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ORIGINAL ARTICLE

Relationship between Some Soil Chemical Properties on the Growth of *Popolus deltoids* in the Western Region of Guilan Province, Iran

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ABSTRACT
The goal of this study was to identify the soil properties responsible for controlling productivity of a poplar clone, Popolus deltoides, in the western region of Guilan. Soil samples were taken from both poor and good growth areas. Chemical soil properties such as pH,EC, exchangeable K, Ca + Mg content, and phosphorus content were determined. Na content, EC and pH of the soils showed a significantly negative correlation while K content of the soils had a positive correlation with the growth of hybrid poplar. The results indicated that soil conditions had a strong influence on the growth of Popolus deltoides in the western region of Guilan province. Further work in this area is needed to understand how Popolus deltoides clone compare to Green Giant and whether the growth requirements of these different clones change over time.
***Key Words**: Poplar, Soil, Growth, Guilan*

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INTRODUCTION

As demand for wood products and fiber increases, forest managers face the challenge of growing more wood on less land. Shorter rotations and diversification of products may help mitigate this pressure. Poplars (*Populus* L. spp.) are preferred plantation species, because their fast growth is expected to meet the extensive demands of wood for poles, pulp and fuel [1]. The rotation age ranges from 8 to 26 years depending on a number of factors, including climate, site, and management regime. Poplars have a high demand for moisture and nutrients. Poplars prefer moist, well-drained sites, and grow well on fluvial floodplains where water and nutrients are abundant. Productivity of plantations depends strongly on soil nutrient supply and it may be malleable under the influence of management practices and species [2]. Almost all the industrial plantations are monocultures, and questions are being raised about the sustainability of their growth and their effects on the site [3]. Repeated harvesting of fast-growing trees such as poplar plantations on short rotations may deplete site nutrients. To maximize their growth, it is important to understand the relationship between growth rate, plant nutrient requirements and the ability of soil to supply nutrients [4]. Soil properties have a strong influence on the growth of poplar. In a review article, Ayik [5] reported that poplar trees grow best in soils having 35% or less clay content, 6.5-8.0 pH, and >10% soil porosity. In Guilan, there are no studies related to the influence of soil properties on the growth of hybrid poplar, most studies focused on the aboveground production of poplar. In this study, the poplar (*Populus deltoides*) plantation of western region of Guilan province was selected to determine the effects of soil properties on the growth of poplar trees due to poor growth performance in some parts of the area.

MATERIALS AND METHODS

Site Characteristics

The study area is located at western of Guilan province, between cities of Somesara and Astara, on the northern parts of Iran. Mean annual precipitation in the area is 900 mm and mean relative humidity is 72 %. Mean annual temperature is 25°C with the maximum and minimum temperatures being 39 and 9.8 C, respectively (D.M.G.M., 1990). Poplar trees were planted by 4m x 4 m distances in 1996-98. Three sample plots (10 x 10 m) representative of the study area were selected in each site. Supporting low, medium and high productivity stands in the study area.

Tree Growth Measurements

Diameters of trees at 1.3 m height (DBH), and tree heights were measured in the 10 m × 10 m area plot.

Soil Sampling and Analysis

Soils were sampled to a depth of 60 cm in all plantations and control plots in August using a 7.6 cm diameter core sampler (n = 3 cores/plot) taken at 30 cm interval. Analyses were conducted to determine some chemical and physical properties of the soil samples. The samples were air-dried, ground and sieved through a 2 mm-mesh sized sieve. Soil texture was determined by Bouyoucos hydrometer method Soil pH and EC was determined in a 1:2.5, soil: water solution. Soil organic carbon was determined using the Walkley-Black method. Available P was determined with spectrophotometer by using Olsen method. Exchangeable cations (Ca^{2+}+ Mg^{2+} and K+) were extracted from the neutral ammonium acetate solution and measured by [6].

