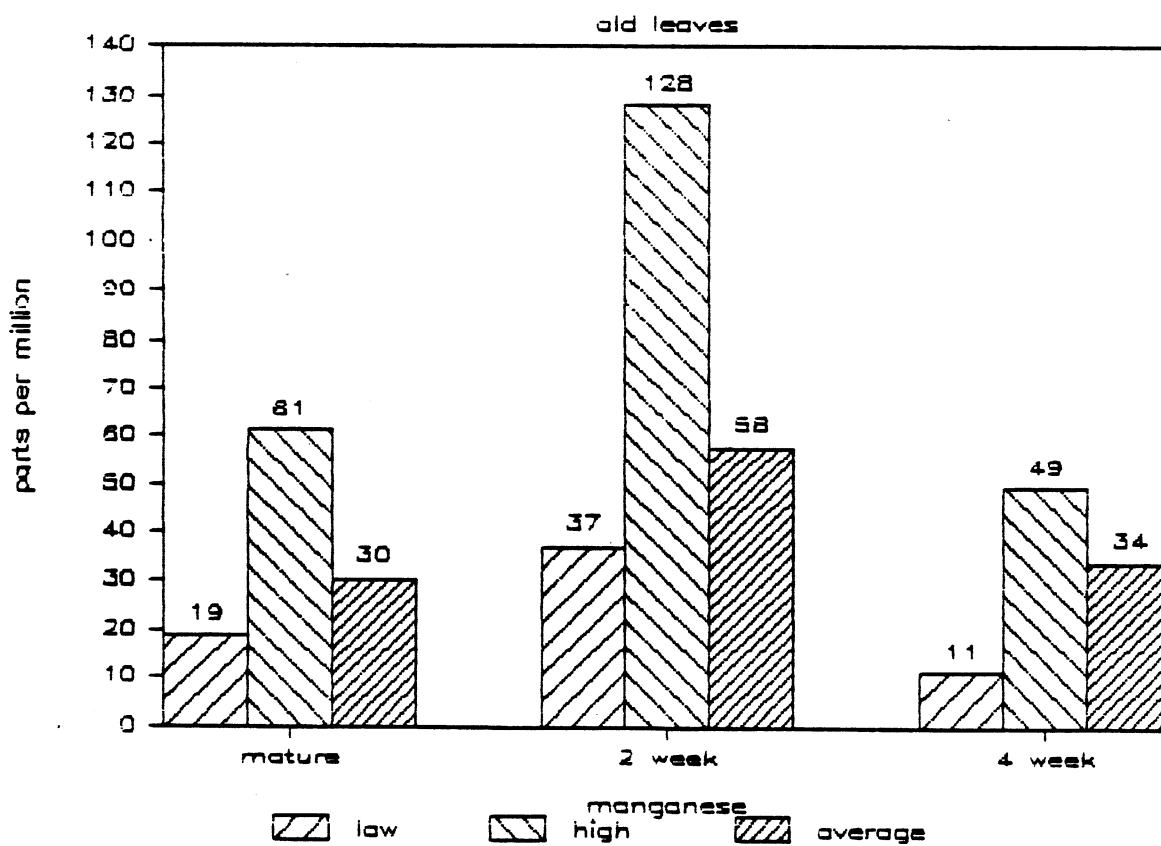
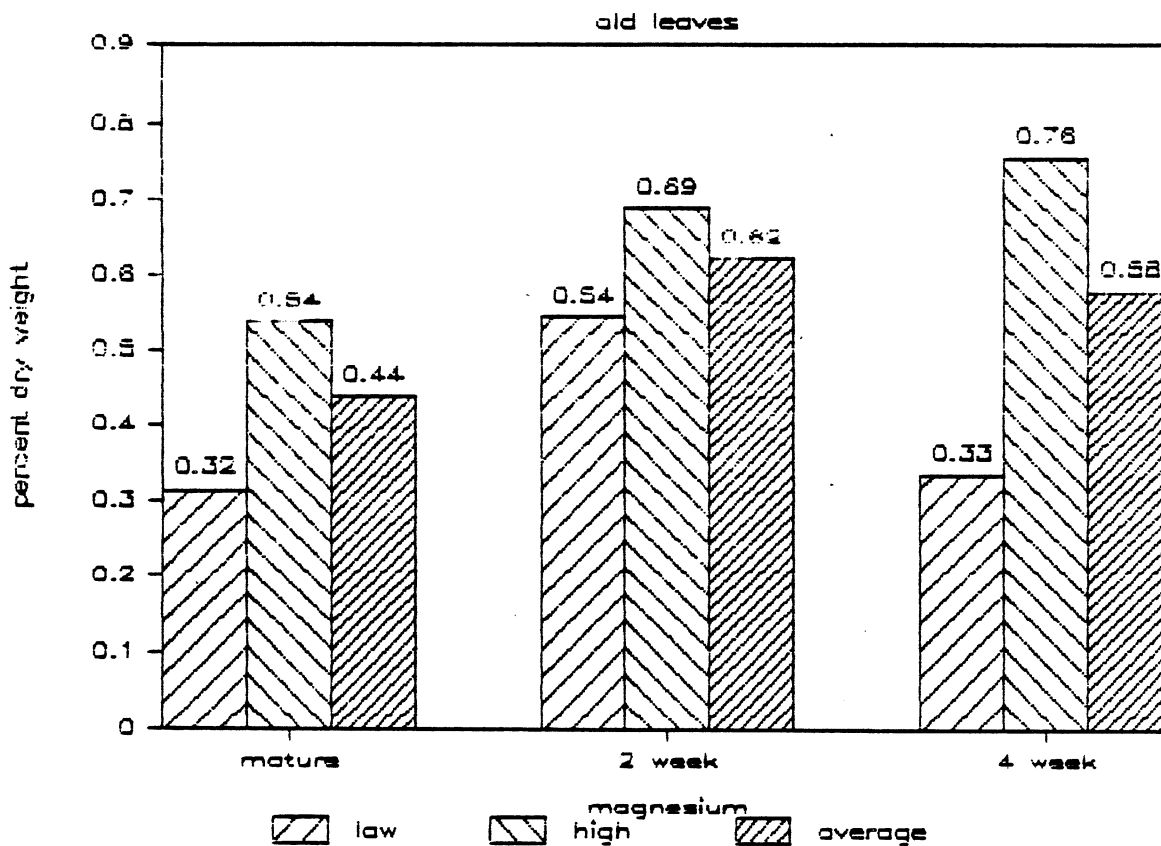
old leaves



old leaves

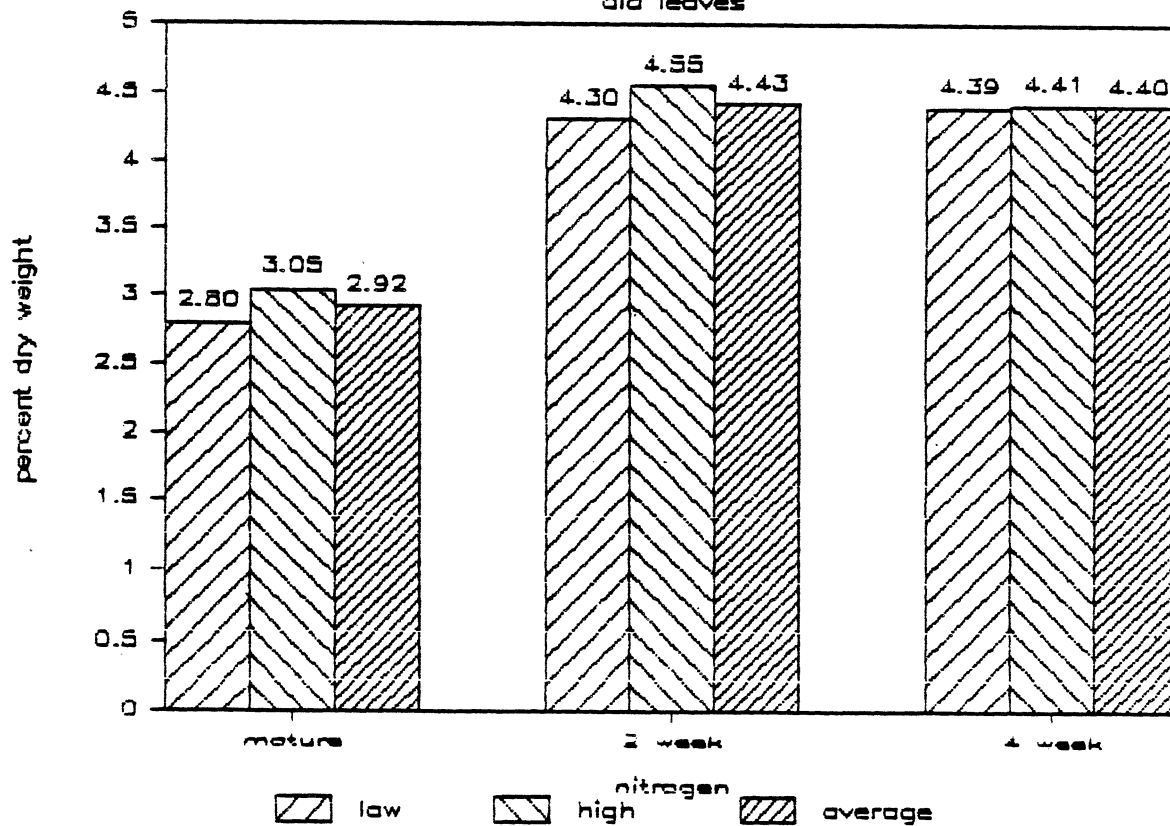


COLLARDS

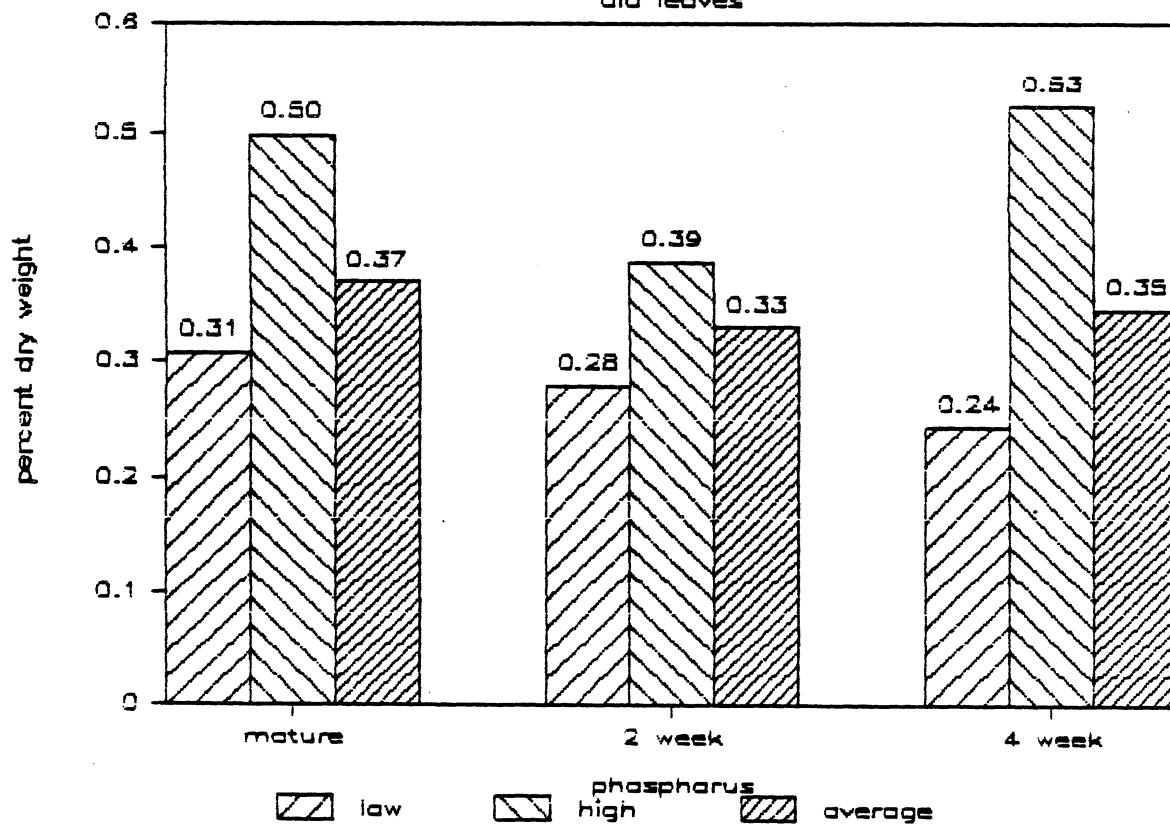


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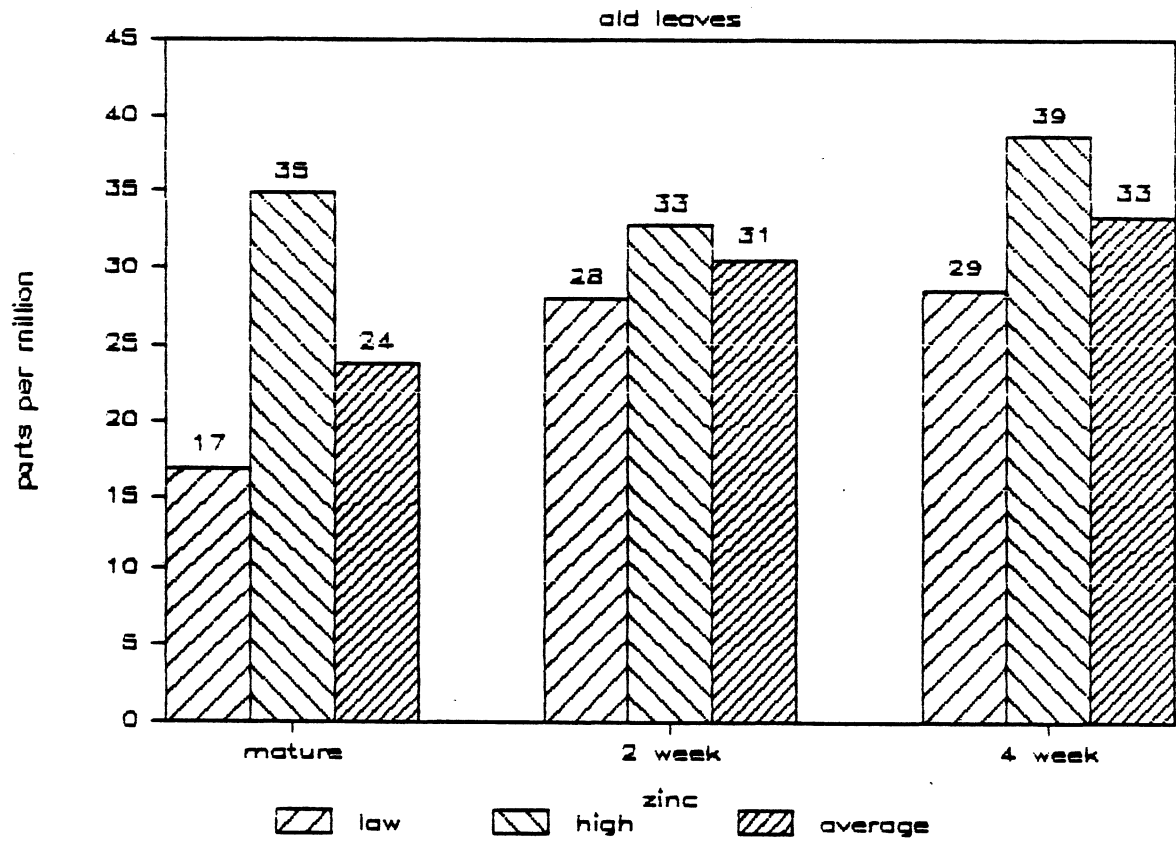
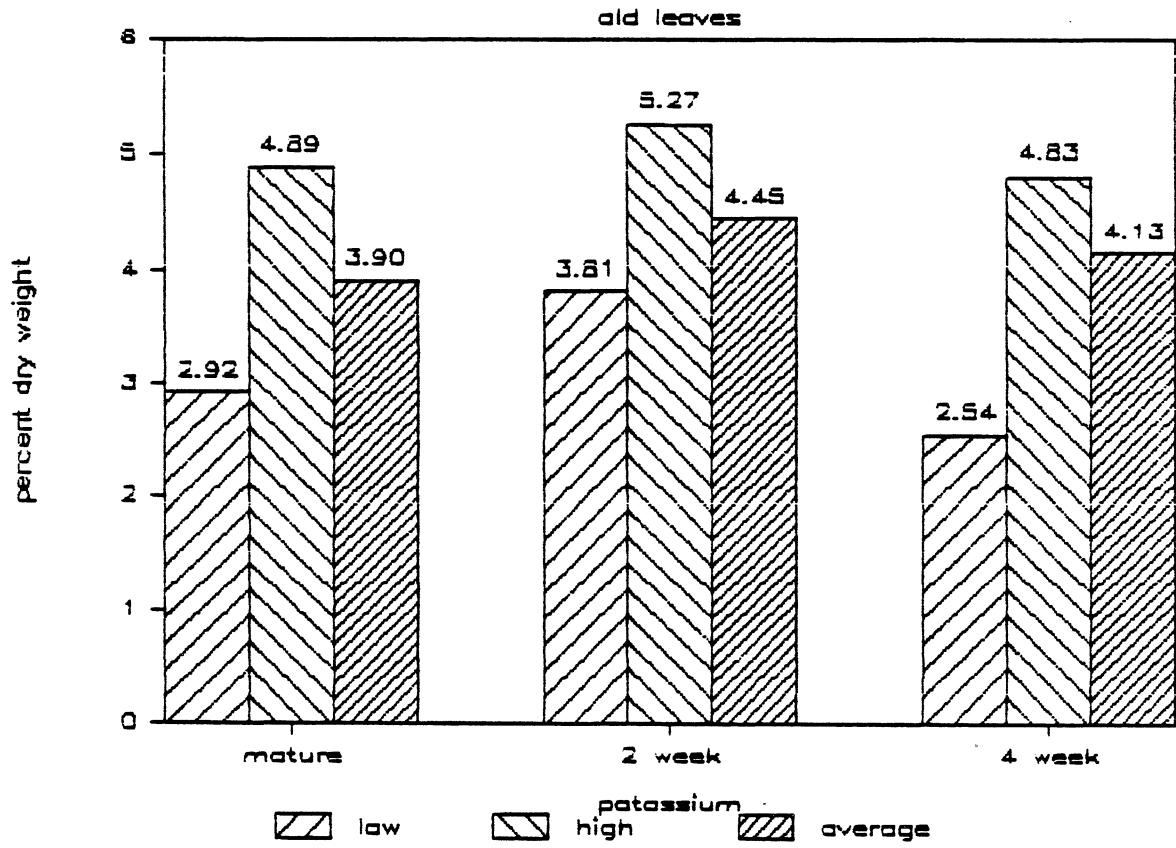
old leaves



old leaves

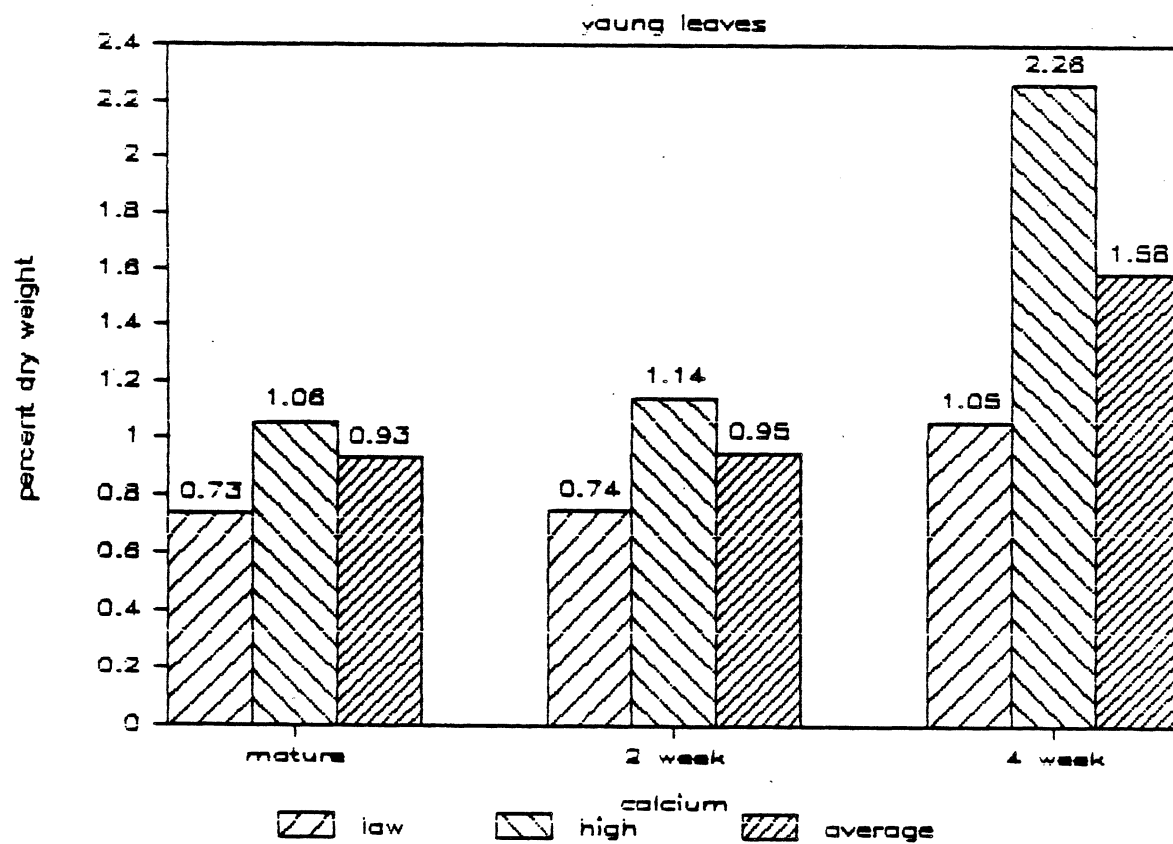
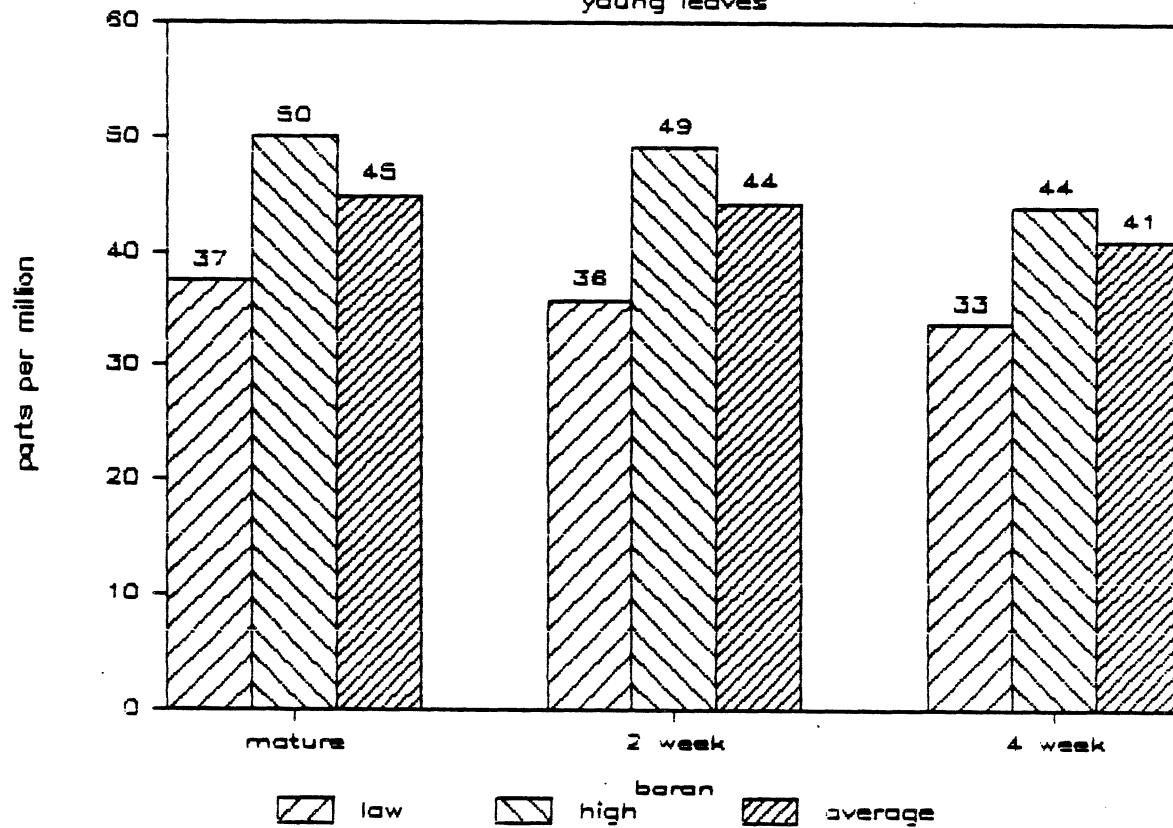


COLLARDS

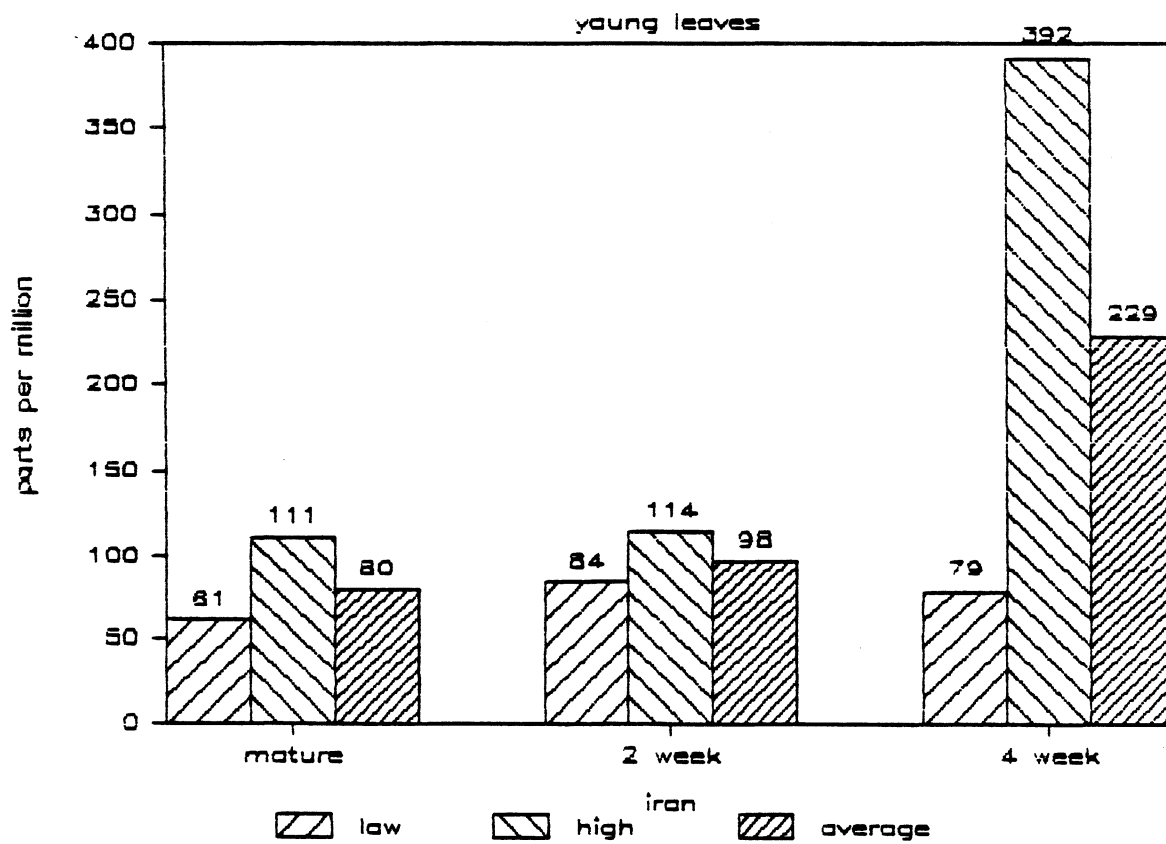
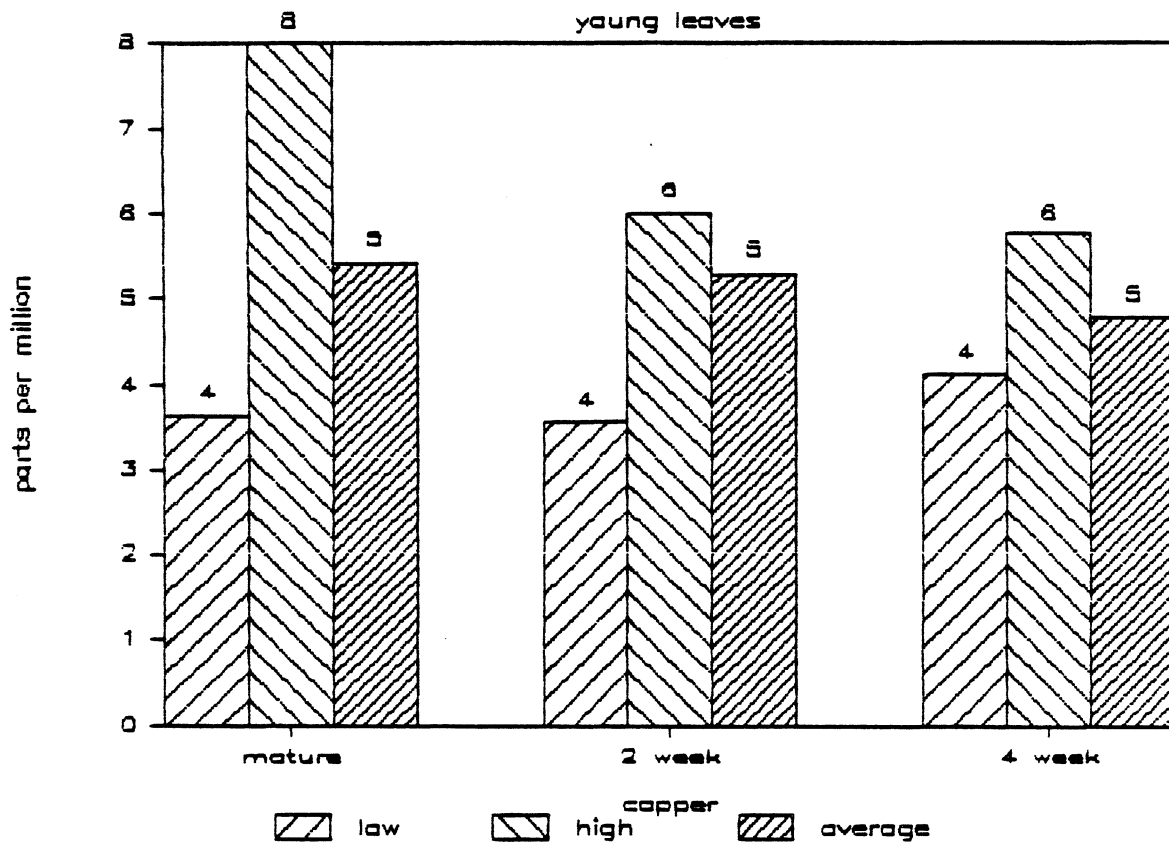


