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Micronutrients status of plum orchards in Peshawar valley

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Abstract

A nutritional survey was performed to assess the micronutrients status of selected plum orchards in Peshawar valley. Representative soil (0-30 cm depth) and leaf samples were collected from 40 plum orchards during May 2008. Results showed that the concentration of AB-DTPA extractable Zn ranged from 0.04 to 1.34 µg g^{-1}, Mn 0.04 to 19.8 µg g^{-1}, Fe 4.8 to 21.0 µg g^{-1}, Cu 0.43 to 10.6 µg g^{-1} and available B 0.01 to 0.62 µg g^{-1} in soil. Based on soil test, Zn was deficient in 95%, B in 90% and Mn in 5% plum orchards. The leaf analysis showed that the concentration of Zn ranged from 19.6 to 99.9 µg g^{-1}, Mn from 20.2 to 77.8 µg g^{-1}, Fe from 11.0 to 158.0 µg g^{-1}, Cu from 2.60 to 74.0 µg g^{-1}, and B from 5 to 26 µg g^{-1} dry matter. Based on tissue test, Zn was deficient in 17%, Mn in 2%, Fe in 45%, Cu in 13% and B in 95% plum orchards. The soils of plum orchards were alkaline in reaction (pH 7.79 to 8.62), non-saline (EC 0.08 to 0.21ds m^{-1}), low in organic matter (0.28 to 3. 04) and were calcareous in nature (Lime 4.70 to 22.5%). Present survey suggested that the plum orchards require special attention to overcome micronutrients deficiencies. Hence, the growers are advised to use micronutrients, specifically Zn and B along with other fertilizers for getting maximum yield and good quality plum fruit

Key words: Plum, micronutrients, chemical properties, deficiency, critical level

Introduction

Plum (*Prunus domestica* L.) is an important stone fruit crop of NWFP and has great nutritional role in our daily food requirements. Plum is a source of minerals and vitamins (Gregory, 1993). It is grown in different areas of NWFP including Peshawar, Nowshera, Charsadda, Mardan and Swat areas. Earlier surveys of plum orchards indicated deficiencies of micronutrients in NWFP (Muhammad *et al*., 1995). Due to nutrient deficiencies, plum orchards are now turning into unproductive plantation, producing poor quality fruit. Moreover, soils of this region are low in organic matter content, mostly calcareous in nature and alkaline in reaction and these conditions are not favorable to micronutrients availability (Zekri and Obreza, 2003). Furthermore, appearance of nutrients deficiencies symptoms and responses to added nutrients indicated the prevalence of nutritional disorders of micronutrients (Zn, Cu, Fe, Mn and B) in NWFP (Rehman and Haq, 2006; Khattak and Hussain, 2007). In spite of the fact that the total quantities of micronutrients present in soil may be adequate, nutrients translocation does not match with growth or uptake, which can be clearly seen from the yellowness of young plum leaves. This phenomenon is very common in Pakistan in stone fruit plants, such as peach, apricot and plum, which are related to Fe deficiencies (Rehman, 1990). The formation of gum pockets is another common problem in plum, which is due to deficiency of B (Shorrocks, 1984). So far, no adequate information is available on micronutrients status of plum orchards in this region and role of micronutrients on the yield and quality of plum fruits. Therefore, present research was designed to study the prevailing micronutrients status of plum orchards in Peshawar valley and to compare the micronutrients status with the standard criteria for nutrient indexation. This study will certainly help in micronutrients recommendations for plum orchards that will optimize the financial returns of the plum growers.

Materials and Methods

A survey was conducted to assess the micronutrients (Zn, Cu, Fe, Mn and B) status of plum orchards in Peshawar valley during May, 2008. For this, 40 plum orchards were surveyed in Peshawar, Nowshera, Charsadda and Mardan areas according to the procedure described by Catara (1987). Representative soil samples from 0-30 cm depth and leaf samples from the crossing point (of which the soil samples) were collected from each orchard. During the survey, general observations on the appearance of plum orchards were also recorded and where possible relevant information from the concerned farmers were collected.

Processing of samples

Soil samples were properly packed, labeled and transferred to the laboratory of the Department of Soil and Environmental Sciences. After air-drying, twigs and stones were removed from soil samples, ground and passed through a 2 mm sieve and stored for laboratory analysis.

Similarly, freshly collected leaves were washed with tape water and then with distilled water within 24 hours of sampling. After air-drying, the samples were oven dried at

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70 °C to a constant weight, ground by a mini Willey mill and stored in plastic bottles for chemical analysis.

Determination of extractable micronutrients in soil

The concentration of extractable micronutrients (Zn, Cu, Fe, and Mn) in soil was determined by the AB-DTPA extraction procedure (Soltanpour and Schwab, 1977) and the extracts were read for Zn, Cu, Fe and Mn on an atomic absorption spectrophotometer. The concentration of extractable B in soil was determined by the dilute hydrochloric acid method as described by Ryan *et al.* (2001) followed by curcumin oxalic acid color development procedure as described by Jackson (1973) and read at 540 nm on a spectrophotometer.

