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Effect of polluted soil combination with wheat husk on the aerial growth of *Cosmos bipinnatus* plants in pot trials

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Abstract

Environment is badly affected by various types of pollution (Air, water, soil, noise, thermal and nuclear pollution) due to numerous anthropogenic activities. Plants are also affected by these pollutions as their morphological, physiological characteristics and metabolism got distressed. *Cosmos bipinnatus*is an annual herbaceous blooming plant belonging to the family Asteraceae. It is mainly found in human-exploited areas such as roadsides, ditches and agricultural places. It possesses a variety of conventional herbal qualities that are utilised to treat a wide range of diseases such as jaundice, intermittent fever and splenomegaly and also has antioxidant activity. *Cosmos bipinnatus* plant is also affected by different types of pollution mainly by soil pollution Therefore, the present study was carried out to evaluate the effect of various types of treatments along with polluted soil on the morphology of *Cosmos bipinnatus* mainly on its shoot and root length. The results showed a substantial correlation between C*osmos bipinnatus* plant shoot and root length at different soil combinations and concentrations (Polluted soil (1:1), unpolluted soil (1:1), polluted soil + Coarse soil (9:1, 8:2, 7:3, 6:4, 5:5), and polluted soil + wheat husk (9:1, 8:2, 7:3, 6:4, 5:5). It was observed that the length of root and shoot was increased with the reduction in polluted soil concentration with the increase in combination of wheat husk applied.

Keywords: *Cosmos bipinnatus,* Inhibited Growth, shoot length, soil pollution, Wheat husk.

Introduction

Soil structure is an important abiotic factor that regulates plant growth by influencing the function of plant roots and soil-borne microorganisms. Understanding the different types of soil is crucial for agricultural productivity (Gupta *et al.*, 2015). Food or nutrients, temperature, oxygen, and water are all essential supports that any sort of soil can supply. Agriculture classifies soil into six major categories. These soils are classified based on their texture, such as sandy soil, clay soil, silt soil, chalky soil, peat soil, and loamy soil (Bot and Benites, 2005; Bai *et al.*, 2013; Garbeva *et al.*, 2004). According to one of the findings, loamy soil, which consists of sand, clay, and silt, is the optimum soil for plant growth and development (Al-Humairi *et al.*, 2019; Albalasmeh *et al.*, 2022). It has been found

that humus soil exhibits considerable growth in plants in terms of agronomic, physiological, and biochemical characteristics, followed by other soils (sandy soil, garden soil, and yellow-brown soil) (Quan and Liang, 2017).Furthermore, it has been observed that soil organic matter and plant growth-promoting microbes significantly increase plant growth in *Cabbage* and *Spodoptera litura (*Sripontan *et al*., 2014; Turan *et al*., 2014). Over time, the pollutant present in the soil hammered the plant's growth and development. According to Kulkarni *et al.*, 2007, plant growth is also enhanced by the soil-mixed agro- waste material. Pot growth flower species growth also increased by the substitute of vermicomposting in the soil (Roberts *et al*., 2007). According to the findings by Kulkarni *et al*., 2007, cheap wheat husk can be utilise for improvement of soil fertility at the place of inorganic fertilizers.

A plant's height and root length directly represent its growth. Therefore, there is an urgent need to elucidate the effect of different soil types on plant growth. *Cosmos bipinnatus* (family- *Asteraceae)* is an annual herbaceous flowering plant also known as "Garden cosmos" or "Mexican aster". The genus name is derived from the Greek word cosmos, which indicates order and harmony (Jang *et al*., 2008; Vargas-Amado *et al*., 2013). They have various traditional herbal properties that can be used to treat many diseases, such as intermittent fever, splenomegaly, and jaundice. They also exhibit an antioxidant and antigenotoxic effect against oxidative DNA damage (Jang *et al*., 2008; Santiago-Cruz *et al*, 2014). Hence, the current study describes a pot experiment to illustrate the effect of different soil concentrations and combinations on the *Cosmos bipinnatus* plant. During the whole experiment, *Cosmos bipinnatus* was cultured in various soil compositions and the results were analysed after a fixed interval of time, i.e., 20, 40, 60, and 80 days.

Material and Methods

Selection of study site: Water and soil samples were collected at depths ranging from 1 to 15 cm from the Dravyavati River at Sitapura industrial area near Goner region (lat 26.76944^{o} long 75.89672^{o}). The soil was air dried stones and wood particles were removed by hand in order to characterize the soil. The air dried soil samples were crushed using a hammer and sieve through 2 mm mesh sieve. Further, they were thoroughly mixed to make the sample homogenous for an experiment.