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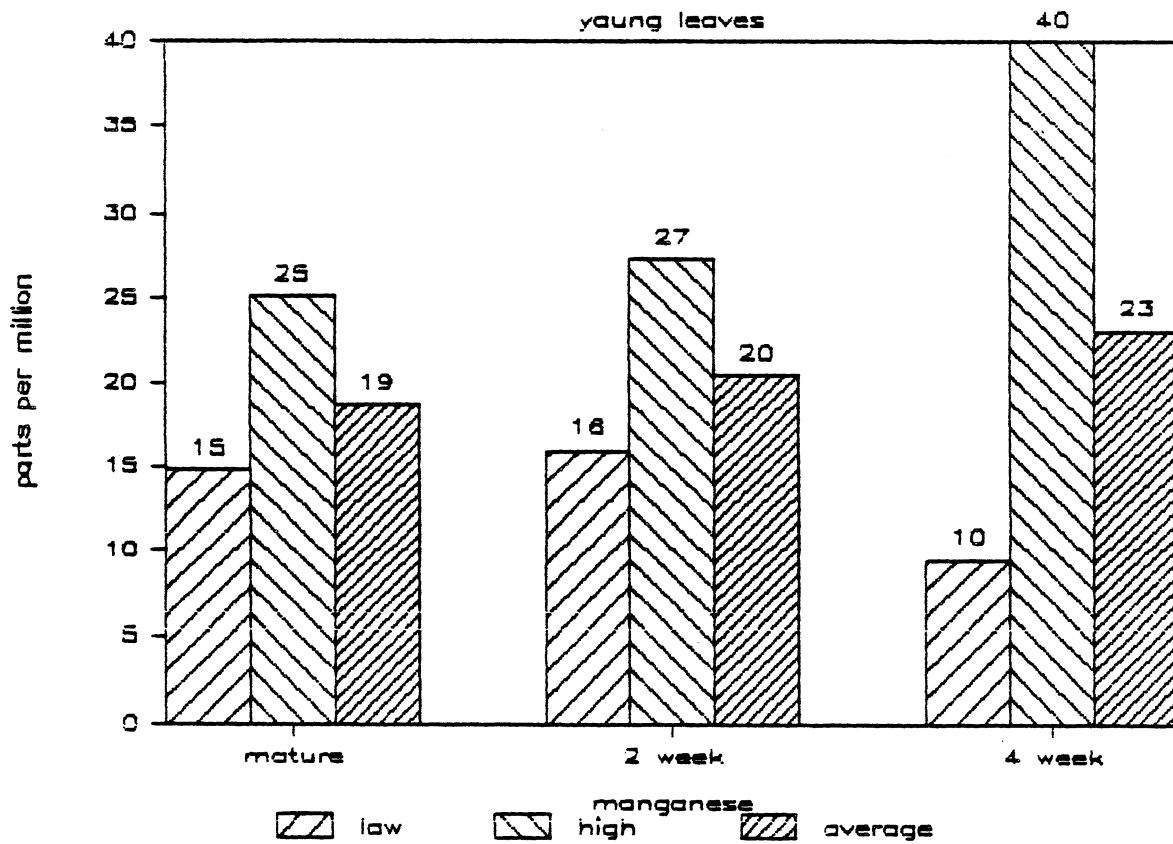
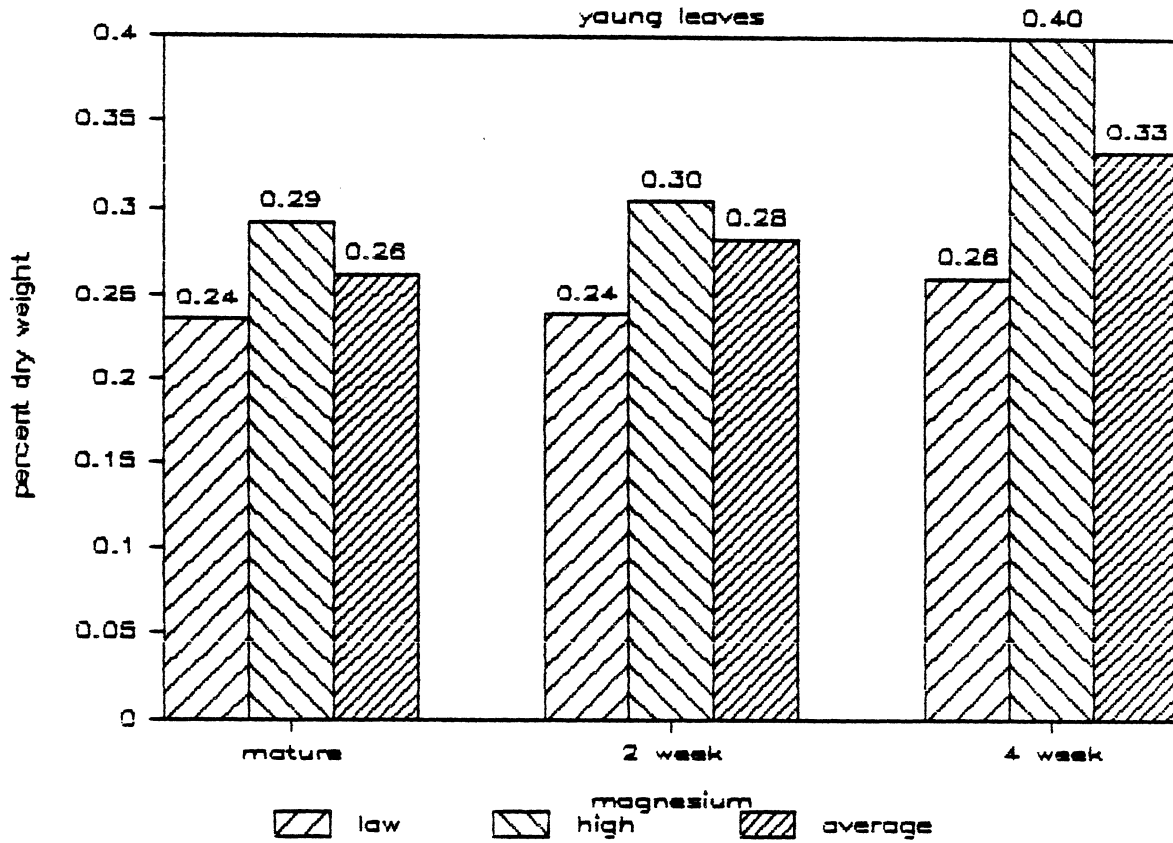
young leaves



COLLARDS

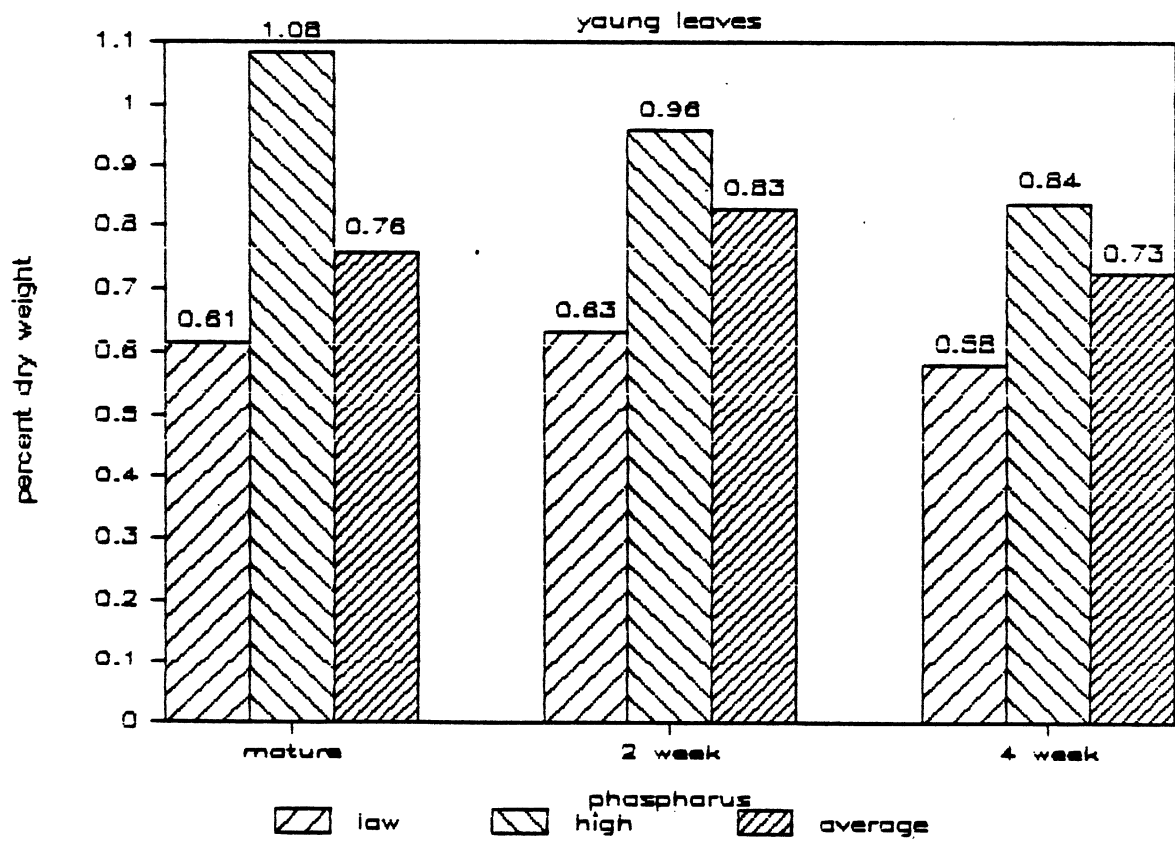
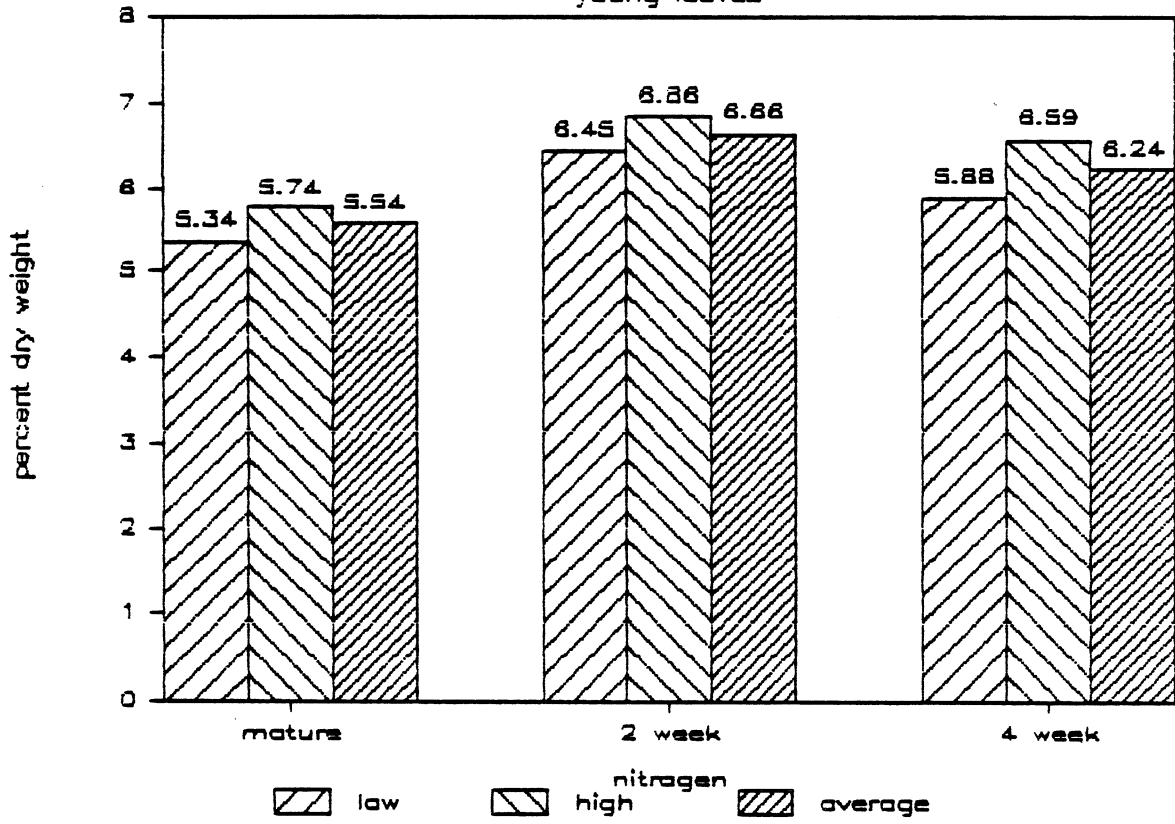


COLLARDS



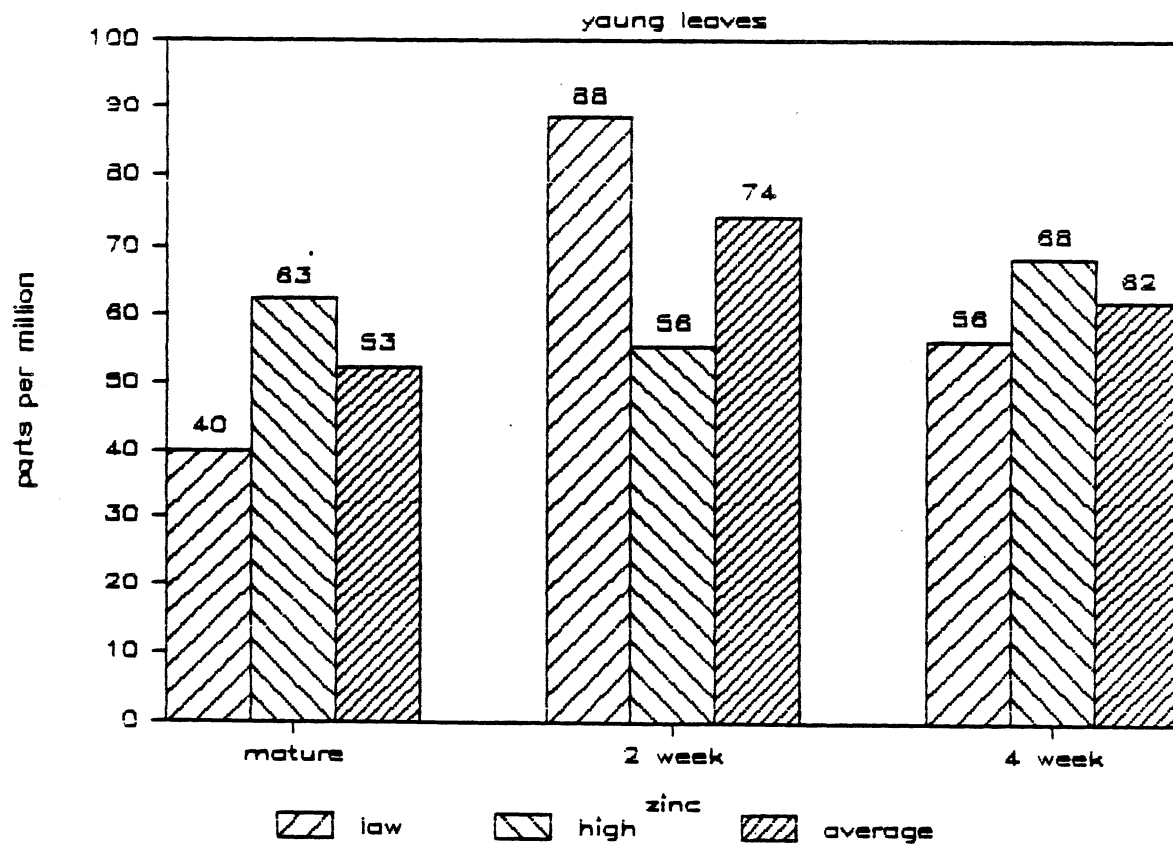
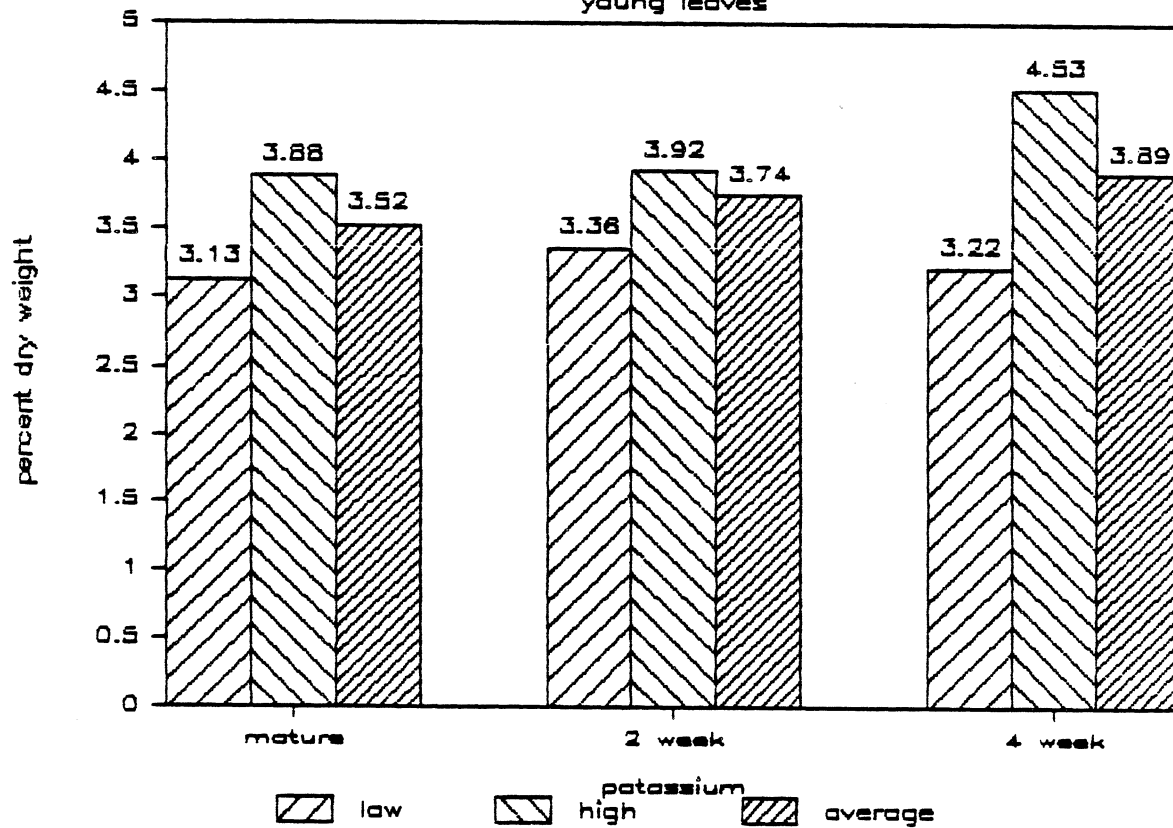
COLLARDS

