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Seedling growth of Jerusalem Thorn - *Parkinsonia aculeata* L. in different soil types

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The disturbances and changes in soil properties due to industrial and anthropogenic activities influenced plant growth. The behavior of evergreen spiny Leguminous small branching weed tree Jerusalem Thorn - *Parkinsonia aculeata* L. seedling was found sensitive to soil treatment of different areas in pot experiments. A better seedling growth performance depends on available soil conditions. The comparative study showed that soil of Universal Chemicals and Indus Battery Factory significantly ($p<0.05$) decreased plant height of *P. aculeata* and highly improved in the soil of National Foods Ltd. Root size of *P. aculeata* in all soil samples was found more sensitive to seedling growth of *P. aculeata* than other growth variable. The negative and positive correlation in physical and chemical properties of soil also showed variation with different seedling growth parameters of *P.aculeata.* A positive correlation with significance level ($p<0.01$) was found among growth parameters of *P. aculeata* with bulk density and sand. Porosity, silt and clay showed high significantly ($p<0.01$) negative correlation for growth performance of *P. aculeata* and no significant correlation was found for water holding capacity of soil.

Keywords: Jerusalem Thorn, soil types, seedling growth, seedling dry weight,

INTRODUCTION

The soil system offers goods services to humankind (Berendse et al., 2015; Brevik et al., 2015; Decock et al., 2015; Smith et al., 2015). The plant growth and development depend on soil types. Flora in any specific geographic region inhabit a particular ecosystem (Badhsha et al., 2013). The habitat disturbance may influence on diversity of species (Schamp et al., 2003) and distribution of plant species in the region. The anthropogenic and industrial activities are affecting three main components of environments viz. air, water, soil and ultimately influence on plant growth (Shafiq 2002; Rehman 2006; Rehman and Iqbal, 2006; Shafiq and Iqbal, 2012; Abad et al., 2014; Rab et al., 2018; Farooqui et al., 2018, 2016, 2019; Shafiq et al., 2019; Iqbal et al., 2020; Kabiret et al., 2020). The textile and dairy industrial waste water effluent influenced on seedling growth of wheat, rice and chick pea (Begum et al., 2011; Rathod et al., 2015; Kaur and Sharma, 2017). Pakistan is a developing country and these activities are leading to degradation of natural ecosystem. Boutra and Sanders (2001) concluded that lack of moisture and low soil fertility limit crop production.

Parkinsonia aculeata L. is a mall spiny, evergreen shade tree. *P. aculeata* is a local weed

in tropical America, native to southwestern United States, Mexico and spread in Brazil and Asia (Isley, 1975; Almeida et al., 2005; EDIS, 2020).

P. aculeata is used for firewood, medicine, fodder and well adapted in arid areas. It is also useful in soil stabilization and valued for its tolerance capability of soil and climate extremes. *P. aculeata* is naturalized in tropical and southern Africa, Pakistan, Oceania, and beyond its native range in the U.S.A, Central America and southern America (Bionet, 2020) and considered an internationally weed plant species. In Pakistan, *P. aculeata* is very common roadside as an avenue plant and well grow in problematic areas and helps in controlling soil erosion (PFD, 2020).

This research was to conducted test the hypothesis that plant growth influenced by soil types. *P. aculeata* (local name, Kabuli kikar or Vilayati kikar) was selected due to its promising cultivation capabilities as multipurpose in semiarid regions and preferred to grow in harsh climatic conditions of Pakistan.

