Scientific Papers. Series A. Agronomy, Vol. LX, 2017
ISSN 2285-5785; ISSN CD-ROM 2285-5793; ISSN Online 2285-5807; ISSN-L 2285-5785

SUGAR BEET LEAF CHARACTREISTICS AND WITE SUGAR CONTENTS CHANGE BY ZINC AND PHOSPHORUS

Hamid MADANI[1], Saeid BORJI[2], Nourali SAJEDI[1]

[1]Islamic Azad University, College of Agriculture, Arak Branch, Arak, Iran
[2]Ministry of Agri- Jahad, Markazi Province, Ashtian Agri- Jahad Organization, Ashtian, Iran

Corresponding author email: h-madani@iau-arak.ac.ir

Abstract

The aim of current study was to verify the effect of zinc and phosphorus application in soil on leaf characteristics and sugar content in sugar beet root. For this purpose, Sugar beet was grown under field conditions for 2009-2010 cropping season in Arak, Navazen, Iran. The experiment was a completely randomized block design with a factorial arrangement in three replications. Zinc treatment was from two levels of zinc (Z) soil application. Z1 as control and Z2 was 25 kg/ha $ZnSO_4$ as soil application and phosphorus treatment were P1 to P4 with four levels of 125, 250, 375 kg/ha ammonium super phosphate (ASP) and non as control, respectively. In young sugar beet fields, the use of low amounts of ammonium super phosphate will show the best response for zinc interaction. In our experiment at 45 days after sowing date, the sugar beet leaf chlorosise could decrease by 25 kg/ha $ZnSO_4$ as soil application. In all recorded data in 70, 85 and 100 days after sugar beet seed sowing date the number of yellow leaves was decreased when zinc sulfate insert in soils. In addition, phosphorus and zinc interaction had significant effects on petiole water content. Petiole water content is a much related treat to viability of sugar beet leaf and its functions especially in young stage of plant. Petiole RWC at 85 days after planting date has significant changes too. LAI was significant changes when plants were 45 days old.

***Key words**: sugar beet, zinc, phosphorus, leaf, petiole, LAI.*

INTRODUCTION

In most calcareous Iranian soils, the solubility of micronutrients is far less due to high soil pH, low organic material and also water limitation condition (Shirinyan and Ponomarenko, 1981). This kind of chemical and biologic nutrient interaction is the main cause for limiting micronutrient elements uptake by plants (Madani et al., 2014). In sugar beet plants the leaf organs playing important roles in photo-synthesis and assimilation those are very influents on plant growth characteristics and sugar accumulation in roots. The other most important roles of sugar beet leave regard to ability of wide sugar leaf tissues to stay green or yellow.

Root system with a large size in sugar beet plant need to a wide range of macronutrients (Hopkins and Ellsworth, 2003). Phosphorus is one of the impact factors in root yield and sugar assimilation (Salimpour et al., 2010). Root crops needs to simple way to option and accumulate microelements (Alloway, 2008; Khorgamy and Farnia, 2009). Total value of zinc is depending to other chemicals in soil and their interaction. Zinc is in different forms in the soil as water-soluble, exchange, connected to organic matter and stabilized by the secondary clay minerals (Alloway, 2008). Zinc mobility and uptake in soil is dependent on many factors such as soil acidity, zinc total value in the soil, organic matter and soil type (Simms and Smith, 2001; Alloway, 2008). Zinc is essential micronutrients for proteins production in plants. In addition, it seems that soil application of zinc can considerably improve root yield especially in poor soils (Sagardoy et al., 2009). In maize, zinc concentration in roots and shoots were increased by zinc application both in soil and foliar. Regarding the form of application, zinc concentrations in roots and shoots showed a similar trend. The highest zinc doses promoted the maximum zinc concentration in plants both for soil and foliar application (Carolina et al., 2011). Zinc is also essential for plants, and Zn deficiency is a common problem in plants grown in high pH, calcareous soils (Cakmak et al., 1996), whereas in low pH soils Zn availability is generally high (Chaney, 1993). Phosphorus is a component of nucleic acids and

lipids and is important in the production and transport of sugars, fat and protein during sugar beet production. Phosphorus is especially important during early root development. A good supply of phosphorus ensures rapid root growth and good uptake of other nutrients. Phosphorus is very immobile in the soil and is only taken up within 1-2 mm from the root.
The objective of the present study was to investigate the effects of soil application of different levels of phosphorus chemical fertilizer and Zinc soil application on total number of leaf formation, no. of active and non active leave and growth, photosynthetic characteristics and water content, leaf area index and white sugar content in sugar beet (*Beta vulgaris* L.).