young leaves



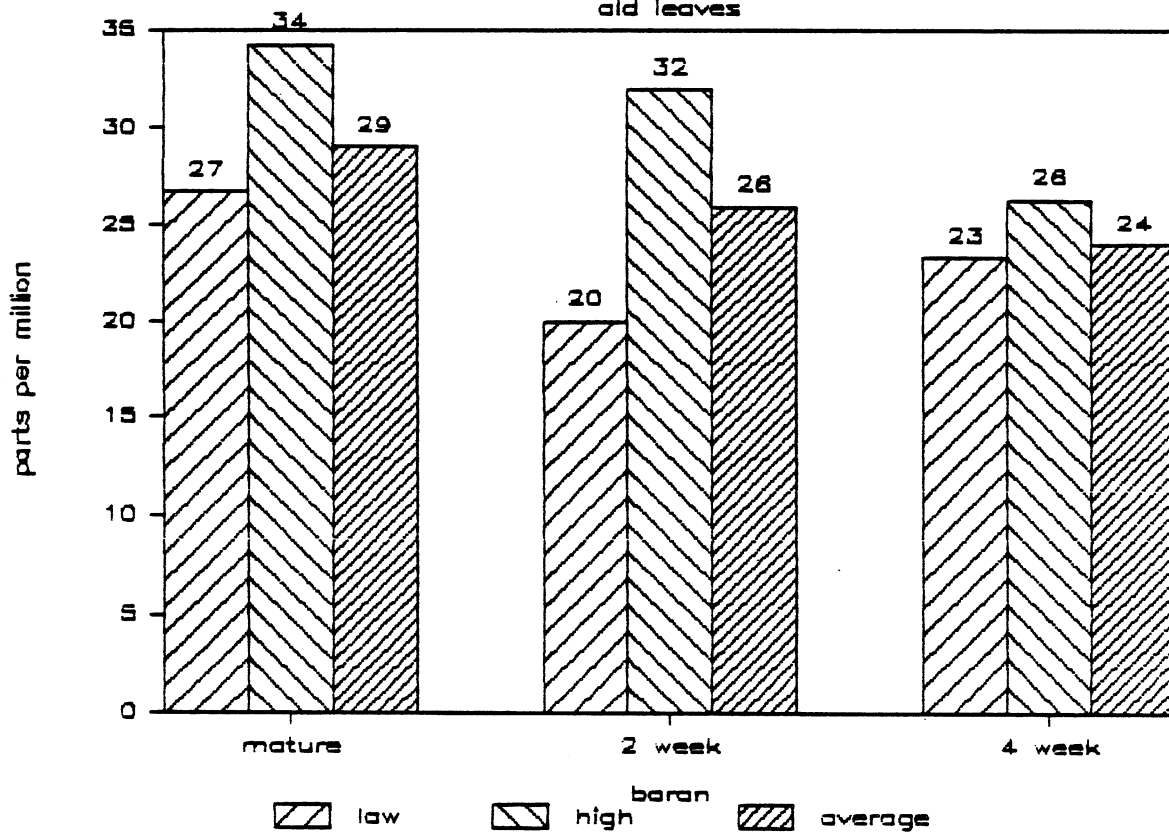
COLLARDS

young leaves

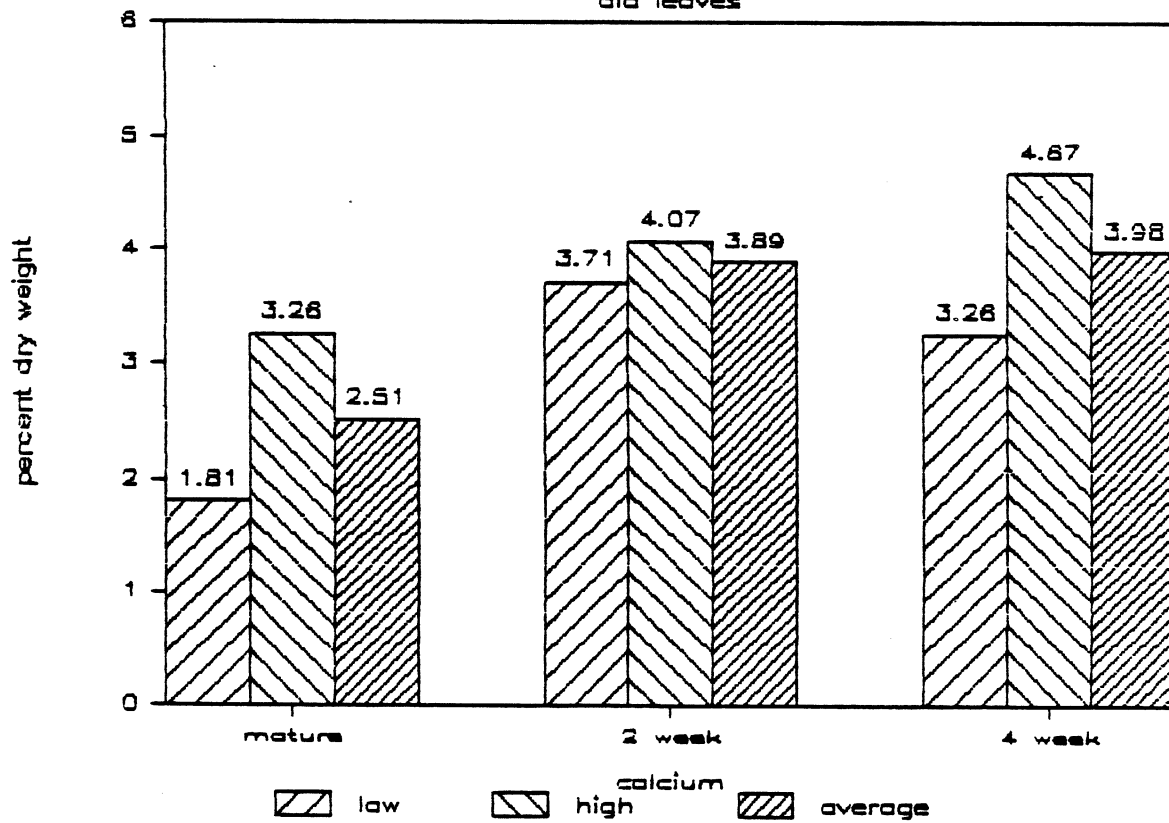


KALE

aid leaves

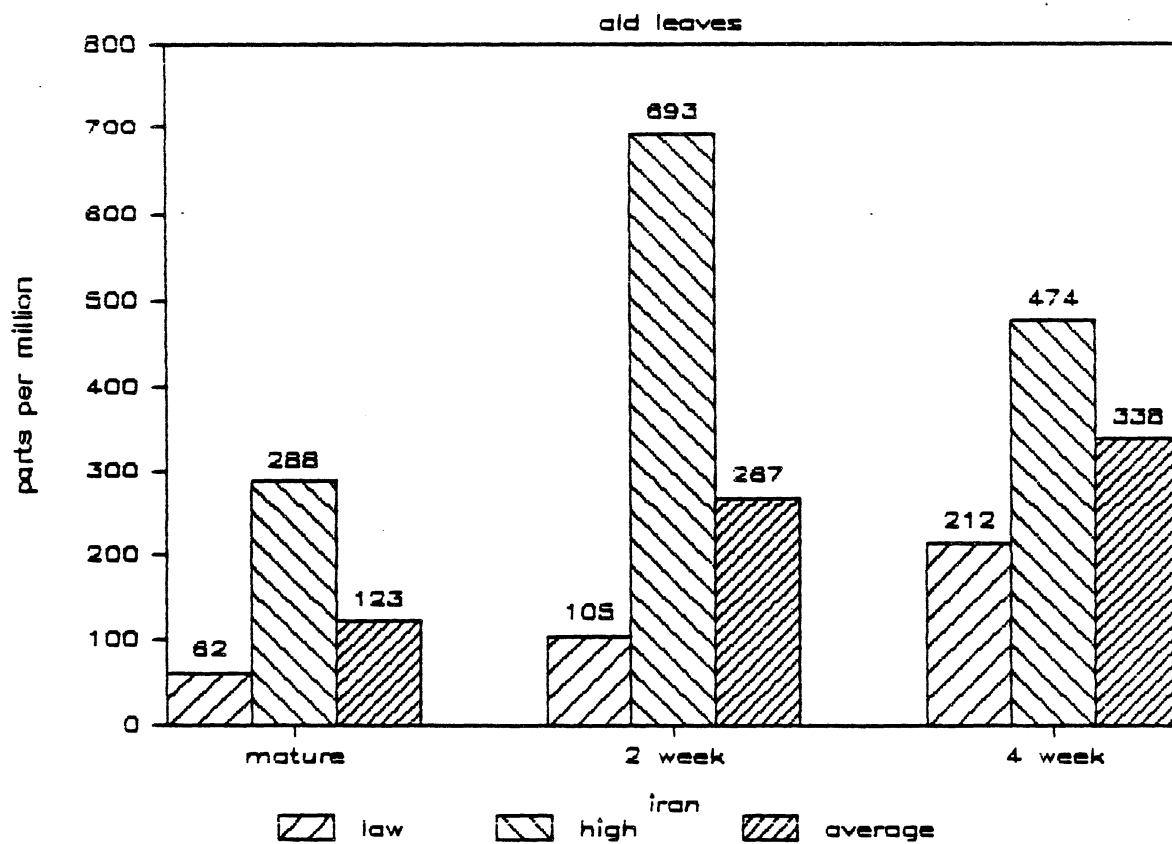
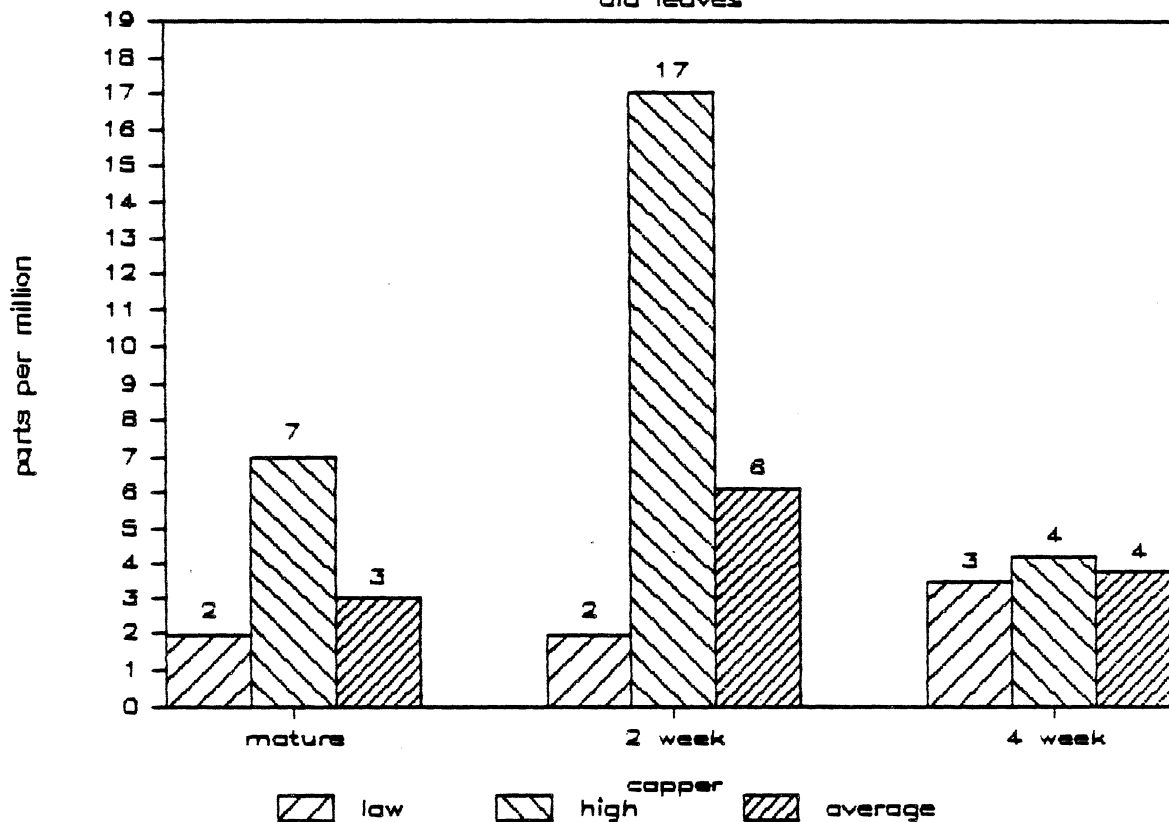


aid leaves



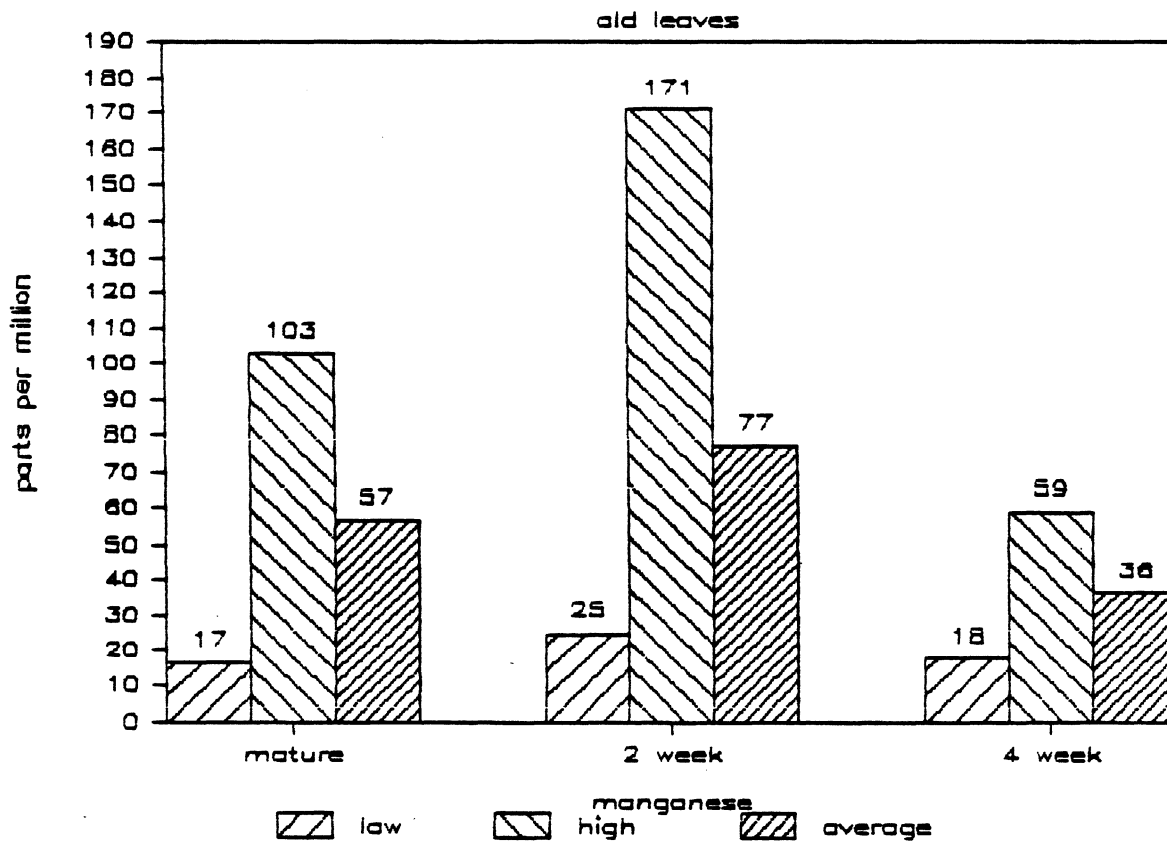
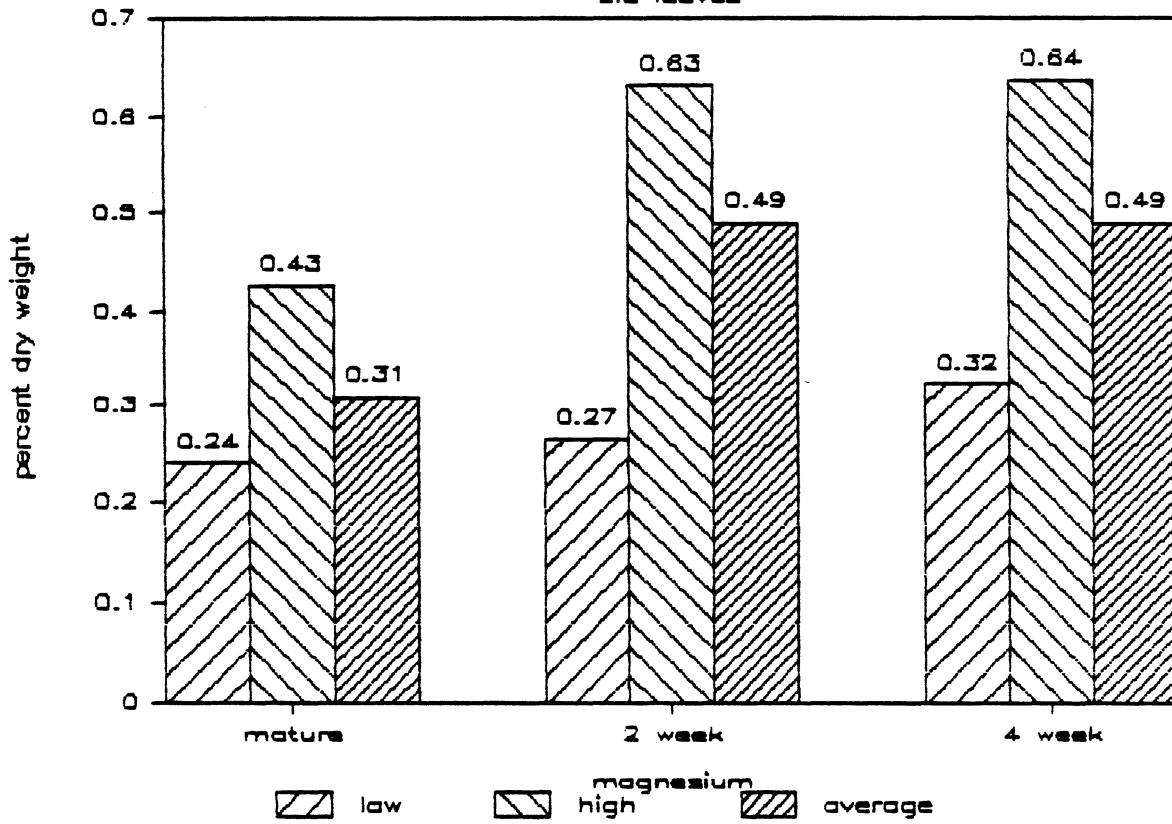
KALE

old leaves



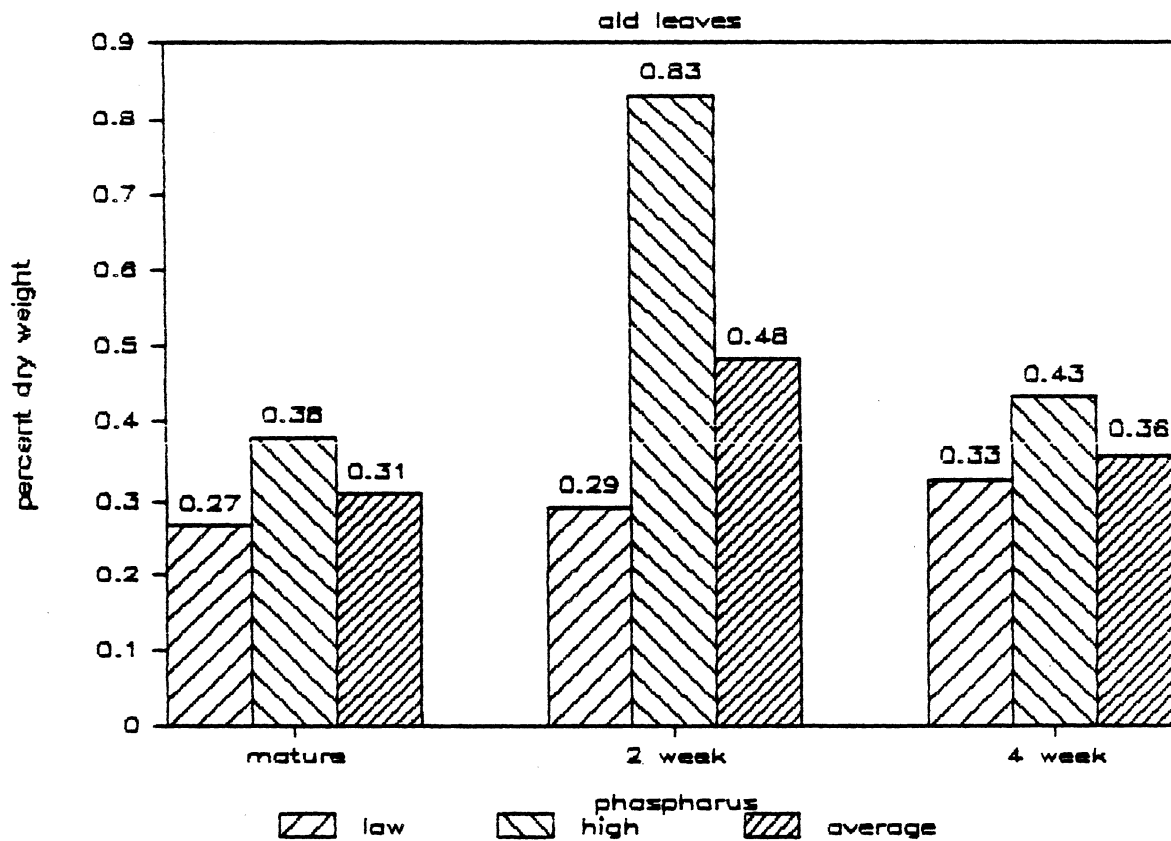
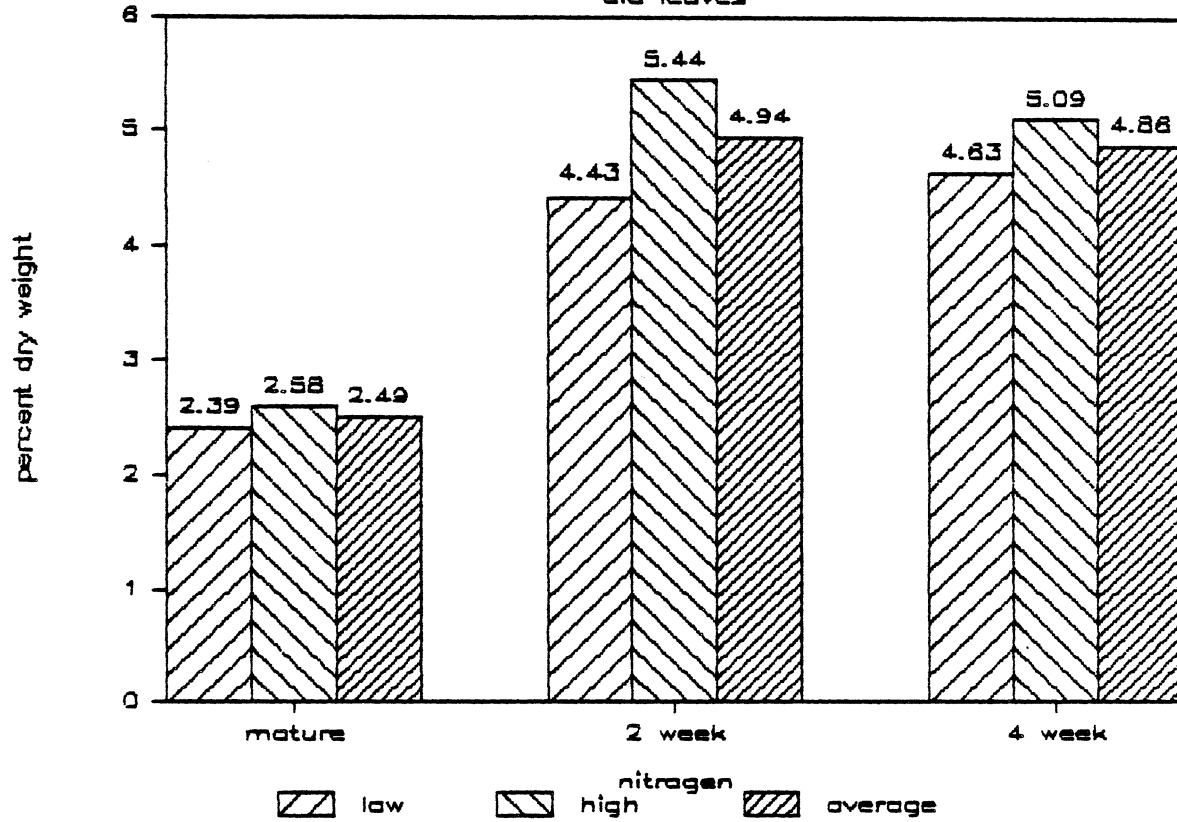
KALE

old leaves



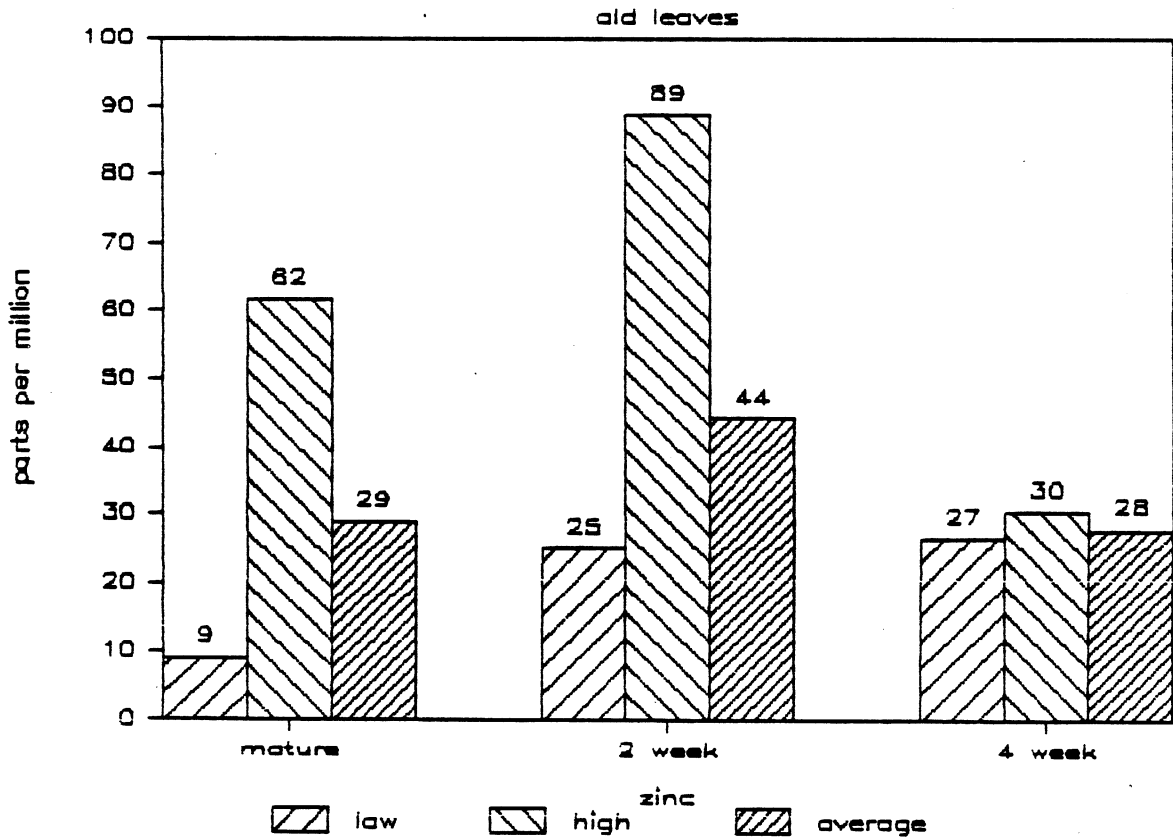
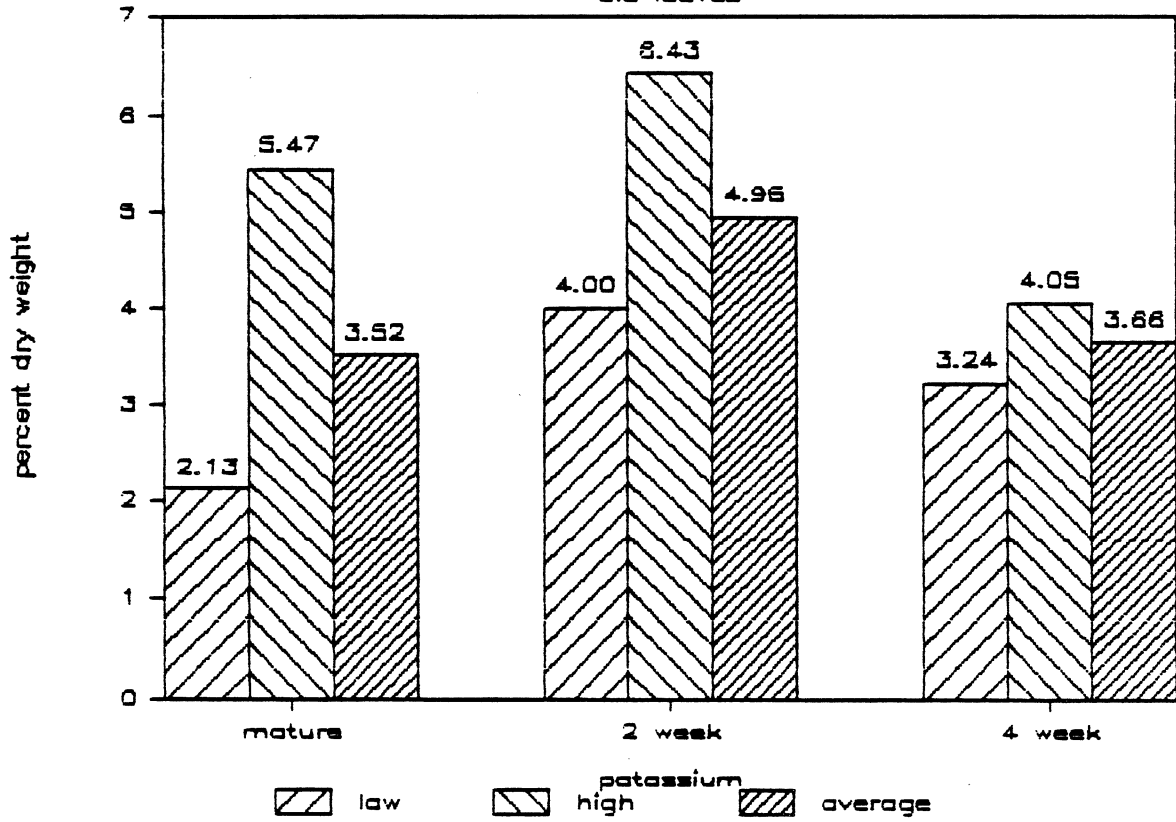
KALE

