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DIAGNOSIS OF ZINC DEFICIENCY IN CANOLA (*BRASSICA NAPUS* CV. EUREKA) BY PLANT ANALYSIS

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ABSTRACT

Canola plants (*Brassica napus* cv. Eureka) were grown in zinc (Zn) deficient sand with seven levels of Zn supply (0, 67, 133, 200, 267, 533, and 1067 μg Zn/kg soil) for 39 days. Critical Zn concentrations in young leaf blades and petioles were established for the diagnosis of Zn deficiency in canola plants during vegetative growth, by assessing the relationship between Zn concentrations in leaves and shoot dry matter on 39 days after sowing (DAS). Zinc concentrations in leaf blades and petioles increased with increasing Zn supply, but Zn concentrations were always 50% higher in the youngest open leaf (YOL) than in the youngest mature leaf (YML). The relationship between shoot dry matter and Zn concentrations in leaf petioles exhibited Piper-Steenbjerg curvature, indicating their unsuitability for Zn deficiency diagnosis or their inclusion with leaf blades. By contrast, inclusion of leaf mid-ribs with leaf blades did not alter the relationship between shoot dry matter and Zn concentrations, nor the critical Zn concentration. Critical Zn concentrations in the YOL, YOL+1 and YOL+2 blades on 39 DAS, corresponding with the stem elongation stage, were 15-18, 8-11 and 6-9 mg Zn/kg dry matter, respectively. The blade of YOL+2 which is also the YML is recommended for the diagnosis of Zn deficiency in canola plants, with the critical Zn concentration of 6-9 mg Zn/kg dry matter.

INTRODUCTION

Plant analysis has been used to diagnose Zn deficiency in crops such as clover, peanuts, navy bean, and wheat by developing critical Zn concentrations (Reuter and Robinson, 1986). By contrast, there are no suitable plant analysis standards for diagnosing Zn deficiency in oilseed rape plants. The present study was designed to develop critical concentrations for Zn deficiency diagnosis in canola plants during the vegetative growth stage and to identify the most suitable plant parts for sampling.

EXPERIMENTAL

Canola (*Brassica napus* cv. Eureka).was grown in quadruplicate pots at 7 levels of added Zn (µg Zn/kg soil): 0, 67, 133, 200, 267, 533, and 1067. The soil used and experimental procedures in this experiment were similar to those described by Bell *et al.* (1990). Root zone temperature was maintained at 20-22 ^{o}C throughout the experimental period. Plants were harvested at 39 days after sowing (stage 2,3 according to Sylvester-Bradley 1985). The plant shoots were divided into the blades and petioles of the youngest open leaf (YOL), the leaf immediately older than the YOL (YOL+1), the YOL+2, and the remainder of shoots. All the dry samples were digested in concentrated nitric acid at 130 ^{o}C for Zn determination by inductively coupled plasma spectrometry (Zarcinas *et al.* 1987). The relationships between Zn concentrations in leaves and shoot dry weights were fitted with the Mitscherlich and two-phase linear models.

Omitting Zn severely depressed shoot growth of canola and the lowest level of Zn supply, marginally depressed it (Table 1). maximum shoot dry weight was obtained with 133 or more µg Zn/kg soil. Increasing Zn supply increased Zn concentrations in the leaves: in the YOL, Zn concentrations reached a maximum at 267 µg Zn/kg but in the older leaves Zn concentrations increased progressively to a maximum at the highest rate of Zn supply. Zinc concentrations generally decreased with leaf age, resulting a lower Zn concentrations in old leaves (YOL+2) than young ones (YOL).

In general, plant growth closely correlated with Zn concentrations in YOL, YOL+1 and YOL+2 leaf blades, but less so with Zn concentrations in leaf mid-ribs and petioles. For most relationships between shoot dry matter and Zn concentrations in the leaf blades, the two-phase linear model fitted the data better than the Mitscherlich model. The critical Zn concentrations in YOL, YOL+1 and YOL+2 leaf blades (mg Zn/kg dry matter) (± standard error) estimated from the two-phase linear model were 16 ± 1.1, 9.4 ± 0.6 and 7.6 ± 0.6, respectively, on 39 DAS.

For Zn deficiency diagnosis, the YOL blade is not recommended for sampling in canola plants because its critical value dropped sharply as the leaf aged making the accuracy of the diagnosis too sensitive to precise sampling of the correct leaf. Similarly, leaf petioles should not be included with leaf blades in Zn analysis, due to Piper-Steenbjerg effect associated with the relationship between shoot dry matter and Zn concentrations in leaf petioles. The inclusion of leaf mid-ribs with blade tissues did not significantly change the relationship between shoot dry matter and Zn concentrations, nor Zn critical concentrations in leaf blades.

The critical Zn concentrations in YOL+1 and YOL+2 blades estimated on 39 DAS (stem elongation stage) were 8-11 and 6-9 mg Zn/kg dry matter, respectively, in the present experiment. These critical Zn levels are compatible to those of youngest fully expanded leaf blades in peanut plants (8-10 mg Zn/kg dry matter: Bell *et al.* 1990), but lower than those in sub-clover (12-14 mg

Zn/kg dry matter: Reuter *et al.* 1982) and soybean (15 mg Zn/kg dry matter: Ohki 1977). The YOL+2 which corresponds to the YML is recommended as the most suitable leaf for Zn-deficiency diagnosis in canola plants.

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Table 1 Effect of zinc (Zn) supply on shoot dry matter (g DM/plant) and Zn concentrations (mg/kg DM) in the youngest open leaf blades (YOL), YOL+1 and YOL+2 at 39 days after sowing in a Zn deficient sand. Values are means of four replicates (± standard errors).

Zn supply (*u*g /kg soil)	Shoot DM	Zn concn		
		YOL	YOL+1	YOL+2
0	0.4 ±0.2	6 ±1	5 ±1	4 ±1
67	4.8 ±0.9	18 ±2	11 ±2	8 ±1
133	5.0 ±0.1	28 ±4	18 ±2	12 ±1
200	5.1 ±0.3	31 ±4	21 ±2	14 ±1
267	4.9 ±0.3	41 ±2	25 ±2	17 ±2
533	5.2 ±0.3	41 ±1	28 ±3	20 ±1
1067	5.2 ±0.2	44 ±2	34 ±2	26 ±1