Experimental setup: The experiments were conducted in 36 earthen pots of size 9 inches. For the experiment, a combination of waste (living and nonliving material such as coarse soil and wheat husk) and polluted soil samples were collected from the sites of the Dravyavati River. For the analysis of soil, we quantified the samples in various concentrations and combinations along with a standard control (unpolluted soil).The following groups of soil concentrations and combinations were setup; Polluted soil (1:1),

unpolluted soil (1:1), Polluted soil (Nala soil) + Coarse soil (9:1, 8:2, 7:3, 6:4, 5:5), and Nala soil + wheat husk (9:1, 8:2, 7:3, 6:4, 5:5).The experiment was performed in triplicate. Seeds of *Cosmos bipinnatus* were sown in each pot for saplings. These pots were lined with polythene bags to prevent leaching and irrigated on alternate days with Dravyavati River wastewater effluent, and unpolluted soil irrigated with unpolluted water location shown in figure1. These plants were uprooted after a fixed interval (20, 40, 60 and 80 days).Root and shoot length were measured for each pot plants (Fig 2 and 3).

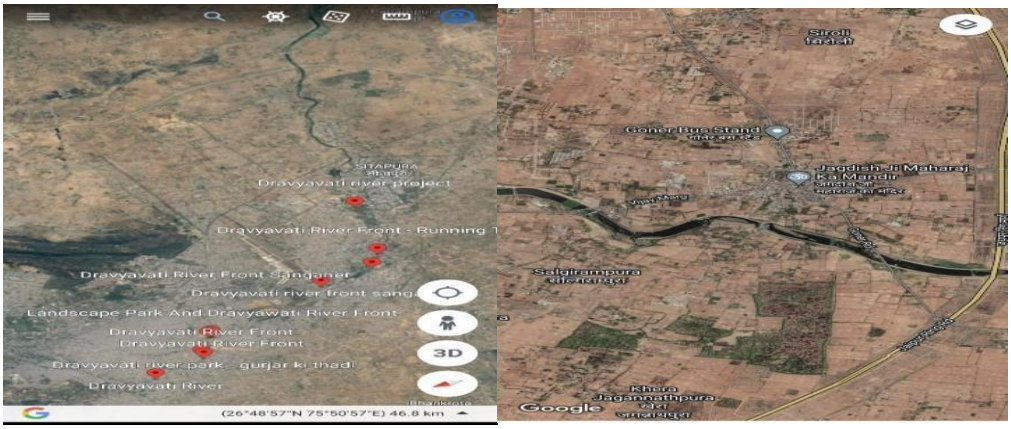

Figure 1: Showing soil collection sites for conducting an experiment

Table 1: Composition of soil types to grow *Cosmos bipinnatus* plant.

S.no	Soil Compositions		Composition Ratio
1.	Polluted soil	Polluted soil	1:0
2.	Unpolluted soil	Unpolluted soil	1:0
3.	Nala soil + Coarse soil	Nala soil + wheat husk	9:1
4.	Nala soil + Coarse soil	Nala soil + wheat husk	8:2
5.	Nala soil + Coarse soil	Nala soil + wheat husk	7:3
6.	Nala soil + Coarse soil	Nala soil + wheat husk	6:4
7.	Nala soil + Coarse soil	Nala soil + wheat husk	5:5

*****Experimentsareperformed in triplicates

Figure 2: *Cosmos bipinnatus* growth after different soil treatments; *Cosmos bipinnatus* Growth after 60 days

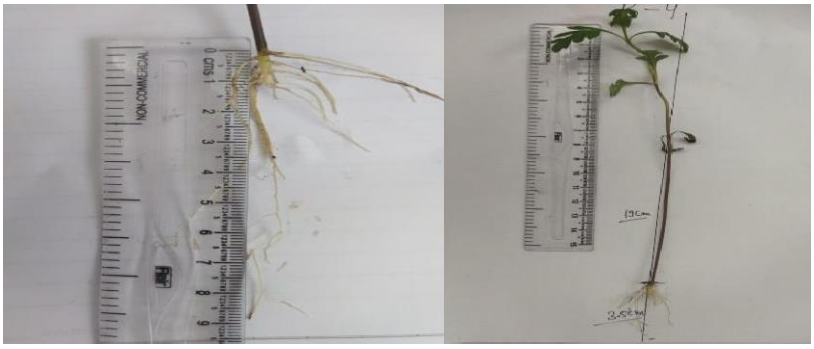

Figure 3: Measurement of root and shoot length of *Cosmos bipinnatus* plant after 40 days.

