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Research Article

Effect of Different Soil Types on Seedling Growth of *Pisum sativum* L.

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Abstract

Background and Objective: The use of vegetable (Pea) to assess the influence of edaphic characteristic on the seedling growth performance capacity was recommended according to adaptation ability. The aim of the present study was to investigate the edaphic characteristics of the campus areas soil. **Materials and Methods:** The soil samples were collected from 5 different sites, A: Abid general store, B: E-Type football ground, C: D-Types houses, D: Graveyard, E: Staff colony gate of the University Campus. The experiment was further conducted in a greenhouse under uniform natural conditions at the Department of Botany, University of Karachi in June, 2011 to investigate the effects of different soil types on the growth of pea. Data was analyzed using COSTAT. **Result:** This study showed a significant $p<0.05$ difference in seedling growth performance and biomass production of pea (*Pisum sativum*) seedlings when treated with different types of soil collected from different sites of the University Campus. The root growth performance of *Pisum sativum* (*P. sativum*) was found highest with the treatment of E-Type football ground site soil. The better growth performance of *P. sativum* seedlings in terms of shoot length, seedling length, number of leaves and leaf area was found with the treatment of staff colony gate soil as compared to other sites soils. The soil treatment of D-Types house site showed low root, shoot and seedling length of *P. sativum* as compared with other soil treatment. The soil treatment of staff colony gate had a stimulating effect on number of leaves for pea seedlings. The treatment of staff colony gate site soil produced the highest phenolic contents in the *P. sativum* seedlings as compared to other sites soil treatment. The treatment of E-Type football ground site soil produced highest soluble sugar contents in pea seedlings as compared to other soil treatment. **Conclusion:** Anthropogenic activities affected the edaphic characteristics of the campus area. It was found that the seedling growth performance of *P. sativum* was better in response to Abid general store area soil as compared to other areas soil treatment. The treatment with Graveyard area soil showed low seedling growth performance of *P. sativum*.

Key words: *Pisum sativum*, seedling growth, seedling dry weight, soil influence, anthropogenic activities

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Competing Interest: The authors have declared that no competing interest exists.

Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

Soil is an important component of the earth's biosphere[1]. Plant-soil relationships in the surface soil layer affect crop productivity, nitrate leaching and plant pest interactions[2]. Soil is one of the most important natural resources and a major factor in global food production[3]. There has been an innate interest in soil and land quality since the advent of agriculture[4]. The soil characteristics below the grounds are recognized as possible key factors in affecting plant species coexistence and community organization[5]. Inappropriate land use and poor soil management adversely affect the environment and soil's productivity[6].

The *leguminosae* is one of the largest plant families in plant kingdom. *Pisum sativum* L. (Family *Leguminosae*, sub family *Papilionaceae*) is well known as an annual vegetable. Germination was the initial stage of a plant life cycles and determine where and when a crop can be established[7]. High rate of increase in population density and construction of new structure are affecting distribution of plant species, physical, chemical and biological properties of soil. Interest in the quality of soil and its effects on vegetable has been increased since last couple of decade. Such types of studies on vegetable such as on *P. sativum* are scanty in the country. Therefore, the present study was carried out with the aim to find out the effects of different soil types on seedling growth and biomass production of *P. sativum*. The objective of the present study was also to investigate the edaphic characteristics of the campus areas soil.

MATERIALS AND METHODS

A research was carried out to find out the effects of different soil types on seedling growth of pea (*Pisum sativum* L.). The soil samples were collected from 5 different sites, A: Abid general store, B: E-Type football ground, C: D-Types houses, D: Graveyard, E: Staff colony gate of the University Campus. The soil sample collection sites (A: Abid General store were dominated by *Suaeda*, *Aeluropus* and *Prosopis* community followed by site B: E-Type football ground by *Suaeda* and *Aeluropus*, C: D-Types houses site by *Salvia*, *Crotolus* and *Zygophyllum*, site D: Graveyard by *Zygophyllum*, *Abutilon* and *Salvia*, E: Staff colony gate by *Calotropis*, *Tricholus* and *Tribulus*, respectively) have been studied in earlier studies[8].

