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Micronutrient concentration of Okra *(Hibiscus esculentus)* leaves and fruits as influenced by nitrogen fertilization.

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Abstract

The influence of nitrogen fertilization on leaf and fruit micronutrient composition of okra plants, was studied in field trials from 1975 to 1977. Leaf-Fe was higher at the vegetative stage than at the flowering and fruiting stages of growth. Its concentration decreased steadily at the vegetative stage as nitrogen rates increased, but the converse occurred at the flowering and fruiting stages. Similar effects were noticed in leaf-Mn.

The highest Mn, Cu and Zn accumulations in the leaves were observed at fruiting. Leaf-Cu was low at all stages of growth relative to other micronutrients. Fruit-Fe and Mn were generally low compared to the leaf concentration, while fruit-Cu and Zn were almost as high as the leaf concentration.

Introduction

The fruit of okra, *Hibiscus esculentus* L., is frequently included in the dietary formulation of the people living in the hot humid tropics of the world. It is mostly eaten in the green stage as fresh vegetable after blancing in hot water; although some people prefer it dried or fried. Large scale cultivation of okra for fresh market and commercial freezing operations, has been made in the lower Rio Grande Valley of Texas and Northwestern New Mexico of the United States of America (Hipp and Cowley, 1971) Despite these, very little has been done to improve its production through improved fertilizer management. Ahmed and Tulloch-Reid (1968) showed that maximum yield was obtained with fertilizer application of 112 kg N, 168 kg P and 280 kg K per hectare. They also showed that nitrogen applied as sulphate of ammonia at rates larger than 112 kg/ha, reduced yield in the absence of liming. Similarly, Asif and Greig (1972). and Sigh and Singh (1965) observed separately that high nitrogen rates larger than 136 kg N/ha, also depressed yield. This decrease could also be attributed to the acidifying role of sulphate of ammonia applied to the soil (Obi, 1976).

Most small scale okra farmers in Nigeria regard nitrogen as the most limiting element in Okra production. This is because of the high N requirement of the crop, the low N status of the soil commonly used for vegetable production, and N loss in the soil due to leaching. Consequently, large doses of nitrogen are often applied in most cases, in the form of sulphate of ammonia. This practice will undoubtedly affect soil acidity and crop nutrient status particularly micronutrients in the plant leaves and fruits. The purpose of this study was to estimate the concentration of Fe, Mn, Cu and Zn in okra leaves sampled at the vegetative, flowering and fruiting stages of growth, and in the fruits as influenced by increasing rates of nitrogen fertilization.

Material and Methods

The study was conducted in a field that had been in fallow for 10 years. The soil of the field belongs to the 'Iwo' soil series (Oxic palenstalf), and has low to medium humus content with weakly to strongly acid subsoil (Agboola and Fayemi, 1971). It is generally well drained, deep and derived from gneisses (Smyth and Montgomery, 1962). Annual precipitation of the experimental site was 1500mm, while the surface soil composition was: pH (0.01 M $Cacl_2$), 5.9; organic carbon, 2.20%, total-N, 0.14%; Exch. K, 124 ppm; Exch. Ca, 1055 ppm; and Exch. Mg, 220 ppm determined in 0.1N NH_4OAc.

The experimental design was a randomized complete block with 5 replications. There were 5 nitrogen treatments; 0, 20, 40, 80 and 160 kg N/ha applied as sulphate of ammonia. Basal application of P as single superphosphate and K as potassium chloride, each at 100 kg/ha was ploughed in. The 20 kg N/ha treatment was applied once but the 40 and 80 kg N/ha treatments were applied in two splits, while the 160 kg N/ha treatment was applied in three splits. The applications were timed to coincide with early vegetative, flowering and fruiting stages of growth. The N treatments were placed by hand at about 8 cm from the base of the plants, using calibrated containers to ensure uniform distribution.

Okra (cv. dwarf) seeds were planted by hand and thinned to a single plant at a standard spacing of 1 by 1 meter. Plot size was 20 by 4 meters, and the experiment was conducted from March to July in 1975, 1976 and 1977.

Leaf samples were taken from fully expanded young leaves (laminae plus petioles) from about the middle of the plant during the vegetative stage of growth which was about 4 weeks after germination, at flowering, and at fruiting. In all cases, leaf samples were taken about a week after fertilizer application. Okra fruits were also harvested fresh twice weekly starting from mid June to the first week in August.

