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Reserach Article

Physical and Chemical Properties of Vineyard Soils in Manisa Province Alaşehir District

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Abstract

This research was carried out on 100 soil samples collected from 0-60 cm depths from 100 vineyards in 20 rural settlements in order to determine the general characteristics of the soils where grape production is made in the Alaşehir district of Manisa, which has the largest vineyard areas. With this research, the soil pH, EC, organic matter, textural classes, macro and micro nutrients of Manisa vineyard were determined. Results of the analysis of soil samples related to research area were compared with the limit values and fertility conditions of soils were evaluated. According to the findings; although the pH of the vineyard soil of Manisa province samples varies from strongly alkaline to neutral and the majority of the samples were characterized by organic matter deficiency. The salt values of vineyard soils were not constitute limiting factor. In terms of total nitrogen, all samples were classified in the lower nitrogen class. Approximately 48% of soil was calcareous, the available phosphorus was low by 29% and medium by 71% and the available potassium was found to be very low by 97% and low by 3%. Furthermore, available magnesium was very low (3%), low by 26%, medium by 27%, higher by 28%, and very high (16%); and the available calcium was very low (26%), low by 27%, medium by 34% and higher (13%). It was also found that available zinc was low by 69% of the samples; iron content was adequate by 65% of the soil; manganese and copper were adequate in all samples. However, it was concluded that there are important relationships among the nutrient content of the vineyard soil samples.
Keywords: Viticulture, Soil Properties, Nutrient Contents, Alaşehir.

Manisa İli Alaşehir İlçesi Bağ Topraklarının Fiziksel ve Kimyasal Özellikleri

Öz

Bu araştırma, Manisa ilinin en büyük bağ alanlarına sahip Alaşehir ilçesinde üzüm üretiminin yapıldığı toprakların genel özelliklerini belirlemek amacıyla, 20 kırsal yerleşim yerlerindeki 100 bağdan 0–60 cm derinliklerden olmak üzere toplanan 100 toprak örneği üzerinde gerçekleştirilmiştir. Bu araştırma ile Manisa bağlarının toprak pH, EC, organik madde, doku sınıfları, makro ve mikro besin maddesi özellikleri belirlenmiştir. Araştırma alanıyla ilgili toprak örneklerinin analiz sonuçları sınır değerlerle karşılaştırılmış ve toprakların verimlilik durumları değerlendirilmiştir. Bulgulara göre; Manisa ili bağ toprak örneklerinin pH'ı kuvvetli alkalinden nötre doğru değişmekle birlikte örneklerin çoğu organik madde eksikliğiyle karakterize edilmiştir. Bağ topraklarının tuz değerleri sınırlayıcı bir faktör oluşturmamaktadır. Toplam azot açısından, tüm örnekleri alt azot sınıfında sınıflandırılmıştır. Bağ topraklarının yaklaşık %48'i kalkerli, mevcut fosforun %29'unun düşük ve %71'inin orta, mevcut potasyumun %97'sinin çok düşük ve %3'ünün ise düşük olduğu bulunmuştur. Mevcut magnezyumun %3'ünün çok düşük, %26'sının düşük, %27'sinin orta, %28'inin yüksek ve %16'sının çok yüksekolduğu tespit edilmiştir. Mevcut kalsiyumun %26'sının çok düşük, %27'sinin düşük, %34'ünün orta ve %13'ünün yüksek olduğu belirlenmiştir. Ayrıca bağ toprak örneklerinin %69'unda mevcut çinkonun düşük olduğu saptanmıştır. Demir, %65'inde yeterli; manganez ve bakır, tüm örneklerde yeterli

bulunmuştur. Bununla birlikte, bağ toprak örneklerinin besin element içerikleri arasında önemli ilişkilerin olduğu sonucuna varılmıştır.
Anahtar Kelimeler: Bağcılık, Toprak özellikleri, Besin maddeleri, Alaşehir.

Introduction

Turkey, located in the most convenient climate zone in the world for viticulture, has a longstanding and long–established viniculture culture and a rich grapevine gene potential due to its location in the center of the geography where the gene centers intersect (Celik, 2011).

