Estımatıon of Nutrıtıonal Status of Potato(*Solanum Tuberosum* L.) Plant by Soıl and Leaf Analyses Grown in Oltu Town of Erzurum

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***Abstract*— This study was conducted to determine the fertility potential of potato grown soils in Oltu Town region of Erzurum city to achive this a total of 13 (2 replicate sampling from each locations) soil (was performed to determine soil texture, lime content, soil pH, total salt, soil organic matter content ,cation exchange capacity (CEC) and macro and micronutrient concentrations) and leaf samples were collected (macro and micro nutrient content) and analyzed.**

The results showed that 30.77 % clay loamy, 61.54% sandy clay loam texture of the study area, respectively. Most of the soil pH slightly alkaline reactions. Soil organic matter content was deficient in all the region's soils and approximately half of the soils were classed as saline soils. Total N (7.69%), Mn (100%), and B (89.47 %)were in unsuffecient level and Pb and Cd is not at toxic levels in plant and soils. The analysis also showed plant available nutrients (Calcium Ca. Magnesium Mg and Potassium. K) concentrations of soil samples in adequate proportions. Plant available nutrients such as Iron (Fe) and Cupper (Cu) were at suffecient levels. Also Lead (Pb). Nicel (Ni) and Cadmium (Cd) were not at toxic levels in plant and soil samples. Plant available nutrient such as Manganes (Mn), Boron (B) was low in soils sampled from Oltu town agriculture soils.

As a result of this. potato plant leaves grown on Oltu town agriculture soils recorded insufficient levels of Phosphorus (P), boron (B), and zinc (Zn). The results indicates that growers should make an attempt to conserve and improve the current fertility status of the soils.

***Index Terms*— potato. critical nutrient levels. leaf analysis. soil analysis. fertility potential**

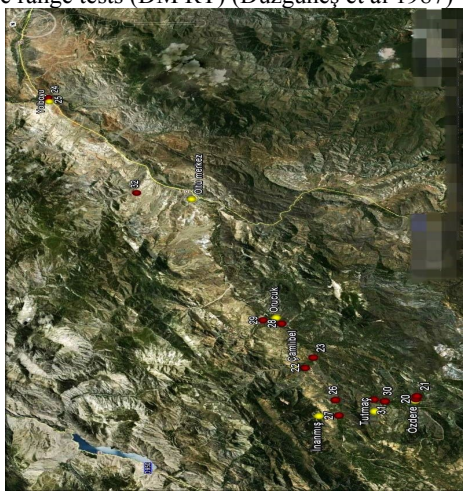
I. INTRODUCTION

Chemical soil analysis shows the potential availability of nutrients that roots may take up under conditions favorable for root growth and activity. Plant analyses in the strict sense reflects only the actual nutritional status of plants. Therefore. in prenciple a combination of both methods provides a beter basis for recommending fertilizer applications than one method alone (Marschner. 1997)[1].

Potato is one of the important products that are cultivated in the world and in Turkey. Recently. there has been important developments and variations in the usage of potato in human nutrition. It is certain that the suitable fertilizer and fertilization will be used to raise the yield per unit of area of potato and reveal the features of the required quality (Tugay et al 1999).

II. MATERIAL AND METHOD

Soils from 13 (2 replicate each locations) representative were sampled (Jackson 1962) [2]. from potato grown fields in early April. 2010 with the aim of defining the nutrient potential in potato plants cultivated in Oltu region soils. Soil samples from 0-40 cm depth in selected particular stations were taken and sieved with a 2mm mesh screen to analyse the different chemical properties and soil nutrient status. Leaf tissue was oven dried at 68 °C for 48hours and ground to pass through a 1-mm mesh screen. The potato plant leaf sampled in start flowering from the 4th leaf plant leaf sample was taken June 2010 . The Kjeldahl method and Vapodest 10 Rapid Kjeldahl Distillation Unit (Gerhardt. Konigswinter. Germany) were used to determine total N (Bremner. 1982) [3].. Macro elements (C.K.Mg. Na and P) , micro elements (B.Cu.Fe.Mn and Zn) and some heavy metals (Cd. Ni. Pb) were determined using an inductively coupled plasma spectrophotometer (Optima 2100 DV. ICP/OES; Perkin-Elmer. Shelton. CT) (Mertens. 2005). All the data was subjected to analysis of variance using SPSS. a statistical program for data analysis. Means were separated by Duncan's multiple range tests (DM RT) (Düzgüneş et al 1987)[4]..