Statistical Analysis

The relationship between soil properties and mean DBH and height growth was determined using linear regression and correlation analyses with DBH and height growth as the dependent and soil properties as the independent variables.

RESULTS AND DISCUSSION

Table 1. Some statistical parameters of soil properties

	Range	Min.	Max.	Average
DBH(cm)	22.50	11.17	33.67	19.16
Height(m)	19.82	12.68	32.50	20.49
Sand%	66.00	11.00	77.00	44.67
Clay%	44.00	1.00	45.00	21.22
O.C%	7.29	0.59	7.88	2.64
N%	0.61	0.05	0.66	0.22
pH	3.05	5.12	8.17	7.08
EC(dSm^{-1})	1.04	0.18	1.22	0.490
CCE%	14.00	0.00	14.00	4.93
P($mgkg^{-1}$)	65.09	0.63	65.72	23.31
K($mgkg^{-1}$)	448.10	20.39	468.46	161.13
Ca+Mg (meq/kg)	19.90	7.70	27.60	16.16
Na (meq/kg)	8.89	7.38	16.27	10.13

Soil Texture

The textures were mainly sandy loam and clay. The mean clay and sand content of the soils were 19% and 43% respectively (Table 1). There was a positive correlation between the sand content of soils and growth. Clay content had a negative correlation with growth but the relationships were not significant at $P<0.05$(Fig. 1). An increase in sand content in soils results in an improved soil aeration. In contrast, soils containing too much clay may have high water-holding capacities but inadequate aeration [7].

Soil Organic Matter

Soil organic matter has significant positive correlation with growth ($r = 0.34$, $P = 0.04$) (Fig.2). Mean soil organic matter content of soils was 2.64% (Table 1). This value shows that the soil organic matter contents of the soils in the study area were relatively high. Tufekcloglu et al [8] reported that mean soil organic matter content of soil under poplar plantation in Turkey was low 1.15%.

Soil pH

Soil pH was negatively correlated with growth ($r=-0.45$, $P =0.005$) (Fig. 3). The mean pH value of the soils was 7.08 (Table 1). According to Ayik [5], hybrid poplar shows the best growth at pH values of 6.5-8. The pH values of the soils were within the optimum pH range that favors the growth of poplar. However, the negative correlation between soil pH and growth indicates the possibility that hybrid poplar prefers soils with neutral pH. Leavengood *et al*. [9] observed a similar response to high soil pH in a hybrid poplar trial in Oregon, USA. They reported that the MAHG of hybrid poplar clones ranged from 101.6 cm in the replication with lower pH (7.9) to 83.2 cm in the middle replication and 76.2 cm in the highest pH (8.5) replication. Also Tufekcloglu *et al* [7] found same negative correlation between soil pH and mean annual height growth of poplar in turkey($r=-0.45$, $P=0.005$).