According to the statistics of the year 2016, Turkey is one of the world's major wine producing countries with 435 227 hectares of vineyards and 4 000 000 tonnes of grape production. In terms of area and production it takes the 5th and 6th places in the world, respectively. Table grape accounts for 49.8% total grape production, and dried grape and wine varieties follow table grape with 38.4% and 11.8%, respectively (Anonymous, 2017). Grape is a valuable product that has a significant place in the agricultural sector of Turkey with its diversity of evaluation forms, domestic market consumption and export share, and thus constitutes the area of activity and direct income of a large farmer's sector.

Soil fertility is defined as containing sufficient and balanced amounts of nutrients, soils with suitable physical, chemical and biological properties for the growth of crop plants. It is also important for knowing the soil properties and determining the possible effects in advance for the healthy development of plant and the creation of a suitable nutrition program (Basar, 2001; Basayigit et al., 2008). In the agricultural production process, if the nutrients required for the plants are not found in the soil in sufficient amounts or in excessive amounts, they limit the utilization of the plants in the soil and cause the cultivated product to be negatively affected (Turan et al., 2010; Karaman, 2012). Increase yield and quality in viticulture could be changed depending on variety, rootstock, type of soil, content of available nutrients in the soil and tillage, fertilization, summer and winter trim, plant protection etc. as cultural practices (Viets et al., 1973; Winkler et al., 1974; Kovancı and Atalay, 1977; Çelik, 1996; Yağmur et al., 2002; Bahar et al., 2006; Uzun, 2011; Çelik, 2011; Zengin and Özbahçe, 2011; Bahar et al.,, 2018). Soil analysis is one of the most practiced methods in determining the physical and chemical properties of soils, and in researching nutrients and nutritional status of plants (Mulla and Mc Bratney, 2001). In this respect, many studies have been carried out in order to determine the various soil characteristics and productivity conditions of different regions and agricultural areas throughout Turkey, to identify possible problems in advance and to increase the yield and continuity of cultivated plants (Atalay, 1977; Atalay, 1978; Brohi and Aydeniz, 1987; Aktas and Karacal, 1988; Irget and Atalay, 1992; Aydın and Coban, 2002; Coban, 2008; Ates and Turan, 2015).

The Aegean Region (especially, Manisa and its surroundings) is in the first place among seven districts of Turkey, accounting for 28% of total vineyard area and 45% of grape production. According to the statistical data related to the year 2016; in Alaşehir, 120 251 hectares of vineyards are being used and 458 683 tons of fresh grapes are produced (Anonymous, 2018). Sultani Cekirdeksiz, Mevlana, Red Globe, Superior Seedless, Crimson Seedless, Antep Karası, Trakya Ilkeren are produced and imported mainly in Alasehir province. This study has been designed with the belief that it is important to determine status of physical and chemical properties of vineyard soil in Alasehir province where the grape is intensely produced in Aegean Region. It is also important that changes can be monitored which will happen in future.

Material and Methods

Experimental Site

Experiments were conducted in 2015 in Alaşehir district of Manisa located in Western Turkey (38°20′N, 28°38′W). The total area of this district is 977 km² and its elevation from sea level to center is 189 meters. Alaşehir district is the largest grape producing vineyard area of Manisa Province (Figure 1). The area has a transition towards a continental climate from a Mediterranean climate. The annual average temperature is recorded as 16.7°C with and a mean annual precipitation of 598 mm, the summer months, including harvesting season, are quite hot with mean temperature as 30°C. Location of soil samplings taken from vineyards are given in Table 1.