Data Collection and Analysis: A correlation matrix is a square matrix that contains the correlation coefficients between multiple variables. Each variable in the matrix is compared with every other variable, and the correlation coefficient quantifies the strength and direction of the relationship between them.

The correlation matrix (Table 3) provides a convenient way to examine the relationships between multiple variables simultaneously which has been done by the software SPSS, version 16.0.

To determine the effect of different soil types on the *Cosmos bipinnatus*growth,the length of root and shootwas recordedafter a fixed interval of 20, 40, 60, and 80 days. Comparisons of average root length and average shoot length in different compositions of soil types were also analysed. Collected data showing in table 2 below.

Results

Effect of different soil combinations on *Cosmos bipinnatus* growth: The pot experiment (*Ex-situ*) was carried out in 36 pots. To evaluate the effect of different soils on *Cosmos bipinnatus,* various concentrations and combinations of soil were used. The soil combination consisted of Nala soil + wheat husk, Nala soil + coarse soil, polluted soil and unpolluted soil (Control) along with different concentrations as per the **Table. 1**.The root length (in cm) and shoot length (in cm) of *Cosmos bipinnatus* were recorded after 20, 40, 60 and 80 days to analyse the growth of *Cosmos bipinnatus.* The experiment was repeated three times. According to the recorded data, Nala Soil and Wheat husk (5:5) show significant growth in root length and shoot length as compared to other soil types.

As per **Table 2,** we examine the effect of soil type on *Cosmos bipinnatus* plant growth after 20, 40, 60 and 80 days. It has been observed that the measured length of the shoot in Nala Soil and Coarse soil (7:3) exhibits substantial results when compared to other soil types. Furthermore, the combination of Nala Soil and Wheat husk (6:4)

results in a considerable increase in the root length of *Cosmos bipinnatus*, Nala soil and wheat husk (5:5) shows significant growth in root length as well as shoot length. It has been observed that the combination of Nala soil and wheat husk (6:4 ratios) showed significant results as compared to other combinations of soil. After 20, 40, 60, and 80 days, the average length of shoot and root was 19 cm (S), 6.4 cm (R), 35 cm (S), 8.83 cm (R), 53.5 cm (S), 12.16 cm (R), 48 cm (S), and 30.33 cm (R). After 80 days of interval, the combination of Nala soil and wheat husk (5:5 ratio) also showed a significant increase in shoot length, i.e., 67.66 cm± (1.45) as compared to other combinations of soil types.

Table 2: Average shoot and root length of *Cosmos bipinnatus* in cm after 20, 40, 60 and 80 days, numbers inside parenthesis indicate ± 1 S.E.(n = number of replicates)

S. No.	**Treatments**	**n**	**Comparisons between average shoot (S) and root (R) length in different soil compositions**							
			20 days		**40 days**		**60 days**		**80 days**	
			S± (cm)	**R**± (cm)	**S**± (cm)	**R**± (cm)	**S**±(cm)	**R**± (cm)	**S**±(cm)	**R**± (cm)
1.	**PS**	3	13 (0.57)	3 (0.57)	26.6 (0.88)	6.0 (0.57)	31.6 (0.88)	9.0 (0.57)	41.6 (0.88)	15.6 (2.33)
2.	**US**	3	22.3 (1.45)	8.3 (0.33)	37.0 (1.54)	8.0 (0.57)	46.0 (0.57)	13.6 (0.88)	54.0 (1.15)	30.6 (1.2)
3.	**B1**	3	11.8 (0.44)	3.5 (0.28)	32.3 (2.8)	5.6 (0.33)	36.3 (0.88)	11.6 (0.88)	48.0 (1.15)	19.3 (1.45)
4.	**B2**	3	12.1 (0.72)	4.8 (0.44)	32.3 (1.45)	6.1 (0.44)	37.3 (0.88)	11.0 (0.57)	46.3 (0.88)	19.6 (1.45)
5.	**B3**	3	16.5 (1.75)	6.1 (0.44)	32.0 (1.20)	7.9 (0.20)	42.0 (1.15)	13.3 (0.88)	44.3 (1.45)	22.0 (1.15)
6.	**B4**	3	17.3 (1.20)	5.8 (1.07)	33.0 (2.08)	7.5 (0.28)	51.0 (0.57)	15.0 (1.15)	53.3 (1.76)	25.0 (1.15)
7.	**B5**	3	17.6 (0.33)	6.1 (0.92)	32.0 (1.73)	7.8 (0.11)	52.3 (1.45)	15.6 (0.88)	54.0 (1.15)	23.3 (0.88)
8.	**H1**	3	15.6 (0.33)	5.1 (0.16)	25.0 (1.73)	6.6 (0.66)	42.6 (1.45)	10.6 (0.66)	41.6 (0.88)	16.6 (0.88)
9.	**H2**	3	17.0 (1.0)	6.0 (0.57)	32.6 (1.76)	8.0 (0.57)	52.6 (0.88)	12.0 (0.57)	52.0 (1.15)	20.3 (0.88)
10	**H3**	3	18.6 (1.33)	6.5 (0.76)	35.0 (1.73)	9.0 (0.57)	54.2 (1.33)	14.0 (0.57)	50.0 (1.15)	25.0 (0.57)
11.	**H4**	3	19.0 (2.08)	6.4 (0.30)	35.0 (2.88)	8.8 (1.09)	53.5 (0.76)	12.1(1.48)	48.0(1.15)	30.3(0.88)
12.	**H5**	3	22.3 (1.45)	7.0 (0.57)	30.0 (2.88)	9.0 (1.15)	53.0 (1.73)	15.1(1.01)	67.6(1.45)	25.0(0.57)

