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Data Article

Data on rhizosphere pH, phosphorus uptake and wheat growth responses upon TiO_2 nanoparticles application

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ABSTRACT

In this study, the data sets and analyses provided the information on the characterization of titanium dioxide nanoparticles (TiO_2 NPs), and their impacts on rhizosphere pH, and soil-bound phosphorus (P) availability to plants together with relevant parameters. For this purpose, wheat (*Triticum aestivum* L.) was cultivated in the TiO_2 NPs amended soil over a period of 60 days. After harvesting, the soil and plants were analyzed to examine the rhizosphere pH, P availability in rhizosphere soil, uptake in roots and shoots, biomass produced, chlorophyll content and translocation to different plant parts monitored by SEM and EDX techniques in response to different dosages of TiO_2 NPs. The strong relationship can be found among TiO_2 NPs application, P availability, and plant growth.

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Specifications Table

Subject area	*Environmental and agricultural applications*
More specific subject area	*Material synthesis, Effects of nanoparticles on soil-plant system, Nanobiotechnology*
Type of data	*Tables of TiO_2 effect on P concentration and plant biomass* *SEM and EDX images of TiO_2 NPs and their uptake by roots and leaves of plant* *Graphs of effect of TiO_2 NPs on rhizosphere soil, and P and chlorophyll content of leaves*
How data was acquired	*SEM, EDX, XRD, UV/Visible double beam spectrophotometer, chlorophyll meter (CCM 200-plus, Opti-Sciences, England, measurement area 0.7 cm^2)*
Data format	*Raw, analyzed*
Experimental factors	*Wheat seeds were grown in sandy loam soil containing different concentrations of TiO_2 NPs. The experiments were held in a greenhouse for 60 days under ambient conditions.*
Experimental features	*Effects of soil application of TiO_2 NPs were measured on rhizosphere soil, roots, and shoots of plant*
Data source location	*Islamabad, Pakistan*
Data accessibility	*Data is available with this manuscript*

Value of the data

- The data provides information of TiO_2 NPs effects on wheat over a period of 60 days for better understanding of their long-term impacts on plant growth.
- The data can help to understand the relationship between TiO_2 NPs application and phytoavailability of P for farm and field level applications to ensure nutrient management.
- The data suggested the scientific community to extend the exposure time and comparison with other plant species instead of very short term bioassays.
- Future experiments can be compared with this data to predict the optimum concentrations of NPs for better plant development for different plant species.

1. Data

The datasets and analyses described the impacts of soil applied titanium dioxide nanoparticles (TiO_2 NPs) on wheat (*Triticum aestivum* L.) plants. Corresponding figures, graphs, and images are provided with this article.

2. Experimental design, materials, and methods

2.1. Synthesis and characterization of TiO_2 NPs

TiO_2 general purpose reagent was obtained from Sigma Aldrich Inc. (purity > 99%, St. Louis, MO, USA) and further processed, and calcined at 500 °C to synthesize pure anatase crystal structure of TiO_2 NPs as described in Zahra et al. [1]. Scanning electron microscope (SEM, Jeol, JSM 6490A, Tokyo, Japan), energy-dispersive X-ray spectroscopy (EDX, Jeol, JED 2300), and X-ray diffraction (XRD) analyses of as-prepared TiO_2 NPs were performed as shown in Fig 1.

