Effects of Landfills on Onopordum bracteatum

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***Abstract*—**Landfills are still the most widely used solid waste disposal method used across the Turkish Mediterranean Cities. During dumping or after the capacity of the landfill has been reached, a decontamination and remediation program should be taken for the area. So, researches of vegetation dynamics on waste landfill are very important. The study was conducted to understand to relation of Onopordum bracteatum which grows on landfill by itself and landfills. The test plants were collected from three different areas. First area was Antalya-Kizilli Landfill Site, second area was border of the landfill and the last area was 5 km far from the landfill site for control set. Results showed that the plants on landfill have more amounts N, P, K, Ca, Mg, S, Zn and B. The results indicate that plants could be grown well on the landfill.

***Keywords*—**Landfill, Mediterranean Cities, Onopordum bracteatum.

I. Introduction

WASTE landfill caused to negative effects on flora and fauna resulting from changed land- use have been described by landscape ecologists all over Europe[1] and have been reported for Mediterranean landscapes by several authors such as the montado and agro-silvo-pastoral landscapes in Portugal[2], the Tuscany landscapes in Italy[3], the mountainous landscapes in northern Italy[4], the shrub and woodland landscapes in Israel and other Mediterranean countries[5].

Aside from imparting aesthetic value, natural or planted vegetation on a landfill has an important role in erosion control and removal of contaminants, and may also be used in leaching treatment[6] vegetative amelioration is the main tool in controlling the environmental risks of solid waste disposal sites and to transfer them has into a nature.

Previous studies show that number of 120 plant species consisting of trees, shrubs, and grasses are appropriate for plant cover establishment in different types of vegetative amelioration [7] One of the most common plant mixtures used in rehabilitation comprises grasses and legumes. Grasses are regarded as the most appropriate plants for protection from soil erosion, while legumes grow rapidly, particularly in soils with a low concentration of nitrogen [8][9]. The researches of vegetation dynamics on waste landfill are very important. Erdogan et al. (2010) determined Amaranthus albus L., Portulaca olearace L., Sonchus oleraceus L., Scolymus hispanicus L., Xanthium spinosum L., Chenopodium album L., Medicago prostrata, Centaureu eabitropa, Solanum nigrum, Carthamus lanatus, Carduus pycnocephalus L., Echinops ritro L.on Sofulu solid waste landfill in Adana that is another Mediterranean city in Turkey [10].

A lot of Onopordum bracteatum plants are on the Kizilli Solid waste landfill. The study was conducted to understand to relation between O. bracteatum and landfill. We hope that the outcomes would make a contribution towards a better understanding of the ecology of a plant that suitable for using revegetation and the likely physical requirements for their sustainable establishment on waste landfill site.

II. Description Of Study Area

Kizilli Solid Waste Landfill site is located in 27 km north of the City of Antalya in the South Mediterranean region of Turkey (Fig. 1). The Landfill site spreads over an area of 247 acres in a forest area and has been used as the major disposal site since October 17, 2003 for the refuses from the City with a population of 2.092.537 [11].

The climatic characteristics of Antalya are typical to those of Mediterranean. Annual mean rainfall is 1065 mm, annual mean temperature is 18.6°C, annual evaporation is 1791 mm and mean absolute humidity is 64%. The rainfall reaches the highest value in January and December. The soils of the landfill site and its environs are rocky stony soils assigned to classes V and VI according to the US Soil Classification System. They are considered not to be suitable for agriculture. Antalya Waste Landfill Site and its near environment are owned by the Provincial Directorate for Environment and Forestry. There are several native species growing in and around the site. Among them are Arbutus andrachne.

Fig 1. The location of Kizilli Landfill Site in Antalya[12].

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Quercus aucheri, Phillyrea latifolia, Quercus coccifera, Calicotome villosa, Pistacia lentiscus, Cistus creticus, Cistus salviifolius, Myrtus communis, Sarcopoterium spinosum, Coridothymus capitatus, Olea europea, Spartium junceum, Fontanesia phillyreoides, Laurus nobilis, Pinus pinea[13.]