Figure; Soil and potato leaf sampled points of Oltu Town plain

III. RESULTS AND DİSCUSSION

Evaluation of The Soil Analyses results

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Chemical and physical proferties of sampled soils; texture classes ranged from 30.77 % clay loamy, 61.54% sandy clay loamy of soils sampled from Oltu region . Statistical analysis showed close relation between the plant nutrient availability and the soil texture (Kacar and Katkat 2007)[5]..

Soil reaction (pH) of the soil samples ranged from 7.81-8.21 and averaging 7.99. This findings suggests that all of the soil samples are light alkaline in reaction (FAO 1990[1].; tovep 1991[1].; Günes vd 1998[1].). The pH of the soil is an important factor that affects the chemical. biological and physical processes in soils (Yıldız 2012) [ ].

The organic matter content of the soil samples ranged from 0.47- 4.1 % with an average of 2.37 %. This finding suggested that 15.38 % of the soil samples are very low. 30.76% are low and 50% are low, 23.07% medium and 23.07 % avarage and 7.69 high level respectively. The organic matter content of the soil had a negative weight dramatically because of the organic colloids that it contains. The weight of the organic colloids contents are far more than the clay minerals (Bakırcıoğlu 2009)[8].

The $CaCO_3$ content of the soil samples ranged from 2.9-17.09 % averaging 9.42 %. This finding suggests that all the soil samples are medium and high level. The fact that the lime contents of the soils are made unavailable of micro elements especially phosphorous and zinc (Udo vd 1970[9].; Mengel and Kirkby 1982[10].; Kacar vd 1998[11].).

The EC of the soil samples ranged from 0.4-0.76 dS/cm and averaging 0.58 dS/cm. This finding suggests that 61.53 % of the soil samples are medium salty , 38.47 % are high salty. The saltness stress is an environmental stress factor in terms of the cultivated plants and is the group of the chemical stress. The fact that the growth medium has a problem in terms of the salt brings about many negative effects (Yakıt and Tuna 2006)[12]..

Also the CEC of the soil samples ranged from 18.36-24.53 cmol kg-1 with an average of 21.22 cmol kg-1 (FAO 1990[1].; Tovep 1991[1].; Güneş vd 1998[1]).

The total amount of nitrogen in the soil ranged from 0.08-0.20 % with an average of 0,15%. These findings suggest that 7.69% of the samples are low whereas 10,52% were low and 46.15% adaquate and 46.15% high level. Plant available NH_4^+-N level of the soil samples ranged from 28-70 mg kg-1 and averaging 54.01 mg kg-1. Plant available NO_3- N level of the soil samples ranged from 28-70 mg kg-1 averaging 48.46 mg kg-1.

Plant available P level of the soil samples ranged from 17-50 mg kg-1 and avaraging 37.08 mg kg-1. This finding suggests that 30.76 % of the samples are adequate level. 69.24 % are high

The exchangeable K level ranged from 2.09-2.80 cmolkg-1 with an average of 2.42 cmol kg^1.

Ca excahangeable level also ranged from 11,93-15.94 cmol kg-1 with 13.79 cmol kg-1 avearage. These findings suggest that all of the samples are sufficient

Mg exchangeable level ranged from 3.40-4.55 cmol kg-1. averaging 3.92 cmol kg-1. This finding indicates a 30.76 % sufficience whereas 69.24 % were in excess.

Na showed an exchangeable range of 0.42-0.56 cmol kg-1and avaraging 0.49 cmol kg-1.