MATERIALS AND METHODS

The experiment was performed at the greenhouse of Department of Botany, University of Karachi, Pakistan. The soil samples were collected from five different areas **A**= Karachi University Campus; **B** = Indus Battery Factory; **C** = Universal Chemicals Factory; **D** = Haroon Textile Factory; **E** = National Foods Ltd. Factory from 0-50-centimeter depth and after air dried and passed through 2 mm sieved. The mature seeds of *Parkinsonia aculeata* L were randomly collected from the plant growing in the Karachi University Campus. The micropyle ends of seeds were cut with scissors to break seed dormancy and were sown in a garden soil at 1.00 cm depth in earthen pots and irrigated with tap watered daily. Uniform size seedlings with two-week of age were transferred in plastic pots of 20 cm diameter and 9.8 cm in depth soil of five different areas of Karachi. The seedlings were subjected to treatment of soil of different areas. The experiment was completely randomized design with five replicates. One seedling of *P. aculeata* was planted in each pot and watered regularly with tap water. Pots were shuffled every week to avoid light and shade effects. Seedlings were taken out from pots after eight weeks, washed their roots with water and measured selected seedlings growth parameters. Plant materials was dried in an oven at 80 °C for 24 hours for the determination of dry weight. The root/shoot ratio, leaf weight ratio, specific leaf area and leaf area ratio were also determined as described by Rehman and Iqbal (2009).

Statistical analysis

Statistical analysis by ANOVA and DMRT on personal computer at 5% probability level using SPSS Software package program of version 13was performed.

RESULTSAND DISCUSSION

The plant soil relationships feedback provides an interaction role of plants and soil microorganisms (deSoua et al., 2018). Industrial activities and discharge of pollutants from industries are causing environmental pollution problems including soil physicochemical properties of the area and plant growth. A better seedling growth performance depends on available soil conditions. This comparative study showed variable effects on different seedling growth characteristics of *P. aculeata* (Table 1-4). It had maximum root (20.64 cm), shoot (24.68 cm), seedling height (45.32 cm) and plant cover (18.66 cm) of *P. aculeata* in soil of National Foods Ltd. Factory was noted (Table 1). The seedlings of *P. aculeata* raised in soil of Indus Battery Factory and Universal Chemicals Factory better seedling growth and number of leaves. Studies have also shown lowest root (5.40 cm), shoot (11.90 cm), seedling length (17.30 cm), plant cover (11.60 cm) and leaf area (0.82 sq. cm) of *P. aculeata* in soil of Karachi University Campus was recorded. The root growth of *P. aculeata* was found most sensitive than shoot. Plant species growing in industrial area showed variation in the biochemical properties (Agbaire and Esiefarienrhe, 2009).

In Table 2, significantly highest seedling fresh and dry weight of *P. aculeata* with soil treatment of National Foods Ltd. Factory and the lowest in the soil of Karachi University Campus was noted.An interest has been developed by researchers in recent years for the soil quality (Carter et al., 2004) to increase the vegetation cover for the improvement of environmental conditions. The Pearson's correlation between M.W.H.C., B.D. Porosity, sand, silt, clay, $CaCO_3$, Cl, pH, O.M., T.O.C., Sulphur, E.C., T.D.S., Na^+, and K^+ content in soil and seedling growth of *P. aculeata* was calculated.

Table 1: Effects of different areas soil on *Parkinsonia aculeata* seedling growth

Treatments	Root length (cm)	Shoot length (cm)	Seedling length (cm)	Plant cover (cm)	Number of leaves	Leaf area (Sq cm)
A	5.40± 0.26d	11.90±0.74d	17.30±0.98d	11.60±0.34d	9.00±0.45c	0.82±0.05d
B	7.38±0.25c	14.04±0.32c	21.42±0.35c	13.12±0.38c	10.60±0.87c	1.16±0.13d
C	7.82±0.39c	14.44±0.31c	22.26±0.43c	13.46±-0.26c	11.80±0.66c	1.61±0.05c
D	12.50±0.42b	20.56±0.74b	33.06±1.15b	17.02±0.65b	17.20±2.64b	2.55±0.15b
E	20.64±0.80a	24.68±0.81a	45.32±1.60a	18.66±0.59a	23.80±1.28a	3.02±0.21a
L.S.D. (p<0.05)	1.38	1.84	3.00	1.37	4.17	0.39

Sites: A = Karachi University Campus; B = Indus Battery Factory; C = Universal Chemicals Factory; D = Haroon Textile Factory; E = National Foods Ltd. Factory. Means followed by the same letter in the same column are not significantly different according to Duncan Multiple Range Test at p<0.05 level. ± Standard Error, L.S.D. Least Significant Difference