MATERIALS AND METHODS

A field experiment was conducted during 2010 in the research farms in Arak, Navazen (49° 46´N, 34°06´E and elevation 1710 m above sea level), Iran. The experiment was a factorial arrangement in a completely randomized block design with three replications. Zinc treatment was from two levels of zinc (Z) soil application. Z1 as control and Z2 was 25 kg/ha $ZnSO_4$ as soil application and phosphorus treatment were P1 to P4 with four levels of 125, 250, 375 kg/ha ammonium super phosphate (ASP) and non as control, respectively. The soil zinc and phosphorus content measured according to Black. 1983 (Table 1). Then total needs of fertilizers insert to the soil before planting time.

Table 1. Soil test properties results

Physical properties	0-40 depth (cm)
Soil texture	Clay loam
Clay (%)	42
Silt (%)	39
Fine send (%)	19
Chemical analysis	
Available (K) (mg/1000 g soil)	123
Available (P) (mg/1000 g soil)	5.7
Total nitrogen (mg/1000 g soil)	0.12
Zn (mg/1000 g soil)	2.3
Mn (mg/1000 g soil)	0.2
Cu (mg/1000 g soil)	0.2
Fe (mg/1000 g soil)	1.6
CaCO3 (%)	28
Organic matter (%)	1.1
EC (ds/m/25°C)	0.6
pH	8.0

In this experiment the sugar beet (SBSI005 Crouse cv.) seeds were obtained from the Sugar Beet Research Institute, Karaj. Iran. The field was plowed in autumn 2009 and then was used two cross over disk in spring 2010. The experimental unit area was 18 square meters consisting of six rows (6 m long and 3 m with 50 cm between rows). Seeds were hand sown on June 10^{th} and harvesting time was 10^{th} October 2010 in 2.5×6 m plots with a inter row space of 0.5 m. Nitrogen and potassium fertilizers were added before sowing at a rate of 300 and 200 kg/ha as a form of urea (46% N) in three equal portions and potassium sulfate (50% K_2O), respectively. Thinning operation was done twice. Number of green and yellow leave and trash leaf were measured at 45, 60, 70, 85 and 100 days after sowing date. At harvest time, the petiole water content (PWC), leaf area index (LAI) and white sugar content (WSC) parameters were recorded. The sucrose percentage was determined according to Dutton and Bowler (1984) obtained data were statistically analyzed as factorial experiments in complete randomize design and the treatments means were compared by using Duncan multiple test and 5% of probability.

RESULTS AND DISCUSSIONS

The results presented in Table 2 indicated that green, yellow and trash leaf numbers of sugar beet plants were significantly differed responses to zinc, phosphorus treatments and Z.P interaction. Zinc treatment had not significant effect on change of number of green leaf per plants from 45 to 100 days after planting date. The yellow leaf number in sugar beet was changed by zinc significantly at 45, 70, 85 and 100 days after planting. Number of trash leaf also, had no significant changes from 45 to 85 days after sowing date. Phosphorus treatment could change the number of green leaf at 70 days after sowing date significantly. Number of yellow leaf except for 70 days after sowing date in all other sugar beet stages significantly changed. But number of trash leaf changed in all sugar beet stages significantly except for 60 and 100 days after sowing date. Furthermore, the interaction effects of Z and P treatments in 45 days after sowing date had no effect on number of green leaf. the number of yellow leaf showed significant change from 45 and 70 to 100 days after sowing significantly. Number of dry leaf in case of ZP interaction was significant changes at 85 to 100 days after sowing date. The trash leaf number of sugar beets in 100 days after sowing date increased significantly more by using 250 kg/ha ammonium super phosphate compared to the control treatment but, by zinc application in case of 25 kg/ha $ZnSO_4$ as soil application the number of trash leaf reduced from 2.8 to 1.2 significantly. It showed that zinc application could improve the number of loss leaf in 100 days after sowing date as a good point. Sagardoy et al. (2009) also, reported same trends. Therefore, leaf photosynthesis duration and sugar accumulation could increase by zinc application in calcareous soil. Use of large amount of P (more than 250 kg/ha ammonium super phosphate) in similar soil condition would decrease trash leaf numbers when zinc application was used.