The concentration of Fe. Cu. Zn. Pb. Mn. B. Cd and Ni were compared with the critical values (Lindsay ve Norwell 1969[1].; FAO 1990; Tovep 1991[1].; Güneş vd 1998[1].. in Yıldız 2012[1]). Results indicated that the amounts of plant available Fe level of the soil samples ranged from 0.83-3.11 mg kg-1 with an average of 1.46 mg kg-1. This finding suggests that all of the soilsamples % are sufficient .

Plant available Cu level of the soil samples ranged from 2.38-4.69 averaging 3.40 mgkg-1. This suggests that all the samples are sufficient. The research further revealed that Zn levels of soil samples ranged from 0.84-6.72. averaging 1,38 mg kg-1. This finding suggests that 61.54% of the samples were excess. B levels of soil samples also ranged from 0.26-1.06 mgkg-1 averaging 0.61 mgkg-1. This suggests that 89.47 of soil samples are low and 10.53% of the soil samples were sufficient. The up take of B is limited by a pH of <5.5 or > 6.8. sandy soil with low organic matter (Yıldız 2012)[1]..

Plant available level of Mn ranged from 1.12-12.34 mgkg-1 and averaging 4.74 mgkg-1. This suggests that 76.92% of these samples are very low and 23.08 % were low. These results are in line with previous results found by Taban et al. 1997[1].; Parlak et al. 2008[1].; Turan et al. 2010[1].; works conducted from different soils sampled from different regions and plants. A sample range of 0,09-0,32 mg kg-1 and averaging 0,17 mgkg-1 of Pb concentration was observed. Ni concentration ranging from 0,15-0.60 at an average of 0.3 mg kg-1 was further observed. Finally. a Cd concentration ranging from 0,01-0,04 mgkg-1 at an average of 0.02 mgkg-1 was also observed.

Evaluation of Mineral Content in Potato Leaf samples

The content level of macro and micro elements in leaf samples of potato plant were compared with the limit values for potato (Yıldız 2012)[1].. As a result of the evaluation. N content of the leaf samples ranged from 3.21-5.10 % with an average of 4,27 %. Nitrogen content were high in all leaf samples.

P content of the leaf samples ranged from 0,12-0,20 % with an average of 0,14%. 92.3 % of the leaf samples were low whereas 7.70 % were sufficient. Because of the availability of P. several side-effects on the internal and external factors of the soil resulted in drought. excessive moisture or low temperature and clayey in type. The availability of the soil plant nutrients is related to the climatic factors. Due to this. more fertilizer should be applied in high temperature areas especially in the morning and as light intensity increases. It is adviced that texture classification of the soil is very important irrigation for irrigation purposes. Although the P level of the soils were low. its content level in the leaf samples ranged from 0.02% -0.15%.

K content of leaf samples ranged from 3.0 -6,52 % with an average 4,79%. All of leaf samples were in excess.

Ca content of the leaf also ranged from %0.82-1.30 % with an average of and it is averaging 0.97. This finding suggests that all of % of the leaf samples are excess.

Mg content of the leaf samples ranged from 0,29-1,45 % averaging 0,64%. This finding suggests that 38.46% of the leaf samples are sufficient. 61.54 % of the leaf samples are high.

Na content of the leaf samples ranged from 0,01-0,04 % and it is averaging 0,02%.

S content of the leaf samples ranged from 0,22-0,74 % averaging 0,43%. This finding suggests that all of the leaf samples are sufficient and excess respectively.

Fe content of the leaf samples ranged from 125.8-376.8 mg kg-1 averaging 204.97 mg kg-1. This finding suggests that

23.07% of the leaf samples are sufficient 76.93 % of the leaf samples are excess.

Cu content the leaf samples ranged from 11.17-19.87 mg kg-1 averaging 16,00 mg kg-1. This finding suggests that all of the leaf samples are sufficent.

Zn of the leaf samples ranged from 18.82-47.16 kg-1. averaging 27.11 mg kg-1. This finding suggests that 84.61% of the leaf samples are low. 15.39% of the leaf samples are sufficient.