Determination of extractable micronutrients in leaf

The concentration of micronutrients (Zn, Cu, Fe, Mn and B) in leaf samples was determined using dry ashing technique as described by Jones and Case (1990). The extract was read for Zn, Cu, Fe and Mn on an atomic absorption spectrophotometer, while B concentration in the digest was read on spectrophotometer at 540 nm after color development with curcumin oxalic acid as described by Jackson (1973).

Other chemical properties of soil

Other soil properties such as soil pH (McLean, 1982), electrical conductivity (Rhoades, 1982), lime (Cottenie, 1980) and organic matter (Nelson and Sommers, 1996) contents were measured in the laboratory of the Department of Soil and Environmental Sciences.

Statistical Analysis

Descriptive statistics was used for calculations of means, standard deviations, and coefficient of variations (Bhatti, 2006). In addition, nutrient status was compared with standard criteria for nutrient indexation as reported by Soltanpour (1985), Johnson and Fixen (1990), Jones *et al.* (1991) adapted from Zia *et al*. (2004).

Results and Discussion

Micronutrients concentration in soils of plum orchards

The soil analysis of plum orchards showed deficiencies of micronutrients to varying levels in Peshawar valley (Table 1). Based on soil test, such deficiencies were found only in case of Zn, B and Mn (Figure 1). Results showed that Zn concentration ranged from 0.04 to 1.34 µg g^{-1}. The determined values were compared with the established critical values (Table 2) as suggested by Soltanpour (1985), and indicated that 95% samples were found deficient and 5% adequate in Zn. The Cu concentration in soils ranged from 0.43 to 10.6 µg g^{-1}, which showed a great variation of Cu concentration in soils. The results revealed that 5% soils were adequate and 95% were above the critical level, showing no deficiency of Cu in soils of the plum orchards of Peshawar valley. The concentration of Fe varied from 4.80 to 21.0 µg g^{-1} in soils. Iron was adequate in 5% and excess in 95% plum orchards showing no deficiency in the surveyed plum orchards soils. The concentration of Mn in soils ranged from 0.04 to 19.8 µg g^{-1}. This shows that Mn was deficient in 5%, adequate in 5% and excess in 90% soils of plum orchards. Similarly, B concentration ranged from 0.10 to 0.62 µg g^{-1}, indicated that 90% samples were deficient, 8% adequate and 2% above the critical level as reported by Johnson and Fixen (1990).

Micronutrients concentration in leaves of plum orchards

Like soil analysis, the leaf analysis also showed deficiencies of micronutrients to varying levels of plum orchards (Table 3). Based on leaf tissue test, micronutrients deficiencies were found in the ascending order, such as B > Fe > Zn > Cu > Mn in the surveyed plum orchards of Peshawar valley (Figure 2). The determined values were compared with the established critical values (Table 4) as reported in the literature (Jones *et al*., 1991; Zia *et al*., 2004). Results showed that Zn concentration in leaf ranged from 19.6 to 99.9 µg g^{-1}, indicating that 17% leaf samples of plum orchards were deficient, and 83% were adequate in Zn. The concentration of Cu in plum leaves ranged from 2.60 to 74.0 µg g^{-1}, showing that 13% plum orchards were deficient and 87% were adequate in Cu. The Fe concentration in leaf samples ranged from 11 to 158 µg g^{-1} and found that 45% samples were deficient, 53% adequate, and 2% were excess in Fe. Low deficiency was found in case of Mn concentration where it ranged from 20.2 to 77.8 µg g^{-1}, indicating that 98% orchards were in adequate range and only 2% orchards were deficient in leaf. The B concentration in leaf samples ranged from 5 to 26 µg g^{-1}, indicating that 95% plum orchards were extremely deficient and only 5% adequate in B (Jones *et al*., 1991; Zia *et al*., 2004).

Chemical properties of plum orchards soils

The soil samples were also analyzed for pH, electrical conductivity, organic matter and lime contents (Table 5). The results showed that soil pH ranged from 7.79 to 8.62 with a mean value of 8.21 indicating that the soils of plum orchards were alkaline in reaction. Electrical conductivity ranged from 0.08 to 0.21 dS m^{-1} with a mean value of 0.15, which shows that the plum orchards soils were non-saline

Table 1. Range and mean values of micronutrients in plum orchards soils

Micronutrient (µg g^{-1})	Range		Mean	±SD	%CV
	Min	Max			
Zn	0.04	1.34	0.47	0.23	48.93
Cu	0.43	10.60	4.64	2.45	52.80
Fe	4.80	21.02	10.34	4.32	17.40
Mn	0.04	19.80	8.91	5.40	60.60
B	0.01	0.62	0.22	0.36	163.60

Table 2. Index values for micronutrients in soils reported by various sources

Micronutrient (µg g-1)	Deficient	Adequate	Excessive
Zn	<0.9	0.9-1.5	>1.5
Cu	<0.2	0.2-0.5	>0.5
Fe	<0.3	3.0-5.0	>5.0
Mn	<0.5	0.5-1.0	>1.0
B	<0.45	0.45-1.0	>1.0