Table 2. Effect of zinc and phosphorus soil application on leaf number of sugar beet

Treatments	Zinc			Phosphorus			Z.P Interaction		
D.F	1			3			3		
Day after planting	No. of leaf			No. of leaf			No. of leaf		
	Green	Yellow	Trash	Green	Yellow	Trash	Green	Yellow	Trash
45	ns	*	n/a	ns	**	n/a	ns	**	n/a
60	ns	ns	ns	ns	ns	*	ns	ns	ns
70	ns	**	ns	*	**	ns	ns	**	ns
85	ns	**	ns	ns	**	ns	ns	**	**
100	ns	*	**	ns	**	**	ns	**	**

ns, *,** = nonsignificant and significant probability level at 5%, respectively

The control treatments for P application also, had same effect on trash leaf numbers too. Thus, zinc application was the most cause for stay greening the leaf and prevention for leaf maturity and dried. Figure 1 will show that in poor soils of P, zinc application has not sharp effect on increase of green leaf age and sugar assimilation duration. In young sugar beet fields, the use of low amounts of ammonium super phosphate will show the best response for zinc interaction. In our experiment at 45 days after sowing date, the leaf chlorosise could decrease by 25 kg/ha $ZnSO_4$ as soil application. In all recorded data in 70, 85 and 100 days after sugar beet seed sowing date the numbers of yellow leaf were decreased when zinc sulphate insert in soils. Simms and Smith (2001) and Dahdoh et al. (1988) reported same results.

Table 3. Effect of zinc and phosphorus soil application on some plant characteristics in sugar beet

Treatments	Zinc			Phosphorus			Z.P Interaction		
D.F	1			3			3		
Day after planting	PWC	LAI	WSC	PWC	LAI	WSC	PWC	LAI	WSC
45	ns	ns	n/a	**	*	N/A	**	**	n/a
60	ns	ns	n/a	ns	**	N/A	ns	Ns	n/a
70	ns	ns	n/a	ns	ns	N/A	ns	Ns	n/a
85	ns	ns	n/a	ns	ns	N/A	**	Ns	n/a
100	ns	ns	n/a	ns	**	N/A	ns	Ns	n/a
Ripening stage	n/a	n/a	ns	n/a	n/a	ns	n/a	n/a	ns

n/a: nonapplicant, ns: nonsignificant, * and **: significant at 5% and 1% validity levels

