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Full Length Article

A Multivariate Approach to Soil and Crop Yield under Diverse Cropping System in Punjab, Pakistan

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Abstract

Inappropriate land use can deplete nutrient contents of crop land that leads to reduce nutrient concentrations and productivity. However, monitoring nutrient status of crop land can help producer take appropriate remedial measures before significant loss occur productivity. The objective of study was to quantify the soil physicochemical properties under various cropping systems. The study was undertaken on five cropping systems wheat-groundnut (W-G), wheat-rice (W-R), fallow- wheat/gram (F-W/G), mix cropping (Mix C) and wheat-cotton(W-C) in Punjab Pakistan. Geo reference 470 soil samples were collected randomly to investigate the soil bulk density gcm^{-3} (BD), soil moisture % (SM), total organic carbon % (TOC), organic matter % (OM), zinc (Zn), boron (B) and iron (Fe) as well as grain yield t/ha (GY). The findings of the classical analysis, cluster analysis, PCA, correlation and interpolated maps showed a significant variation in soil characteristics, emphasizing the necessity of focused nutrient management at particular areas to preserve soil fertility for sustainable crop production. Mean maximum value (1.52 gcm^{-3}) of BD was determined in soil under F-W/G cropping system while the minimum BD (1.26 gcm^{-3}) was observed in W-R cropping system. SM, TOC, OM, Zn and B was 40.4%, 59.37%, 54.71%, 65.45% and 45.45%, more in mix cropping system compare with lowest values of fallow-wheat/gram cropping system while the Fe concentration was 58.35% higher in W-R cropping system compare with least concentration of F-W/G cropping system. Comparing yield under five cropping systems mix cropping shows highest yield which was 78.9% more than fallow-wheat/gram cropping. Maps of spatial variability indicate that the research area's deficiencies were found from the southern to the northern regions. In conclusion, mix cropping or addition of legumes in rotation can improve the soil nutrients status and also enhance the crop productivity.

Key words: Soil nutrients; Cropping system; Crop yield; Multivariate analysis

Introduction

Soil is an extremely complex ecosystem and a highly valuable resource from an eco-centric and anthropocentric perspective. Given its numerous vital purposes, soil is without a doubt one of our most important and strategic resources. These include: (i) providing food, fuel and fiber; (ii) breaking down organic matter (such as dead plant and animal material); (iii) recycling vital nutrients; (iv) detoxifying organic contaminants; (v) sequestering carbon; (vi) controlling water quality and supply; (vii) providing habitat for a wide variety of animals and microorganisms (soil is an important reservoir of biodiversity); (viii) source of raw materials (clay, sand, gravel) (Yang *et al*. 2020). Soil characteristics are the main contributors of agricultural productivity and are impacted by a range of elements such as climate, soil types, and agronomic techniques (Hijbeek *et al*. 2019). By improving the physical, chemical, and biological characteristics of the soil, adding more organic material to agricultural operations can greatly increase soil fertility (Gai *et al*. 2019).

Nutrient deficient soil is alarming around the world, due to this fact many cultivars of important crops were highly susceptible to low levels of major and minor nutrients (Rehman and Adnan 2018). A number of factors are involved in decreasing agriculture crop production in Pakistan among which soil fertility finds its deserved place (Khattak and Hussain 2007). Due to poor status of available nutrients some of Pakistani soils are unable to support optimum levels of crop productivity (Ahmed and Rashid 2003). The nutrients like nitrogen (N), phosphorus (P) and potassium (K) are required in large and on regular basis to

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the crops and are referred as macro nutrients, while micronutrients like Fe, B and Zn are required in smaller amount as compared with macro nutrients and perform a vital role in various physiological functions of crops. Production and their relation to nutrition security and human health has become more prevalent in recent years. Many of the nutrients required for human health come from soil, either from plants or from products of animals eaten by humans (Shukla *et al*. 2017; Steffan *et al*. 2018).

Increasing agro-system productivity was the initial goal of cropping systems, anticipates about cropping systems' environmental sustainability have increased in modern agriculture (Fargione *et al*. 2018). Cropping system's worth and efficiency are determined by a number of elements, including the kinds of crops that are rotated (Tiemann *et al*. 2015), the duration of the rotation (Bennett *et al*. 2012), the farmland's agronomic history, and the soil's properties (Bainard *et al*. 2017). Crop nutrient uptake and water availability are influenced by the physical characteristics and ecology of the soil (Giannitsopoulos *et al*. 2019). A better soil structure can boost biodiversity, water availability, nutrient and water recycling, and soil porosity (Alaoui *et al*. 2011). These improvements in soil quality result into better growing conditions for crops. Soil organic matter (SOM) plays a vital role in ecosystem functionality, significantly contributing to soil sustainability and productivity in cropping systems (Pankhurst *et al*. 2002). Soil organic carbon, a critical component of soil quality, influences soil structure, nutrient availability, and water retention (Ghorai *et al*. 2023).