old leaves



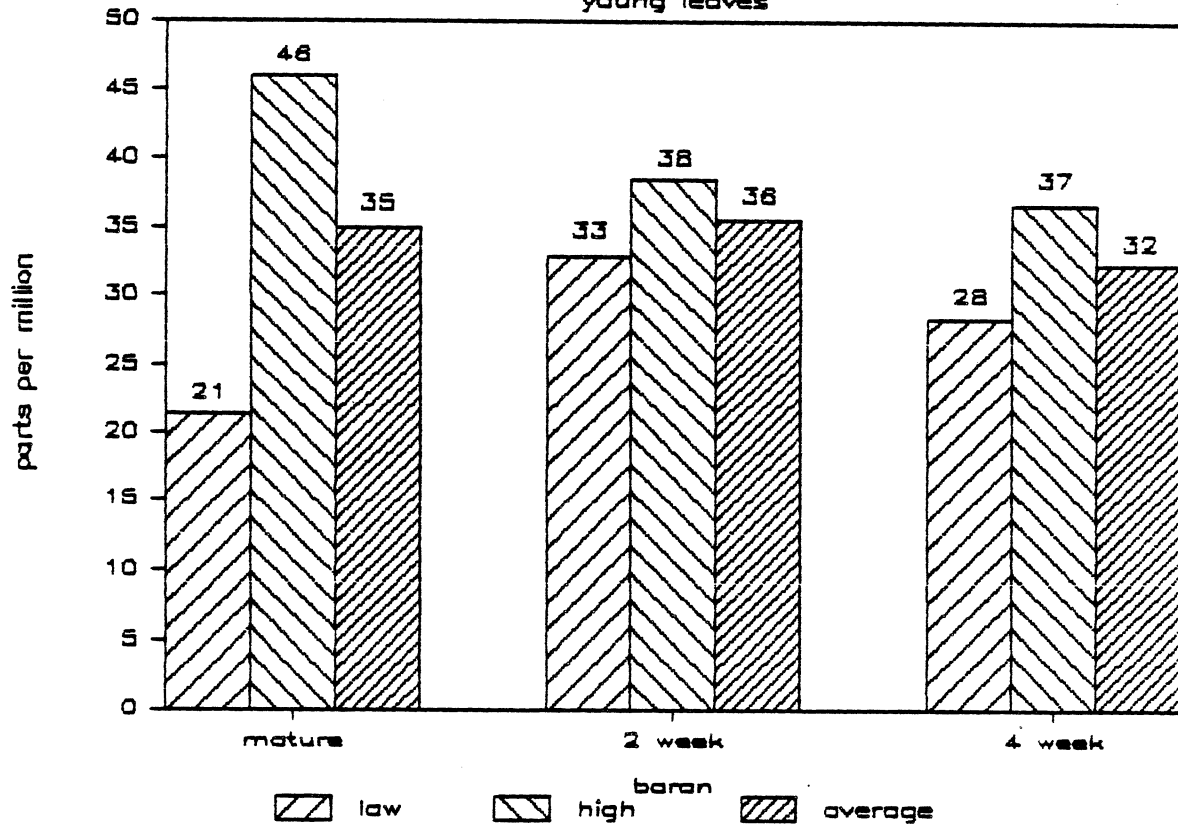
KALE

old leaves

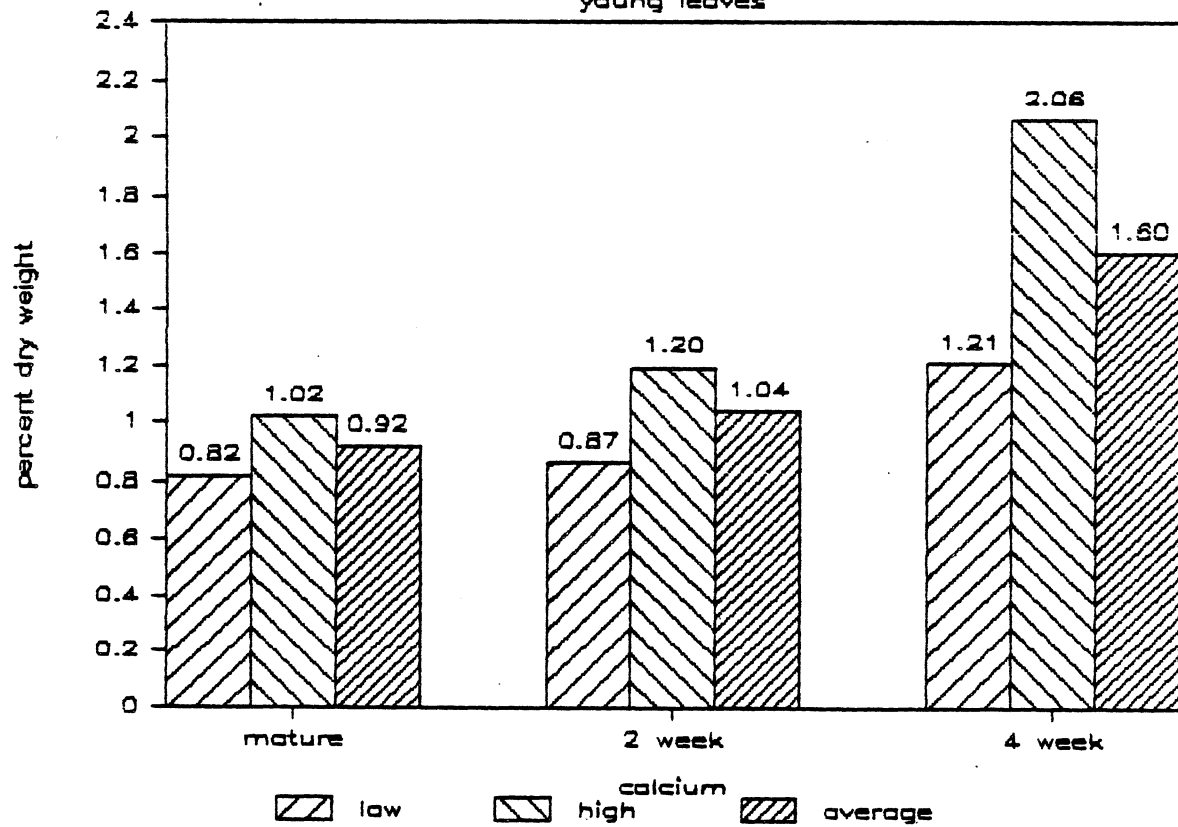


KALE

young leaves

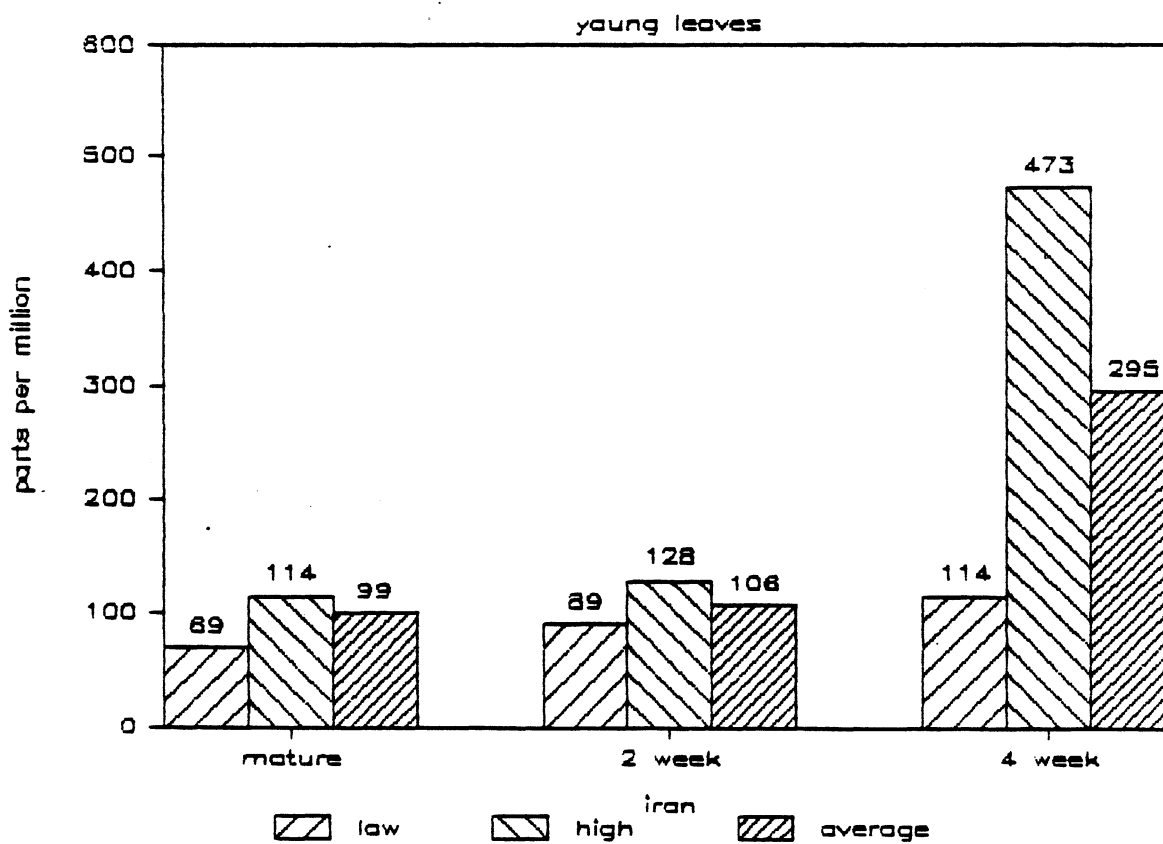
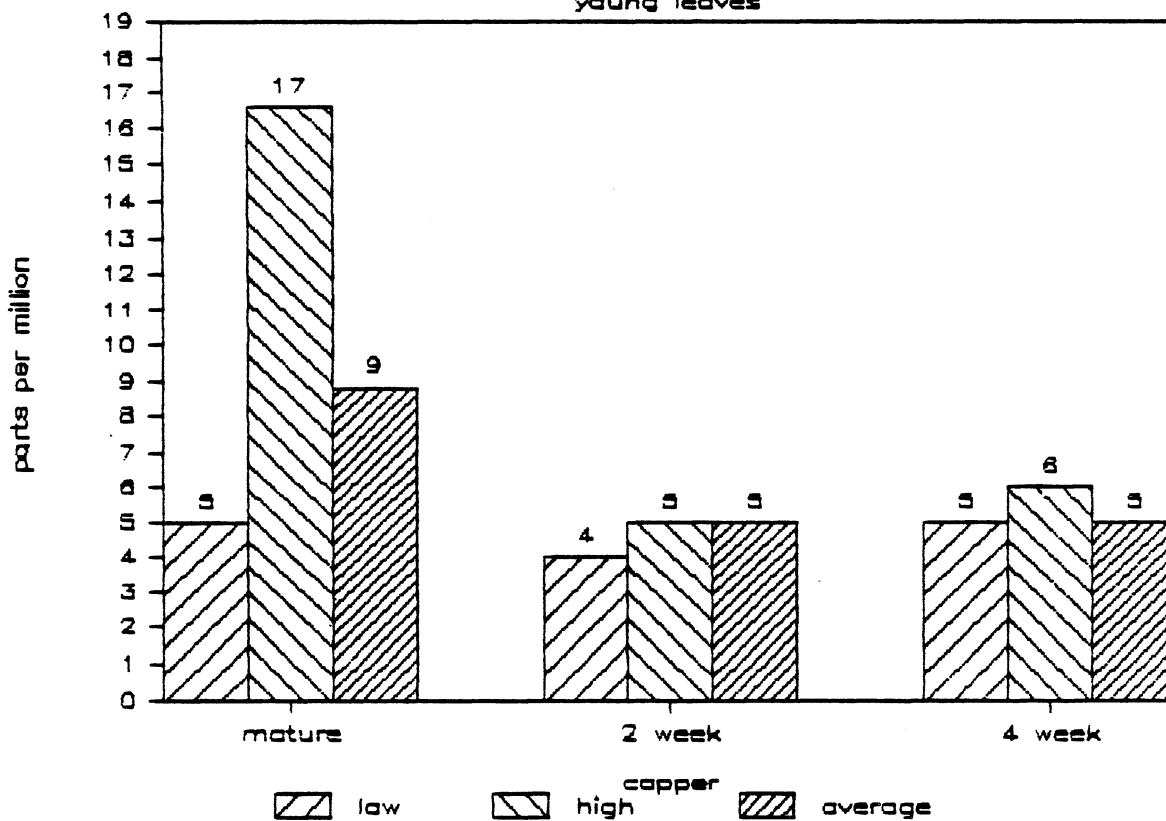


young leaves



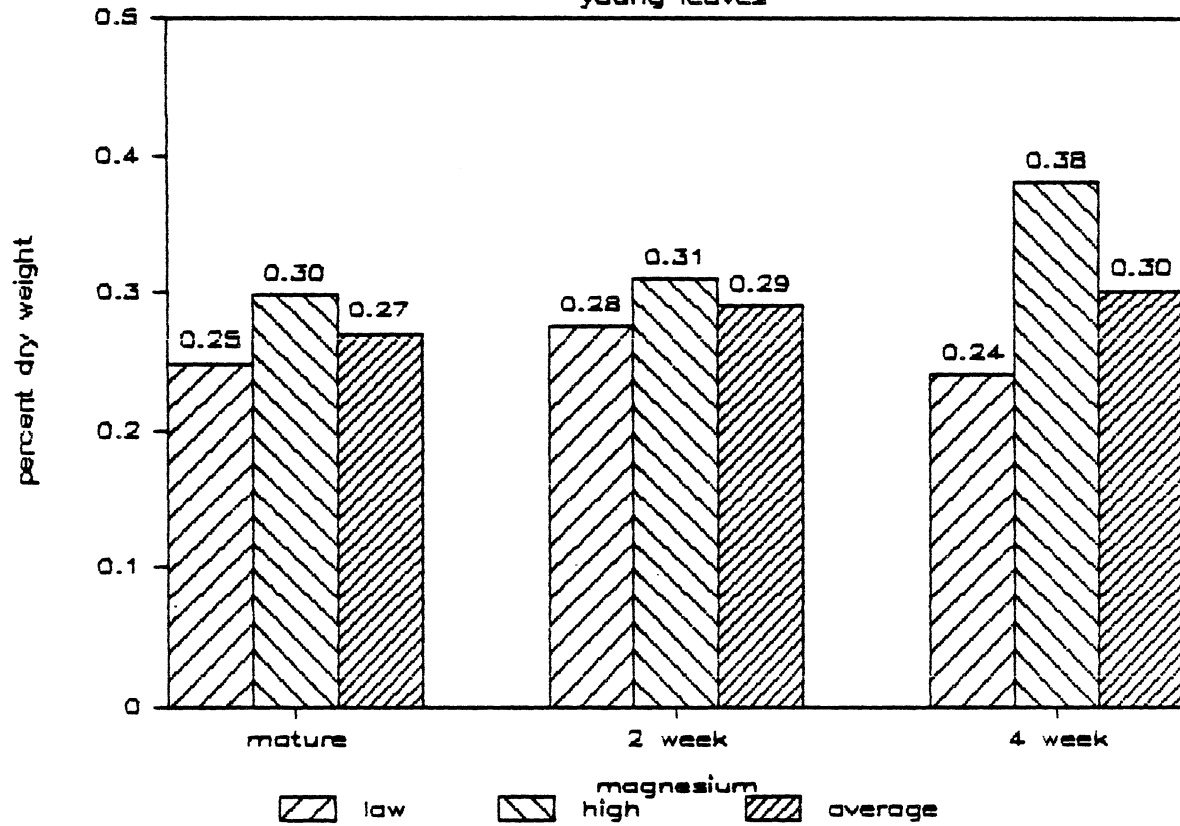
KALE

young leaves

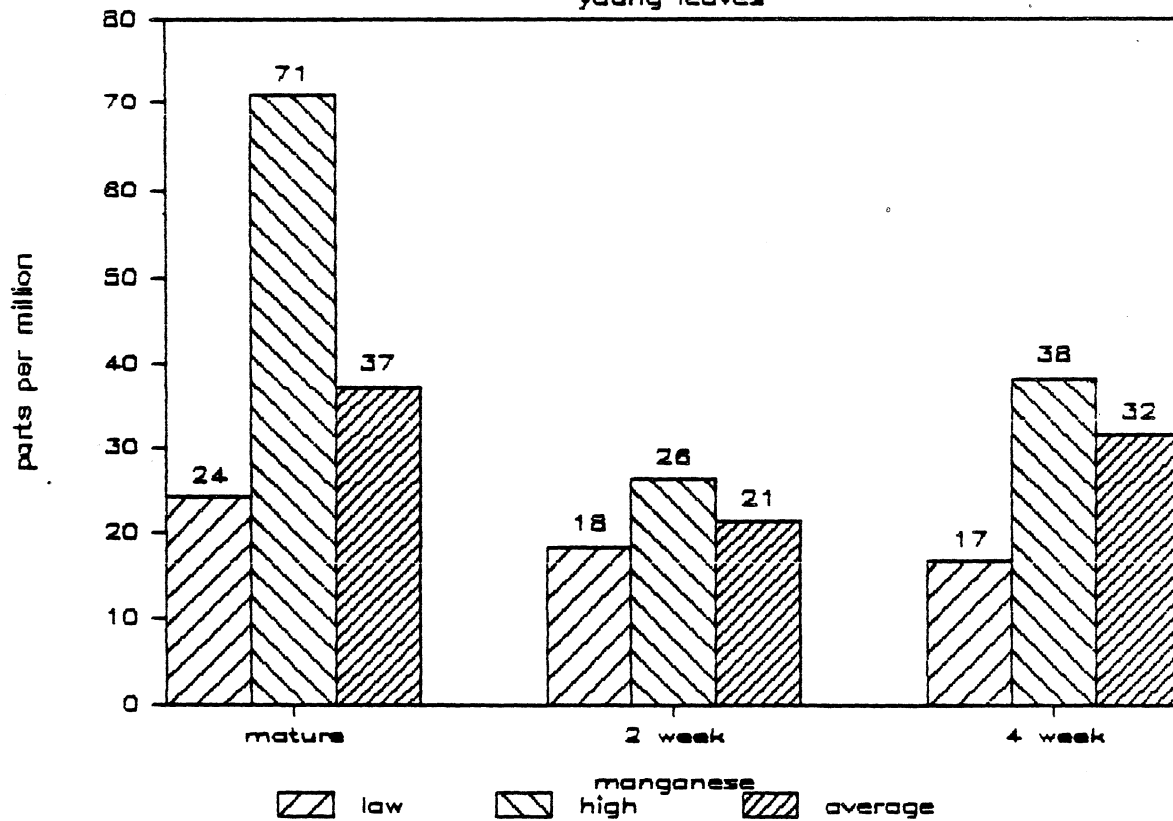


KALE

young leaves

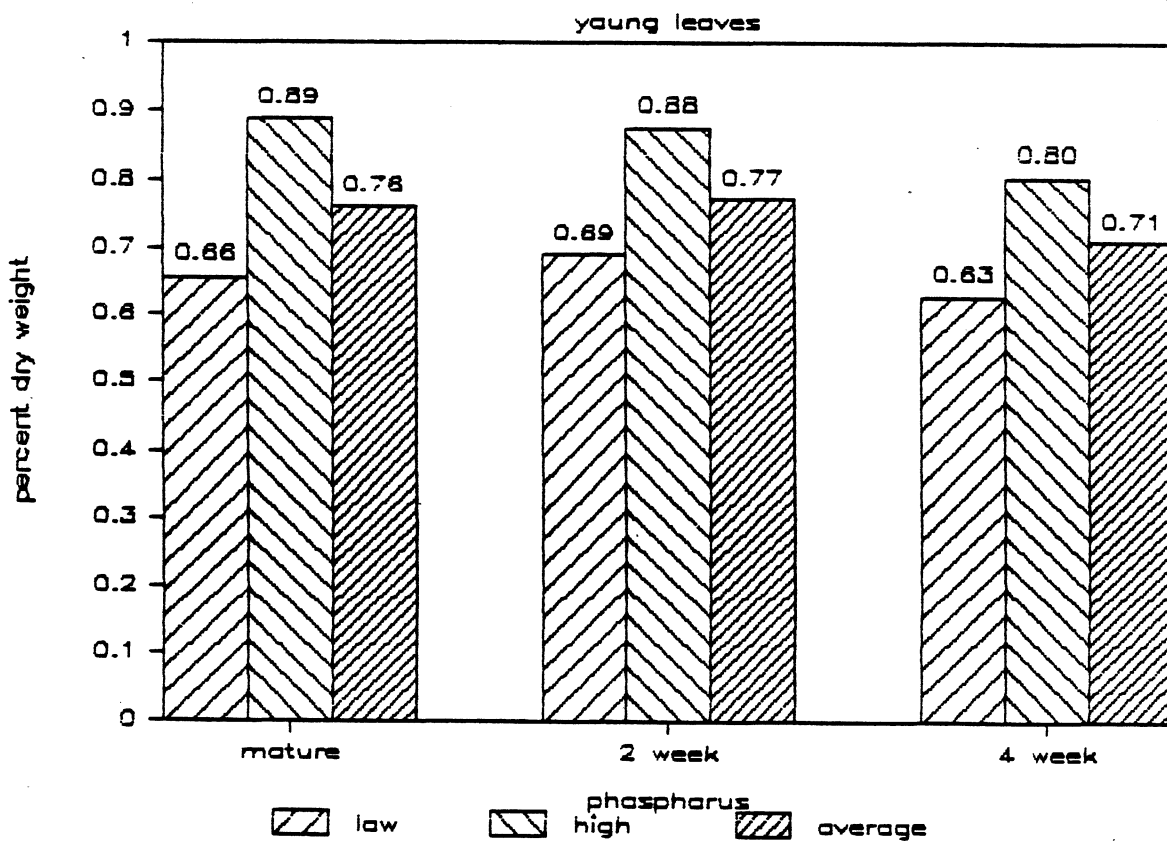
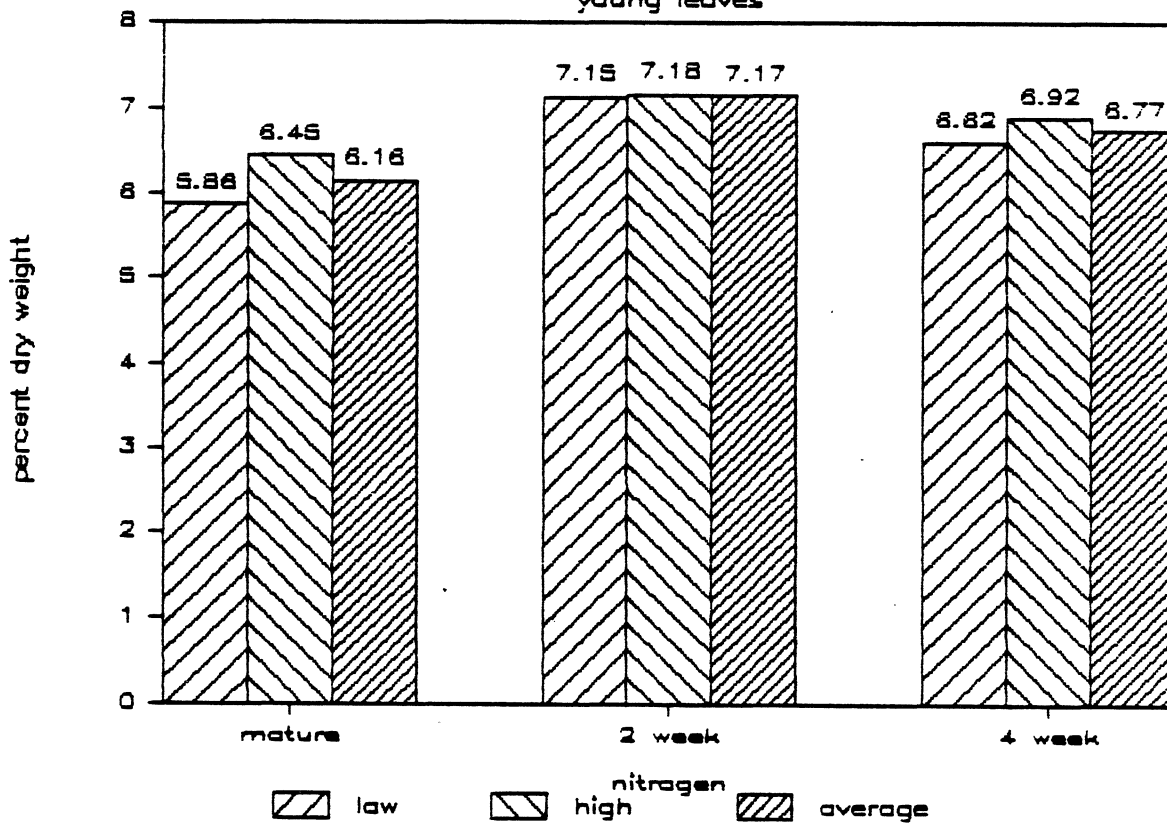


young leaves



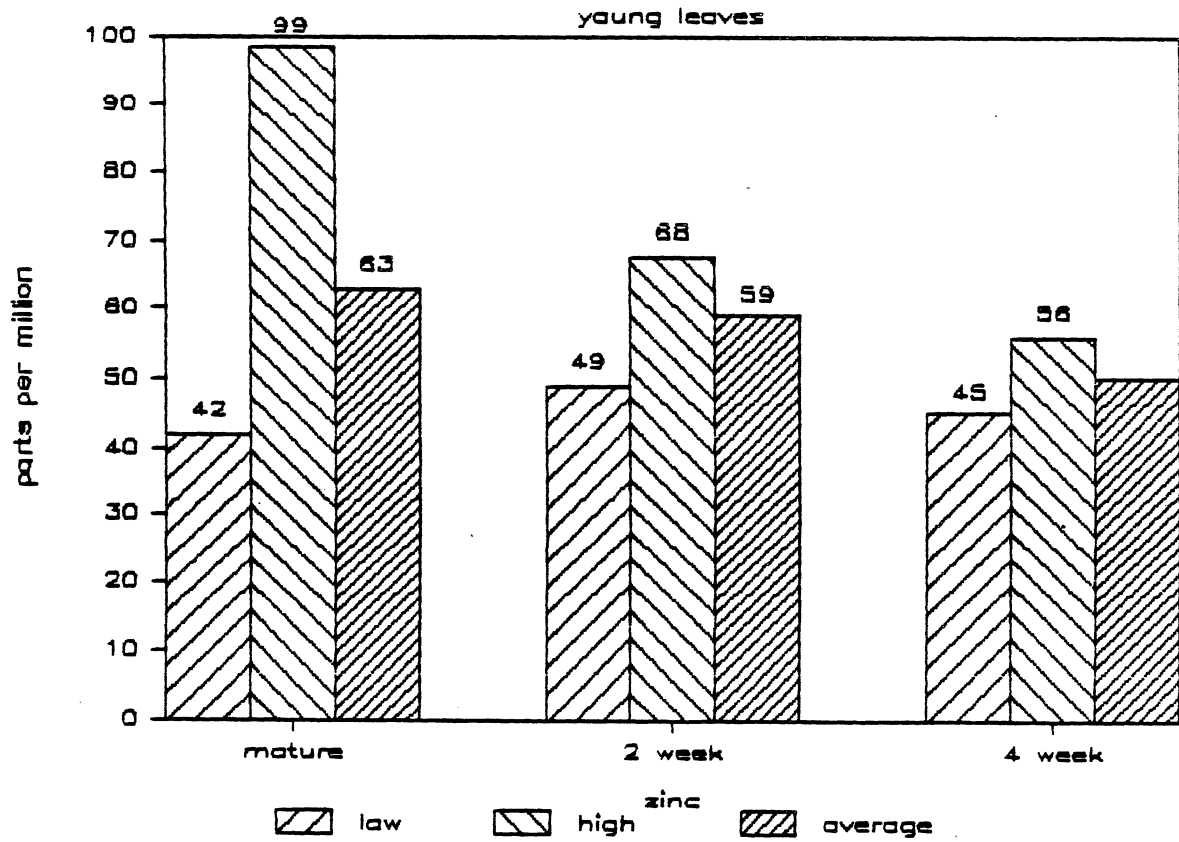
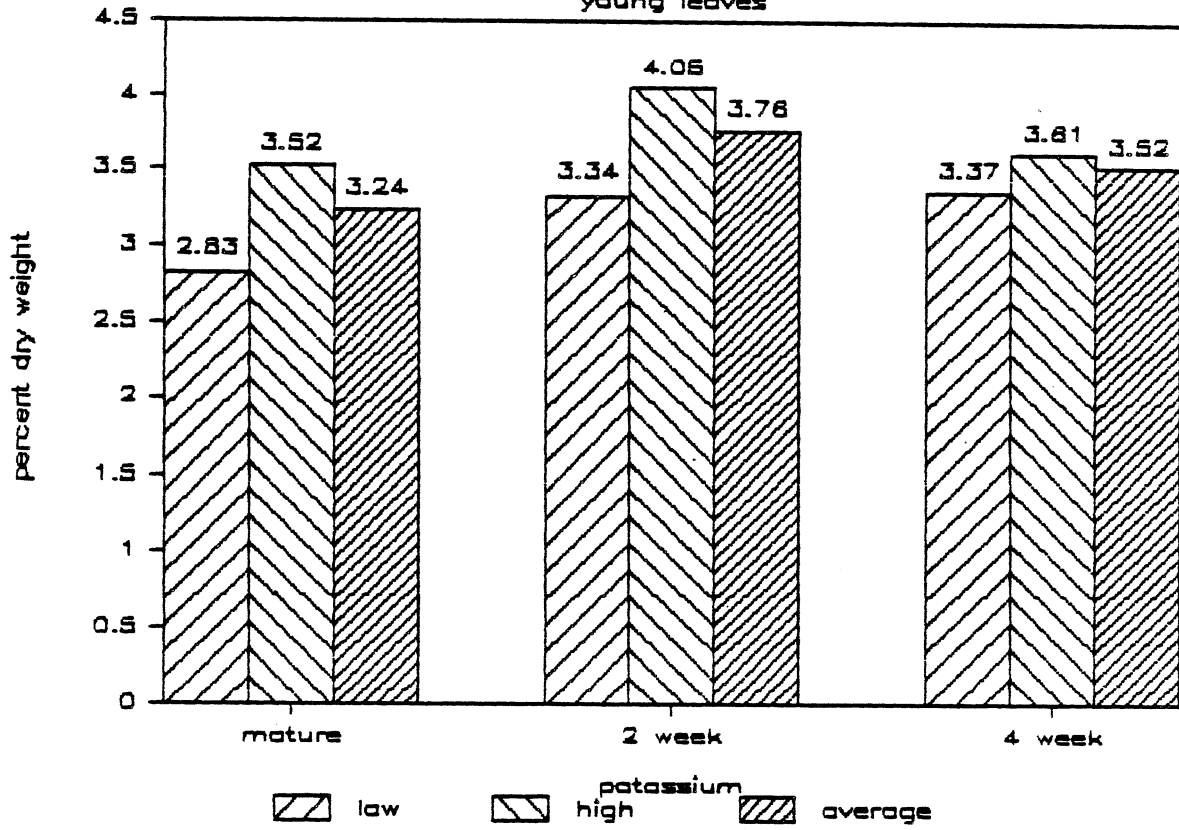
KALE

young leaves



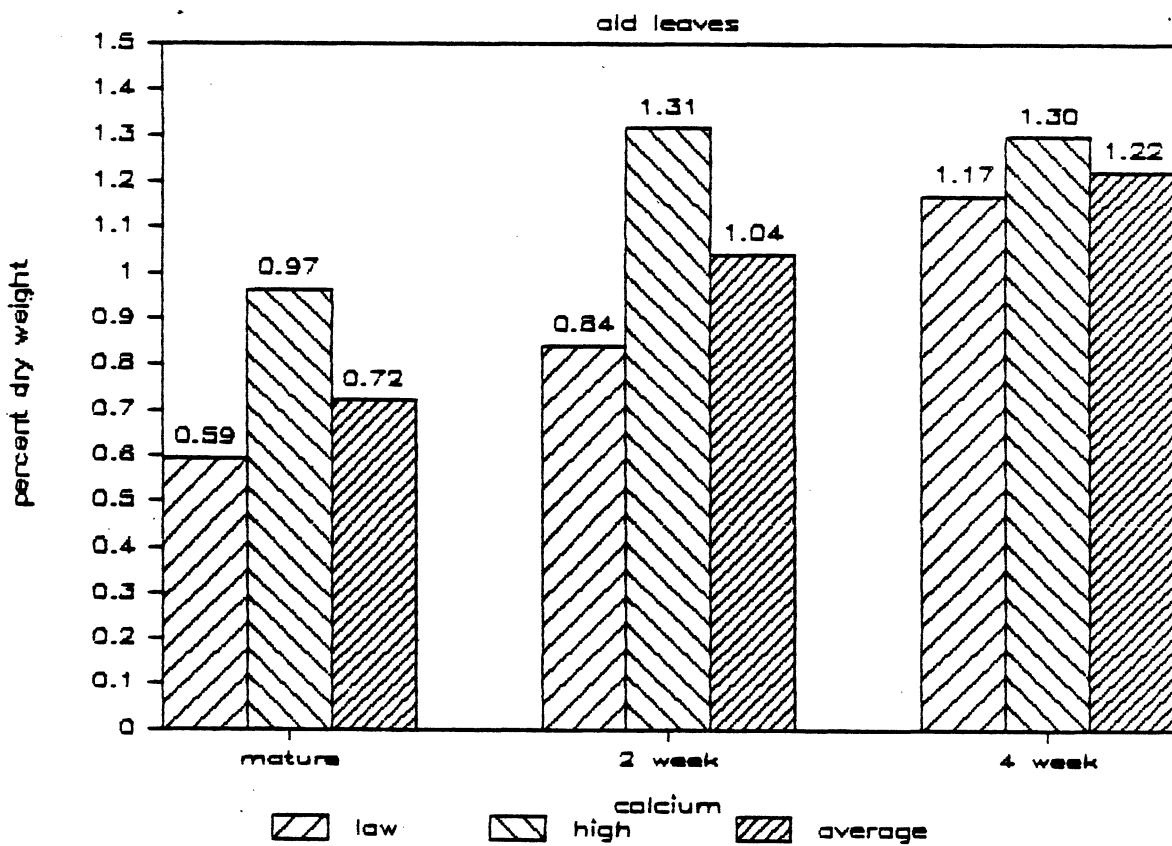
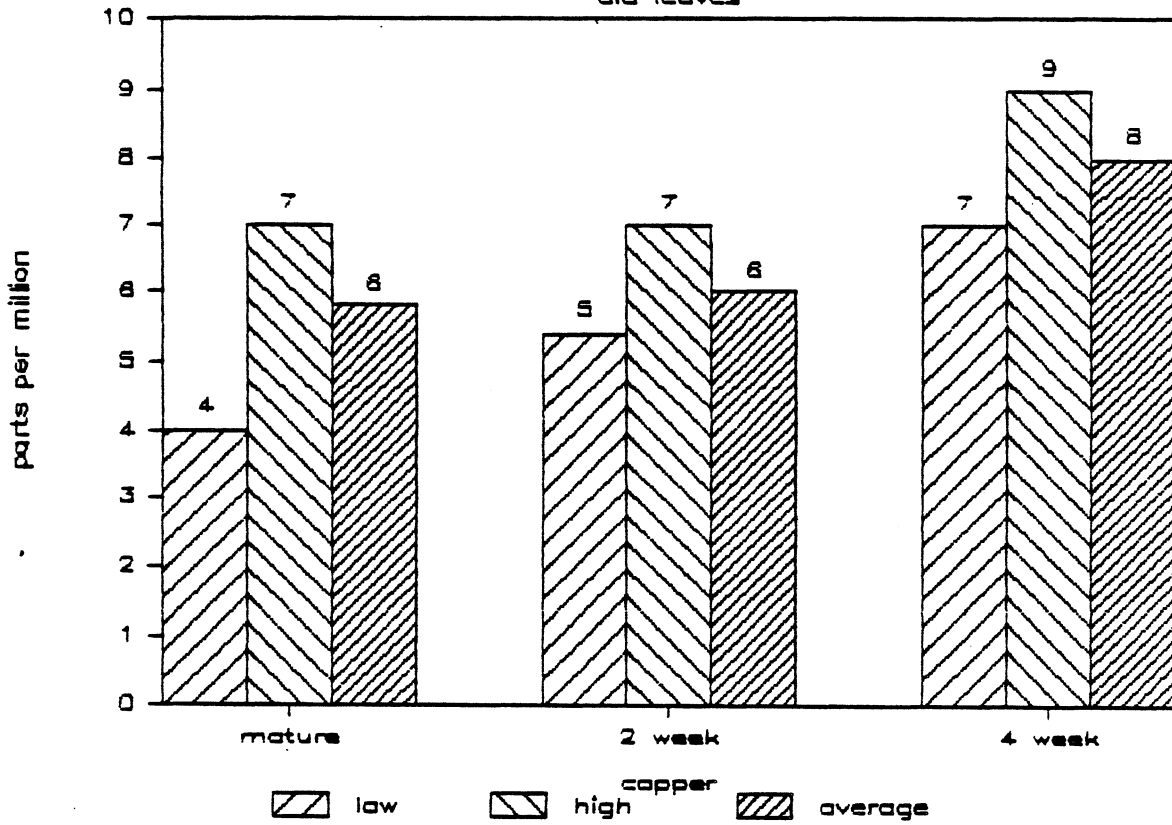
KALE