The leaf samples were washed in distilled water following standard procedures to eliminate micronutrient contamination. They were oven-dried at 65°C to constant weight, and ground in a Wiley micro-hammer mill. The fresh fruits were weighed soon after each harvest and similarly dried at 65°C. The samples were subsequently ashed in a muffle furnace, and dissolved in dilute HCl before being analyzed for Fe, Mn, Cu, Zn, using an atomic absorption spectrophotometer.

Results and Discussion

Leaf Micronutrient

There was no visible micronutrient stress observed on the foliage of the okra plants during the period of the experiment. However, marked differences were noted in the concentration of the individual micronutrients in the young leaves. Leaf composition was therefore used as an index of the micronutrient status of the plant. Loneragan *et al.*, (1976) had stressed the value of leaf nutrient concentration as an index for assessing the relationship between nutrient supply and the development of nutrient deficiency in plants. They showed that for some micronutrients, the youngest leaves were more sensitive for diagnosing nutritional syndromes than either the oldest leaf or the whole plant.

As shown in Fig. 1, leaf-Fe varied markedly with changes in stages of plant growth. In the control, leaf Fe was highest at the vegetative growth stage and lower at the flowering and fruiting stages. In the fertilizer-treated plants, increasing N application caused a decrease in leaf-Fe at the vegetative stage, and increased it only slightly at fruiting. However, it resulted in a significant increase of the leaf-Fe at flowering. The observed effect of N rates on leaf-Fe at the vegetative stage may be due to a dilution effect, while the effect at flowering may be attributed to Fe mobility in the soil, which can lead to Fe uptake and translocation to the aerial parts of the plant. It is probable that there was no uptake of Fe by the plants from the soil during fruiting and hence, leaf-Fe at this stage of growth was relatively low. Asif and Greig (1972) found that about 65% of plant-Fe was found in the roots and that the remainder moved slowly to the top of the okra plant as growth progressed. It is possible, also, that a large proportion of the Fe in the okra root may be chelated or stored in the root with gradual translocation to and accumulation in the leaves when soil supply of Fe is inadequate.

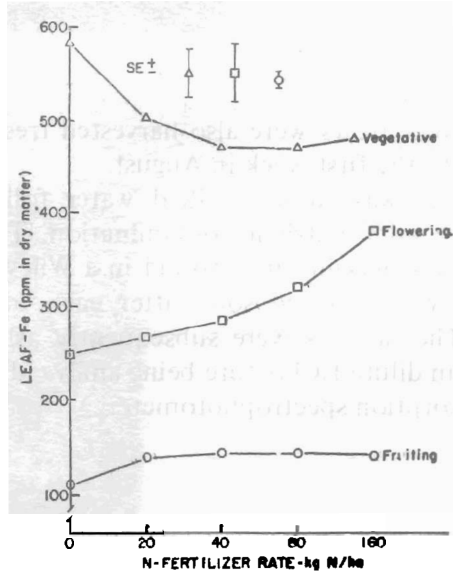

Fig. 1. Iron concentration of okra leaves sampled at three stages of growth as influenced by nitrogen fertilization.

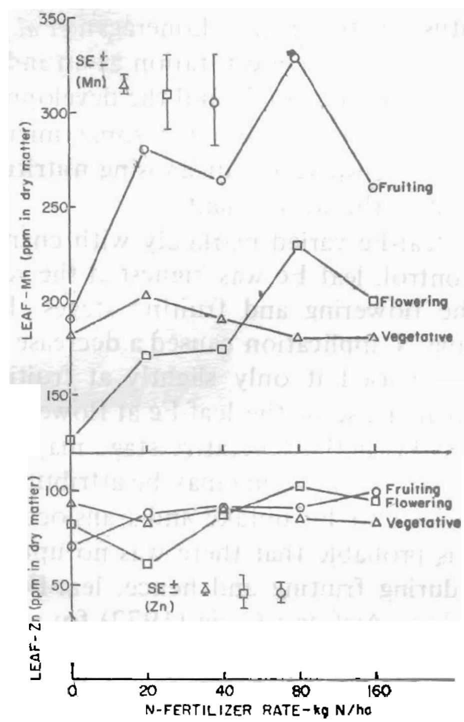

Fig. 2. Manganese and Zinc content of okra leaves sampled at three stages of growth as influenced by nitrogen fertilization.