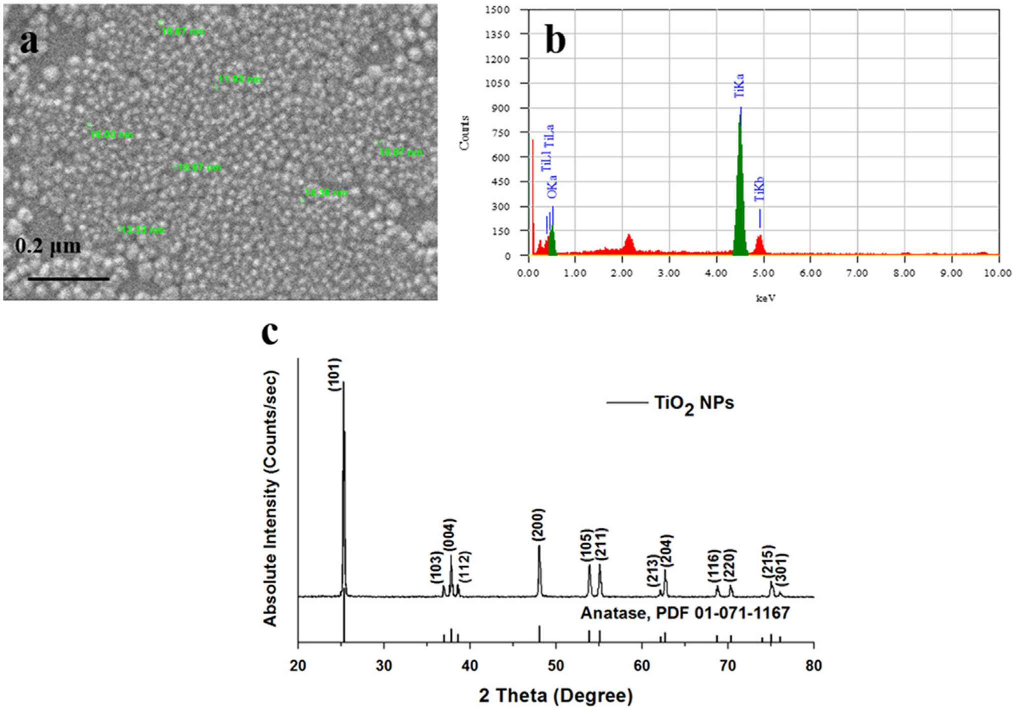


Fig. 1. Characterization results of TiO_2 NPs. (a) SEM image, (b) EDX and, (c) XRD spectrum of TiO_2 NPs.

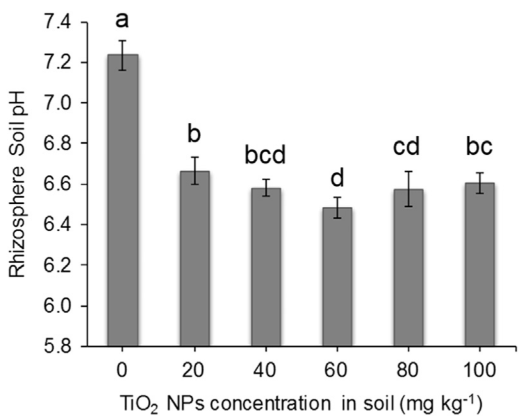


Fig. 2. Effect of TiO_2 NPs treatments on rhizosphere soil pH. Different alphabets correspond to statistically significant results at $p < 0.05$.

2.2. Soil application of TiO_2 NPs

TiO_2 NPs suspensions were prepared by mixing their various concentrations (0, 20, 40, 60, 80, and 100 mg L^{-1}) in deionized water and sonicated for 30 min. Four replicates of each treatment level, and the control group (without TiO_2 NPs) were maintained. Healthy seeds of wheat (Galaxy 2013) were obtained from the Ayub Agricultural Research Institute, Faisalabad, Pakistan. Three seeds were sown in each pot with as-prepared concentrations of TiO_2 NPs. The experiments were conducted in a greenhouse for 60

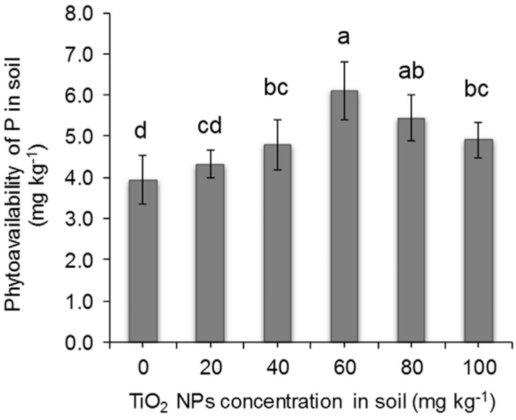


FIG. 3. Effect of TiO_2 NPs treatments on phytoavailability of P in rhizosphere soil. Different alphabets correspond to statistically significant results at *p* < *0.05*.