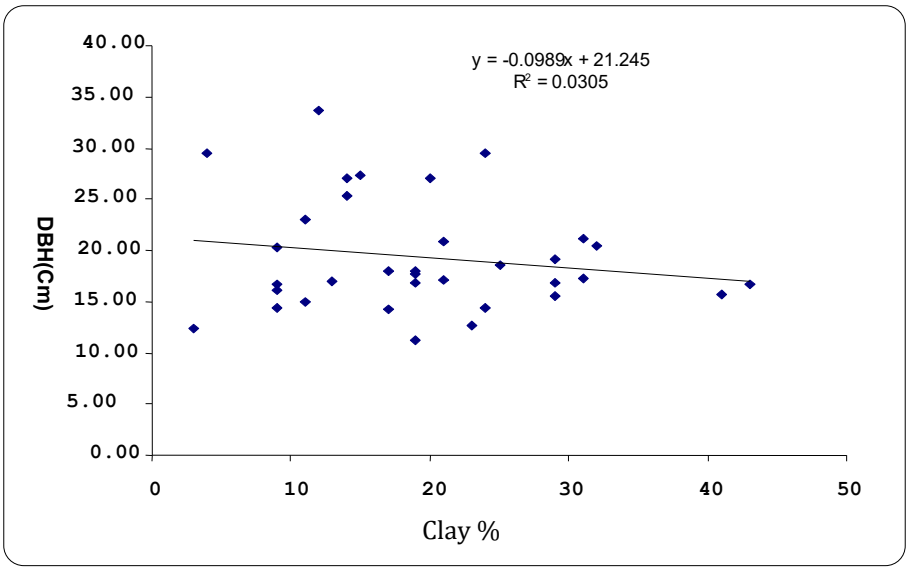

Fig.1. Relationship between DBH and clay content of soil

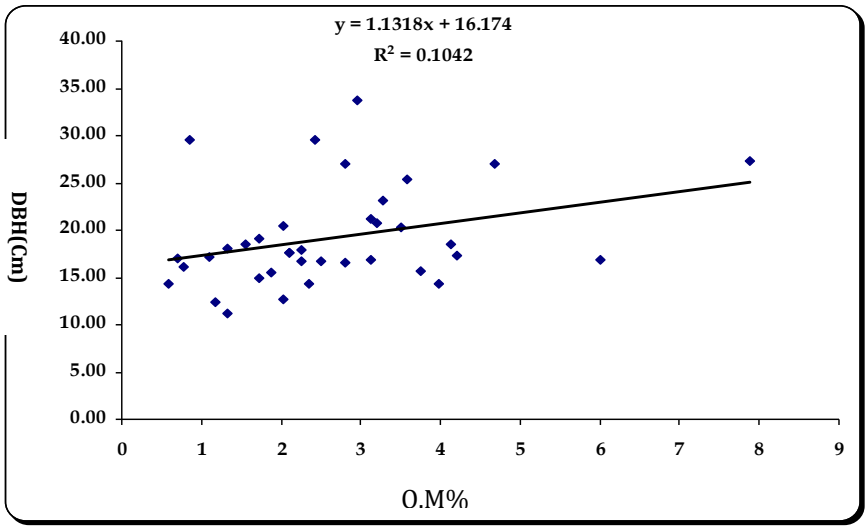

Fig.2. Relationship between DBH and O.M content of soil

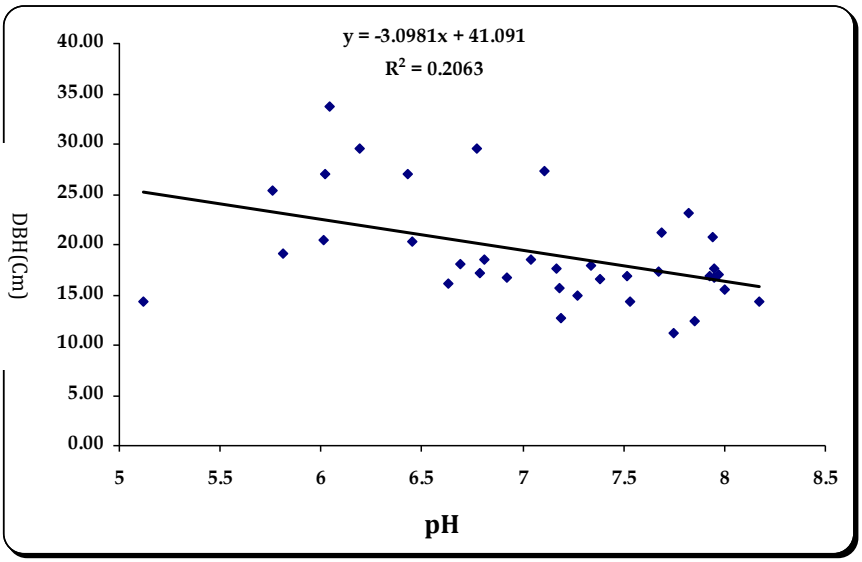

Fig.3. Relationship between DBH and pH of soil

Potassium

There was significant positive relationship between growth and the exchangeable potassium content of the soils (r = 0.42, P = 0.01) (Fig.4). The mean exchangeable potassium content of the soils was 161.13 mg kg-1 (Table 1). The exchangeable potassium concentrations in the soils were sufficient for the normal growth of plants based on Scheffer and Schachtschabelos [10] classification of soils for their potassium needs and for normal poplar growth according to Zengin [11].