The total average amount of solid waste deposited in the site was reported to be 269.707 tons/day in 2004, 326.041 tons/day in 2005, 376.119 tons/day in 2006, 366.939 tons/day in 2007, 386.306 tons/day in 2008 and 418.488 tons/day in 2009. Total 568.077 tons of domestic solid waste was disposed Kizilli Solid Waste Landfill in 2012[14]. As a typical Mediterranean city, 75,5% of the refuse is of household origin.

III. Plant Material

Onopordum bracteatum is belonging to the family Asteraceae, native to Europe (mainly the Mediterranean region), northern Africa, the Canary Islands, the Caucasus, and southwest and central Asia (Fig 2). They grow on disturbed land, roadsides, arable land and pastures [15].

Fig. 2 Onopordum bracteatum plants in the research area

They are biennials with branched, spinose winged stems, growing 0.5–3 m tall. In the first season they form a basal rosette of gray-green felted leaves and rarely a few flower heads. In the second season they grow rapidly to their final height, flowering extensively, and then die off after seed maturation [15].

IV. Method

The study was conducted to understand to relations between landfills and Onopordum bracteatum which grows on landfill by itself. The test plants were collected from three different areas. First area was Antalya-Kizilli Landfill Site, second area was border of the landfill and the last area was 5 km far from the landfill site for control set.

Soils, collected at a depth of 0-10 cm and 0-30 cm from the research areas were passed through a 2 mm sieve and homogenized with a gardening mixer. The soil pH was measured with an InoLab pH meter in a 1:2 soil water mixture[16], the lime content (%) with a Scheibler calcimeter [17], the organic carbon content (C%) with the Anne method, and the nitrogen content (N%) with the Kjeldahl method [18]. The Walkley Black (WB) method used for determining Soil Organic Matter [19]. Sodium bicarbonate (NaHCO3)-extractable phosphorus, termed Olsen-P [20]. Exchangeable cations are extracted from the soil using an extracting solution (1N NH4OAc) at pH 7.0. The extracted solution is then analyzed by AA (atomic absorption) for the soil cations [21]. Inductively Coupled Plasma (ICP-OES) was used for the determination of Metals [22]. B was determined by azometin-H merhods [23].

The plants were harvested from the research areas and divided into roots and stems. Plant parts were oven-dried at 80 ºC for 2 d and ground. For metal and as analysis, media samples (< 60 µm) were digested with concentrated nitric acid. Metal analysis on the soil and plants parts solutions were performed using and Inductively Coupled Plasma (ICP-OES) Spectrometer [22].

In this research plants characteristics were determined. Visual assessment for plants on root and upper part was done according to Kolb visual assessment techniques [24].The assessment scales were described as 1=impression insufficient, 3=impression sufficient, 5=impression satisfying, 7=impression good and 9=impression very good.

The mean values of groups were compared with ANOVA test. A significance level of $P<0.05$ was used through the study. The program SPSS Version 20.0 software was used for statistical analyses. Tests of multiple comparisons between the means were done by Duncan’s new multiple range tests.

V. Results And Discussion

A. Soil Properties

Many factors influence soil micronutrient dynamics, such as pH, organic matter, vegetation, and management factors, such as addition of organic amendments [25]. Soils may become polluted with high concentrations of heavy metals both naturally, as a result of proximity to mineral outcrops or ore bodies, oranthropogenically, as a result of industrial activities [26], [27]. Among pollutants, heavy metals have been the subject of particular attention because of their long-standing toxicity when exceeding specific thresholds. Among the key issues in the environmental research on macro, microelements and heavy metals are their mobility in the ecosystem and transfer in the food chains [28]-[33]. Organic amendments may influence soil properties for years after application ceases as only a fraction of the organic material may be initially degraded or become available to plants and soil microorganisms [34]-[36]. The purpose of this study was determining the effect of landfill on the O. bracteatum in the Mediterranean climate. Soil characteristics are given in Table I.