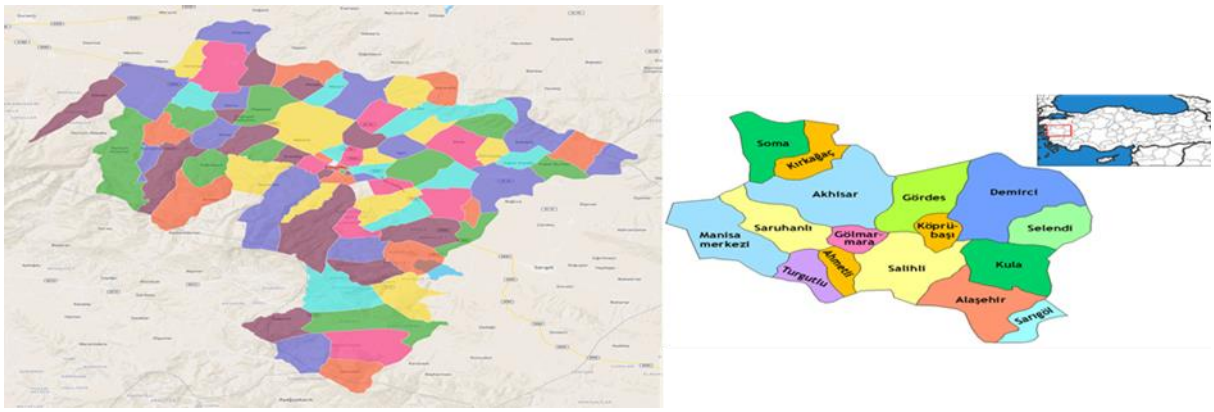

Figure 1. Map of the province of Alaşehir district of Manisa, Turkey.

Table 1. Name of rural settlements and number of collected samples

Rural settlements	Number of vineyard	District	Number of vineyard
Yesilyurt	9	**Kozluca**	5
Kavaklidere	5	**Piyadeler**	5
Sahyar	5	**Badinca**	4
Akkecili	8	**Örnekkoy**	4
Merkez	6	**Delemenler**	4
AlemSahli	5	**Badinca**	4
Sobran	4	**Matarli**	4
Toygar	5	**Belenyaka**	4
Killik	6	**Uzumlu**	5
Baklaci	4	**Yenikoy**	4

Methods

A total of 100 soil samples collected at fruit setting stage from 0-60 cm depth at which the vine's nutrient uptake and root development are the highest from 100 vineyards in 20 rural settlements Alaşehir district in Manisa of several points of vineyards. Sultani Çekirdeksiz, Mevlana, Red Globe, Superior Seedless, Crimson Seedless, Antep Karası, Trakya Ilkeren grape varieties are mainly produced and imported in the Alasehir district.

Soils were mixed, dried in the shade, and aiming to prepare for analysis, soils are pounded with a wooden hammer, passed through from a 2 mm sieve (Chapman and Pratt, 1961). As stated from Ulgen and Yurtsever (1995), soil texture was determined by adding distilled water to soil samples until soil samples reached the saturation. pH meter is used to determine soil reaction (pH) (Jackson, 1967; Kacar, 1995). EC meter is used to determine electrical conductivity (Soil Survey Staff, 1951); soil salinity (%) were determined as electrical conductivity (EC) with a ratio of 1:5 soil: distilled water suspension set have been different places of according to Richards (1954). Organic matter was determined using a wet oxidation technique (Nelson and Sommer, 1982). The amount of lime ($CaCO_3$) was determined according to Caglar (1958). Total nitrogen (N) was determined by using the Kjeldahl method (Kacar, 1995). Available phosphorus (P) was determined according to Olsen et al., (1954). Available calcium (Ca), magnesium (Mg) and potassium (K) were determined by extraction with 1 N ammonium acetate according to Bayraklı (1987). Available iron (Fe), manganese (Mn), zinc (Zn) and copper (Cu) by extraction with 0.05 DTPA–TEA according to Lindsay and Norvell (1978).

Some physical and chemical properties of soils assessed by Pearson correlation coefficient and their relationships, with each other, are examined.

Results and Discussion

Soil Analysis

The minimum, maximum and average values of the characteristics of soil samples contents of research areas by rural settlements are given in Table 2. As can be seen from Table 2. classification according to the limit value of each investigated property of Alaşehir vineyard area was performed and the following average results have been obtained.