Table 2: *Parkinsonia aculeata* growth of in soils of different areas

Treatments	Seedling fresh weight (g)	Total plant dry weight (g)	Root/Shoot ratio	Leaf weight ratio	Specific leaf area ($cm^2\ g^{-1}$)	Leaf area ratio ($cm^2\ g^{-1}$)
A	0.64±0.02e	0.29±0.02d	0.18±0.014c	0.11±0.005b	24.73±2.49a	2.96±0.30b
B	0.76±0.04d	0.33±0.02cd	0.22±0.025b	0.14±0.007ab	24.17±4.64a	3.64±0.58ab
C	0.87±0.05c	0.37±0.01c	0.18±0.015c	0.14±0.012ab	30.40±2.29a	4.20±0.15a
D	1.46±0.03b	0.58±0.03b	0.23±0.003b	0.15±0.018ab	31.23±5.67a	4.45±0.33a
E	1.72±0.02a	0.75±0.02a	0.37±0.015a	0.16±0.014a	25.72±2.52a	4.31±0.41a
L.S.D. (p<0.05)	0.10	0.06	0.05	0.04	11.16	1.12

Table 3: Pearson's correlation of soil physical characteristics and growth of *Parkinsonia aculeata*

Growth parameters	M.W.H.C.	B.D.	Porosity	Sand	Silt	Clay
Root length	-0.093	0.571**	-0.573**	0.927**	-0.843**	-0.785**
Shoot length	-0.088	0.557**	-0.560**	0.952**	-0.891**	-0.719**
Seedling size	-0.091	0.570**	-0.572**	0.948**	-0.873**	-0.761**
Plant cover	-0.067	0.549**	-0.553**	0.934**	-0.882**	-0.676**
Number of leaves	-0.121	0.546**	-0.547**	0.860**	-0.800**	-0.666**
Leaf area	-0.154	0.646**	-0.650**	0.950**	-0.921**	-0.608**
Seedling fresh weight	-0.154	0.602**	-0.603**	0.982**	-0.942**	-0.664**
Total plant dry weight	-0.161	0.618**	-0.619**	0.961**	-0.917**	-0.665**

Abbreviation used: M.W.H.C. = Water Holding Capacity; B.D. = Bulk Density

Table 4: Pearson's correlation of soil chemical characteristics and growth of *Parkinsonia aculeata*

Growth parameters	$CaCO_3$	Cl	pH	O.M.	T.O.C.	S	E.C.	T.D.S.	Na	K
Root length	-0.224	0.193	0.749**	-0.425*	-0.425*	0.834**	-0.672**	-0.667**	-0.382	-0.681**
Shoot length	-0.234	0.362	0.609**	-0.455*	-0.456*	0.705**	-0.658**	-0.653**	-0.237	-0.518**
Seedling size	-0.231	0.275	0.690**	-0.443*	-0.444*	0.781**	-0.672**	-0.667**	-0.317	-0.610**
Plant cover	-0.237	0.424*	0.527**	-0.450*	-0.450*	0.623**	-0.635**	-0.630**	-0.146	-0.432*
Number of leaves	-0.247	0.260	0.638**	-0.435*	-0.435*	0.710**	-0.636**	-0.632**	-0.282	-0.545**
Leaf area	-0.353	0.493*	0.534**	-0.546**	-0.547**	0.602**	-0.716**	-0.712**	-0.079	-0.382
Seedling fresh weight	-0.299	0.454*	0.586**	-0.530**	-0.531**	0.673**	-0.707**	-0.702**	-0.184	-0.451*
Total plant dry weight	-0.313	0.408*	0.617**	-0.526**	-0.527**	0.694**	-0.714**	-0.709**	-0.203	-0.483*

A positive correlation with significance level ($p<0.01$) was found among growth parameters of *P. aculeata* with bulk density and sand. Porosity, silt and clay showed high significantly ($p<0.01$) negative correlation for growth performance of *P. aculeata* and no significant correlation was found for water holding capacity of soil (Table 3).

Table 4 in present study exhibit a high significant ($p<0.01$) positive correlation among growth parameters and pH and sulphur. Electrical conductivity, total dissolved salts and potassium content significantly negative correlation with growth parameters. There were no significant correlation was recorded among calcium carbonate, chloride and sodium contents with different growth parameters of *P. aculeata*.