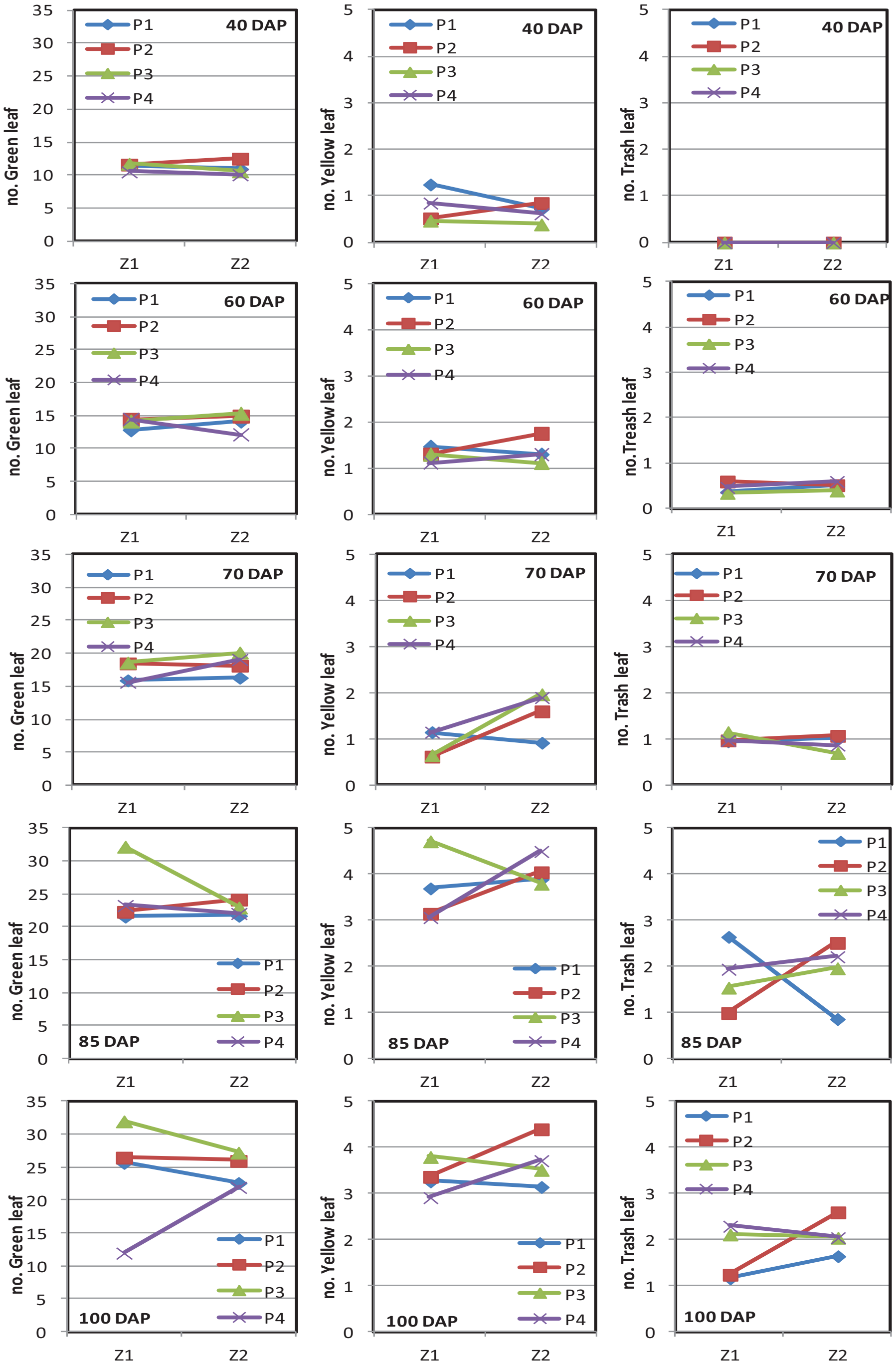

Figure 1. Zinc and phosphorus interaction effects on leaf number of sugar beet. Z1: control and Z2 were 25 kg/ha $ZnSO_4$ as soil application and P1 to P4 were 125, 250, 375 kg/ha ammonium super phosphate (ASP) and control, respectively

CONCLUSIONS

The results presented in Table 3 indicated that zinc effects on petiole water content and leaf area index in sugar beet plant were non significant changed from 45 to 100 days after sowing. Phosphorus effects on petiole water content and leaf area index in sugar beet plant were significant changed in plants with 45 days old. This significant change was stable for leaf area index for 15 days more and 100 days after sowing simultaneously (60 and 100 days old in sugar beet plant). Phosphorus and zinc interaction effects had significant effects on petiole water content as a very related treat to viability of sugar beet leaf and its functions in young stage of plant and also, in 85 days after sowing date. LAI was significant changes when plants were 45 days old. Zinc and phosphorus interaction had nonsignificant effect on white sugar contents compared to the control treatment in sugar beet roots.

ACKNOWLEDGEMENTS

This research work was carried out with the support of Islamic Azad University, Research and Technology Department.

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