The results from the statistical analyses showed that there was significant interaction between growing areas’ soil for Organic matter, K, Ca contents ($p<0.05$). The landfill’s border soil was very rich, control soil was rich and landfills soil was poor categories for organic material contents [37]. Whole research areas’ soil had high P contents [38]. According to Mallarino and Sawyer (2003) [39], the landfill’s border soils were very high, control soils were optimum and landfill soils were very low categories for K contents. Whole research areas’ soil was over limed [40].

TABLE I
SELECTED SOIL PROPERTIES

Parameter	Landfill Main±SE	Border Main±SE	Control Main±SE
pH(1:2.5)	7.4	7.4	7.6
Structure	sandy loam	sandy loam	loam
CaCO3 (%)	63.9	50.2	48.8
Salinity (dS/m)	121.3	242.6	98.3
Org.Matter(%)	0.56 ± 0.32^{b}	5.96 ± 3.55^{a}	3.1 ± 0.9^{ab}
P(ppm)	49.33±23.86	53.33±16.50	29±2
K (ppm)	85.66 ± 53.85^{b}	362.66 ± 87.58^{a}	181 ± 46.22^{b}
Ca(ppm)	3730.3 ± 160.5^{b}	6191.66 ± 185.9^{a}	6405.66 ± 334.02^{a}
Mg (ppm)	40.33±8.02	164±24.02	150.67±6.65

The values shown with different letters are statistically significant ($p<0.05$).
S.E.: Standard Error

B. Plant properties

Landfills are often uninhabitable for plants and animals due to their inherent lack of nutrients and exceedingly poor water holding capacity [41]. Such landfills types are common worldwide, and their natural attenuation and restoration can ultimately take hundreds of years [42]. Kizilli landfill cover material has similar properties. One of the major obstacles to restoration of these sites is the lack of finely textured substrate which is capable of retaining water and providing nutrients. Natural vegetation cover can potentially provide a cost effective and practical solution to this problem, provided that they can be sourced locally and applied safely without subsequent risk of water and wind erosion [43], [44]. Some natural plants like O. bracteatum can grow on landfills so they can be useful for soil on the landfills. In this research, it was tried to understand to relation between O. bracteatum' stems and roots and landfills by statistically.

The results from the statistical analyses showed that there were no significant interaction between growing area and plant's stem P, Ca, Mg, S, Fe, Mn, Cu and B contents that experienced ($p>0.05$). But, there were significant differences between plant growing area and plant's stems N, K and Zn contents ($p>0.05$). Landfill plants' stem of N, P, K, Ca, S, Fe, Mn, Zn, Cu and B contents were more than border and control plants' stem. The effects of landfill on plant stems contents are given in Table II

TABLE II
EFFECTS OF LANDFILL ON PLANT STEMS CONTENTS

Parameter	Landfill Main±SE	Border Main±SE	Control Main±SE
N (%)	2.58 ± 0.2^{a}	1.01 ± 0.19^{b}	1.09 ± 0.24^{b}
P (ppm)	1686.33±492.22	1582±141.49	1657±639.22
K (%)	3.133 ± 0.45^{a}	2 ± 0.27^{b}	2.233 ± 0.38^{b}
Ca (%)	3.13±1.13	4±1.64	2.168±0.55
Mg (ppm)	2422.33±865.98	1658.33±191.44	2628.67±768.16
S (ppm)	2341.33±544.6	2435.33±509.84	1659.33±454.24
Fe (ppm)	115.33±72.29	111±58.38	106.67±13.196
Mn (ppm)	28.67±10.11	15.33±9.45	13.67±3.78
Zn (ppm)	57 ± 8.88^{a}	44.33 ± 13.2^{a}	20 ± 2.64^{b}
Cu (ppm)	11.3±1.85	11.1±3.96	10.77±2.29
B (ppm)	96±14.52	95±21.93	78.33±13.31

The values shown with different letters are statistically significant ($p<0.05$).
S.E.: Standard Error

The results from the statistical analyses showed that there were no significant interaction between growing area and plant's root Mg, S, Fe, Mn and B contents that experienced ($p>0.05$). But, there were significant differences between plant growing area and plant's root N, P, K, Ca, Zn and Cu contents ($p>0.05$). The effects of landfill on plant roots contents are given in Table III.