Polluted soil (PS), Unpolluted soil (US), Nala soil 90% + Coarse soil 10% (B1), Nala soil 80% + Coarse soil 20% (B2), Nala soil 70% + Coarse soil 30% (B3), Nala soil 60% + Coarse soil 40% (B4), Nala soil 50% + Coarse soil 50% (B5), Nala soil 90% + wheat husk 10% (H1), Nala soil 80% + wheat husk 20% (H2), Nala soil 70% + wheat husk 30% (H3), Nala soil 60% + wheat husk 40% (H4), Nala soil 50% + wheat husk 50% (H5), root (R), shoot (S)

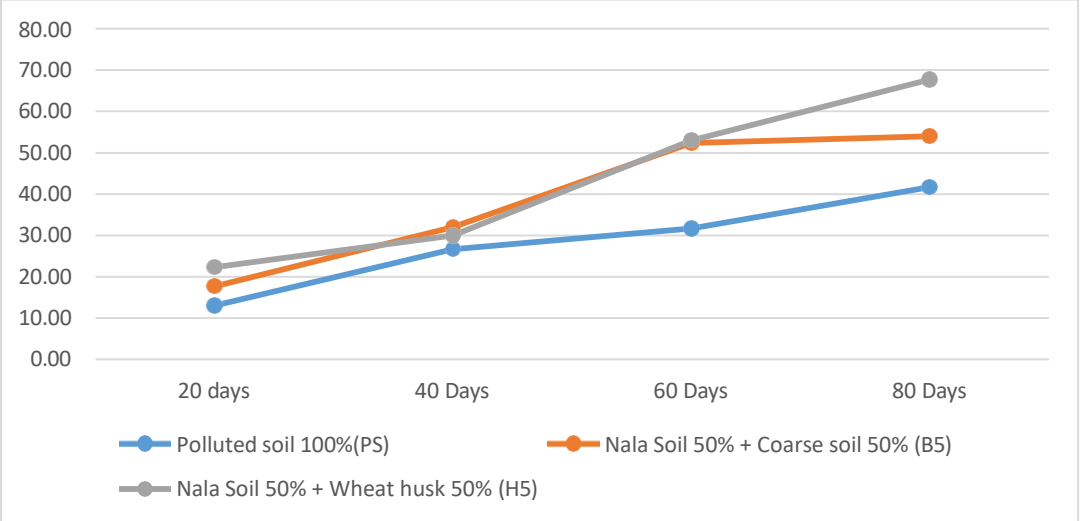

Figure 4: *Cosmos bipinnatus* plant Shoot length in cm with different composition of soil.