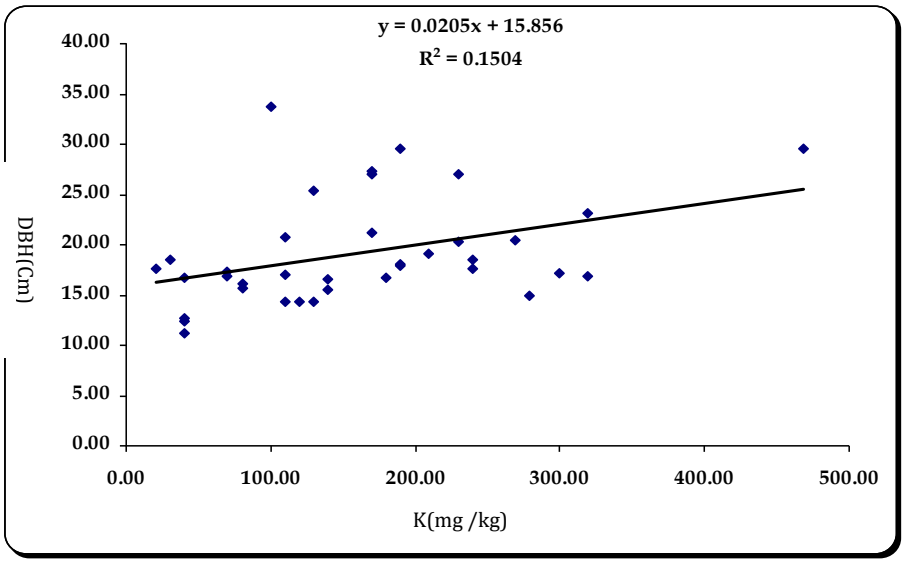

Fig 4. Relationship between DBH and K content of soil

Sodium

There was no significant relationship between the exchangeable sodium content of the soils and growth (r =-0.29, P = 0.08). The mean exchangeable sodium content of the soils was 10.13 meq kg^{-1} (Table 1). Although sodium concentrations in forest soils are generally low, they were higher in the study area. The relatively higher concentration of sodium might have resulted from the deposition by the wind from the sea.

Calcium+ Magnesium

There was no significant correlation between available Ca+Mg and growth (r=-0.095, P = 0.57). The mean exchangeable Ca+Mg content of the soils was 16.16meq kg-1 (Table 1). Exchangeable Ca+Mg concentrations were quite high in the study area and sufficient for the normal growth of poplars according to Zengin (1991).

Phosphorus

There was no significant correlation between growth and the amount of phosphorus. The mean phosphorus content of the soils was 23.31 mg kg-1 (Table 1). This value was higher than the threshold value of AyÝk (1989) (<15 mgkg-1).

Salinity

Salinity in the study area did not reach levels of toxicity for poplars (Troeh and Thomson, 1993). The highest value was 1.22 dS/m. The mean salinity content of the soils was 0.490 dS/m (Table 1). There was no significant relationship between salinity and growth (r = 0.15, P =0.37).

CONCLUSIONS

Poplar growth was influenced by the soil properties in the study area. K content was positively correlated with growth, while pH was negatively correlated. The negative correlation between growth and pH suggests that hybrid poplar prefers soils with neutral pH. The positive correlation between K content and growth indicates that potassium fertilizer should be used in these areas.

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