In this research plants' stems had got more than nutrient elements to the plants' roots. Several studies demonstrated that metal concentration in the plant tissue was a fraction of the heavy metal content in the growing environment [45]. It has been well documented that the contents of metals was more in lower part of the plant grown on contaminated soil than in stem [46]-[48]. The root tissues were contents significantly greater concentrations of metals than stems, indicating high plant availability of the substrate metals as well as its limited mobility once inside the plant. This is consistent with previous observations [49], [50].

TABLE III
EFFECTS OF LANDFILL ON PLANT ROOTS CONTENTS

Parameter	Landfill Main±SE	Border Main±SE	Control Main±SE
N (%)	1.36 ± 0.135^{a}	0.45 ± 0.06^{b}	0.49 ± 0.06^{b}
P (ppm)	484 ± 3^{b}	833.33 ± 213.93^{a}	222 ± 61.44^{c}
K (%)	2.2 ± 0.36^{a}	0.73 ± 0.15^{b}	1.5 ± 0.6^{ab}
Ca (%)	1.733 ± 0.25^{b}	1.567 ± 0.35^{b}	3.03 ± 0.41^{a}
Mg (ppm)	1863.67±349	2265±1407	1989.67±735.01
S (ppm)	1061±135.39	1411.33±987.96	1500±192.28
Fe (ppm)	254.67±121.54	1699±2071.33	1365.33±472.59
Mn (ppm)	24.33±13.51	111.67±138.02	75.67±20.01
Zn (ppm)	24.67 ± 11.93^{b}	36±19.05b	75.33 ± 24.58^{a}
Cu (ppm)	9.63 ± 1.44^{b}	17.43 ± 2.17^{ab}	29.5 ± 13.07^{a}
B (ppm)	61.33±2.51	60±2.64	63.67±8.14

The values shown with different letters are statistically significant ($p<0.05$).
S.E.:Standart Error

Gupta et al. [51] found that C. fistula root tissues contained manganese (294.19 ppm). Erdogan et. al. [52] found that C. *edulis* contained manganese in its roots (118.78 ppm). These manganese contents were much lower than O. *bracteatum* roots" manganese contents.

Yoon et al. [53] reported that *Desmodium paniculatum* contained copper in the root 6 ppm, *Hydrocotyl americana* 32-21 ppm, Phyla-n*odiflora* 31 ppm, *Verbana* rigida14 ppm and *Sesbania herbacea* 12 ppm on a contaminated Florida site. All the plants are native on that site. These copper concentrations were higher than O. *bracteatum* which was growing on *Kizilli* Landfill concentration in the root, except D. *paniculatum.*

Zadeh et al. [54] found that iron contents in roots for *Amaranthus retroflexus* was about 1600 ppm and for Helianthus *annuus* 1450 ppm. These values were higher than O. *bracteatum* roots on landfill and control site, other plant areas' value were higher than these plants' roots value.

When O. *bracteatum* plants were monitored in the different grooving areas, it was founded different plant characteristics. Plants characteristics are given in Table VI.

TABLE VI
SELECTED PLANT CHARACTERISTICS

Parameter	Landfill	Border	Control
Root	5	7	9
Upper parts	9	7	7
Height(cm)	150	110	100
Leaf Color	dark green	green	bright green

The plants which were on the landfill were dark green and tall because of more amount of N. There were too many

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healthy O. bracteatum plants which live in Kizilli landfill site.

VI. CONCLUSION

O. *bracteatum* effective plant for possible remediation treatment, some contaminated and spoilt landscapes can be recovered with this plant. This study strongly supports that monitoring of the wild vegetation in the solid waste landfill. Further studies can inspect how effectively this specie can be utilized in phytoremediation techniques and application of landfill site rehabilitation projects. The present study is only a first approach to detect contents in plants' stem and roots. Undoubtedly, more work is needed to study differences between different species and subspecies of the Astaraceae family and also to study their performance on remediation. The results of such studies may be useful not only for the phyto technologist but also for landscape architects, environmental engineers and ecologists.

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