Table 1
Effect of TiO_2 NPs treatments on plant shoot and root dry biomass of wheat.

TiO_2 NPs Concentration (mg kg^{-1})	Shoot dry biomass (mg)	Root dry biomass (mg)	Total dry biomass (mg)
0	0.73 ± 0.09a	1.11 ± 0.16a	1.37 ± 0.06a
20	0.89 ± 0.05b	1.47 ± 0.12b	1.70 ± 0.05b
40	0.73 ± 0.42b	1.30 ± 0.74b	1.71 ± 0.17b
60	0.63 ± 0.59b	1.19 ± 1.14b	1.81 ± 0.39b
80	0.95 ± 0.05b	1.65 ± 0.13b	1.84 ± 0.04b
100	0.91 ± 0.05b	1.52 ± 0.1b	1.71 ± 0.07b

The values are the means of four replicates ± Standard Deviation (SD). The means followed by similar letter (a) in the same column are not significantly different whereas (b) represents statistically significant difference at $p < 0.05$.

days following randomized block design where the position of the pots was altered to avoid environmental bias effects.

2.3. Analysis of soil and plants

After 60 days of TiO_2 NPs exposure, the plants were uprooted and shaken carefully to remove soil at harvesting. The loosely bound soil adhered to the roots was collected with gentle washing in distilled water (100 mL) to investigate the rhizosphere pH (Fig. 2) and P (Fig. 3) using Olsen's method [2]. The roots and shoots were cut and dried in hot air oven for 48 h at 70 °C. After that, the dry biomass was recorded (Table 1) and stored for P analysis. For plant P content analysis, 100 mg of ground plant samples were added to acid mixture containing 5 mL of $HNO_3/HClO_4$ (2:1). This was digested on a hot plate followed by filtration through Whatman filter paper no. 42 to get clear aliquots for P content analysis (Table 2) using the vanado-molybdo-phosphoric acid colorimetric method [3].

2.4. Estimation of leaf chlorophyll content

A hand-held chlorophyll meter was used to measure the chlorophyll content index (CCI). The CCI readings were taken after the 30th day of NPs exposure for 16 alternate days until harvest. The everyday measurements are the mean of 32–48 readings for each treatment (Fig. 4). Following

Table 2
Effect of TiO_2 NPs treatments on plant shoot and root P concentration of wheat.

TiO_2 NPs Concentration ($mg\,kg^{-1}$)	Shoot P concentration (mg)	Root P concentration (mg)	Total P concentration (mg)
0	1.52 ± 0.17a	1.48 ± 0.13a	3.00 ± 0.03a
20	1.65 ± 0.08b	1.84 ± 0.12b	3.49 ± 0.14b
40	1.77 ± 0.06b	2.08 ± 0.16b	3.85 ± 0.22b
60	0.85 ± 0.08b	2.52 ± 0.19b	4.37 ± 0.47b
80	1.73 ± 0.07b	1.99 ± 0.18b	3.72 ± 0.18b
100	1.68 ± 0.06b	1.90 ± 0.16b	3.58 ± 0.15b

Data is the mean of four replicates ± Standard Deviation (SD). Means followed by different letters in the same column indicate significantly significant results at $p < 0.05$.

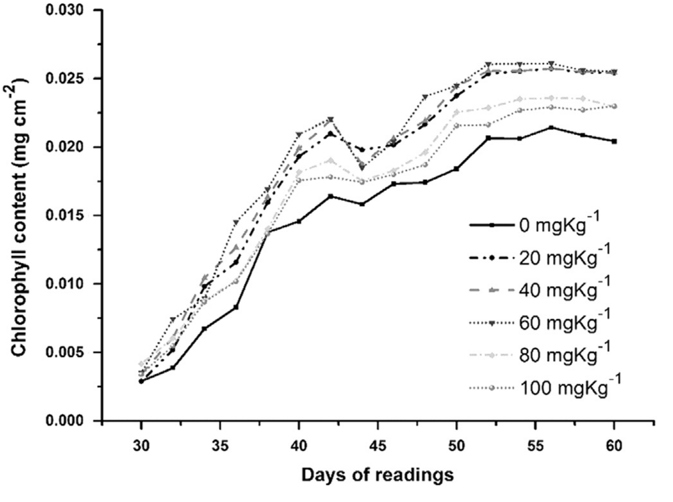


Fig. 4. Effect of TiO_2 NPs treatments on foliar chlorophyll content of wheat on daily basis.