Micronutrient deficiencies are common in semi-arid and arid parts of the world, such as Pakistan's Indus plain. Approximately 30–50% of farmed soils worldwide, including Pakistan (Rashid *et al*. 2022), are predicted to have deficits in Fe and Zn, respectively (Cakmak 2002). More common micronutrient disorders in Pakistan include zinc and boron limitations, which are being documented for various field crops in practically every agro-climatic area of the nation. Zinc shortage has affected more than 60% of Punjab's soils, 21% of Khyber-Pakhtunkhwa's soils, 90% of Sindh's soils, and more than 43% of Balochistan's soils (Zia *et al*. 2006). Iron-deficient crops develop more slowly than usual, and more prone to disease (Chatterjee *et al*. 2006). Scarcities in micronutrients are associated with crops, as well as different cultivars and kinds of soil. Previous studies on Pakistan's alluvial calcareous soils have also shown that Zn usage is necessary to maximize the yield of irrigated crops (Ahmad *et al*. 2011; Rafique *et al*. 2012).

A key indicator of agricultural productivity, crop production is always correlated with soil health. Keeping high crop yields while ensuring sustainable soil management is a crucial area of intersection for agricultural research and policy (Tahat *et al*. 2020; Koudahe *et al*. 2022). This study aims to clarify the impacts of different cropping strategies on crop yields and soil attributes. Additionally, the goal of this strategy is to highlight the remarkable ability of specific farming system to raise agricultural productivity and soil fertility. This study contributes to the growing body of information on sustainable agriculture by assisting legislators, agronomists, and farmers in their endeavors to promote environmentally conscious and productive agricultural systems.

Material and Methods

Site description

The study was carried out in the Punjab Provence between year (2019-2021). Punjab is located in South Asia on the northwest margin of the Indian plate. It is the second biggest province in Pakistan, after Balochistan. In addition to canal irrigation systems, the majority of the province's terrain is ideal for agricultural. Punjab has a varied climate with intense hot in the south and cold temperatures in the north. While the Himalayan foothills are located in the far north.

Data collection

A GPS meter was used to gather 470 soil samples at a depth of 0 to 30 cm from five distinct cropping systems, and the position of each sample was recorded as a latitude and longitude value. After brief interview from farmers regarding management practices, cultivation and rotations of crops we should collect the sample where they following cropping system more than 5 years. Sampling sites were superimposed on the Punjab district map as shown in (Fig. 1), where the district shape file was collected from Survey of Pakistan and maps were produced using GIS software ArcMap (10.3.1) using the IDW interpolation approach. Two to three subsamples from each location in every district under various systems were used to create composite soil sample. The soil samples were brought to the laboratory, where they were air dried in the shade, pulverized, and sieved through a 2 mm sieve then stored in plastic bags for testing. The soil samples were carried out for physicochemical characteristic. A core sampler was used to measure the bulk density of the soil in situ using the core method (Blake and Hartge 1986), Soil moisture percentage were measured by gravimetric method from 0-30 cm depth from all the study area, soil organic matter was measured using the procedure outlined by (Walkley and Black 1934), TOC (Nelson and Sommers 1982), ADTPA zin and iron was analysis using an Atomic Absorption Spectrophotometer (Soltanpour and Schwab 1977). While boron was measured by hot-water extraction procedure and analysed by using Atomic Emission Spectrometry at a wavelength of 440 nm (Bingham 1982). Yield data were collected from one-meter square after successful completion of each crop.

Table 1: Statistical characterization of soil properties in different cropping system

