COMPARATIVE GROWTH AND ZINC UPTAKE OF SOME HIGH YIELDING VARIETIES OF WHEAT IN TARAI SOILS OF UTTAR PRADESH WITH AND WITHOUT ZINC AMENDMENT

C. P. SHARMA AND P. N. SHARMA

Department of Botany, Lucknow University, Lucknow

ABSTRACT

Eight newly released high yielding varieties of wheat (*Triticum aestivum* L.)—C. 273, K. 816, PV. 18, Hira (HD. 1941), HD. 1944, WL. 212, WG. 357, WG. 377—were raised in low zinc 'Tarai' solis of Pantnagar, Uttar Pradesh, with and without zinc amendment. When grown in the native 'Tarai' soil with low (0.10 ppm neutral normal ammonium acetate+0.01% dithizone extractable) zinc, all the varieties other than the 3-gene dwarf variety WG. 377 contained subnormal values of tissue zinc and developed visual symptoms of zinc deficiency. Application of 5 ppm zinc as $ZnSO_4$ to the soil increased available soil zinc to 0.77 ppm. Plants raised on zinc-treated soils had normal or near normal values of tissue zinc; they were largely free from visual symptoms of zinc deficiency and had higher vegetative and grain yield than plants raised on the native low zinc soil.

INTRODUCTION

In an earlier study, AGARWALA, SHARMA, SHARMA AND NAUTIYAL (1971) studied the performance of some high yielding wheat varieties under micronutrient stress in refined sand culture and observed marked differences in varietal reaction under stress of iron, manganese, copper, and zinc. SHARMA, AGARWALA, SHARMA AND AHMED (1971) studied the performance of some of these varieties in soils deficient in zinc and made up for it by addition of zinc sulphate in pot culture and reported that varietal performance in low zinc soils largely resembled the varietal reaction to zinc deficiency in controlled sand culture.

The present investigation was undertaken to study the performance of some newly released high fertilizer responsive varieties of wheat in low zinc 'Tarai' soil of Uttar Pradesh and their response to zinc amendment in these soils.

MATERIAL AND METHODS

Comparative study was made of growth, visual effects of zinc deficiency, dry matter production and zinc uptake in eight varieties of wheat (*Triticum aestivum* L.)—C. 273, PV. 18, K. 816, HD. 1944, WL. 212, WG. 357, WG. 377 and Hira (HD. 1941)—grown in zinc deficient 'Tarai' soils of Pantnagar, district Nainital, Uttar Pradesh. The details of the technique used for preparation of soils and culture of plants were essentially the same as described earlier (SHARMA, AGARWALA, SHARMA & AHMED, 1971). The available (neutral normal ammonium acetate+0.01% dithizone extractable) zinc (SHAW & DEAN, 1952) status of the native soil and that supplied 5 ppm zinc as zinc sulphate was 0.10 and 0.77 ppm respectively. Some other physico-chemical characteristics of the experimental soil are given below:

Soil texture	Silty clay loam	Available Phosphorus (ppm)	27.5
pH	8.5	Available micronutrients	
Organic matter (%)	2.3	Normal Am. Ac. pH 4.8 extractable iron (ppm)	3.3
$CaCO_3$ (%)	2.5	Neutral N Am. Ac. extractable manganese (ppm)	6.5
Moisture saturation (%)	64	Neutral N Am. Ac+0.2% hydroquinone extractable Mn (ppm)	85
E. C. (m. mhos/cm)	0.95	0.1 N HCl extractable Cu (ppm)	3.3

Periodical observations were made of the growth and visual effects of zinc deficiency in the different varieties. At two stages of growth—31 and 98 days—samples were drawn for the estimation of dry matter yield and tissue concentration of zinc. At the later stage, straw and grain yield was determined separately. Since the dry plant material was to be used for estimation of tissue zinc, prior to drying, plant material was washed with a detergent (TEEPOL B-300) and rinsed twice in deionised water.

Dry matter yield was determined by drying plants in forced draught oven at 70°C for 24 hours. Zinc concentration in plant material was estimated by a 'Techtron' model AA120 Atomic Absorption Spectrophotometer in di-acid digests prepared by the method described by Piper (1942).