young leaves

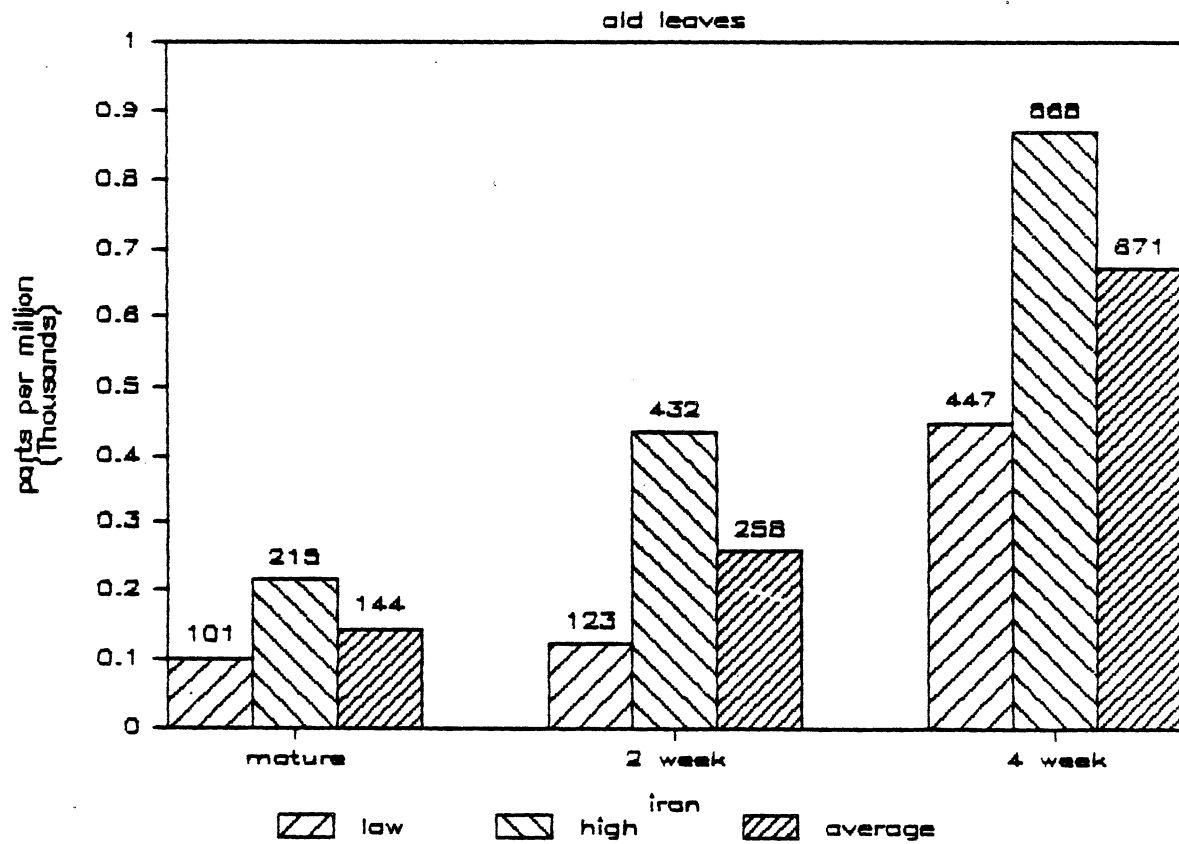
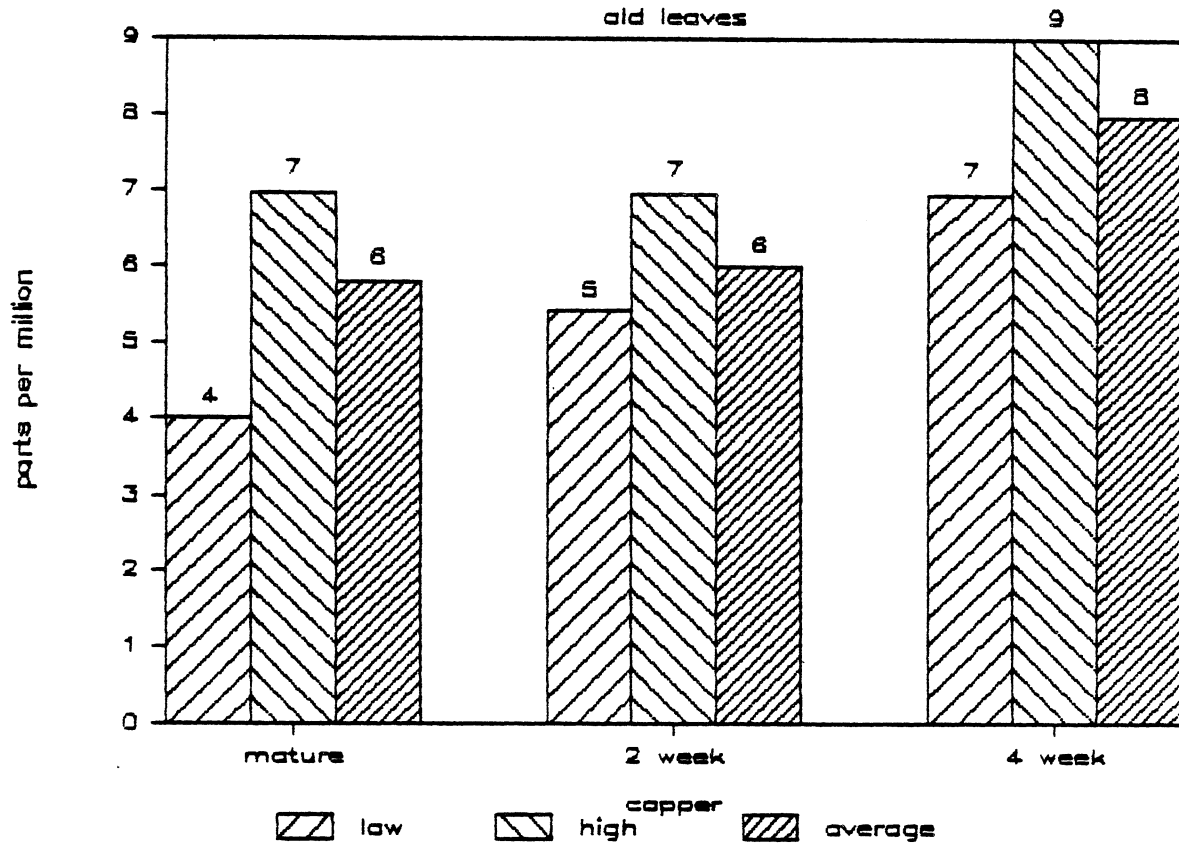


MUSTARDS

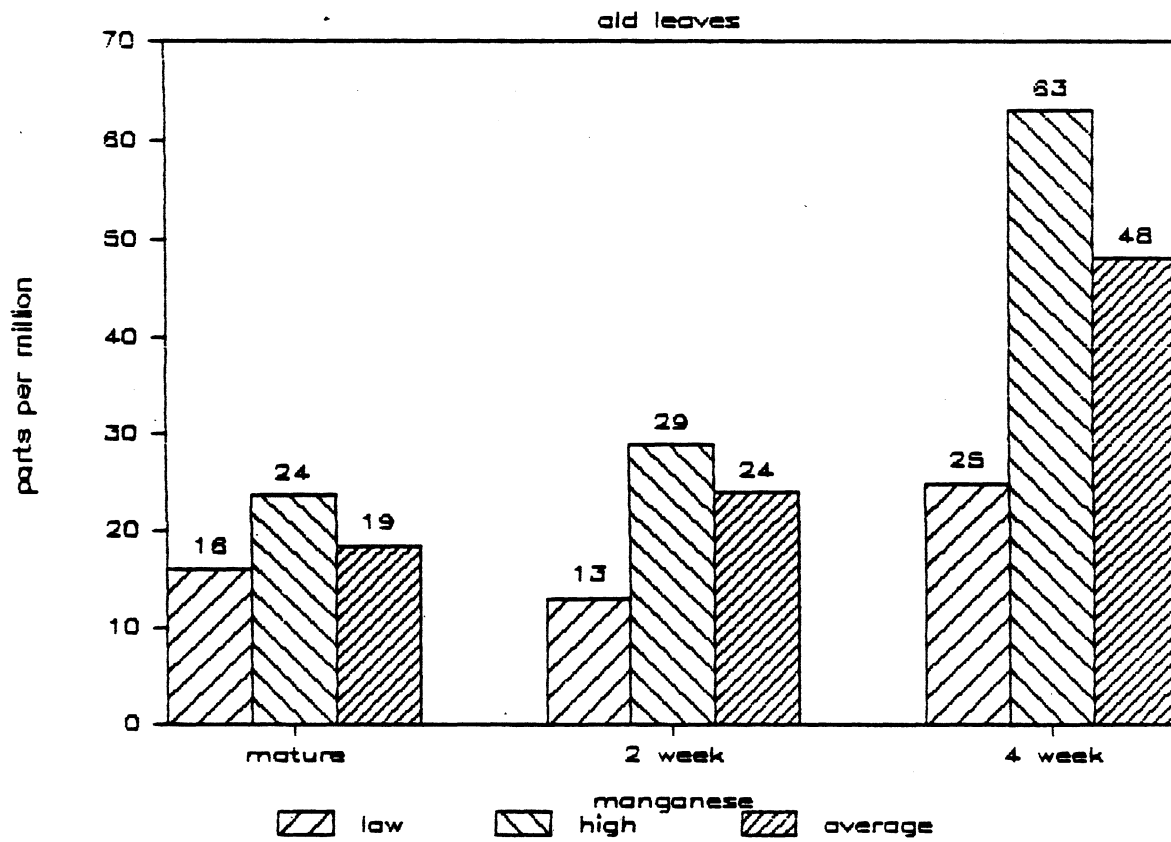
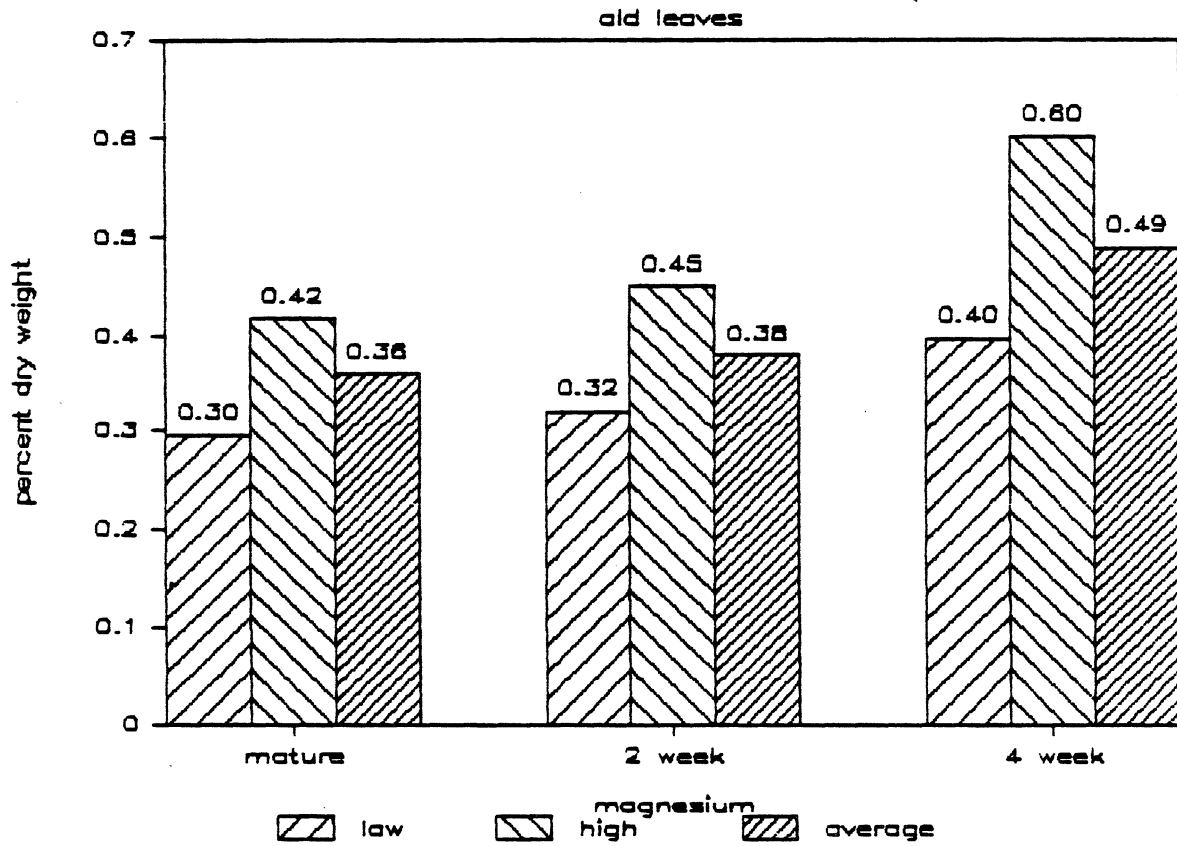
old leaves



MUSTARDS

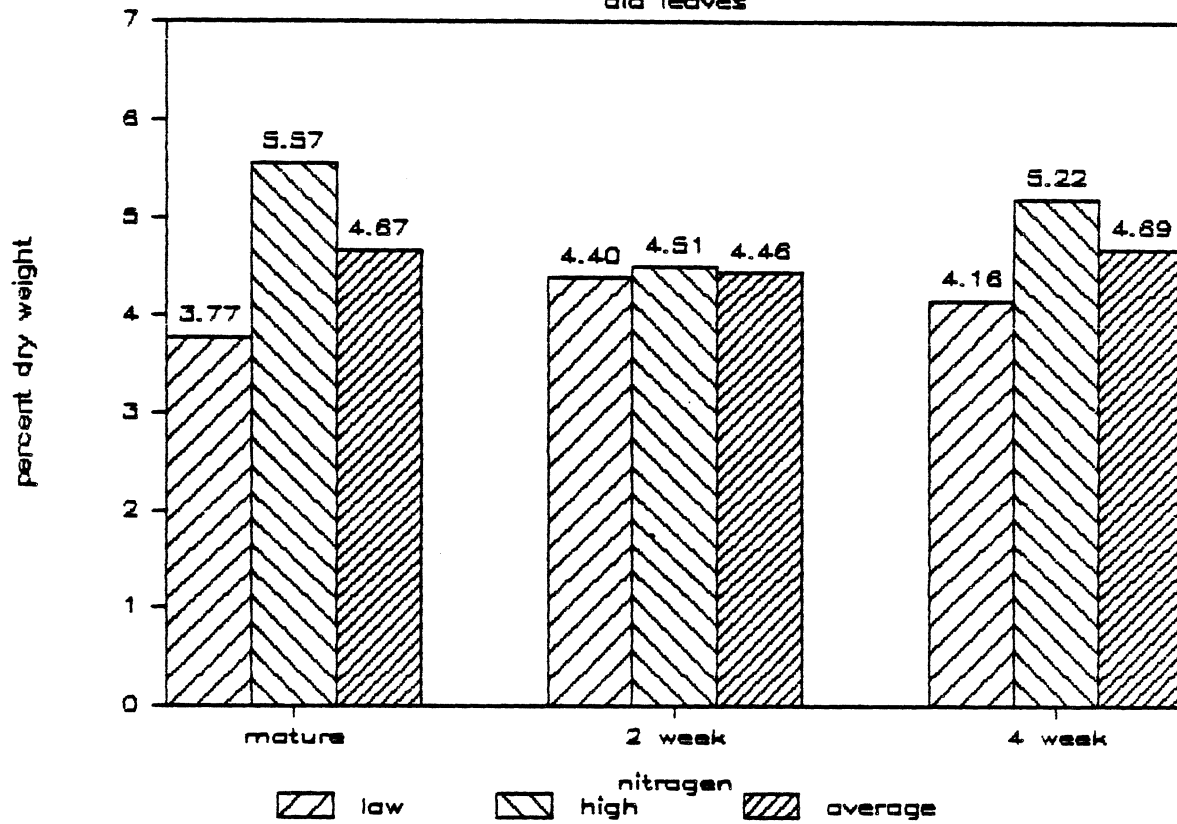


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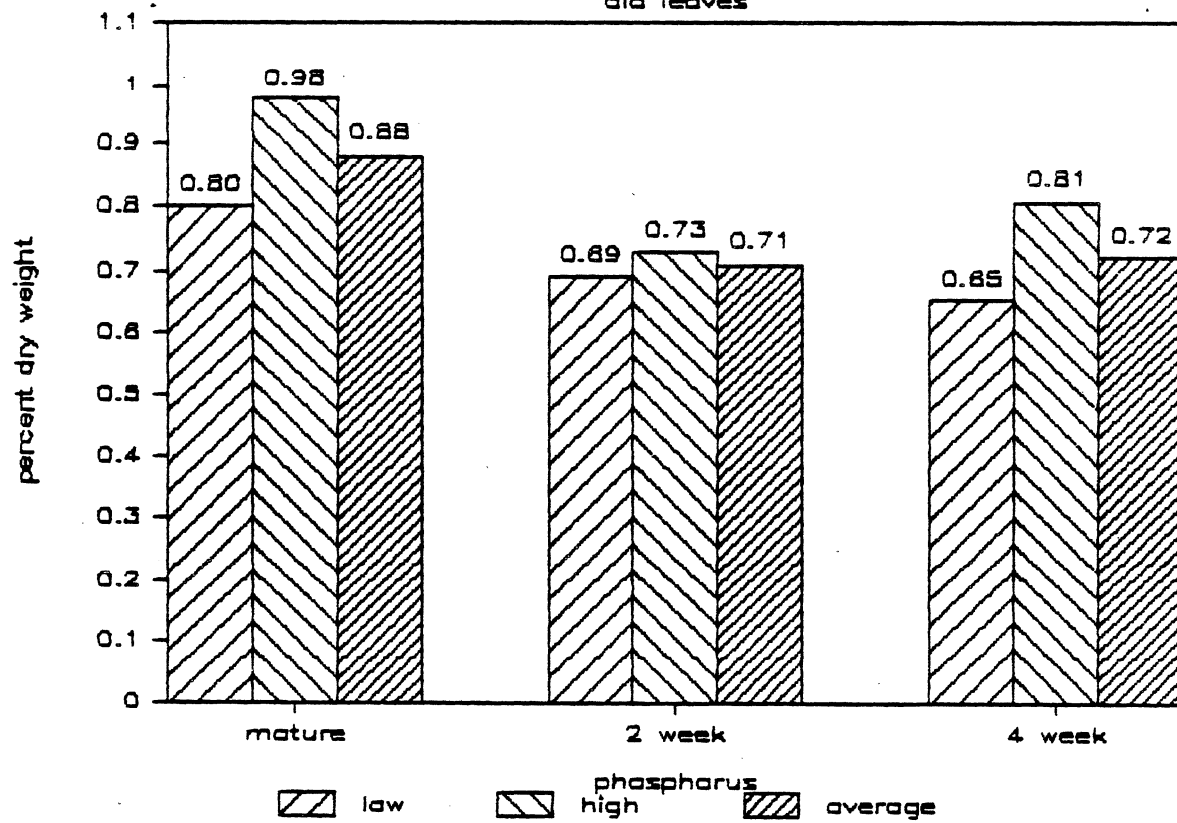


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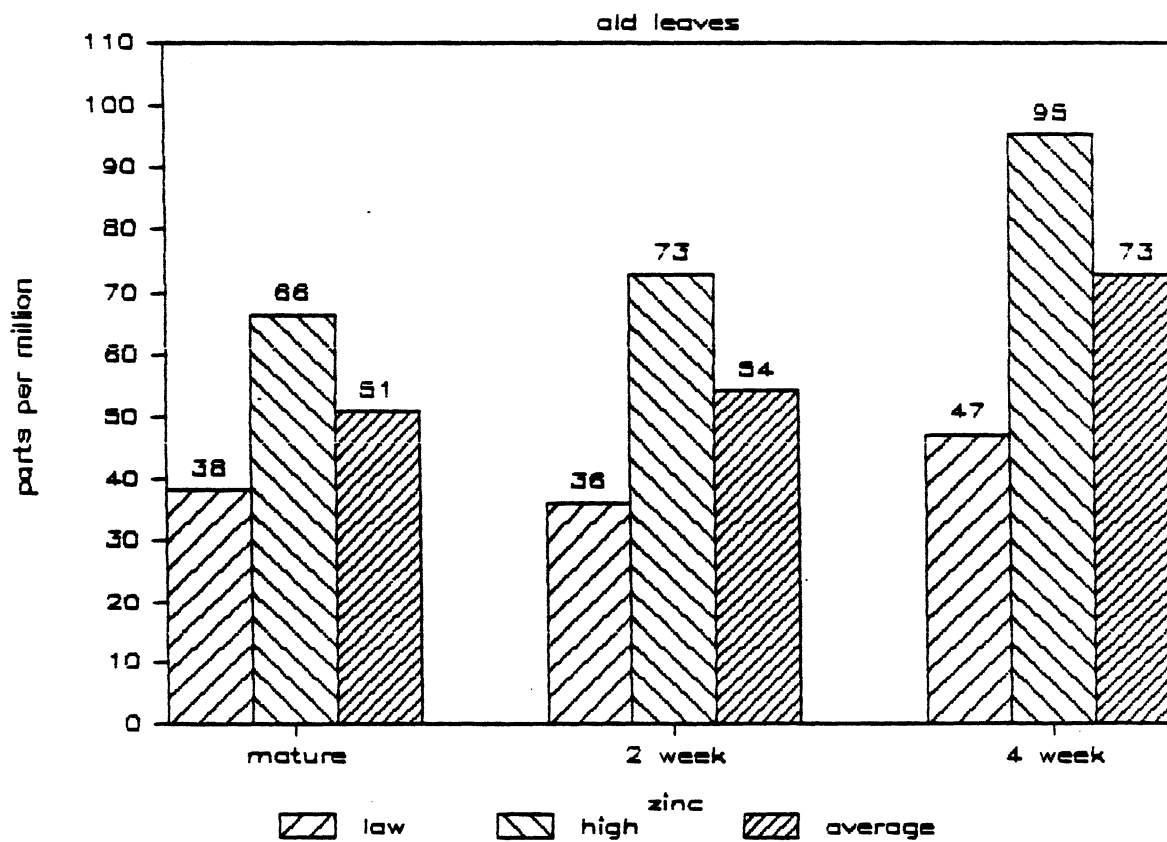
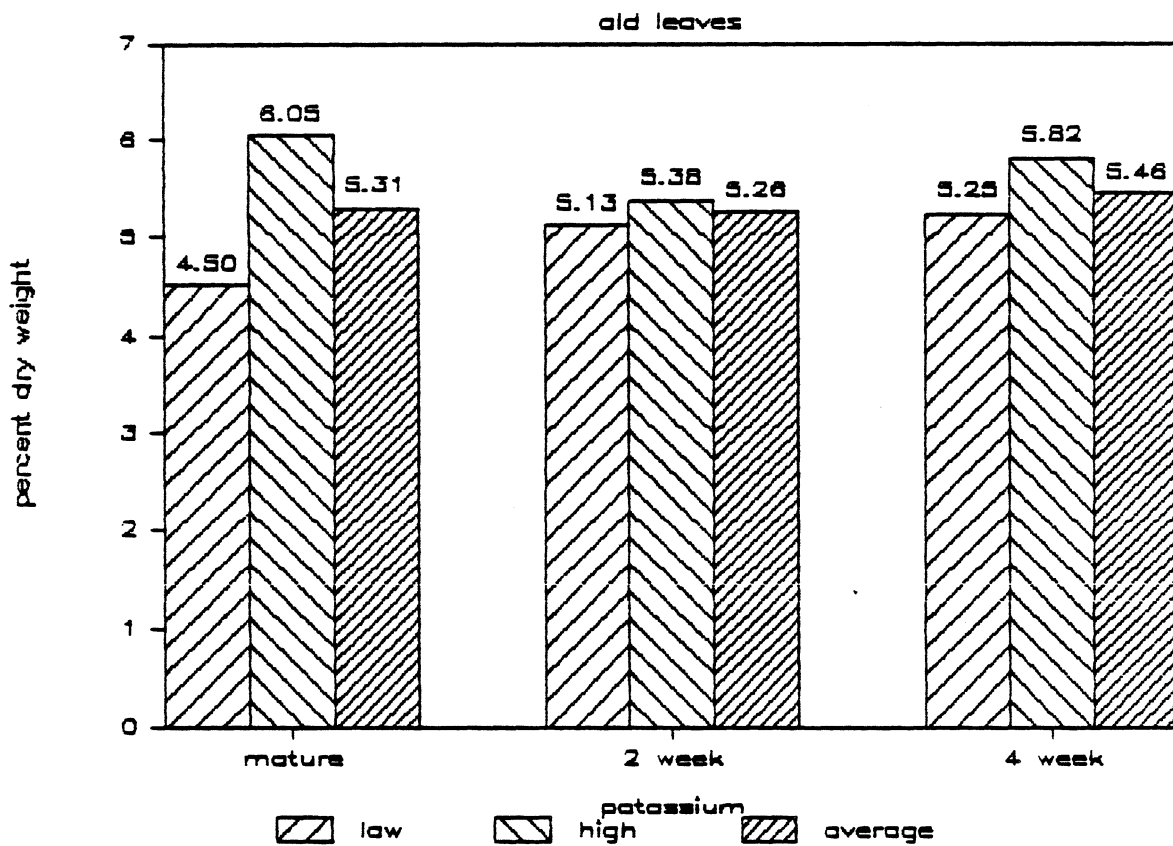
old leaves