Cropping Systems	Descriptive statistic	BD (gcm^{-3})	Moisture (%)	OM (%)	TOC (%)	Zn (mg/kg)	B (mg/kg)	Fe (mg/kg)
Wheat- Groundnut (N=79)	Minimum	1.24	11.62	0.14	0.06	0.07	0.016	0.88
	Maximum	1.64	18.07	0.64	0.43	0.58	0.48	5.74
	Mean	1.50	15.62	0.40	0.24	0.34	0.25	2.85
	Std. Dev	0.26	1.55	0.14	0.095	0.14	0.15	1.41
	CV %	17.18	9.96	35.15	39.58	41.18	60.00	49.47
Wheat-Rice (N=123)	Minimum	0.84	12.08	0.21	0.13	0.12	0.16	4.48
	Maximum	1.51	22.93	0.78	0.55	0.96	0.59	9.5
	Mean	1.26	16.88	0.50	0.3	0.46	0.41	6.7
	Std. Dev	0.17	2.69	0.11	0.08	0.18	0.09	1.55
	CV %	13.60	15.93	22.55	26.67	39.13	21.95	23.13
Fallow- Wheat/ Gram (N=60)	Minimum	1.27	8.24	0.06	0.01	0.02	0.01	1.13
	Maximum	1.72	12.14	0.53	0.36	0.37	0.35	5.14
	Mean	1.52	10.12	0.24	0.13	0.19	0.24	2.79
	Std. Dev	0.11	0.96	0.11	0.07	0.09	0.08	1.34
	CV %	7.22	9.50	46.89	53.85	47.37	33.33	48.03
Mix Cropping (N=131)	Minimum	0.97	12.53	0.26	0.16	0.25	0.15	2.03
	Maximum	1.56	22.78	0.79	0.69	0.86	0.64	8.67
	Mean	1.37	16.98	0.53	0.32	0.55	0.44	4.21
	Std. Dev	0.15	2.62	0.13	0.11	0.15	0.12	1.56
	CV %	10.96	15.44	24.76	34.38	27.27	27.27	37.05
Wheat/ Cotton (N=77)	Minimum	1.12	12.07	0.23	0.12	0.25	0.14	2
	Maximum	1.62	21.52	0.80	0.53	0.79	0.56	7.43
	Mean	1.45	16.56	0.49	0.28	0.49	0.4	4.14
	Std. Dev	0.14	2.78	0.13	0.09	0.14	0.11	1.52
	CV %	9.35	16.79	26.08	32.14	28.57	27.50	36.71

(N) is the number of samples. B.D (bulk density), O.M (organic matter), TOC (total organic matter), Zn (Zinc), B (Boron), Fe (Iron)

Multivariate analysis

Descriptive statistics were used to evaluate the status of basic soil traits by using SPSS (version 16) software. In order to pertinent information extracted from the data. Principal component analysis (PCA), hierarchical cluster analyses (HCA) and correlation matrix these multivariate statistical techniques, were applied using R software (R Core Team 2016). The spatial variability maps were produced using GIS software ArcMap (10.3.1) using the IDW interpolation approach to accurately identify the geochemical data's overall geographical distribution.

Results

Soil physical properties

Soil bulk density is the indicator of the soil structure changes. The bulk density of soil samples collected from various cropping systems were analyzed and results are presented in (Table 1). The highest bulk density (1.52 gcm^{-3}) was recorded in soil under fallow- wheat/gram cropping system followed by wheat-groundnut (1.50 gcm^{-3}), wheat-cotton (1.45 gcm^{-3}) and mix cropping system (1.37 gcm^{-3}) whereas, the lowest (1.26 gcm^{-3}) was observed in wheat-rice cropping system. F/W-G cropping system has 1.82%, 4.56%,10.22% and 17.60% higher value of bulk density as compared to W-G, W-C, Mix C and W-R cropping system.

Data pretended in (Table 1), shows soil moisture percentage under different cropping system of Punjab. Difference between cropping system ranges from (8.24% to 22.93%). Highest mean soil moisture (16.98%) percent was noted in mix cropping system which was followed by wheat-rice (16.88%), wheat-cotton (16.56%) and wheat-groundnut (15.62%) cropping system in contrast fallow-wheat/gram has lowest (10.12%) soil moisture percentage.

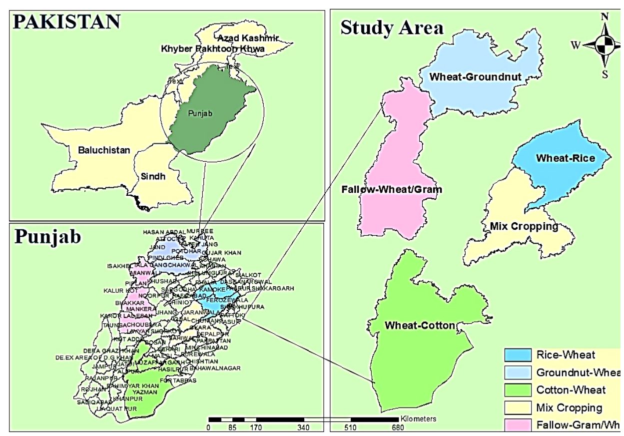

Fig. 1: Site map of study area under different cropping system of Punjab

Soil chemical properties

Soil organic matter indicates the structural formation, nutrient retention, biomass carbon and mineralization processes. Difference in organic matter percentage under cropping system varied from (0.06% to 0.80%) (Table 1). Mix cropping system with an average of (0.53%) OM was at 1st position, remaining at par with wheat-rice (0.50%) and