Physical Analysis of Soil of Alaşehir Vineyards

It has been reported that the saturation develops well in textured soils, which can be aerated for vineyards, even in permeable clayey soils (Colakoglu, 1985). Texture of the soil samples varied between 29.70–70.95%. According to Ulgen and Yurtsever (1995), the area of reasearch soils were classed to 72% loamy, 25% clay–loamy, 2% clay and 1 % sandy in texture. In our study, it has been determined that a significant part of soils examined was medium soils texture (98%). Medium soils texture are the most favorable soils to be used as agricultural lands, and they are almost suitable for growing the all plants. When the results of our study are analyzed, it is understood that the soil of the study area is suitable for practicing the viticulture. It has been reported that the vineyards show the best development in soils which are rich in terms of calcium and their pH limit varies between 6.0–8.0 (Colakoglu, 1985). As can be seen from Table 2., the pH values of soil samples showed differences between 5.74 – 9.16 Soils of the reasearch area were classified as to %48 strong alkaline (48%), alkaline (37%), light alkaline (7%) and neutral (8%) according to Jackson (1967) and Kacar (1995). Soil pH was the limiting factor for viticulture in research areas. Alkaline reaction of soils causes yellowness in the vineyard. Therefore, it has been considered to carry out the necessary applications in the district where the research was conducted (Horuz et al., 2016). Salinity level of soil samples has been varied between 0.02–0.66%. According to the Soil Survey Staff (1951), the soil samples of the overall reasearch area were found with a saltless level between 0.00–0.15%. When the obtained results of our research evaluated, it has been understood that the vineyard can be established in Alaşehir district without any limitation in terms of salinity (Table 2.).

In Table 2., lime ($CaCO_3$) content of soil samples varied between 0.49–56.24 %. Soils of reasearch area were classified as 52% low lime (0.00–2.50%), 27% limy (2.50–5.00%), 14% high (10.00–20.00%) and 7% very high level according to Caglar (1958). Lime in certain amounts in the soil has a positive effect on the physical and chemical properties of soil. However, the large amount of lime in the soil shows some negative effects on plant development. For this reason, it is necessary to find optimum amounts of lime in soil both in terms of soil fertility and plant demands. Kacar and Katkat (1999) reported that the medium calcareous soils are ideal vineyard soils. The salt level of vineyard soils didn't consider a limiting factor. $CaCO_3$ level of soil was without any limitation factor for viticulture in reasearch area. Soil organic matters of the samples varied between 0.80–1.20%. Soil organic matters of the whole reasearch area were determined to be in low (<2.00%) class according to Rauterberg and Kremkus (1951) and Ozbek (1975). The importance of soil organic materials is much more than that of other nutrient materials for grapes (Table 2.). Organic matter has a significant effect on the physical, chemical and biological properties of soils. Guzel (1989) reported that the fertile field soils mostly contain between 2–5% organic matters. According to this information and assessments, it is necessary to take adequate measures to ensure that the contents of organic matter of Alaşehir district lands are between 2–5% due to the low organic matter contents.

Macro Nutrient Contents of Soil of Alaşehir Vineyards

The total nitrogen contents of the soil of reasearch area varied between 0.04–0.06%. The soil samples of reasearch area were found to be low nitrogen level determined by Kacar (1995) as 0.045 % (Table 2.). Nitrogen (N) has a major impact on development, shoot growth, yield and quality in vineyards (Bell and Robson, 1999; Bell and Henschke, 2005). In order to positively affect the development of grapevine, nitrogen enhancing applications should be applied to the Alaşehir vineyard areas. As can be seen from Table 2., the available phosphorus contents of collected samples varied between 4.81–89.71 ppm. The soil phosphorus level of reasearch area has been classified as 29% low and 51% adequate level (7.00–20.00 ppm), and 20% very high level (>20.00 ppm) according to Olsen et al., (1965). The available Potassium content of the soil samples varied between 3.42–130.97 ppm (Table 2.). The soils potassium of reasearch area has been classified to 97% very low level (<100 ppm) and 3% lov level (100.00–200.00 ppm) according to Kacar (1995).

In Table 2., the available magnesium content of soil samples varied between 18.44–1110.00 ppm. The magnesium level of the soil of reasearch area has been reported as 3 % very low level (<55 ppm), 26 % low level (55.00–117.00 ppm), 27% adequate level (117.00–200.00 ppm), 28% high level (200.00–400.00 ppm) and 16% very high level (>400 ppm) according to Kacar (1995). The plant needs Mg to activate many enzymes required for plant growth. It is a primary constituent of the chlorophyll molecule, so deficiency causes leaf chlorosis (Christensen and Peacock, 2000; Tewari et

al., 2006). According to such information and assessments due to the low Mg content, in order to increase grape yield and quality, Mg fertilizer applications should be done. As can be seen from Table 2., the available calcium component in grapes varied between 116.40–5016.00 ppm. Soil calcium level of the reasearch area has been classified as 26% very low level (<715 ppm), 27% low level (715–1440 ppm), 34% adequate level (1440–2867 ppm) and 13% high level (2867–6120 ppm) according to Kacar (1995).