calibration Eq. (1) was used to process the raw data and convert the CCI index values to chlorophyll content expressed as $m\,cm^{-2}$ [4].

$$y = -2.20e^{-03} + 3.09e^{-03}\,x - 5.63e^{-05}x^2 \quad (1)$$

where y = Total chlorophyll content

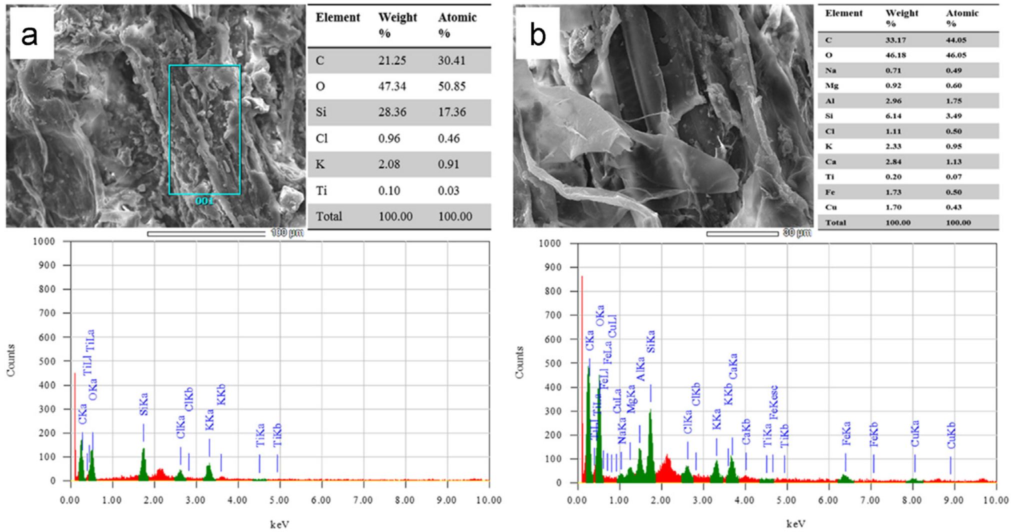
$x = Chlorophyllmetervalue$

2.5. Microscopic analysis of plant

To investigate the uptake of TiO_2 NPs, plant samples were observed under SEM equipped with EDX to demonstrate the elemental composition of the control ($0\,mg\,kg^{-1}$ TiO_2 NPs) and treated ($60\,mg\,kg^{-1}$ TiO_2 NPs) samples of roots (Fig. 5), and shoots (Fig. 6).

2.6. Statistical analysis

The statistical significance analysis was done using Student's *T*-Test available in the Microsoft Excel analysis tool box. One-way ANOVA test was performed to identify statistically significant differences between the treatments. Statistix 8.1 was used to identify the least significant differences (LSD) at $p < 0.05$. All the data presented here supports the findings and discussion in Rafique et al. [5].