CONCLUSION

This research showed serious damaging impacts of different soil types on growth of spiny wood weed tree Jerusalem Thorn - *Parkinsonia aculeata* L. Fabaceae. The seedling growth of *P. aculeata* significantly reduced in soils of Indus Battery and Universal Chemical Factories. In contrast, an increase in the seedlings of *P. aculeata* in soil of Haroon Textile and National Foods Limited recorded. It is suggested that Jerusalem-Thorn might be considered suitable plants to be grown around the Textile and Foods manufacturing types industrial units due to their resistance.

CONFLICT OF INTEREST

The authors declared that no conflict of interest exist among all authors

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AUTHOR CONTRIBUTIONS

MZI designed and supervised the experiment and MK performed the experiment. MS wrote the manuscript. MA and ZRF critically reviewed the article.

REFERENCES

Abad JRS, Khosravi H, Alamdarlou EH. 2014. Assessment of the effects of land use changes on soil physicochemical properties in Jafarabad of Golestan Province, Iran. *Bulletin of Environ., Pharmaco. and Life Sci.* 3(3): 296-300.

Agbaire PO, Esiefarienrhe E. 2009. Air Pollution Tolerance Indices (APTI) of some plants around Otorogun gas plant in Delta State, Nigeria. *J. of Applied Sci. and Environ. Management,* 13:11-14.

Almeida JRM, de Moraes LMP, Torres FAG. 2005. Molecular characterization of the 3-phosphoglycerate kinase gene (*PGK1*) from the methylotrophic yeast *Pichia pastoris.* Yeast, 22(9): 725-737.

Badshah L, Hussain F. Sher Z. 2013. Floristic inventory, ecological characteristics and biological spectrum of rangeland, district Tank, Pakistan. *Pak. J. Bot*., 45(4): 1159-1168.

Begum RA, Zaman MW, Mondol ATMA, Islam MS, Hossain KMF. 2011. Effects of textile industrial waste water and uptake of nutrients on the yield of rice. *Bangladesh J. Agric. Res.* 36(2): 319-331.

Berendse F, van Ruijven J, Jongejans E, Keesstra S. 2015. Loss of plant species diversity reduces soil erosion resistance. *Ecosystems,* 18: 881–888, 2015.

Bionet. 2020. Naturalised distribution (global). https://keys.lucidcentral.org/keys/v3/ eafrinet/ weeds/key/weeds /Media /Html/ *Parkinsonia_aculeata* (Parkinsonia).htm. Accessed on 4-02-2020.

Boutraa T, Sanders FE. 2001. Effects of Interactions of Moisture Regime and Nutrient Addition on Nodulation and Carbon Partitioning in Two Cultivars of Bean (*Phaseolus vulgaris* L.). *J. Agronomy and Crop Sci,* 186: 229-337.

Brevik EC, Cerdà A, Mataix-Solera J, Pereg L, Quinton JN, Six J, Van Oost K. 2015. The interdisciplinary nature of soil. SOIL, 1, 117–129.

Carter MR, Andrews SS, Drinkwater LE. 2004. Systems approaches for improving soil quality. In P. Schjonning, S. Elmholt and B.T. Christenses. Editors Managing Quality:

Challenges in Modern Agriculture, CABI International, Wallingford, UK. pp 261-281.

de Souza T, Augusto Feitosa, de Andrade L. Alves Freitas, H, da Silva Sandim A. 2018. Biological Invasion Influences the Outcome of Plant-Soil Feedback in the Invasive Plant Species from the Brazilian Semi-arid. *Microbiol Ecol,*76: 102-112.

Decock C, Lee J, Necpalova M, Pereira EIP, Tendall DM, Six J. 2015: Mitigating N2O emissions from soil: from patching leaks to transformative action, Soil, 1, 687–694, 2015.

EDIS. 2020. Environmental Horticulture Department. *Parkinsonia aculeata*: Jerusalem-Thorn. https://edis.ifas.ufl.edu/st431 2020. Accessed on 4-02-2020.