Table 3. Range and mean values of micronutrients in leaves of plum orchards

Micronutrient (µg g-1)	Range		Mean	±SD	%CV
	Min	Max			
Zn	19.6	99.6	48.10	22. 21	46.17
Cu	2.6	74.0	11.80	10.94	92.71
Fe	11. 0	158.0	71.05	32. 93	46.34
Mn	20.2	77.8	51.43	13.59	26.50
B	5.0	26.0	12.85	5.70	44.40

Table 4. Index values for micronutrients in soils reported by various sources

Micronutrient (µg g-1)	Deficient	Adequate	Excessive
Zn	<25	25-200	>200
Cu	<6.0	6.0-100	>100
Fe	<60	60-150	>150
Mn	<25	25-200	>200
B	<25	25-100	>100

in nature. Organic matter content ranged from 0.28 to 3.04% with a mean value of 0.91% showed that organic matter was deficient/low in most of the soil samples collected from plum orchards. Lime content in soils ranged from 4.70 to 22.5% with a mean value of 15.0%, indicating that the soils of plum orchards were from moderately to strongly calcareous.

The above-determined soil properties are important in controlling the availability of micronutrients to plants (Sillanpaa, 1982; Zekri and Obreza, 2003). Because of complex nature of soil, soil tests are not widely used to diagnose nutrient deficiencies in stone fruit trees as in the present study no significant correlation were found between the soil nutrient status and plant tissue tests or with other soil properties. However, plant tests are considered the best indicator of plant nutrients status. Relying on plant tests, the present results revealed that plum orchards of Peshawar valley were deficient in varying levels of micronutrients. The deficiency of B and Zn were more severe compared with other micronutrients. These results are in line with the early work of Muhammad *et al*. (1995), but now the extent and severity of deficiency for these micronutrients increases day by day. The deficiency of B and Zn in plum orchards may be due to low content of these nutrients in soils or the unfavorable physico-chemical properties of soils of the Peshawar valley. Patiram *et al*. (2002) also indicated the usefulness of soil properties in assessing the micronutrients availability in mandarin orchards. The present results suggest that the growers should use B and Zn fertilizers

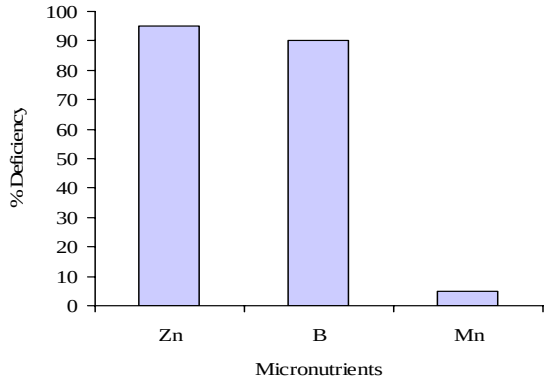

Figure 1. The severity of micronutrients deficiency in plum orchards soils of Peshawar valley

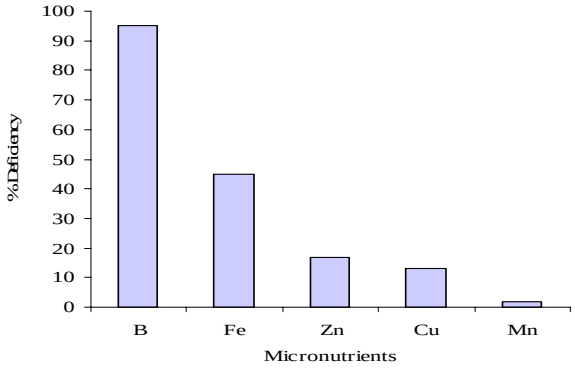

Figure 2. The severity of micronutrients deficiency in plum orchards leaves of Peshawar valley

along with other fertilizers for getting maximum yield and good quality plum fruit. Field experimentations are required to determine suitable dose of micronutrients application to plum orchards in the Peshawar valley.

Table 5. Range and mean values of chemical properties of plum orchards soil

Soil property	Range		Mean	± SD	%CV
	Min	Max			
pH (1:5)	7.79	8.62	8.21	0.14	01.70
EC dS m^{-1}	0.08	0.21	0.15	0.04	26.60
Organic matter (%)	0.28	3.04	0.91	0.60	95.63
Lime (%)	4.70	22.5	15.25	5.05	33.20

Conclusions

Plum orchards were found deficient in various micronutrients, but the deficiency of Zn and B were more severe. Based on leaf tissue test, the deficiencies were in the order, such as B > Fe > Zn > Cu > Mn. The soils of plum orchards were alkaline in reaction, non-saline in nature, deficient in organic matter and were moderate to strongly calcareous in nature. Based on our results, the growers are advised to use micronutrients, specifically Zn and B along with other fertilizers for getting maximum yield and good quality plum fruit.

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