Seedling growth experiment: The experiment was further conducted in a green house under uniform natural conditions at the Department of Botany, University of Karachi in June, 2011 to investigate the effects of different soil types on the growth of pea. The range of maximum temperature and minimum temperature was 22-31 and 11-18°C, respectively during experiment. Atmospheric humidity during the experiment was in the range of 14 - 88%. The weather outlook was mostly sunny with a range of 10:30-11:41 h sun shine. Healthy seeds of *Pisum sativum* L. (Pea) were taken from local market. The seeds of pea were sterilized with aqueous mercuric chloride (0.1%) for 5 min to avoid fungal contamination and thoroughly washed with distilled water. The seeds were placed in moist and wet cloth for few days. When the plumule was emerges out from the seed then were sown in garden loam soil at 1 cm depth in large earthen pots. The pots were irrigated daily with tap water. After 3 weeks, uniform size seedlings were transplanted into pots of 7.3 cm diameter and 9.6 cm in depth in different soil types collected from different sites of the University Campus. Each pot prepared by filling the soil by 2/3 in pot and punching of one hole in the bottom. A total number of 30 pots were randomly divided into five groups for soil type and marked on pot as, A: Abid general store, B: E-Type football ground, C: D-Types houses, D: Graveyard and E: Staff colony gate of the University Campus. There were 6 replicates for each treatment and the experiment was completely randomized. Only one seedling was grown in each pot and the seedlings were irrigated with tap water daily. Every week, pots were reshuffled to avoid light/shade or any other green house effects.

After 5 weeks, seedling were carefully removed from the pots and washed thoroughly to measure root, shoot and seedling length (cm). Number of leaves and leaf area (cm^2) were also recorded. Root, shoot and leaves were separated for drying in an oven at 80°C. The effects of soil types on biomass production (plant fresh weight (g), root dry weight (g), shoot dry weight (g), leaves dry weight (g) and seedling dry weight (g)) of pea seedlings were also noted.

Leaf weight ratio was determined according to following equation:

$$\text{Leaf weight ratio} = \frac{\text{Leaf dry weight}}{\text{Total plant dry weight}}$$

Physiological tests: Phenols were determined by using Folin reagent method. Soluble sugars were estimated by Anthrone reagent method.

Statistical analysis: The obtained seedling growth data collected from various growth indices were statistically analyzed on personal computer using COSTAT version 3.

RESULTS

The result of the present studies showed significant $p<0.05$ difference in seedling growth and biomass production

Table 1: Seedling growth performance of *Pisum sativum* L. in different soil types

	Soil types				
	A	B	C	D	E
Root length (cm)	1.73±0.29^{ab}	4.00±0.490^{c}	2.43± 0.30^{ab}	0.66±0.23^{a}	3.26±1.0^{bc}
Shoot length (cm)	6.50±1.20 ^{a}	6.03±0.420^{a}	17.00±0.12^{b}	2.53±0.74^{a}	17.56±2.97^{b}
Plant height (cm)	8.23±1.44^{b}	10.00±0.880^{b}	19.50±0.37^{c}	3.20±0.97^{a}	20.30±2.41^{c}
Number of leaves	3.33±0.88^{a}	3.00±0.570^{a}	21.00±1.15^{b}	4.00±1.15^{a}	32.60±1.33^{c}
Leaf area (cm^2)	0.68± 0.16^{b}	0.27±0.060^{a}	0.47±0.03^{ab}	0.17±0.01^{a}	1.53±0.12^{c}
Plant fresh weight (g)	0.13± 0.03^{a}	1.30±0.030^{d}	0.67±0.27^{bc}	0.33±0.09^{ab}	1.10±0.10^{cd}
Root dry weight (g)	0.01±0.10^{a}	0.05±0.020^{a}	0.13±0.11^{a}	0.05±0.03^{a}	0.03±0.01^{a}
Shoot dry weight (g)	0.02± 0.001^{b}	0.02±0.001^{ab}	0.03±0.01^{b}	0.01±0.00^{a}	0.03±0.01^{b}
Leaf dry weight (g)	0.07± 0.002^{b}	0.04±0.002^{ab}	0.04±0.02^{ab}	0.01±0.01^{a}	0.03±0.007^{ab}
Total plant dry weight (g)	0.02±0.001^{b}	0.12±0.010^{b}	0.19±0.04^{ab}	0.01±0.01^{b}	0.76±0.06^{ab}
Leaf weight ratio	0.63±0.03^{c}	0.36±0.420^{b}	0.30±0.66^{ab}	0.12±0.01^{a}	0.36±0.31^{b}