Micro Nutrient Contents of Soil of Alaşehir Vineyards

In Table 2., the available zinc components of the soil samples collected from reasearch area varied between 0.01–6.27 ppm. The samples were found to be 67% low level (<0.5 ppm), 30% critical level (0.5–1.0 ppm) and 3% adequate level (>4.50 ppm) according to Lindsay and Norvell (1978). It is involved in multiple metabolic processes and participates in the development of reproductive parts of grape vines. As can be seen from Table 2., the available iron content of the soil samples of reasearch area varied between 1.31–21.66 ppm. The samples were found to be 15% low level (<2.5 ppm), 20% critical level (2.50–4.50 ppm) and 65% adequate level (>4.50 ppm) according to Lindsay and Norvell (1978). Iron has major importance in grapevine nutrition. Fe deficiency has a particularly negative effect on chloroplast size, protein content and photosynthetic efficiency. When the results of our study are analyzed, in Fe–deficient areas, soil or foliar fertilizer applications of Fe should improve grapevine growth, yield and quality. In Table 2., the available copper components varied between 0.06–39.60 ppm. The soil calcium level of the research area has been recorded as 96% adequate level (>0.2 ppm) and 4% critical level (<0.2 ppm) according to Viets and Lindsay (1973). As can be seen from Table 2., available manganese components varied between 0.64–29.34 ppm. The critical value of 1 ppm, which was determined by Lindsay and Norvell (1978) was found to be 98% adequate level (>1 ppm), 2% critical level (<1 ppm) and in all the samples.

Table 2. The min., max.–avg. values of characteristics of soil samples contents of research areas

Properties	Unit	Maximum	Minimum	Average
Saturation	(%)	70.95	29.7	45.52
Texture	–	Clay loam	Sandy	Loamy
pH	–	9.16	5.74	8.24
Salt	(%)	0.66	0.02	0.08
$CaCO_3$	(%)	56.24	0.49	4.46
OM	(%)	1.20	0.80	0.96
N	(%)	0.06	0.04	0.05
K	(ppm)	89.71	4.81	10.16
Mg	(ppm)	130.97	0.04	30.84
Ca	(ppm)	1110	18.44	252.39
Zn	(ppm)	5016.00	116.40	1591.85
Fe	(ppm)	6.27	0.01	0.61
Cu	(ppm)	21.66	1.31	6.34
Mn	(ppm)	39.60	0.06	2.67

As far as the characteristics of soil types, it has seen that the majority of soil samples are found as loamy type (Table 2.). Previous research results indicated that the most of the vineyards in the Aegean Region had a loamy soil, which is generally calcareous, neutral, alkaline and having inadequate organic matter and nitrogen, but has no salt problem in the soil (Kovancı and Atalay, 1977; Konuk and Colakoglu, 1986; Irget, 1988; Atalay and Anac, 1991; Irget and Atalay, 1992; Yener et al., 2002).

Correlation coefficients between characteristics of some physical and chemical properties of vineyard soil of research area

The relationships between the soil characteristics of soil samples taken from reasearch area and their nutrient contents are presented in Table 3. The importance of interactions among different nutrients increase as the agriculture intensifies in Turkey and the deficiencies of nutrients in different products increase. Therefore, revealing the interactions between some of the physical and chemical properties of vineyard soils as well as demonstrating the rates of these interactions is of great importance in order to obtain higher yield and quality products from the vineyards of Alaşehir.

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Table 3. Soil characteristics of soil samples taken from reasearch area and correlation coefficients of some nutrients