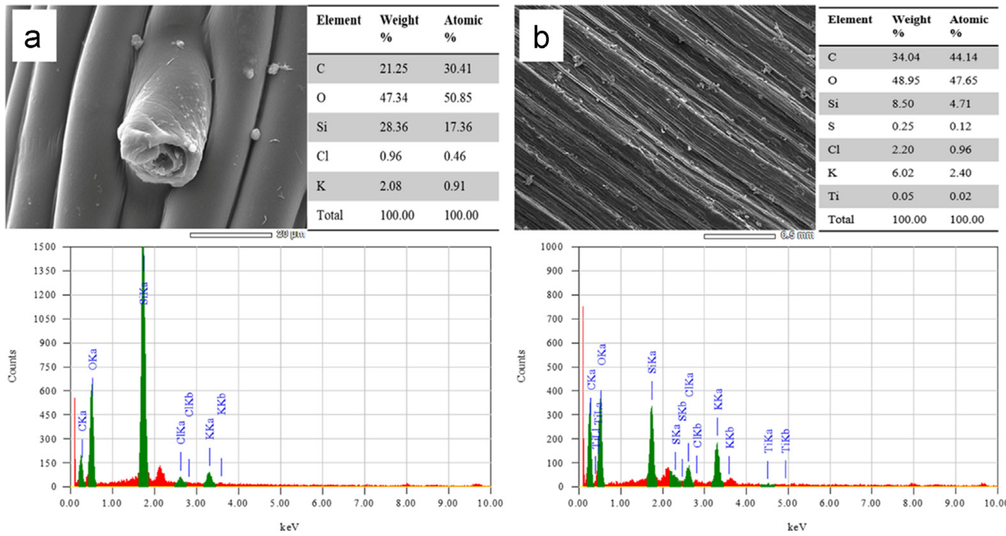
(a)

Element	Weight %	Atomic %
C	21.25	30.41
O	47.34	50.85
Si	28.36	17.36
Cl	0.96	0.46
K	2.08	0.91
Ti	0.10	0.03
Total	100.00	100.00

(b)

Element	Weight %	Atomic %
C	33.17	44.05
O	46.18	46.05
Na	0.71	0.49
Mg	0.92	0.60
Al	2.96	1.75
Si	6.14	3.49
Cl	1.11	0.50
K	2.33	0.95
Ca	2.84	1.13
Ti	0.20	0.07
Fe	1.73	0.50
Cu	1.70	0.43
Total	100.00	100.00

Fig. 5. SEM and EDX analysis of wheat roots at (a) 0 mg kg^{-1}, and (b) 60 mg kg^{-1}. The EDX spectrum was measured at 20 keV.



(a)

Element	Weight %	Atomic %
C	21.25	30.41
O	47.34	50.85
Si	28.36	17.36
Cl	0.96	0.46
K	2.08	0.91
Total	100.00	100.00

(b)

Element	Weight %	Atomic %
C	34.04	44.14
O	48.95	47.65
Si	8.50	4.71
S	0.25	0.12
Cl	2.20	0.96
K	6.02	2.40
Ti	0.05	0.02
Total	100.00	100.00

Fig. 6. SEM and EDX analysis of wheat leaves at (a) 0 mg kg^{-1}, and (b) 60 mg kg^{-1} of TiO_2 NPs treatment. The EDX spectrum was measured at 20 keV.

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Transparency document. Supporting information

Supplementary data associated with this article can be found in the online version at http://dx.doi.org/10.1016/j.dib.2018.02.002.

References

[1] Z. Zahra, N. Waseem, R. Zahra, H. Lee, M.A. Badshah, A. Mehmood, H.K. Choi, M. Arshad, Growth and metabolic responses of rice (*Oryza sativa* L.) cultivated in phosphorus-deficient soil amended with TiO_2 nanoparticles, J Agric. Food Chem. 65 (2017) 5598–5606.
[2] S.R. Olsen, C.V. Cole, F.S. Watanabe, L.A. Dean, Estimation of Available Phosphorus in Soil by Extraction with Sodium Bicarbonate, 939, United States Department of Agriculture, Washington, D.C. (1954) 18–19.
[3] J. Ryan, G. Estefan, A. Rashid, Soil and Plant Analysis: Laboratory Manual, 2nd ed., International Center for Agricultural Research in the Dry Areas (ICARDA), Aleppo, Syria, 2001.
[4] A.D. Richardson, S.P. Duigan, G.P. Berlyn, An evaluation of noninvasive methods to estimate foliar chlorophyll content, New Phytol. 153 (2002) 185–194.
[5] R. Rafique, Z. Zahra, N. Virk, M. Shahid, E. Pinelli, J. Kallerhoff, T.J. Park, M. Arshad, Dose-dependent physiological responses of *Triticum aestivum* L. to soil applied TiO_2 nanoparticles: alterations in chlorophyll content, H_2O_2 production, and genotoxicity, Agric. Ecosyst. Environ. 255 (2018) 95–101.