A: Abid general store, B: E-type football ground, C: D-types houses, D: Graveyard, E: Staff colony gate soil, ±: Standard error statistical significance determined by analysis of variance, number followed by the same letter in the same rows are not significantly different, according to Duncan's multiple range test at $p<0.05$

Table 2: Amount of phenols and soluble sugar of *Pisum sativum* L. in different treated soil types

Soil types	Phenols (mg mL^{-1})	Soluble sugar (mg mL^{-1})
A	44.30±0.80 ^{a}	242.60±5.30 ^{a}
B	84.30±1.40 ^{c}	511.60±3.70 ^{d}
C	63.30±2.60 ^{b}	483.30±2.90 ^{c}
D	52.30±2.60 ^{a}	392.00±4.30 ^{c}
E	100.30±2.30 ^{d}	422.30±4.60 ^{b}

A: Abid general store, B: E-type football ground, C: D-types houses, D: Graveyard, E: Staff colony gate soil, ±: Standard error statistical significance determined by analysis of variance, number followed by the same letter in the same column are not significantly different, according to Duncan's multiple range test at $p<0.05$

of pea (*Pisum sativum*) seedlings when treated with the different types of soil collected from different sites of the University Campus (Table 1). Staff Colony Gate soil treatment produced significantly higher shoot length (17.56 cm), seedling growth (20.30 cm) and leaf area (1.53 cm^2) of pea seedling as compared with soil treatment of Abid general store, E-Type football ground, D-Type houses and Graveyard area. Soil treatment of E-Type football ground area significantly $p<0.05$ produced highest root length (4.0 cm) as compared with soil treatment of Staff colony gate soil (3.26 cm), D-Type houses (2.43 cm) and Abid general store (1.73 cm). Soil treatment of Graveyard area significantly $p<0.05$ produced lowest root length (0.66 cm) of *P. sativum*. A statistically significant $p<0.05$ effects of different areas soil type treatment on biomass production (plant fresh weight, root dry weight, shoot dry weight, leaves dry weight and seedling dry weight) of pea seedlings were also noted. Abid general store site soil treatment highly affected plant fresh weight (0.13 g) of pea seedlings as compared to soil treatment of Graveyard (0.33 g), D-Type houses (0.67 g), Staff colony gate (1.10 g) and E-Type football ground (1.30 g) site. After harvest a significant differences in the dry matter of the above ground parts and the root of the pea plants were recorded. The result obtained showed that soil treatment of Abid general store produced significant effects on root dry weight (0.012 g) of pea seedlings followed by soil treatment of E-Type football ground (0.028 g), Graveyard (0.047 g), E-Type houses (0.055 g) and D-Type houses (0.128 g), respectively.

Table 2 represents the significant amount of difference in phenols and soluble sugar contents of pea when treated with different area soil types. The phenolic contents in pea seedlings were found with the soil treatment of Staff colony gate (100.30 mg mL^{-1}), E-type football ground (84.30 mg mL^{-1}) and D-type houses (52.30 mg mL^{-1}). The treatment of Abid general store site soil produced the lowest phenolic contents (254 mg mL^{-1}) in pea seedlings. Similarly, the sugar contents level was recorded with the soil treatment of E-type football ground (511.60 mg mL^{-1}) and D-type houses (483.30 mg mL^{-1}). The treatment of Abid general store site soil produced the lowest amount of soluble sugar content (242.60 mg mL^{-1}) in pea seedlings.

DISCUSSION

In present studies, the effects of different soil types collected from the different sites of the University Campus showed a significant variation in seedling growth performance of pea (*Pisum sativum*). Variation in seedling growth performance of pea seedlings can be attributed with the treatment of different types of soil. Field pea (*Pisum sativum* L.) is considered a widely adaptable legume crop for soils of various types, from sandy to clayey ones[9]. Furthermore, the availability of minerals can be considered an important cause of variation in seedling growth performance of pea seedlings when treated with different types of the campus soil. Soils are a heterogeneous composition of