	Saturation (%)	**pH**	**Salt (%)**	**$CaCO_3$ (%)**	**P (ppm)**	**K (ppm)**	**N (%)**	**O.M. (%)**	**Zn (ppm)**	**Fe (ppm)**	**Cu (ppm)**	**Mn (ppm)**	**Mg (ppm)**	**Ca (ppm)**
Saturation (%)	1													
pH	0.324 ns	1												
Salt (%)	0.564*	0.130 ns	1											
$CaCO_3$ (%)	0.154 ns	0.104 ns	0.224 ns	1										
P (ppm)	–0.008 ns	–0.330 ns	–0.118 ns	–0.091 ns	1									
K (ppm)	0.489*	0.156 ns	0.346 ns	0.316 ns	0.202 ns	1								
N (%)	–0.476*	–0.090 ns	–0.215 ns	0.099 ns	–0.243 ns	–0.250 ns	1							
O.M. (%)	–0.597*	–1.094 ns	–0.339 ns	0.298 ns	–0.385 ns	–0.397 ns	–0.415	1						
Zn (ppm)	0.108 ns	–0.032 ns	–0.058 ns	–0.017 ns	0.484*	0.096 ns	–0.336 ns	–0.336 ns	1					
Fe (ppm)	0.337 ns	–0.041 ns	0.175 ns	–0.171 ns	0.330 ns	0.078 ns	–0.308 ns	–0.308 ns	0.142 ns	1				
Cu (ppm)	0.228 ns	0.055 ns	0.044 ns	–0.008 ns	0.150 ns	0.218 ns	–0.285 ns	–0.285 ns	0.352 ns	0.203 ns	1			
Mn (ppm)	0.313 ns	–0.101 ns	0.125 ns	–0.120 ns	0.161 ns	0.130 ns	–0.329 ns	–0.329 ns	0.146 ns	0.493*	0.128 ns	1		
Mg (ppm)	0.452*	0.317 ns	0.295 ns	0.228 ns	–0.105 ns	0.560*	–0.154 ns	–0.154 ns	–0.132 ns	0.198 ns	0.035 ns	0.209 ns	1	
Ca (ppm)	0.404*	0.223 ns	0.291 ns	0.408*	–0.197 ns	0.499*	–0.060 ns	–0.060 ns	–0.058 ns	–0.141 ns	–0.066 ns	0.043 ns	0.497*	1

*= significant at 5% ns: not significant.

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The multiple correlation analysis of the content of elements determined in vineyards of Alaşehir. Looking at the correlations among nutrient contents of soil characteristics of reasearch area in 0–60 cm depth, the correlation was significant and positive between saturation percentage (SP) and salt at 5% significance level (0.564); significant and negative between SP and organic matter at 5% significance level (–0.476); significant and negative between SP and nitrogen at 5% significance level (–0.476); significant and positive between SP and potassium at 5% significance level (0.489); significant and positive between SP and magnesium at 5% significance level (0.452); significant and positive between SP and calcium at 5% significance level (0.404); significant and positive between lime and calcium at 5% significance level (0.408); significant and positive between phosphorus and zinc at 5% significance level (0.484); significant and positive between potassium and calcium at 1% significance level (0.499); significant and positive between potassium and magnesium at 5% significance level (0.560); significant and positive between magnesium and calcium at 5% significance level (0.497), and significant and positive between iron and manganese at 5% significance level (0.493).

Conclusions

According to the results of soil samples analyses obtained from reasearch area in Alaşehir district, the soil samples vary from loamy to clayey–loamy structure of which 72% has a loamy structure. The pH of the soil samples varies from highly alkaline to notr, 48% highly alkaline, 38% alkaline, 7% mild alkaline and 5% was notr and the majority of the samples were characterized by organic matter deficiency. The salt values of the vineyard soils were not found a limiting factor. In terms of total nitrogen, all samples were classified as lower nitrogen class. The soil was calcareous, the available P and Ca was medium and the available K was found to be very low. Moreover, the available Mg was medium and higher. It was also found that available Zn was low and Fe was adequate of the samples. Mn and Cu were adequate among whole samples. In addition, the presence of significant bilateral relations regarding to some physical and chemical properties of vineyard soils were also determined. P, K, and Ca directions were variable in reasearch areas of Alaşehir distirct. Fe, Mn and Cu of research area soils were determined as above level and Zn as inadequate level on the recommended level of the soil of whole research area.

According to the overall results of our study, it is determined that it would be beneficial to enrich vineyard area of Alaşehir district of Manisa, where the organic matter is decomposed rapidly due to its high temperature. At least, once in every two years regularly with old farmyard manure as well as supplementing. And also it should be supplied the nitrogenous and zinc fertilizers to research area where N and Zn deficiencies are found in the soil.

Conflict of Interest Statement

The authors declare no conflicts of interest concerned to this work.

Contribution Rate Statement Summary

The authors declare that they have contributed equally to the article.

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