For each treatment a minimum of three pots were maintained under glass-house conditions and all estimations were carried out in triplicate. The significance of the response of plants to zinc amendment was tested by carrying out the analysis of variance. The L. S. D. values ($P=0.05$) are indicated in the text-figures.

RESULTS

Growth and Visual Effects

During the first four weeks, growth of plants of each of the eight varieties was apparently normal. Thereafter, as tillering commenced, the performance of different varieties varied. Between 35 and 42 days growth, all the varieties other than WG. 377 showed patchy discoloration of the lamina of young leaves which was followed by loss of turgor and necrosis of the discoloured areas which later turned buff or greyish brown. The necrotic areas which initially appeared near the middle of the lower half of these leaves, later coalesced to form large irregular patches. The severity of these effects, characteristic of zinc deficiency, varied in the different varieties. The effects were very mild in variety WL. 212, moderately severe in varieties WG. 357, C. 273, and K. 816 and very severe in varieties PV. 18, Hira, and HD. 1944. In varieties Hira and HD. 1944 which were the first to develop visual symptoms of zinc deficiency at 35 days growth, eventually the entire foliage became severely affected. There were, however, some differences in the disease syndrome. For example, in Hira tissue necrosis was preceded by appearance of yellowish or orange tints in the severely discoloured patches on leaf lamina. While zinc deficiency effects appeared early and soon became quite severe in variety PV. 18, this variety showed some recovery from visual pathological effects during the later stages of growth. At no stage of growth was any visual symptom of zinc deficiency observed in variety WG. 377.

Upto about four weeks, there was no obvious difference in the growth of plants raised on the zinc deficient soil and those grown on the soil supplied 5 ppm zinc but, after the initiation of tillering, growth of plants raised on zinc treated soil appeared appreciably better than that of plants grown on the native soil. Zinc amendment not only improved plant growth but largely prevented the appearance of visual symptoms of zinc deficiency in varieties WL. 212, WG. 357, PV. 18, and HD. 1944. In varieties Hira, C. 273, and K. 816 raised in soil supplied 5 ppm zinc, growth was still poor and nearing the boot stage plants showed mild but distinct effects of zinc deficiency.

Dry Matter Production

At 31 days growth, there was no appreciable difference in dry matter yield of plants grown on zinc treated and untreated soils, but at harvest, varieties other than WG. 377 had higher yield when grown in soil supplied 5 ppm zinc than in the native soil (Text-fig. 1). Compared to other varieties, yield response to zinc amendment was more marked, statistically significant, in varieties HD. 1944 and Hira. Variety WG. 377 did not show any significant difference in dry matter yield in zinc treated and untreated soils.

Grain Yield

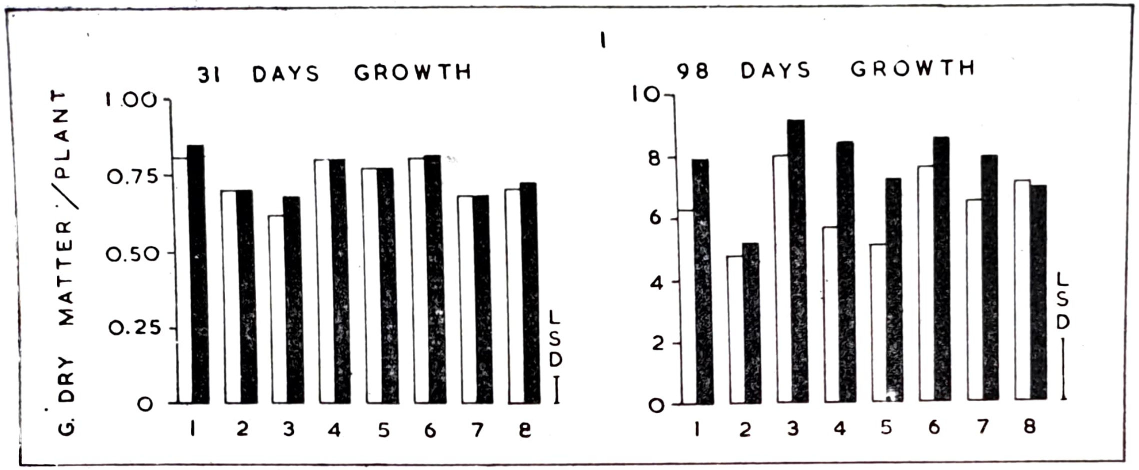
In variety WG. 377 grain production was not appreciably different in plants raised on low zinc soil and soil supplied 5 ppm zinc but in the other varieties the number and dry weight of grains per plant, as also the unit grain weight, was affected by zinc amendment (Text-fig. 2). In each of the varieties except WG. 377 zinc amendment resulted in a significant increase in dry weight yield of grains. The effect was particularly marked and statistically significant in varieties C. 273, WG. 357, HD. 1944, and Hira. The increase in the dry matter yield of grains was a function of the increase in both the number of grains (resulting from increase in effective tillers per plant) and the unit grain weight.