substances. The result of the present studies showed that the seedlings of pea plants grown in soil of D-Type houses area were less healthy and stayed considerably smaller in height, root, shoot length and leaf area than those treated with soil of E-Type football ground and Staff colony gate area, respectively. Growth in terms of seedling length and root length of *P. sativum* were also found significantly higher in Abid general store site soil treatment as compared with the soil treatment of D-Type houses area, E-Type football ground, Staff colony gate and Graveyard area. The above studies suggest that the variation in seedling growth performance of pea seeding depend on the physical and chemical nature of soil collected from different sites of the University Campus. The response of root growth of pea seedling to soil treatment is of particular importance because it affects subsequent plant growth and ability to withstand environmental stresses. Soil treatment of E-Type football ground area significantly $p<0.05$ produced highest root length as compared with soil treatment of Staff colony gate soil, D-Type houses and Abid general store. The soil treatment of E-Type football ground site showed fewer effects on the root growth of pea. The underlying edaphic conditions can be an important cause of influence on the root growth performance of pea. The treatment of different soil type significantly $p<0.05$ affected biomass production of pea seedlings and agreed with the findings of Kundu *et al.*[10], who explained in an investigation, the exposure of different types of abiotic and biotic stresses, such as drought, high temperature, salinity and pathogens adversely affected the growth and productivity of an important crop, *Vigna mungo* (black gram, urdbean). Salt stress imposes a major environmental threat to agriculture by limiting plant growth and reducing crop yield[11]. Nutrient availability varies and mostly depends on soil types. The depressive effect of saline stress (50 and 100 mM NaCl) on dry weight directly was found responsible related to the salt-induced decline in dry weight and N content in shoots of *Pisum sativum* cv. Lincoln[12]. The lowest seedling dry weight of pea was observed in the treatment of Graveyard area soil and indicating the strong influence of soil characteristics of the studied areas. Low seedling dry weight of pea might be due to accumulation of certain nutrients. In another investigation, the reduction in photosynthesis and chlorophyll 'a' synthesis are suggested for cowpea by Joshi *et al.*[13]. Similarly, in another investigation, the effects of soil type (Calcareous, clay loam, sandy soil) and irrigation intervals showed a significant influence on fresh and dry weight of *Thymus vulgaris* during the two seasons[14].

Chemical balance of inorganic elements in the living organism is a basic condition for their proper growth and development[15]. The plants under stress conditions are most likely to be adversely affected by under lying edaphic characters. The concentration of phenolic acids and soluble sugar in the pea seedlings depends upon the soil treatment. A comparison of this study result showed that the contents of phenolic and soluble sugar in seedling of pea were high in E-Type football ground soil treatment. Changes in edpahic character usually caused changes in growth performance of plants as found in present findings for pea seedlings. Pea is a cool season vegetable crop of mild climate regions. Therefore, it gives higher yield in cold humid regions compared to warm dry areas. Pea can grow in many soils, the best yield can be obtained in clay loam, deep, productive, moist, slightly acid (pH 6.5-7.0) soils[16]. In this study, number of leaves of pea was negatively affected from high salt content available in soil of E-type football ground.

CONCLUSION

An intense grazing, construction of new structure and varied human activities are responsible for changing the edaphic characteristics of the University Campus. It is clear from our results that the treatment of different soil types proved to be highly responsive and sensitive for the seedling growth of *P. sativum* and can be used as indicator of soil quality. It was found that the seedling growth performance of *P. sativum* was better in response to Abid general store area soil as compared to other areas soil treatment. The treatment with Graveyard area soil showed low seedling growth performance of *P. sativum*. The physical and chemical edaphic factors such as low percentage of soil porosity, maximum water holding capacity of soil and low concentration of phosphorus in graveyard area soil most likely might be responsible for low seedling growth and biomass productivity (plant fresh weight, shoot, leaf and seedling dry weight) of *P. sativum*. The physical and chemical analysis of the soil characteristics of all studied soil samples confirmed the findings. The availability of suitable mineral nutrient played an important role in the seedling development, in the formation of yield and seedling growth performance of *P. sativum*. Of all the treated soil types, soil treatment collected from Staff colony gate encouraged the shoot length, seedling length and leaf area of pea as compared with the soil treatment of Abid general store, E-Type football ground and Graveyard site area soil. The other encouragement factors were the better availability of phosphorous contents, bulk density and better percentage of soil porosity. The results indicated the ability of that could be useful in future planning for the availability of such types of soil in the area.

SIGNIFICANCE STATEMENTS

This study discover the possible effects of soil collected from the disturbed areas on plant growth that can be beneficial for the people working for increasing the cultivation area of pea. This study help to the researchers to uncover the critical areas of plant soil ecology relationship to increase the pea cultivation area in the country due to its high nutrition value. Thus the significant relationship of plant with soil, collected from the disturbed sites of the University Campus was due to anthropogenic activities reported.

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