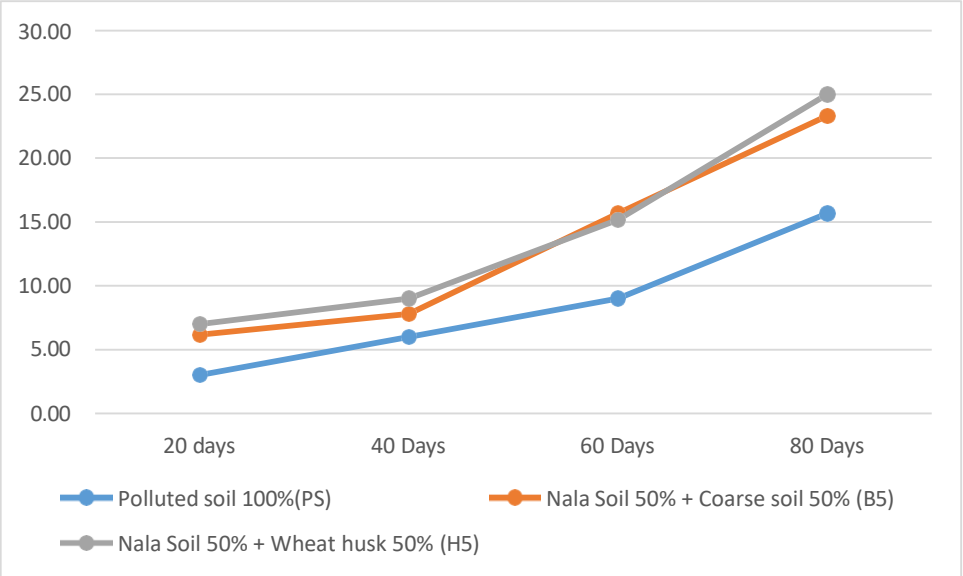

Figure 5: *Cosmos bipinnatus*plant root length (cm) with different composition of soil

Figures 4 and 5 depict the growth of shoot length and root length in which 100 percent polluted soil exhibits the least growth and 50 percent husk of wheat combined with 50 percent polluted soil exhibits the greatest root and shoot growth.

Table 3: Correlation Matrix after soil treatment given to the *Cosmos bipinnatus* plant

		Treatment	Days	SL	RL
Correlation	Treatment	1.000	0.000	0.214	0.175
	Days	0.000	1.000	0.806	0.752
	SL	0.214	0.806	1.000	0.927
	RL	0.175	0.752	0.927	1.000

SL-shoot length; RL- root length

Table 4. Total variance explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1.	2.690	67.256	67.256	2.690	67.256	67.256
2.	1.000	25.009	92.265	1.000	25.009	92.265
3.	.244	6.108	98.373			
4.	.065	1.627	100.000			

Analysis of variance is done by the software SPSS, version 16.0 (Table 4). Data analysis showed significant root length and shoot length by the soil type. In which root length is negatively correlated and shoot length is positively correlated with soil type. Therefore, during the experiment, we found that 50% of normal soil mixed with polluted soil equally affected the root and shoot length. Furthermore, the combination of 60% Nala soil and 40% wheat husk soil also exhibited a considerable increase in root and shoot length. The composition of 50 % wheat husk with 50 % polluted soil shows maximum growth of root and shoots length in *Cosmos bipinnatus.*

Discussion

Cosmos bipinnatus is an annual herb is widely distributed in Mexico. It is found in the mountainous regions of the country. They have antioxidant and antigenotoxic properties against oxidative DNA damage (Vargas-Amado *et al*., 2013; Jang *et al*., 2008; Santiago-Cruz *et al*., 2014). The main objective of this study was to explore the root and shoot length of *Cosmos bipinnatus* in different soil types. We have examined the different sets of soil combinations and concentrations after a fixed interval of 20, 40, 60, and 80 days. In addition to this, the average length of the root and shoot of the *Cosmos bipinnatus* plant was also measured and compared after 20, 40, 60, and 80 days (Fig. 2 and 3). Each experiment was performed in triplicate. After 80 days, the combination of Nala soil and wheat husk (5:5) showed a substantial increase in shoot length and root length as compared to other combinations of soil (Fig. 4 and 5). SPSS, version 16.0 was used for the analysis of variance. During the experiment, we found 50% of normal soil mixed with polluted soil, which equally affected the root and shoot length. Furthermore, Nala soil and wheat husk (5:5 ratios) also showed significant growth in shoot length, i.e., 67.66 cm as compared to other combinations of soil types. Therefore, according to the findings of this study, the length of the root and shoot have significant negative and positive correlations with soil type, respectively and the highest growth of root and shoot length was observed with 50 percent mixing of coarse soil or 50 percent wheat husk with polluted soil.

Conclusion

The current study emphasizes the impact of various soil concentrations along with

living and non-living materials on *Cosmos bipinnatus* plant growth. The whole study exhibited a significant correlation between enhanced morphological characteristics (root length and shoot length) with improved soil composition. Experiments showed that wheat husk with polluted soil can also be used as basic soil material for plant growth.

Authors' contributions: Namrata Jadaun has carried out the field work and collected the specimen. Sonali Pandey has designed the study and contributed by giving important suggestions, drafted the manuscript and has made corrections. Both authors have finalized the manuscript for correspondence. Both authors have read and approved the final manuscript.

Conflict of interest: Authors do not have any conflict of interests to declare.

Ethical issues: None.

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