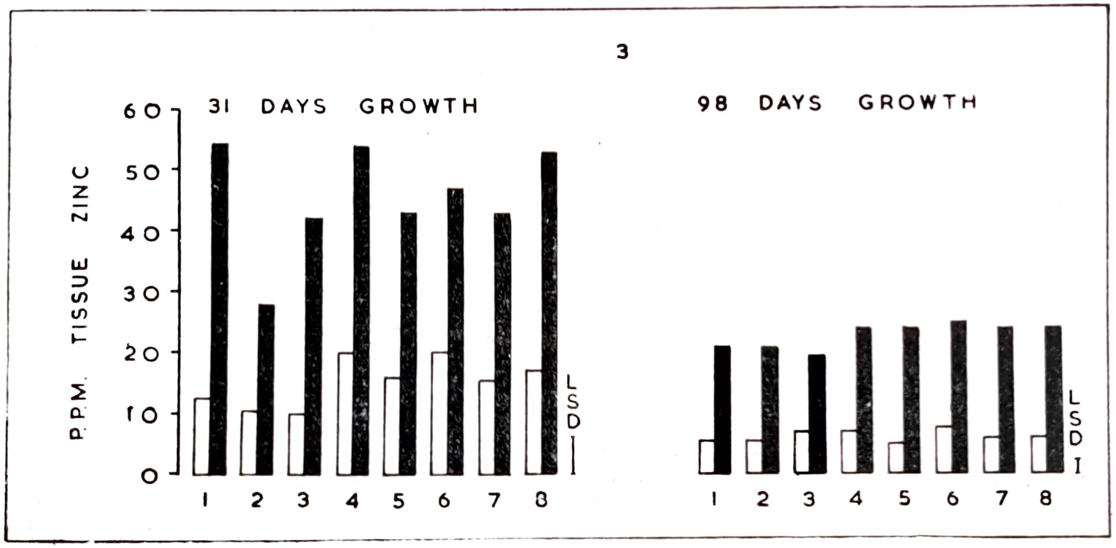
Tissue Zinc

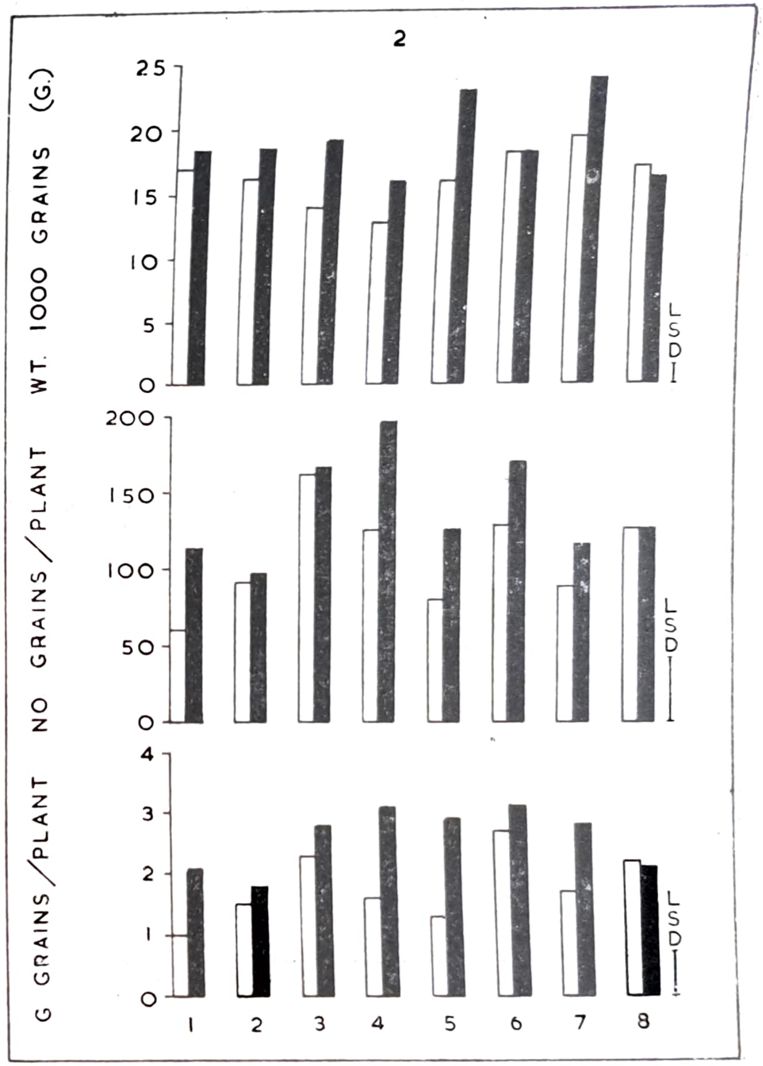
At 31 days growth, before zinc deficiency symptoms became manifest, tissue zinc in the foliage of the different varieties ranged between 10.7 and 19.9 ppm in the native soil and 28.1 to 54.4 ppm in soil supplied 5 ppm zinc (Text-fig. 3). When plants were raised on the native soil (control), comparatively lower values of tissue zinc were found in varieties PV. 18, K. 816 and C. 273 than in other varieties. At the later stage of growth there was a considerable decrease in tissue zinc in each of the varieties grown on both zinc treated and untreated soils. At 98 days growth, tissue zinc in the foliage of control plants ranged between 4.9 to 7.7 ppm and that in plants grown on zinc-treated soil between 9.6 to 24.1 ppm.

DISCUSSION

Performance of different varieties of wheat in zinc deficient Tarai soils of Pantnagar differed considerably. Of the different varieties examined, variety WG. 377 appeared to be resistant to zinc deficiency. Unlike other varieties this variety did not show any visible symptom of zinc deficiency when grown in the low zinc soil. Each of the varieties other than WG. 377 when grown in low zinc Tarai soil of Pantnagar area showed poor growth and visual symptoms of zinc deficiency. Zinc deficiency effects were particularly marked in varieties Hira and HD. 1944. There was hardly any difference in the dry matter production and grain yield of variety WG. 377 grown in the native and the zinc treated soils, but in each of the other varieties zinc amendment resulted in improvement of plant growth and lessened the severity of zinc deficiency effects. Response to added zinc was most marked in varieties Hira and HD. 1944, whose performance in the native soil was very poor. The varietal reaction to zinc deficiency as observed here in soil pot culture is in accord







Text-fig. 1 Dry matter yield of eight high yielding varieties of wheat grown on zinc deficient 'tarai' soil with and without zinc amendment. Empty bars—plants grown on native soil; shaded bars—plants grown on soil with zinc amendment.

Text-fig. 2 Grain yield of eight high yielding varieties of wheat grown on zinc deficient 'tarai' soil with and without zinc amendment. Empty bars—plants grown on native soil, shaded bars plants grown on soil with zinc amendment.