The effect of nitrogen treatment on leaf-Mn and Zn is shown in Fig. 2. There was a general increase in leaf-Mn at the three stages of growth when N was applied at 20 kg/ha. Thereafter, leaf-Mn increased substantially at flowering and fruiting only at the 80 kg N/ha, and was followed by a sharp reduction at the highest N rate. At the vegetative stage of growth, increasing N application gave a steady reduction in leaf-Mn. As noted previously, there was an apparently high uptake of Fe due probably to high soil-Fe supply. This may have interferred with Mn uptake and accumulation in the leaves, particularly at the vegetative state of growth. Working with organic soils, Knezek and Greinert (1971) indicated that Mn was rapidly displaced from Mn-chelate by Fe and that the released Mn was further inactivated as an organic complex. This may account for the large difference between the concentration of Mn and Fe in the leaves and the relatively low concentration of Mn in the plant.

There was no marked effect of treatments on leaf-Zn, except for a slight increase in Zn at flowering with increased N application. The level of Zn in the okra leaves was relatively lower than leaf-Fe. This is in agreement with Ambler and Brown (1969) who found that high concentration of Fe in plants aggravated Zn deficiency, thus suggesting a possible interaction between Fe and Zn in plants.

Leaf-Cu was almost uniformly distributed at all stages of growth of the okra plants (Fig. 3). Nitrogen fertilization had no appreciable effect on it except for some slight increases at flowering and fruiting, and a rather gradual but slight decrease at the vegetative stage. The low leaf-Cu obtained at the various stages of growth may be related to the apparently low Cu supplying potential of the soil (Adepetu et al. 1979). According to Loneragan et al. (1976), the extent to which Cu moves in plants depends strongly on the Cu supplying power of the soil; and when taken up by the plant, Cu moves rather slowly to the leaves. It is also possible that the okra plant may have a low requirement for Cu, which calls for further investigation.

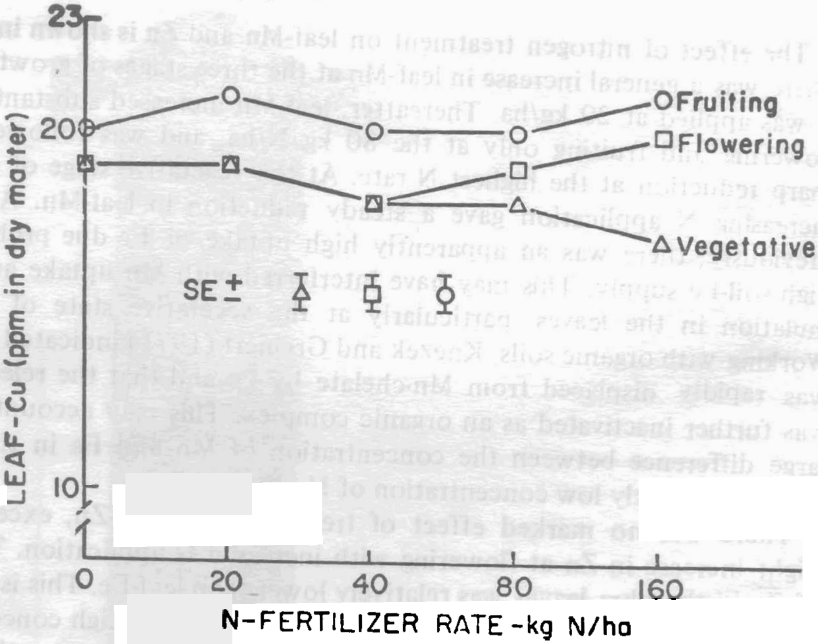

Fig. 3. Copper content of okra leaves sampled at three stages of growth as influenced by nitrogen fertilization.

TABLE 1 – EFFECTS OF INCREASING NITROGEN FERTILIZATION ON MICRONUTRIENT COMPOSITION OF OKRA FRUITS (PPM IN DRY MATTER)

Treatment	*Fe*	*Mn*	*Cu*	*Zn*
0	59	65	12	59
20	59	67	13	59
40	58	71	12	67
80	55	72	11	72
160	40	77	10	70
SE (±)	16	13	1	6
CV %	30	15	8	9

Fruit Micronutrient

Table 1 shows the concentration of micronutrients in the okra fruit as influenced by nitrogen fertilization. Unlike the marked differences obtained in leaf composition at various stages of growth, the okra fruit appeared to accumulate relatively lower levels of these elements. Nitrogen application appears to have no effect on fruit-Fe except for a decrease at the 160 kg N/ha rate. Fruit-Mn showed slight increases as the N fertilizer rate was increased; while fruit-Cu levels were almost similar to the levels obtained in the leaves. However, increasing N treatments produced a slight but significant increasing trend in fruit-Zn. Fruit-Zn was also higher than leaf Zn. It thus appears that okra fruit could accumulate as much Cu and Zn as the leaves, whereas the reverse was the case with Fe and Mn.

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