old leaves

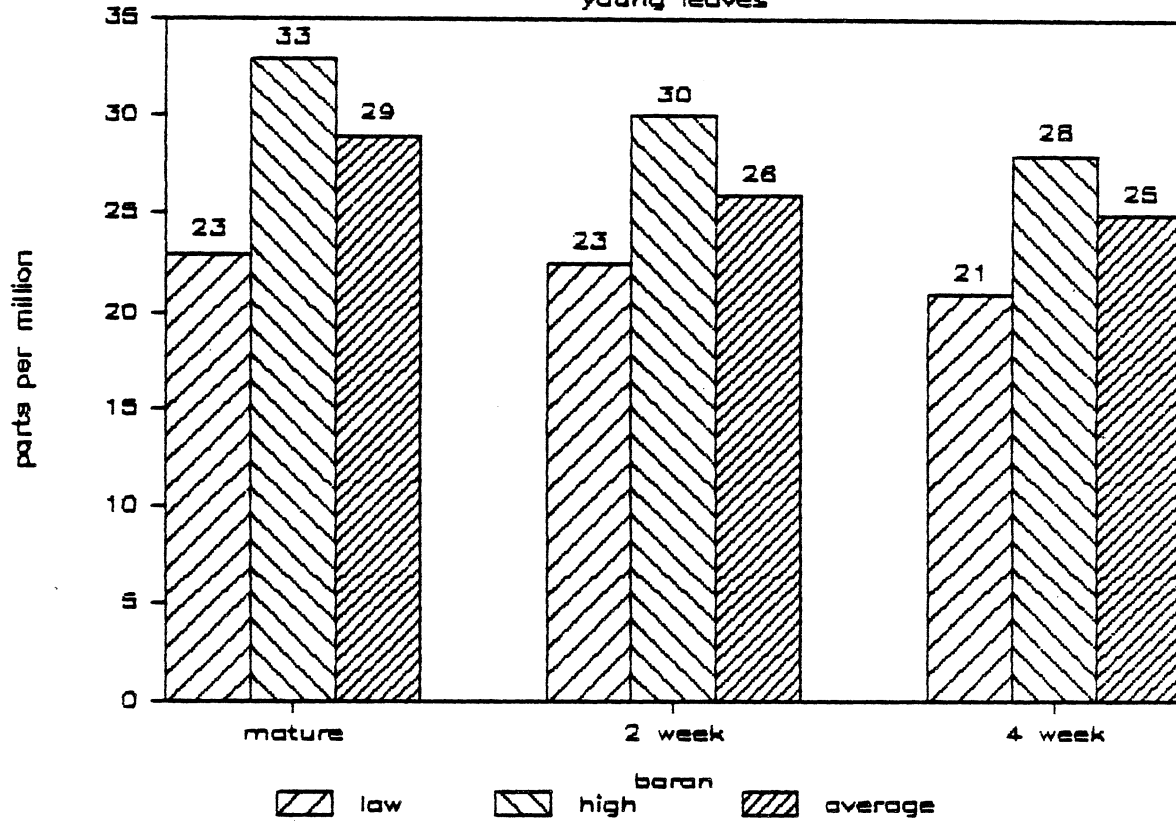


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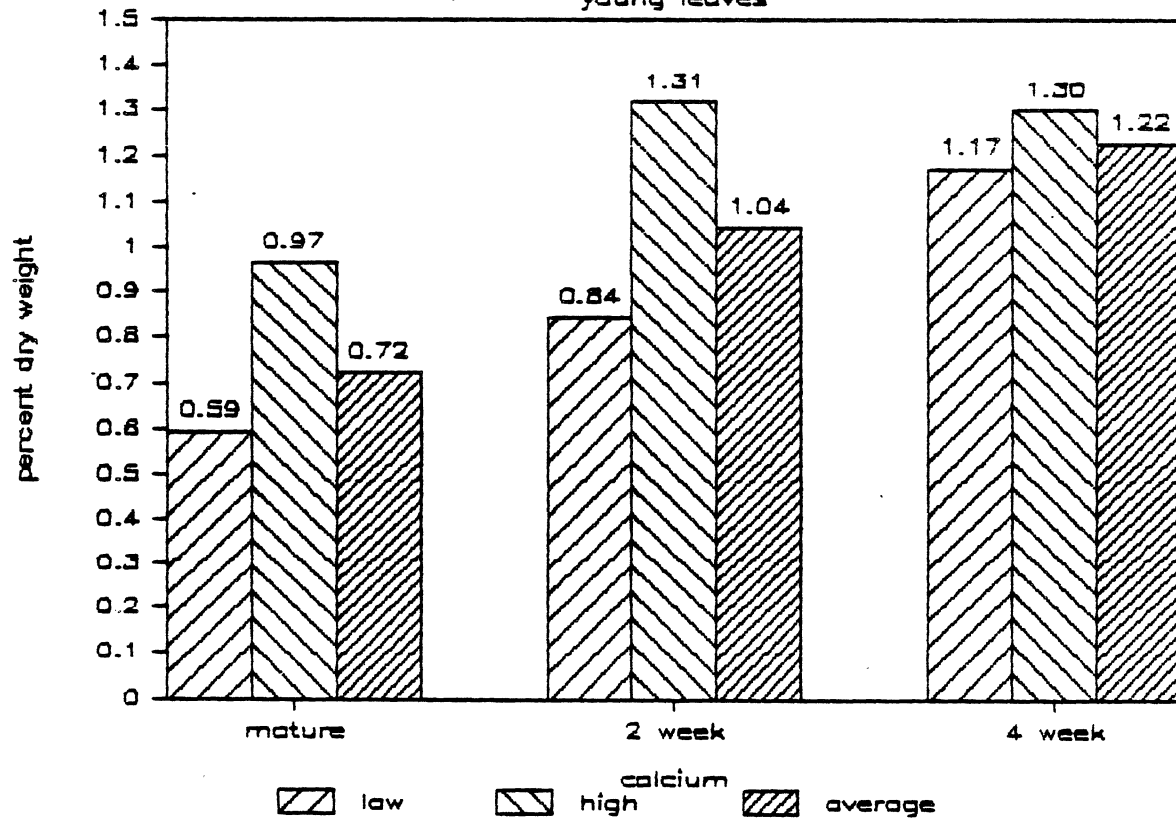


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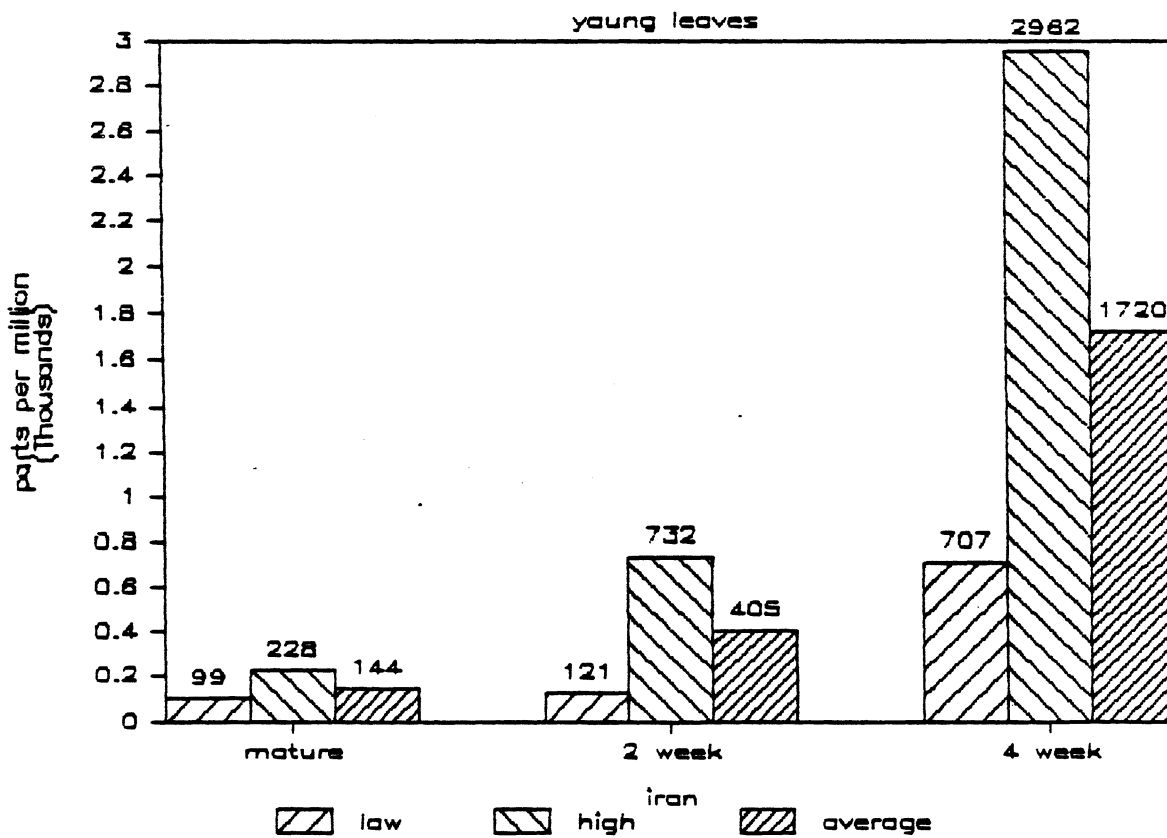
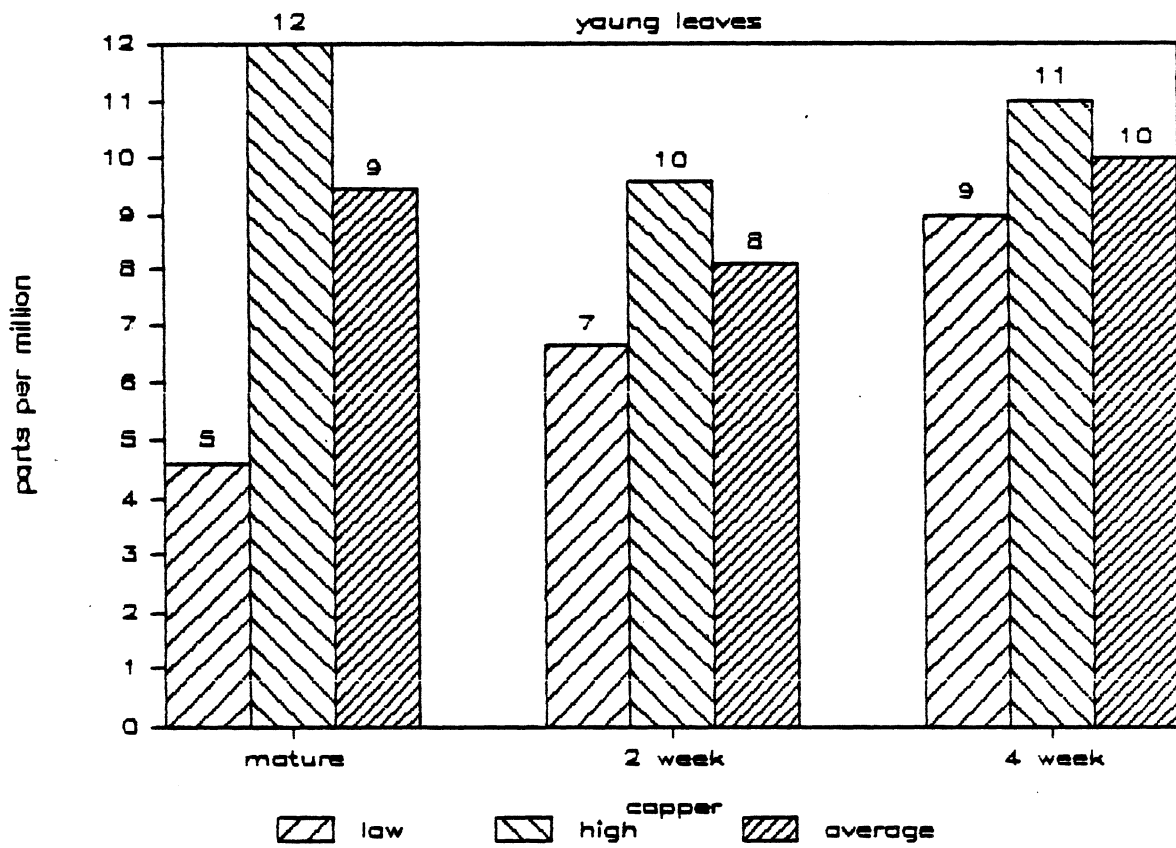
young leaves



young leaves

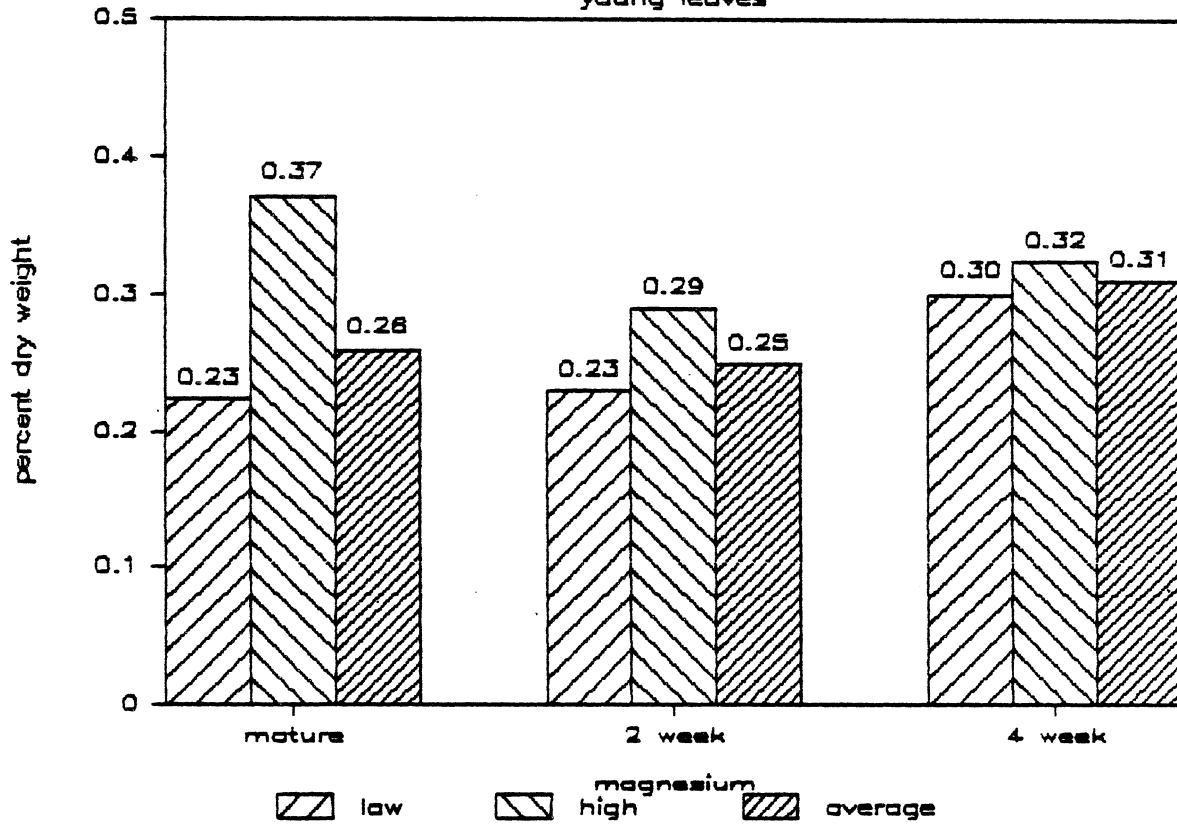


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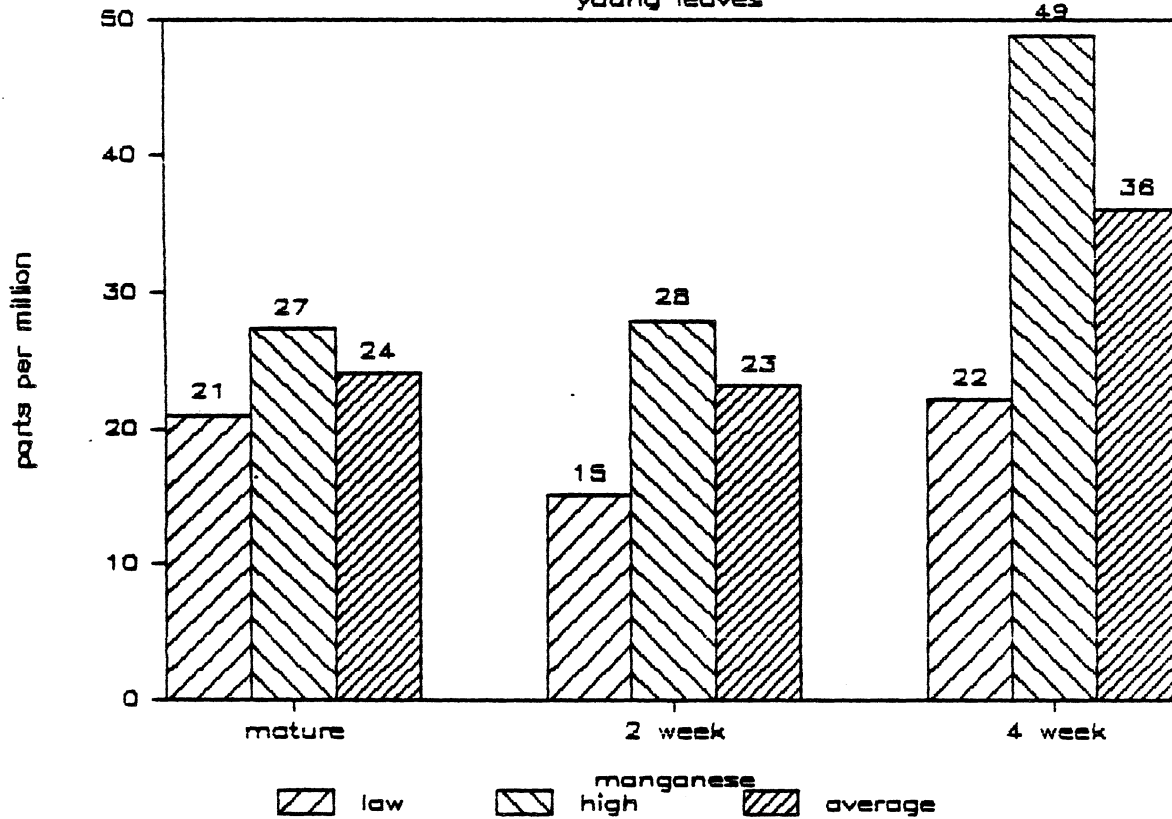


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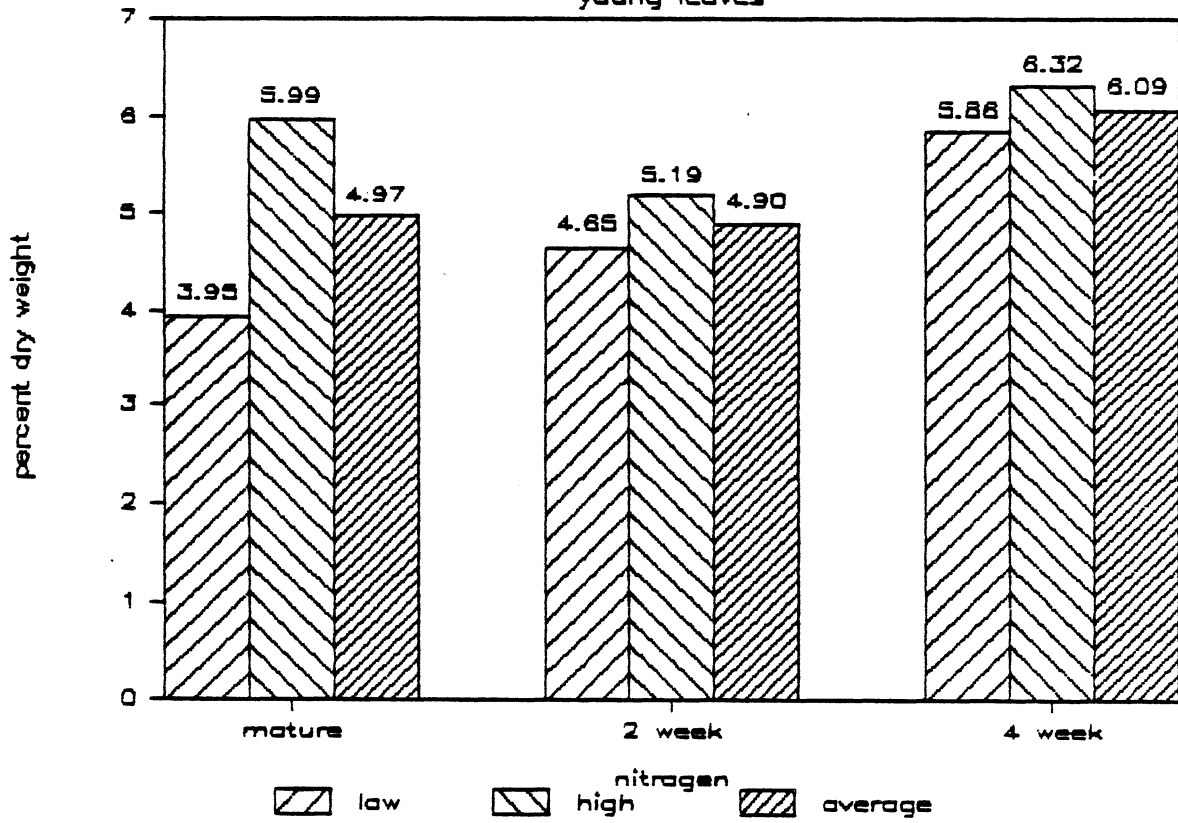


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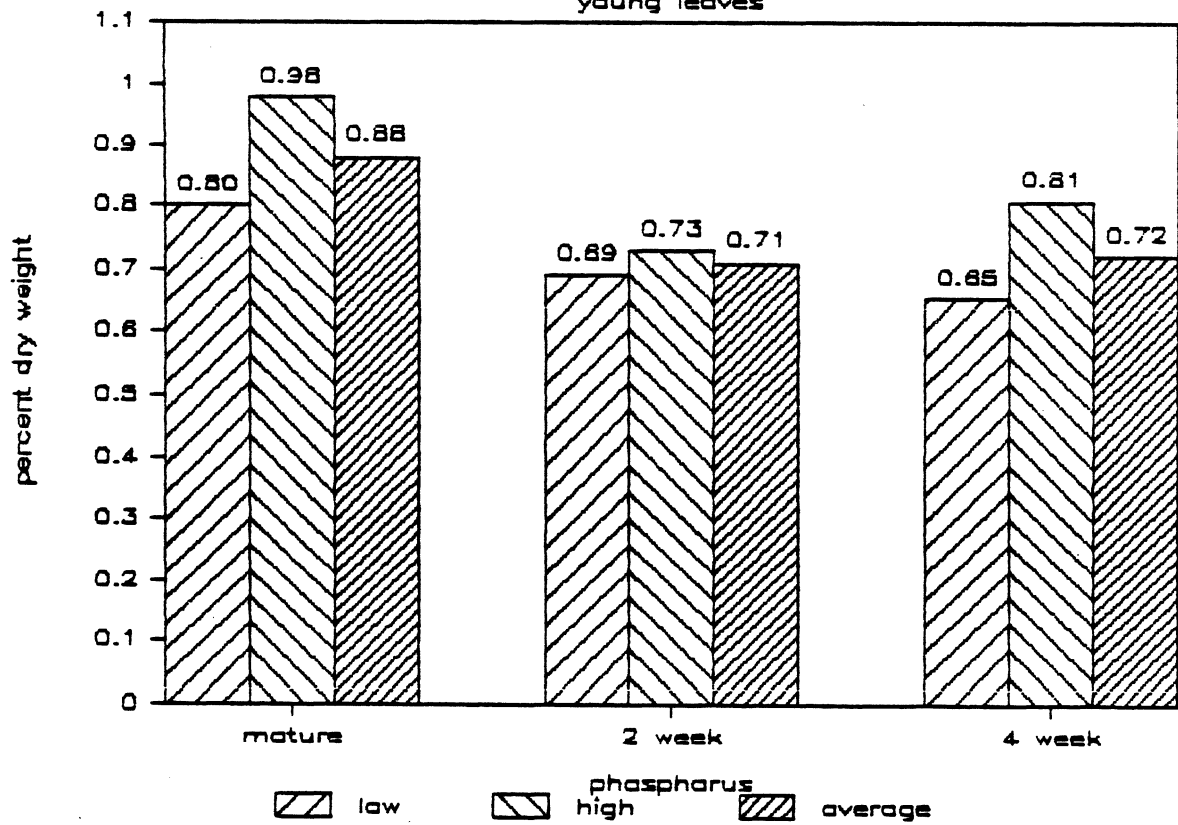


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young leaves

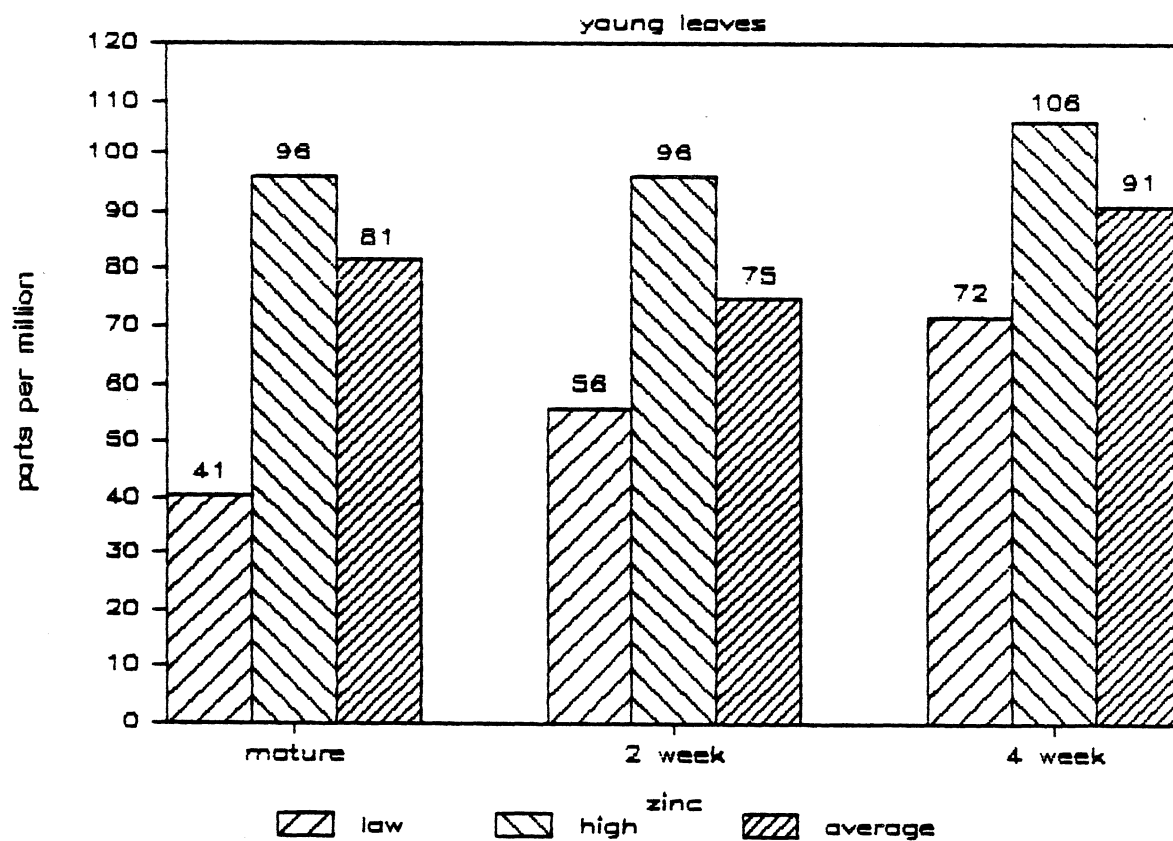
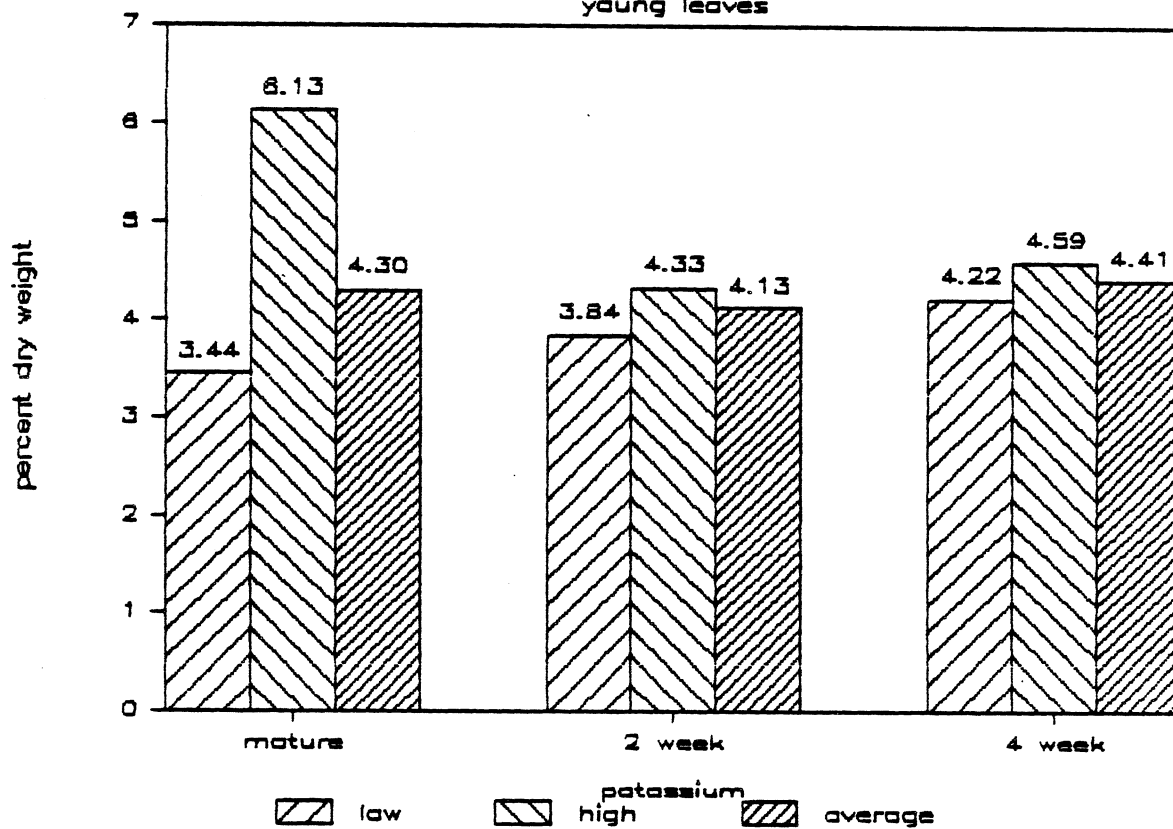