Text-fig. 3 Tissue zinc in eight high yielding varieties of wheat grown on zinc deficient 'tarai' soil with and without zinc amendment. Empty bars—plants grown on native soils; shaded bars—plants grown on soil with zinc amendment.

with the observations based on controlled culture studies (AGARWALA, SHARMA, SHARMA & NAUTIYAL, 1971). These studies would also suggest that under field conditions, where low availability of zinc restricts crop production (JYOTISHI & CHAUBE, 1966; NENE, 1966; PRASAD, MATHUR & CHATTRI, 1966; MEHROTRA & SAXENA, 1967; AGARWALA, MEHROTRA, SHARMA, AHMED & SHARMA, 1970; SIVARAMAN NAIR, MUKERJEE & KATHAVATE, 1968; GREWAL, BHUMBLA & RANDHAWA, 1969; KRISHNAMURTHY, VENKATESWARLU, REDDY & RAO, 1971), tolerant varieties like WG. 377 may still be profitably cultivated and that under such conditions profitable cultivation of susceptible varieties like Hira and HD. 1944 would require suitable zinc amendments. While low uptake of zinc from soils of poor (deficient) zinc status would appear to be the major cause of zinc deficiency, as observed earlier (SHARMA, AGARWALA, SHARMA & AHMED, 1971) here also, the severity of zinc deficiency at different stages of growth was not always a function of tissue zinc suggesting that varietal differences in susceptibility to zinc deficiency cannot be entirely attributed to varietal differences in efficiency of zinc uptake.

ACKNOWLEDGEMENTS

The authors are grateful to Professor S. C. Agarwala, Head of the Department of Botany, Lucknow University for his guidance during the curse of investigations and for providing the facilities for the work.

REFERENCES

AGARWALA, S. C., MEHROTRA, N. K., SHARMA, C. P., AHMED, S. & SHARMA, V. K. (1970). Widespread occurrence of zinc deficiency in eastern region of Uttar Pradesh, *J. Indian Soc. Scil Sci.* **18:** 415-427.

AGARWALA, S. C., SHARMA, C. P., SHARMA, P. N. & NAUTIYAL, B. D. (1971). Susceptibility of some high yielding varieties of wheat to deficiency of micronutrients in sand culture. *Proc. Int. Symp. Soil Fert. Evaln. New Delhi,* **1:** 1047-64.

GREWAL, J. S., BHUMBLA, D. R. & RANDHAWA, N. S. (1969). Available micronutrient status of Punjab, Haryana and Himachal soils. *J. Indian Soc. Soil Sci.* **17:** 27-31.

JYOTISHI, R. P. & CHAUBE, P. G. (1966). Effect of the application of some trace elements as foliar spray and as seed treatment in combination with different levels of nitrogen, under fixed levels of phosphorus and potash, on growth, yield and quality of tomato (*Lycopersicum esculentum* Muller). *Proc. Bihar Acad. agric. Sci.* **14:** 24-36.

KRISHNAMURTHY, C., VENKATESWARLU, J., REDDY, M. G. R. & RAO, G. V. M. M. (1971). Zinc deficiency in Andhra Pradesh. *Proc. Int. Symp. Soil Fert. Evaln. New Delhi.* **1:** 955-967.

MEHROTRA, O. N. & SAXENA, H. K. (1967). Trace element response of importance crops in Uttar Pradesh. 2. Wheat. *Indian J. Agron.* **12:** 287-291.

NENE, Y. L. (1966). Symptoms, cause and control of 'khaira' disease of Paddy. *Indian Phytopath.* **19:** 130-131.

PIPER, C. S. (1942). *Soil and Plant analysis.* Monograph Waite Agric. Res. Inst. The Univ. Adelaide.

PRASAD, N., MATHUR, R. L. & CHATTRI, I. S. (1966). Studies on the control of zinc deficiency of guava in Rajasthan. *Sci. Cult.* **32:** 201-209.

SHARMA, C. P., AGARWALA, S. C., SHARMA, P. N. & AHMED, S. (1971). Performance of eight high yielding wheat varieties in some zinc deficient soils of Uttar Pradesh and their response to zinc amendments in pot culture. *J. Indian Soc. Soil Sci.* **19:** 93-100.

SHAW, E. & DEAN, L. A. (1952). Use of dithizone as an extractant to estimate zinc nutrient status of soils. *Soil Sci.* **73:** 341-34 .

SIVARAMAN NAIR, P. C., MUKERJEE, S. K. & KATHAVATE, Y. V. (1968). Studies on citrus die back in India, I. Micronutrient status in soils and leaves. *Indian J. agric. Sci.* **38:** 184-194.