Mn content of the leaf samples ranged from 23.91-55.93 mgkg-1. averaging 40.33 mgkg-1. This finding suggests that all of% of the leaf samples are sufficient and excess respectively.

B content of leaf samples ranged from 10.55-36.16 mgkg-1. averaging 17,32 mg kg-1. This finding suggests that 92.31 % of the leaf samples are low and 7.69% of the leaf samples are sufficient. When the temperature decrease boron availability decrease. The soil humidity also affects the mass flow and availability of the diffusion boron. Factors that affected transpiration also. negative affects availability of boron. The tubers are small. deformed and high-coloured when the B is not sufficient in the potato (Mahler 2010)[1]. The amount of available boron in the top soils is very changeable and is under the effect of some factors. The amount of available boron changes depending on the texture of the soils. the amount of hydrated iron oxide and aluminium oxide. electrical conductivity. the content of organic substance. the amount and types of changeable cations. the content of lime and the quality of irrigation water (Yıldız 2012)[1]..

The research further obtained results on Pb contents from leaf samples ranging from 0,01-2,63 with an average of 1.09 mgkg-1. Also, Ni leaf content ranged from 0,0-0.76 mgkg-1 averaging 0.28mgkg-1. Obtained Cd content from leaf samples also ranged from 0,02-0.09 mgkg-1 averaging 0,0.5 mgkg-1. Correlation analyses was then applied to the data to determine the reletionship between soil characteristics and leaf mineral content of soils from Pasinler town plain . This is showned in Table 1.

5.CONCLUSION AND SUGGESTIONS

Significiant negative relationships were found for plant available P, NO_3^- ,Mn, B, Fe, Na,K, Cu, Ca, Pb, Zn concentrations, soil pH, $CaCO_3$, sand content of soil sampled from Oltu town with P, K, Mg, Ni, Na, Cu, Mn content of plant leaf samples.

On the other hand Significiant possitive relationships were found for plant available K, Ca, Cd, Ni, B, Mn, Zn, NO_3, Cu, P, N and $CaCO_3$, pH, sand , EC, clay content of soil sampled from Pasinler plain, with P, N, Ca, Mg, S, B, Na content of plant leaf samples.

Results from the study indicates that the soils and plants are deficient in. Total soil N and available N content and plant available nutrient concentrations (P. Fe, Zn, Cu, Ca. Mg and K) of soil samples is sufficient for potato plant growth. Total N (7.69%), Mn (100%), and B (89.47 %)were in unsuffecient level and Pb and Cd is not at toxic levels in plant and soils. P,B and Zn content of plant leaf were low.

Finally, due to Phosphorus (P), Nitrogen (N), boron (B), Manganese (Mn), Zinc (Zn) insufficient levels grown in Oltu-Erzurum growers should make an attempt to conserve and improve current fertility status of the soils. It is suggested that P, Mn, Zn and B sourced from soil and foliar fertilizers should be added towards increasing its productivity by considering field or greenhouse experiments in future.

As a result, Phosphorus (P), Manganese (Mn) boron (B), and zinc (Zn) were insufficient level of potato plant leaves which was grown in Oltu Town of Erzurum. The results indicated that growers should be in an attempt of conservation and improvement of current fertility status of the soils. It was suggested that the P, Mn, Zn, and B sourced soil and foliar fertilizers should be added to increase its productivity by considering with field/greenhouse experiments later on.

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Table 1. The correlation coefficiencies of soil and leaf properties studied (Oltu Town Plain)