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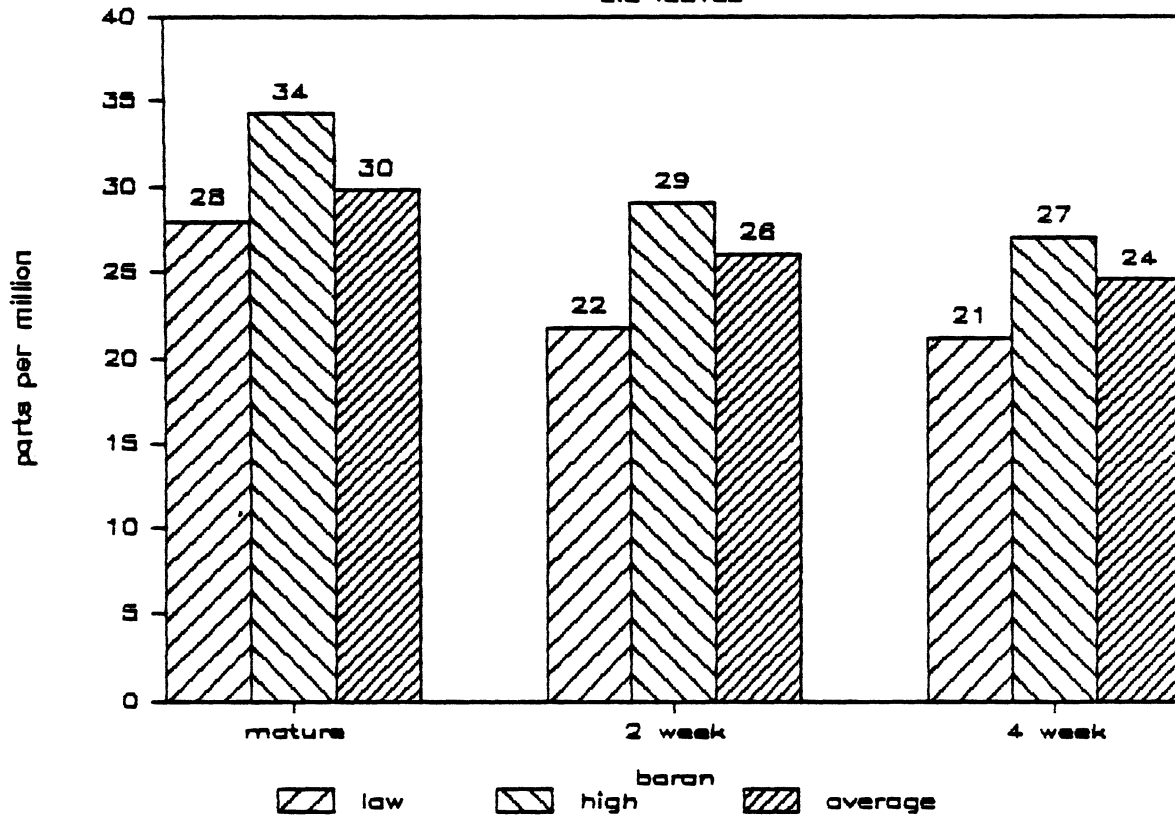
MUSTARDS

young leaves

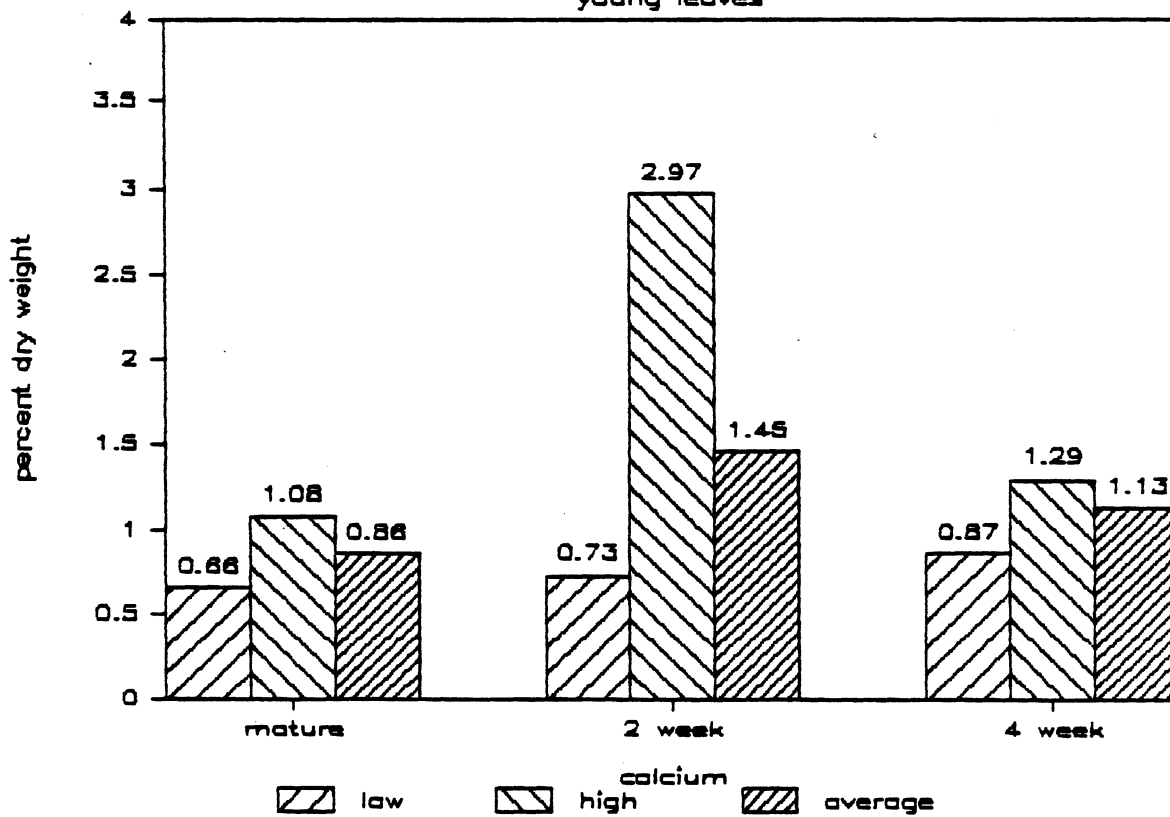


TURNIPS

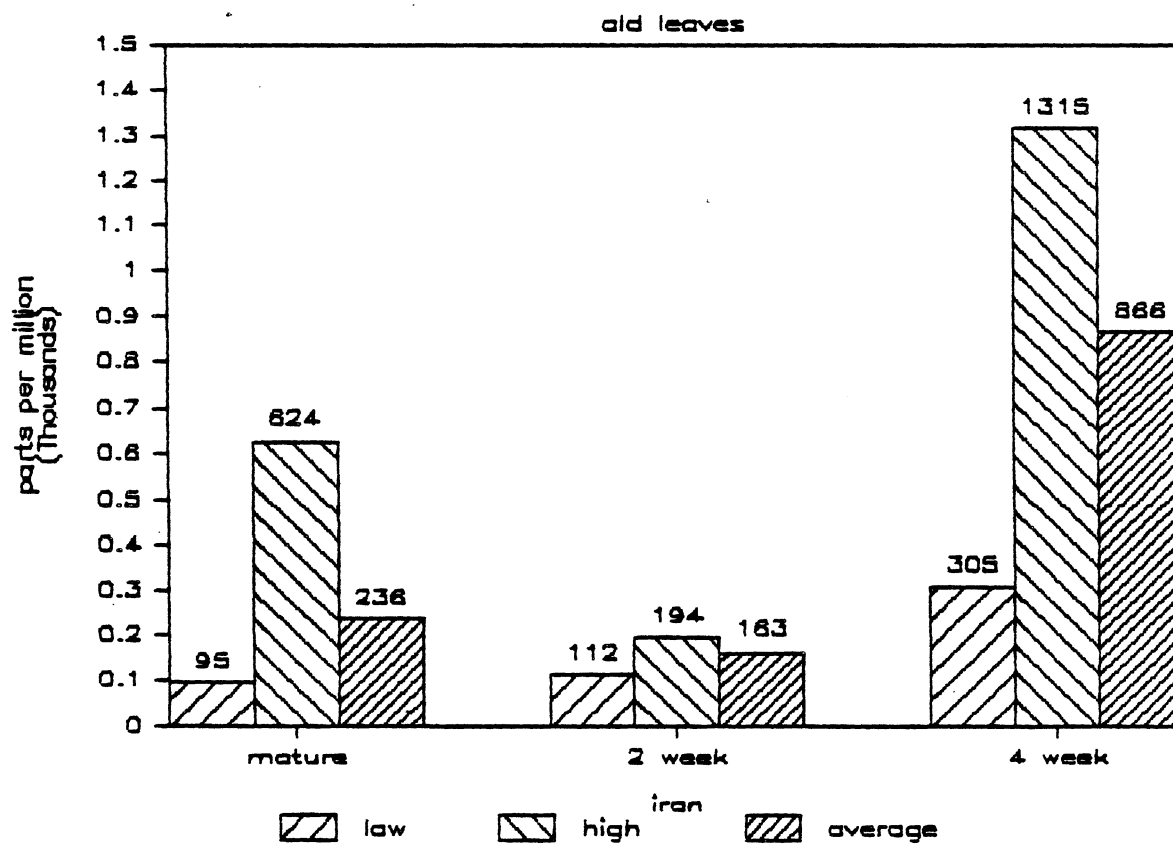
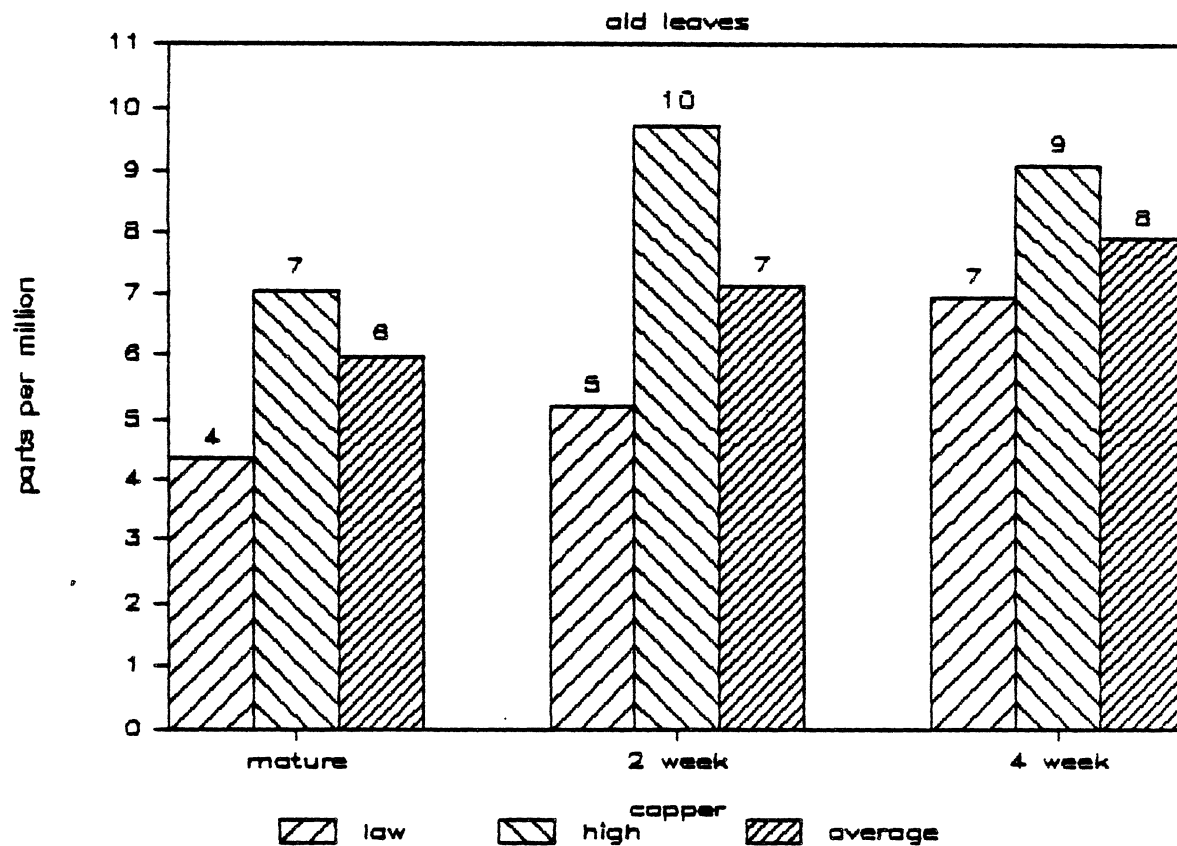
ald leaves



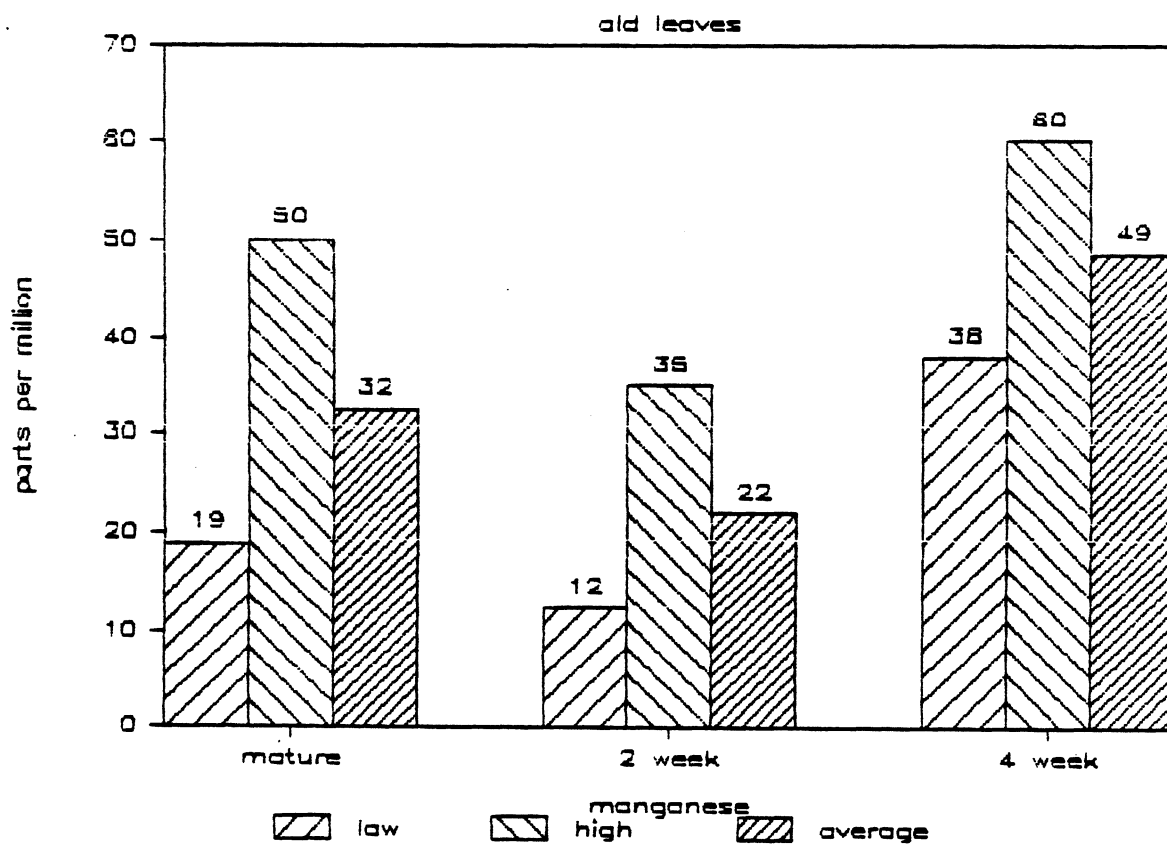
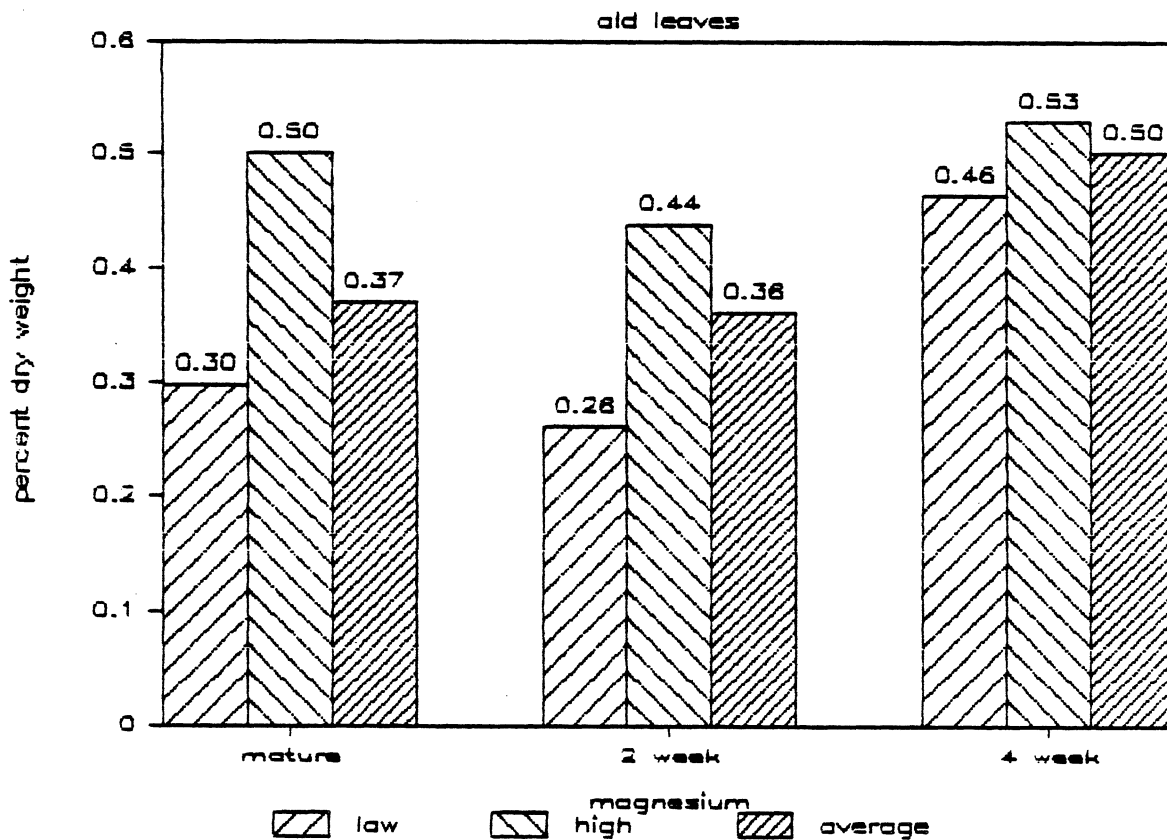
young leaves



TURNIPS

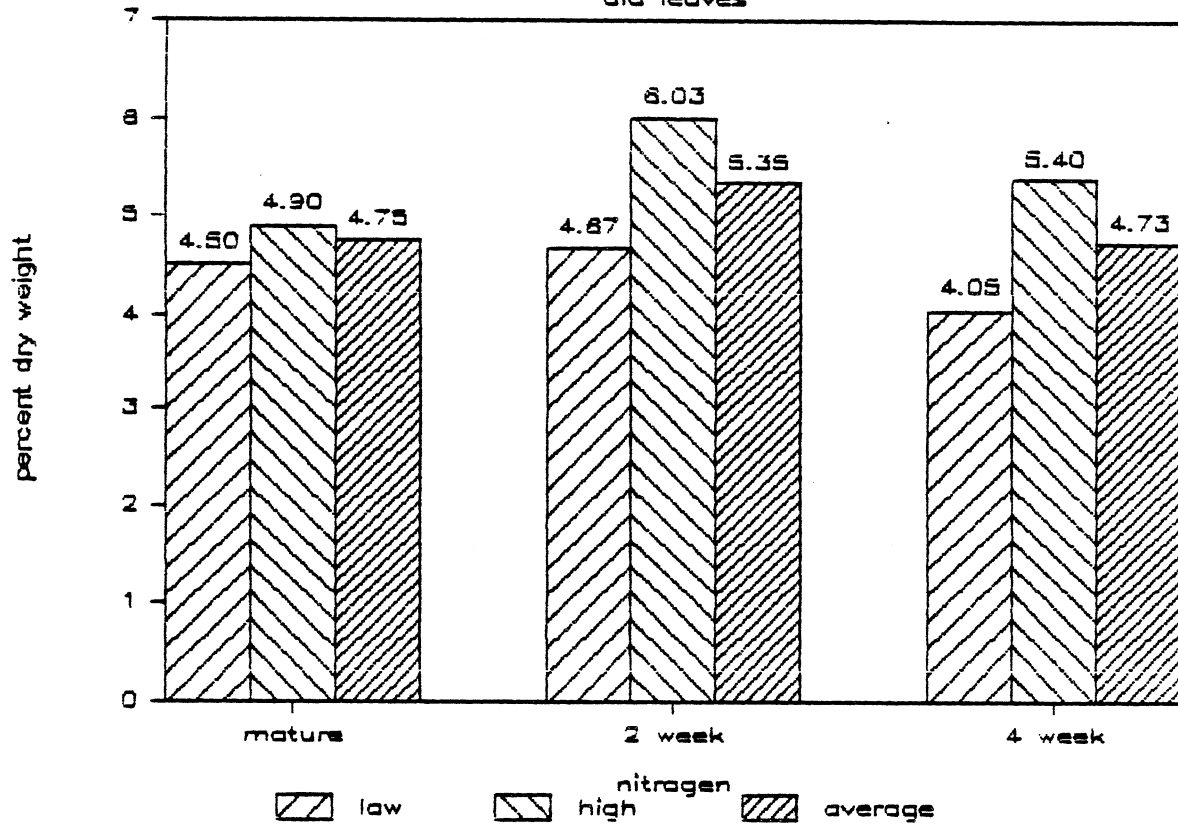


TURNIPS

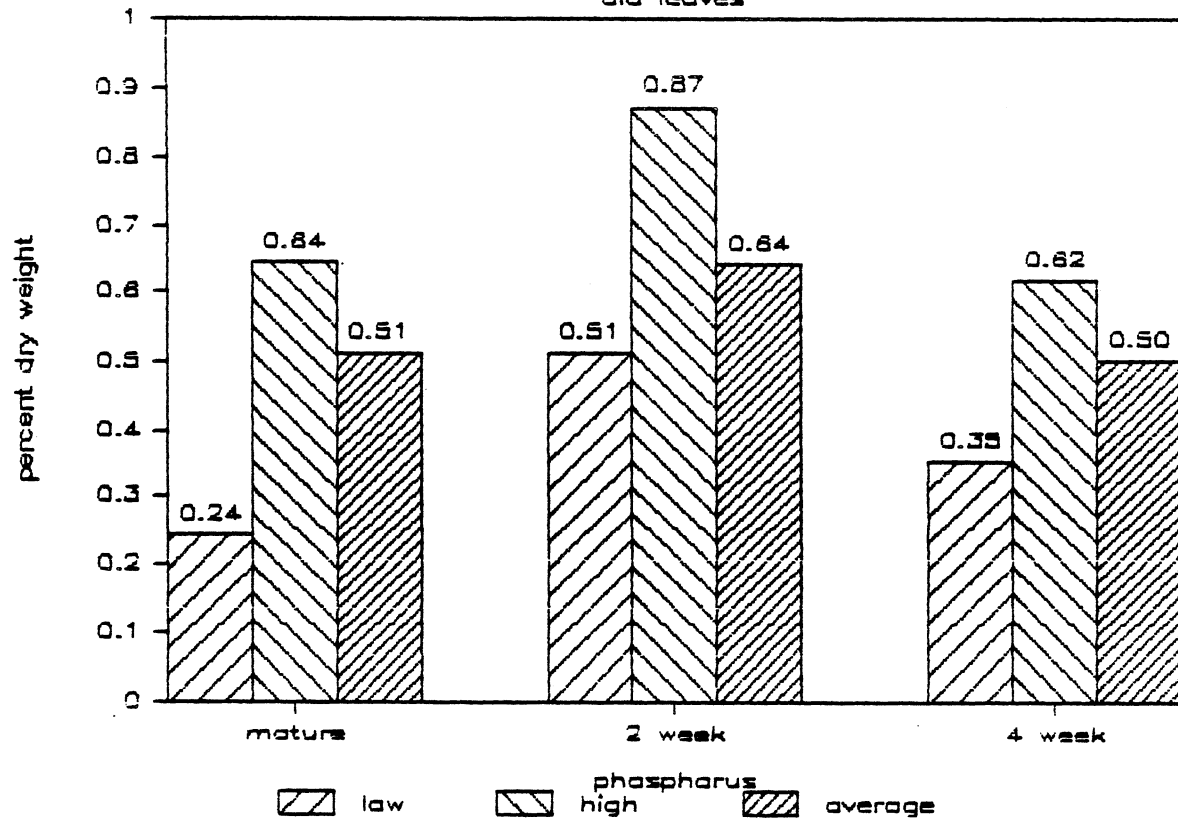


TURNIPS

aid leaves

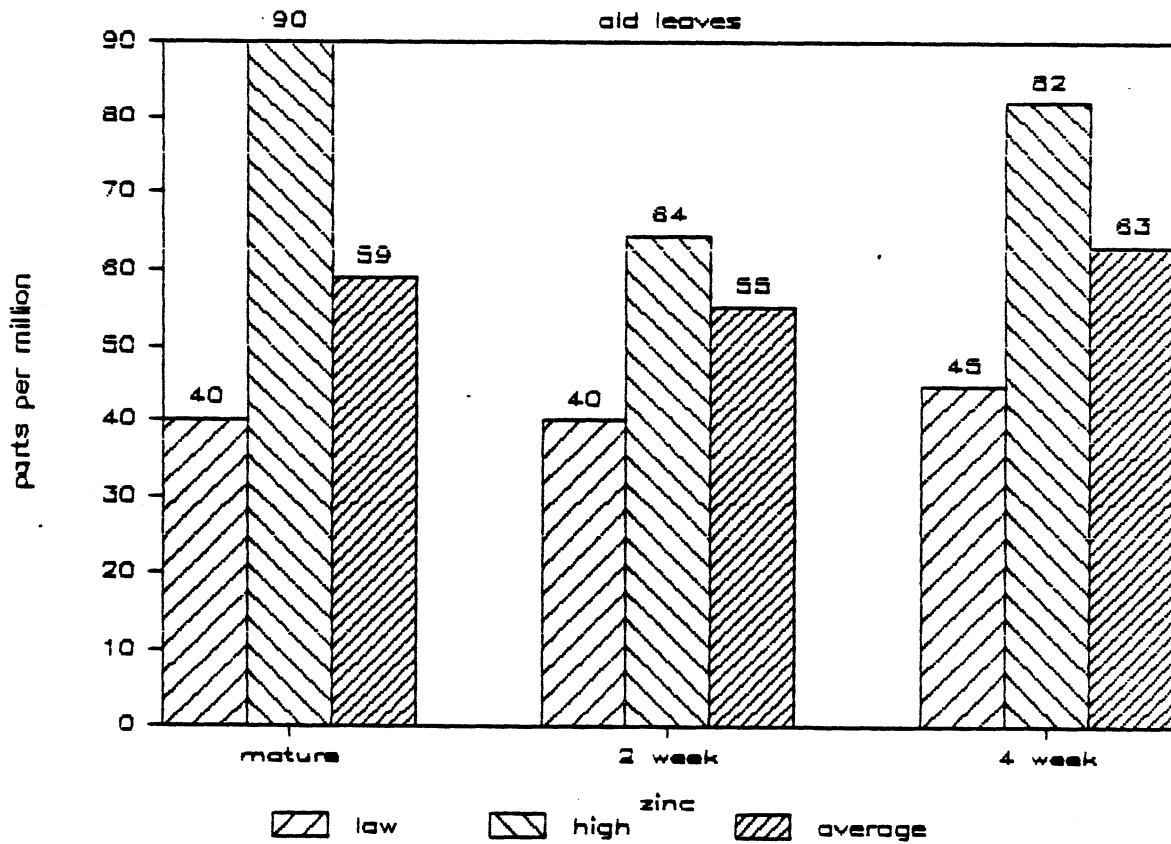
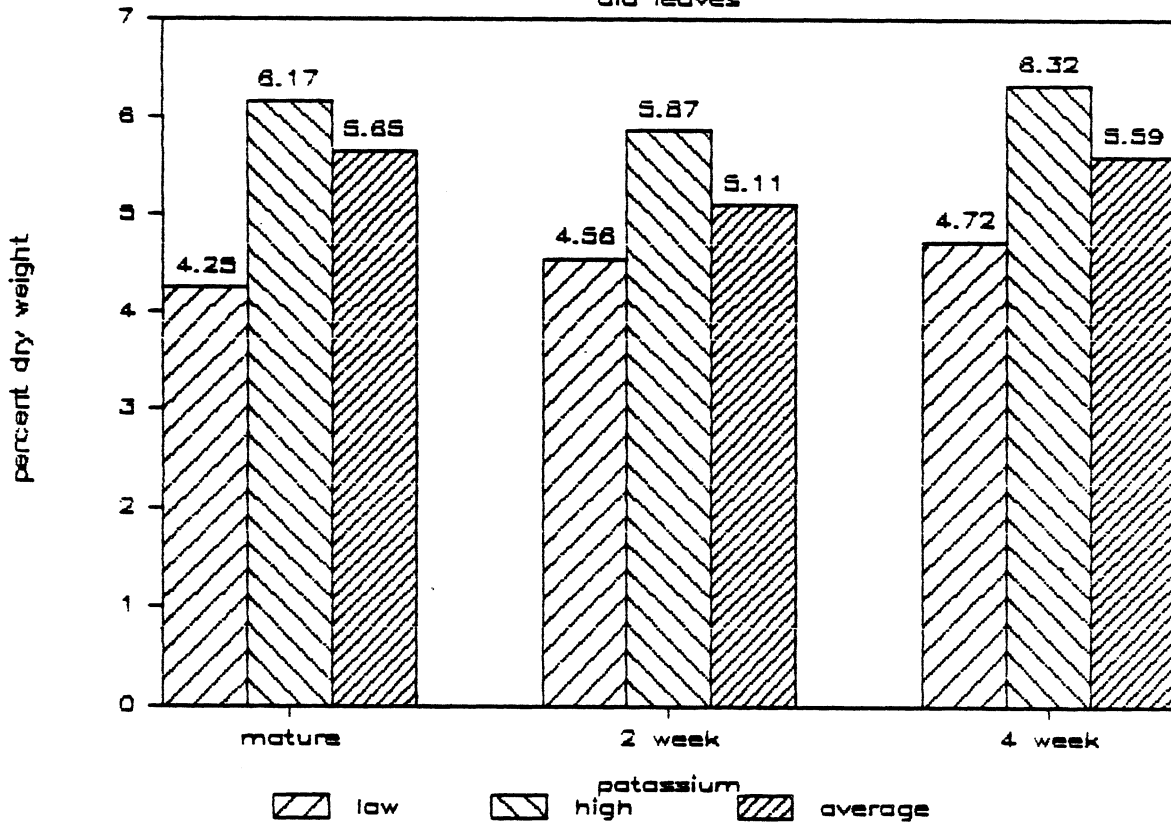