Farooqi ZR, Iqbal MZ, Shafiq M, Kabir M. 2019. Effects of railway engine emission on the seedling growth behavior of woody plant species *Acacia nilotica* (L.) Willd. Ex delile*. Int. J. of Environ. Agri. and Biotechnol. (IJEAB),* (2):349-358.

Farooqi ZR, Iqbal MZ, Kabir M, Shafiq M, Athar M. 2018. Vegetational variation and soil characteristics around the railway track and Shahrah-e-Faisal in Karachi. *Int. J. of Scientific and Engineering Res.* 9(5): 1824-1843.

Farooqi ZR, Iqbal MZ, Kabir M, Shafiq M, Athar M. 2016. Seedling growth of *Adnenthera pavonina* L. in polluted soils of Karachi railway track. *J. of Applied Sci. and Environ. Mangmnt,* 20(2): 463-469.

Iqbal MZ, Jilani A, Shafiq M, Kabir M, Farooqi ZR. 2020. Seasonal variations in some soil characteristics on urban area of Karachi. *Bioscience,* 17(2):786-792.

Isley D. 1975. Leguminosae of the United States: Subfamily Caesalpinioideae. Mem. New York. *Botanical Garden,* 25: 1-228.

Kabir M, Iqbal MZ, Shafiq M, Farooqi ZR, Um E Habiba 2020. The effects of different soils types on seedling growth of *Gliricidia sepium* (Jacquin) Kunth ex Walp. Fabaceae). *Bioscience,* 17(2):832-841.

Kamal R, Mathur N. 2007. Rotenoids from *Parkinsonia aculeata* L. and their *In-vitro* amoebicidal activity. *Asian J. of Experimental Sci.* 21: 317-323.

Kaur V, Sharma G. 2017. Impact of dairy industrial effluent of Punjab (India) on seed germination and early growth of wheat (*Triticum aestivum*). *Ind. J. of Sci. and Techno.* 10(16): 3-9.

Punjab Forest Department. 2020. Forest and Environment Species. Compiled by Publicity and extension division, Punjab Forest Department.24-Cooper Road, Lahore, Pakistan. Pp 156.

Rab J, Iqbal MZ, Shafiq M, Athar M. 2018. Effect of different soil types characteristics on seedling growth of *Pisum sativum* L. *Insight Bot.* 8: 1-5.

Rathod MC, Senjliya B, Dhala DA. 2015. Effect of textile dye on seed germination of chick pea. *Int. J. of Recent Scientific Res.* 6(3): 2938-2043.

Rehman AS. 2006. Effects of soil of industrial areas on plants. Ph.D. Thesis, Department of Botany, University of Karachi, Karachi, Pakistan. 161 pp.

Rehman AS, Iqbal MZ. 2006. Seed germination and seedling growth of trees in soil extracts from Korangi and Landhi Industrial Areas of Karachi. *J. of New Seeds*, 8(4): 33-45.

Rehman SA, Iqbal MZ. 2009. Growth of *Leucaena leucocephala* (lam.) De-wit in different soil compositions of Korangi and Landhi industrial areas of Karachi, Pakistan. *Pak. J. of Bot.* 41: 3125-3138.

Schamp BS, Lonnie W, Aarssen LW. Lee H. 2003. Local plant species richness increases with regional habitat commonness across a gradient of forest productivity. *Folia Geobotanica*, 38: 273-280.

Shafiq M. 2002. Investigation into the effects of automobile pollutants on growth and metal contents of some roadside plants. Ph.D. dissertation. Department of Botany, University of Karachi, Karachi, Pakistan, pp. 99.

Shafiq M, Iqbal MZ. 2012. Impact of Automobile Pollutants on Plants. Lambert Academic Publishing GmbH & Co. KG Heinrich-Böcking-Str. 6-8, 6121, Saarbrücken, Germany. 132 pp.

Shafiq M, Iqbal MZ, Kabir M, Farooqi ZR. 2019. Poison Land. "Vegetation of disturbed and polluted areas in Pakistan". Strategic book publishing & rights agency, U.S.A. pp 173 pp.