Parametres	Locations(Villages)							ÖD
	Çamlıbel	İnanmış	Merkez	Orucuk	Özdere	Tutmaç	Yolboyu	
PH	7,960±0,041 B	7,980±0,041 B	8,210±0,058	8,025±0,041	7,900±0,041 AC	7,805±0,041 C	8,180±0,041 A	**
Org. Mad.	3,360±0,320 A	2,155±0,320 BC	0,910±0,453 D	3,015±0,320	1,700±0,320 AD	3,858±0,320 A	0,855±0,320 D	**
Kireç	16,801±1,648 A	14,475±1,648 AB	10,512±2,331	10,150±1,648	2,917±1,648 BD	5,519±1,648 CD	6,126±1,648 CD	**
EC	0,671±0,056	0,408±0,056	0,420±0,079	0,648±0,056	0,505±0,056	0,636±0,056	0,688±0,056	ns
Kil	24,100±2,537 D	34,089±2,537 BC	37,196±3,588 B	20,530±2,537 D	22,193±2,537 D	26,956±2,537 CD	49,398±2,537 A	**
Silt	14,820±4,872	26,543±4,872	33,476±6,890	26,998±4,872	18,619±4,872	23,948±4,872	27,673±4,872	ns
Kum	61,080±6,342 a	39,368±6,342 bd	29,328±8,969 cd	52,472±6,342 ab	59,188±6,342 ab	49,096±6,342 ac	22,929±6,342 d	*
KDK	19,055±1,326	22,890±1,326	18,660±1,876	21,165±1,326	19,993±1,326	22,050±1,326	23,430±1,326	ns
N	0,095±0,018 c	0,155±0,018 ab	0,140±0,025	0,190±0,018	0,125±0,018 ac	0,175±0,018 ab	0,170±0,018 ab	*
NH_4^+	49,000±10,693	35,000±10,693	56,000±15,122	49,000±10,693	49,000±10,693	49,000±10,693	49,000±10,693	ns
NO_3^-	35,000±4,950 c	49,000±4,950 bc	56,000±7,000	70,000±4,950	35,000±4,950 ac	56,000±4,950 ab	42,000±4,950 bc	*

P	37,000±8,439	21,500±8,439	25,000±11,934	30,000±8,439	35,000±8,439	43,000±8,439	36,000±8,439	ns
P_2O_5	84,730±19,324	49,235±19,324	57,250±27,329	68,700±19,324	80,150±19,324	98,470±19,324	82,440±19,324	ns
K	2,170±0,151	2,610±0,151	2,130±0,214	2,410±0,151	2,275±0,151	2,515±0,151	2,675±0,151	ns
K_2O	2,626±0,183	3,158±0,183	2,577±0,258	2,916±0,183	2,753±0,183	3,043±0,183	3,237±0,183	ns
Ca	12,385±0,862	14,875±0,862	12,130±1,219	13,760±0,862	12,995±0,862	14,335±0,862	15,225±0,862	ns
Mg	3,530±0,244	4,245±0,244	3,460±0,345	3,925±0,244	3,650±0,244	4,085±0,244	4,345±0,244	ns
Na	0,435±0,030	0,525±0,030	0,430±0,042	0,485±0,030	0,460±0,030	0,510±0,030	0,535±0,030	ns
Fe	1,200±0,394	1,508±0,394	0,986±0,557	2,510±0,394	1,571±0,394	1,335±0,394	0,867±0,394	ns
Cu	2,612±0,367 c	3,430±0,367 ac	4,560±0,520 a	2,645±0,367 c	3,258±0,367 bc	3,551±0,367 ac	4,311±0,367a b	*
Zn	4,026±1,000	2,272±1,000	1,826±1,414	4,623±1,000	2,777±1,000	5,081±1,000	1,010±1,000	ns
Pb	0,156±0,038	0,238±0,038	0,199±0,054	0,156±0,038	0,140±0,038	0,110±0,038	0,202±0,038	ns
Mn	4,188±0,477 ab	3,827±0,477 ab	1,103±0,674 d	4,401±0,477	2,682±0,477 ac	1,895±0,477 cd	2,758±0,477 bc	*
B	0,374±0,052 C	0,300±0,052 C	0,770±0,074	0,954±0,052	0,394±0,052 AC	0,812±0,052 AB	0,749±0,052 B	**
Ni	0,282±0,094	0,391±0,094	0,392±0,133	0,372±0,094	0,198±0,094	0,183±0,094	0,424±0,094	ns
Cd	0,016±0,004	0,020±0,004	0,013±,005	0,018±0,004	0,019±0,004	0,029±0,004	0,014±0,004	ns

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