aid leaves



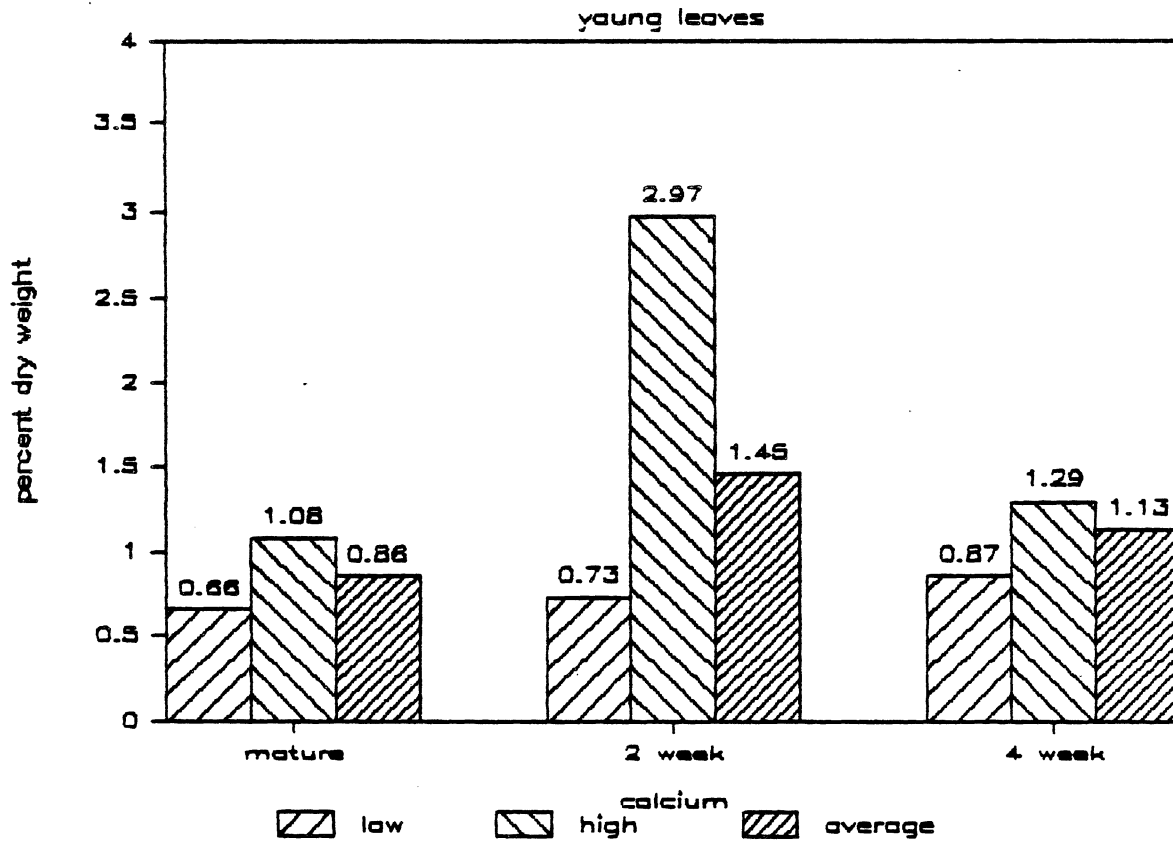
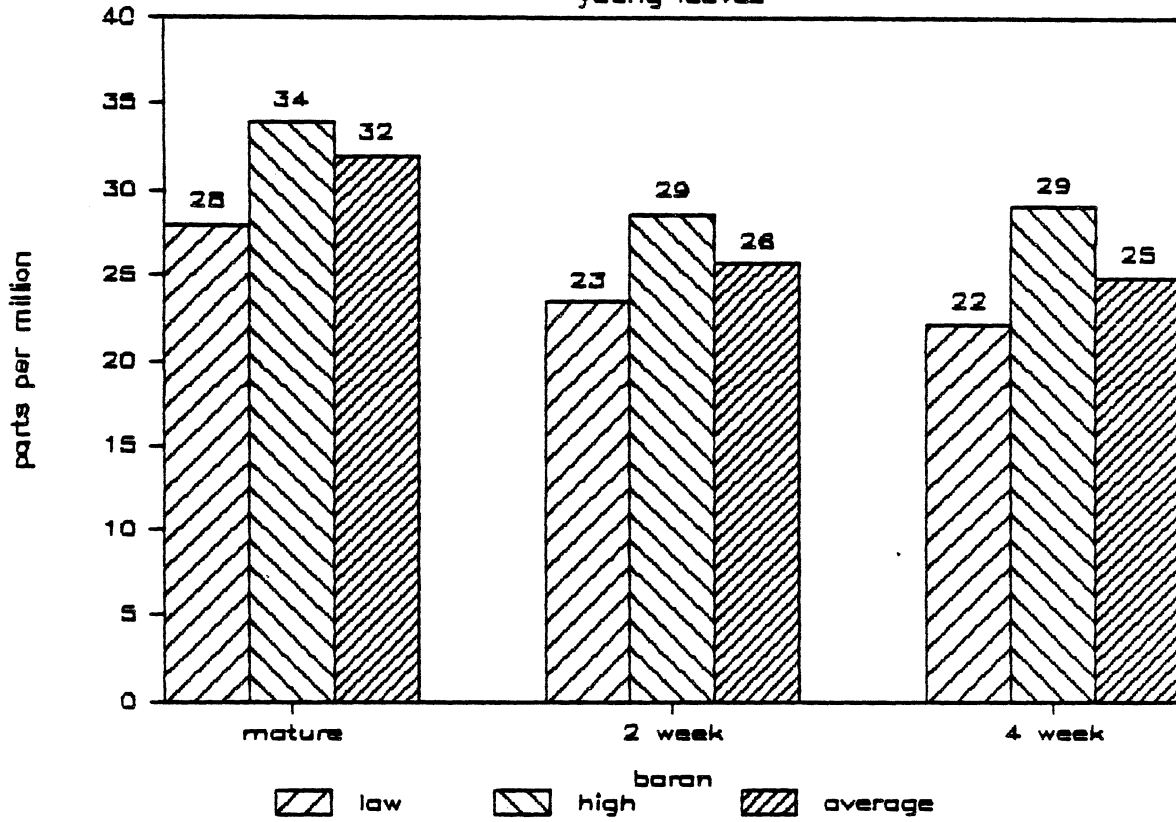
TURNIPS

old leaves



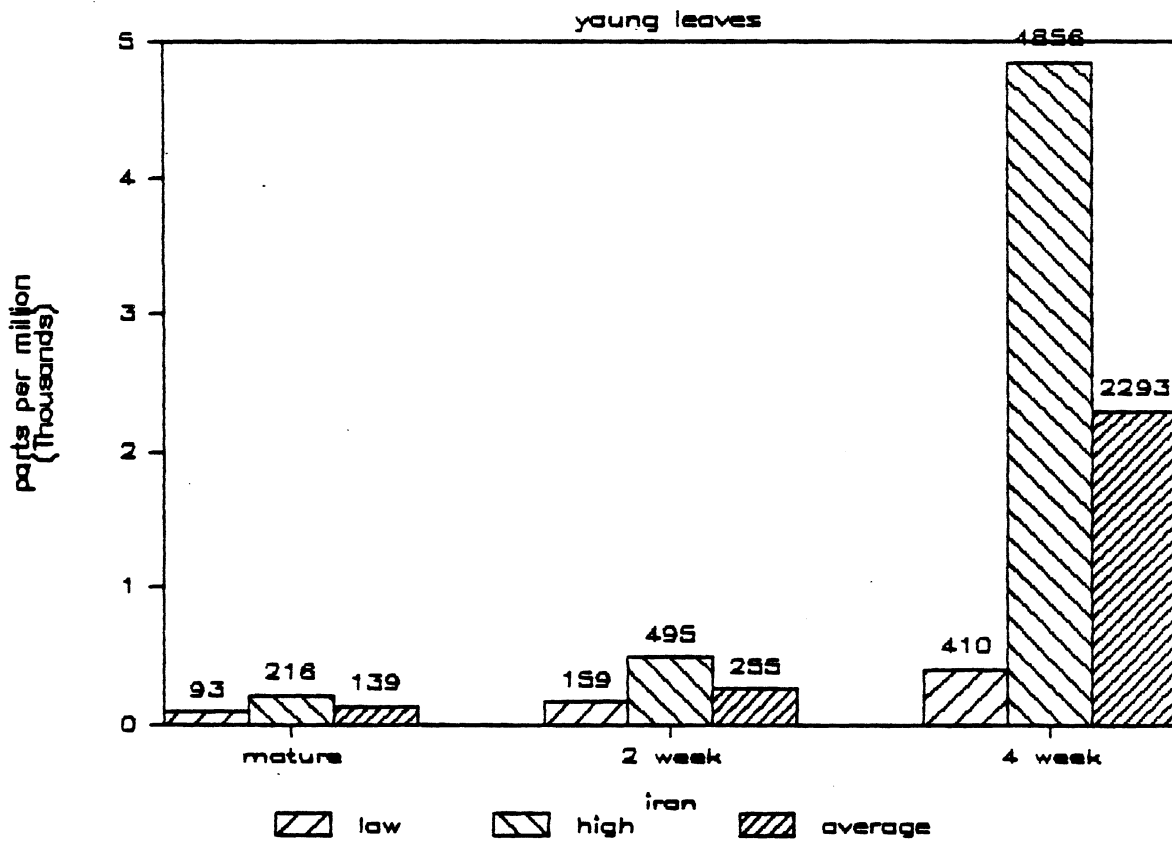
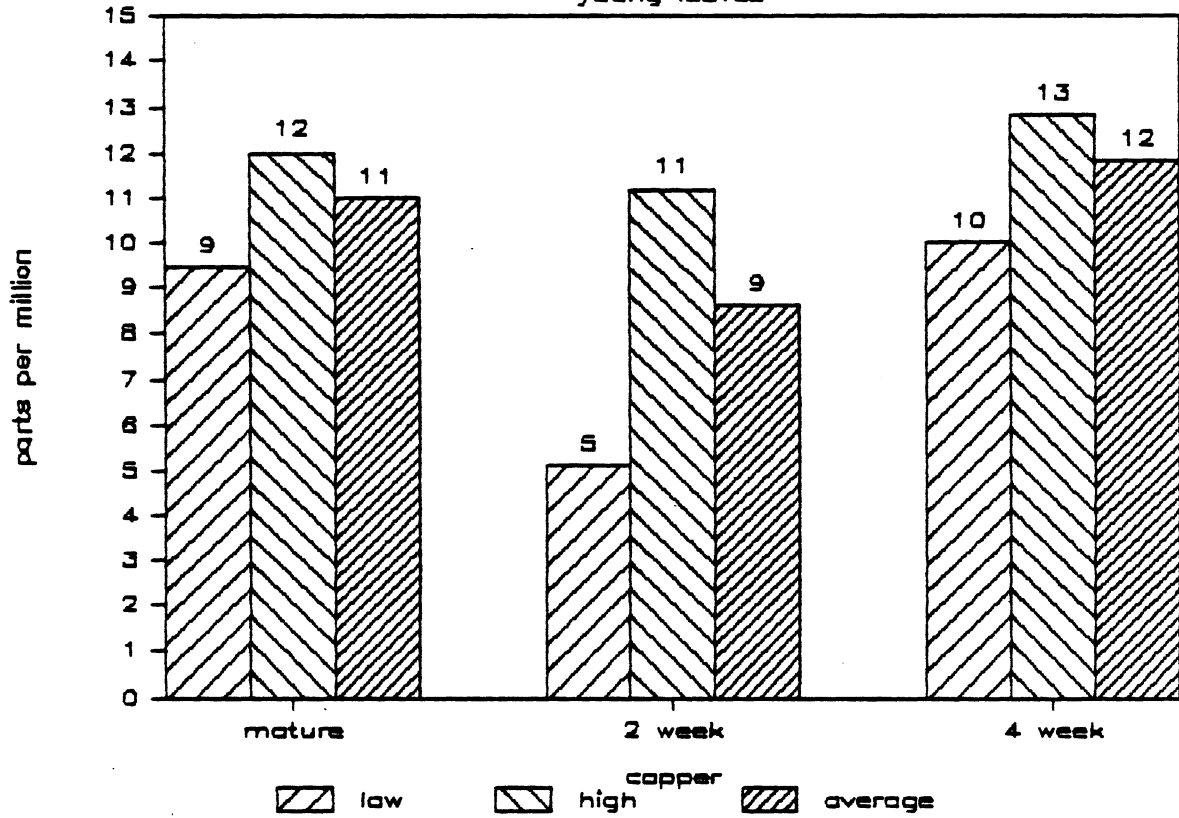
TURNIPS

young leaves



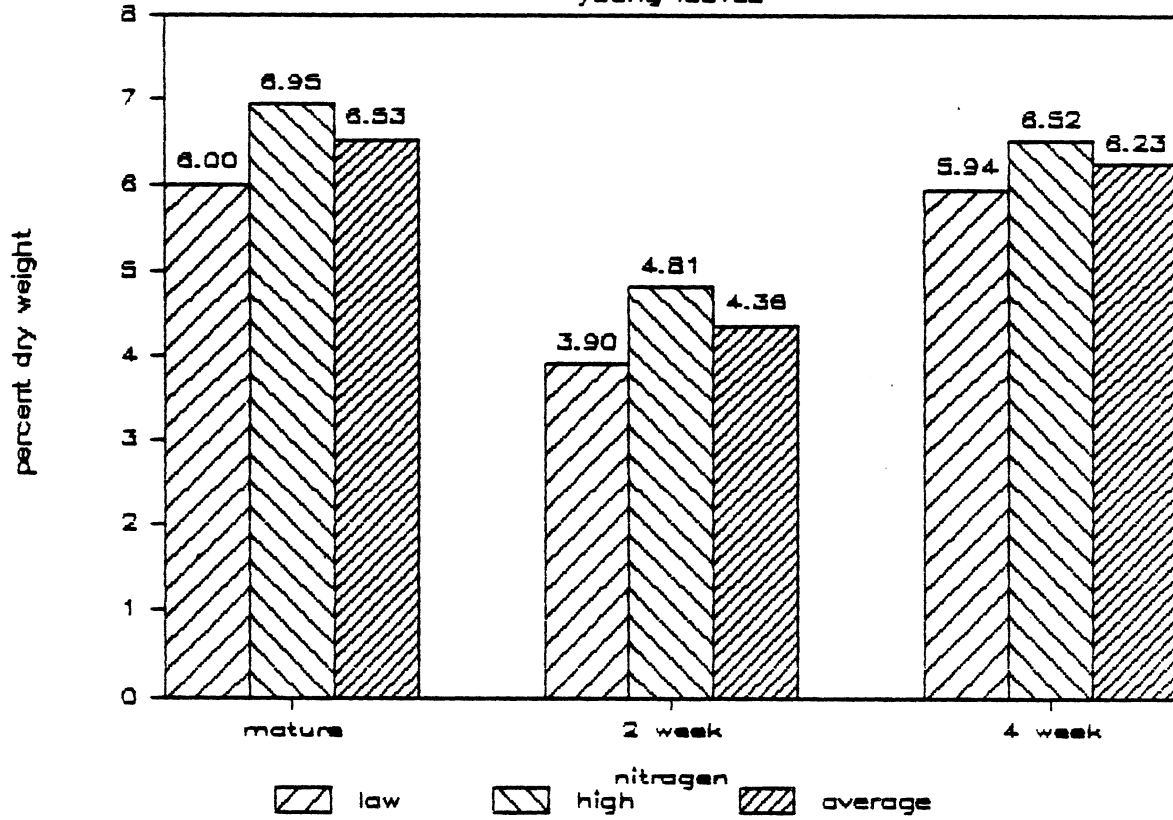
TURNIPS

young leaves

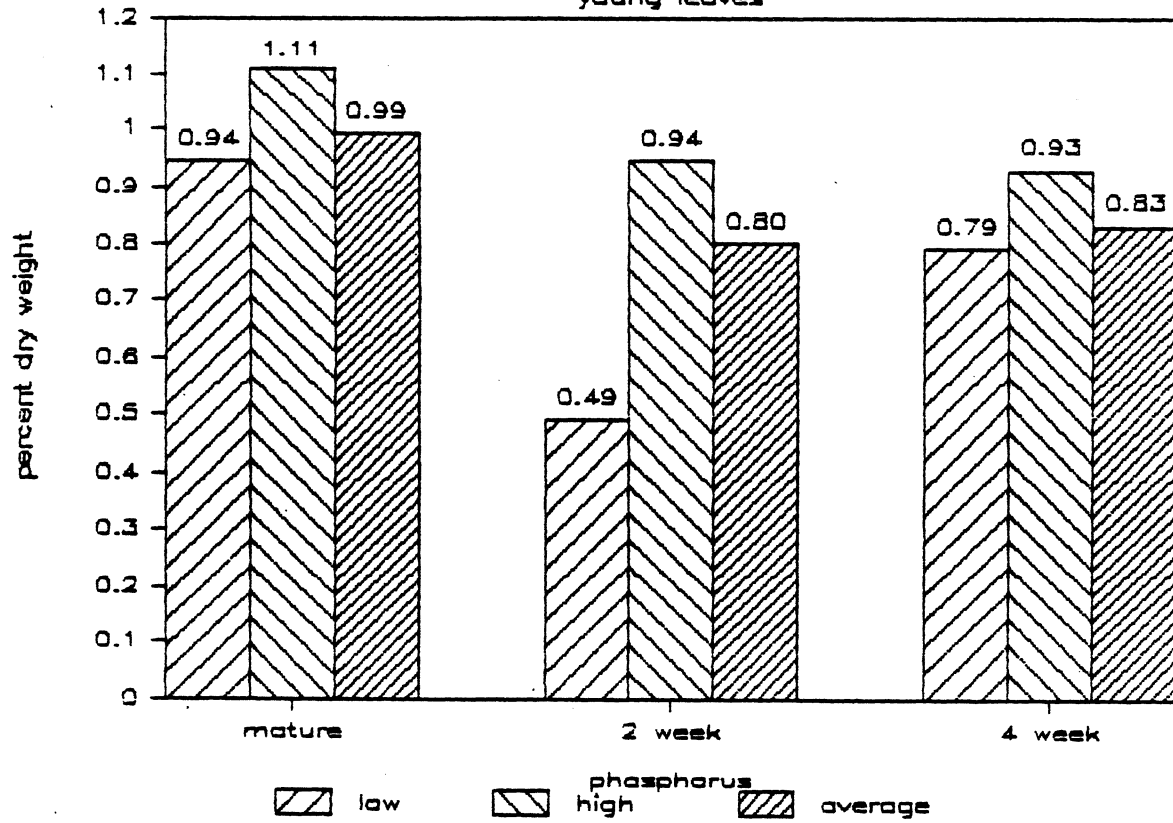


TURNIPS

young leaves

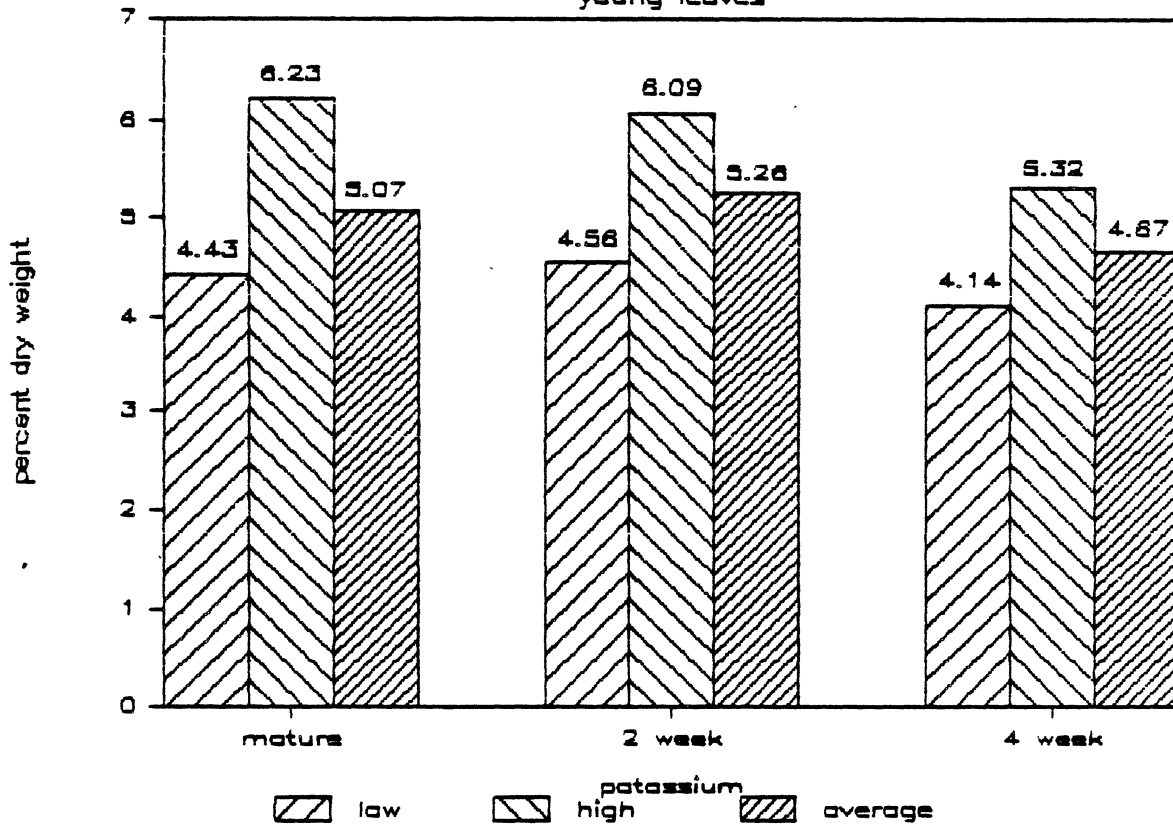


young leaves

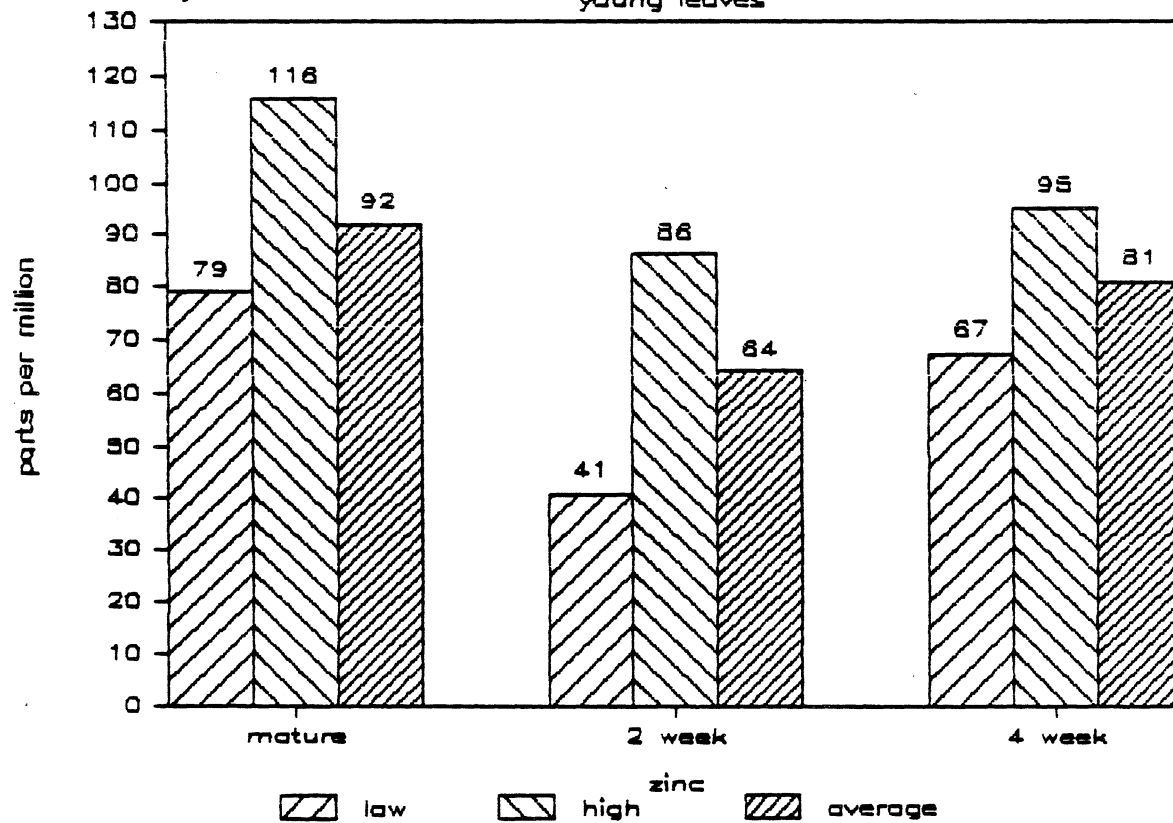


TURNIPS

young leaves



young leaves



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