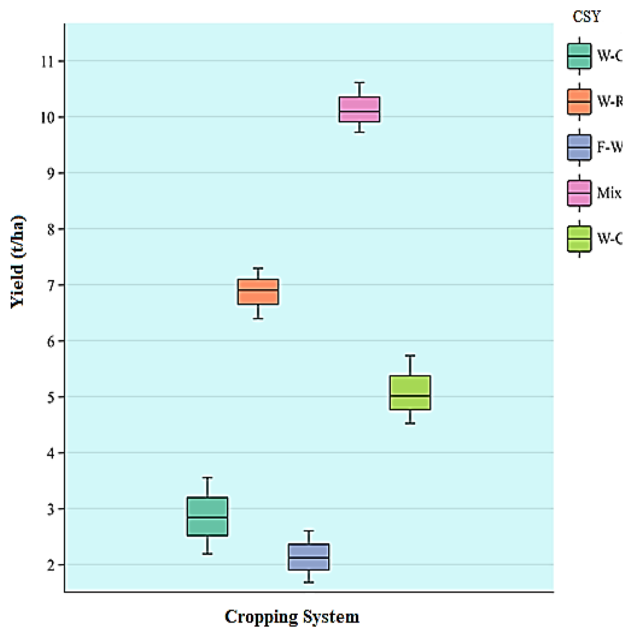

Fig. 2: Yield (t/ha) in different cropping systems(CSY), wheat-groundnut (W-G), wheat-rice (W-R), fallow-wheat/gram (F-W/G), mix cropping (Mix C) and wheat-cotton (W-C)

wheat-cotton cropping system (0.49%), which was 24.15% to 53.91% more amount of organic matter as compared to wheat- groundnut (0.40%) and fallow- wheat/gram cropping system (0.24%), respectively. Total organic carbon indicates soil respiration, soil nutrient source and sink, gaseous fluxes and biomass carbon processes. Difference TOC between the cropping systems were in range of (0.01 to 0.69%) Table 1. The average higher total organic carbon (0.32%) was recorded in soil under mix cropping system followed by wheat-rice (0.30%), wheat-cotton (0.28%) and wheat-groundnut (0.24%) while low amount of total organic carbon content was recorded in fallow-wheat/gram (0.13%) cropping system. Mix cropping system has 6.25%, 12.5%, 25% and 59.37% more total organic carbon content as compared to wheat-rice, wheat-cotton, wheat-groundnut and fallow-wheat/gram cropping system respectively.

Soil fertility status

Zinc (Zn) is essential element for plants, livestock and human. The variation between the different cropping system were ranges from (0.02 to 0.96 mg kg^{-1}) (Table 1). Higher mean value (0.55 mg kg^{-1}) of available zine in soil was examine in mix cropping system, which was at par with wheat- cotton (0.49 mg kg^{-1}), wheat-rice (0.46 mg kg^{-1}) and wheat-groundnut (0.34 mg kg^{-1}). In contrast the fallow-wheat/ gram cropping system have minimum mean value (0.19 mg kg^{-1}) of available zine in soil. Boron (B) is important micronutrient for growth and development of plant. Result interpreted in (Table 1). shows the soil available boron in different cropping system of Punjab. The difference between cropping system for soil boron was range from (0.01 to 0.64 mg kg^{-1}). Mix cropping system has (6.82%), (9.09%), (43.18%) and (45.45%) more soil available born than wheat- rice, wheat- cotton, wheat-groundnut and fallow- wheat/gram cropping system. Iron play important role in metabolic processes. Iron concentration in soil was examine under different cropping system of Punjab with range from (0.88 to 9.5 mg kg^{-1}) data pretended in (Table 1). The mean iron concentration (6.7 mg kg^{-1}) in soil was higher under wheat-rice cropping system, followed by mix cropping (4.21 mg kg^{-1}), wheat-cotton (4.14 mg kg^{-1}) and wheat- groundnut (2.85 mg kg^{-1}), while the lowest (2.79 mg kg^{-1}) iron concentration of soil was noted in fallow- wheat/ gram cropping system.

Crop yield

Yield was calculated for various crops under different cropping systems of Punjab ranges from 2.12 to 10.61 t/ha presented in (Fig. 2). Highest mean yield (10.14 t/ha) was determined in mix cropping system which was followed by wheat-rice cropping system (6.86 t/ha). Whereas, lowest yield (2.13 t/ha) was recorded in fallow- wheat/gram cropping system. Mix cropping system have (78.9, 71.9, 50.3 and 31.6%) more yield from F-W/G, W-G, W-C and W-R cropping system.

Multivariate analysis

The distribution map of soil physical properties (bulk density, soil moisture) and chemical properties (organic matter, total organic carbon, available zinc, available iron and boron) were shown in (Fig. 3). Increasing BD from north to west and southern part of study area. While decreasing trend was observed towards the eastern and central part of the study area (Fig. 3a).

Based on the map of soil moisture percentage the amount was higher toward the cultivated area where surface irrigation can apply, this trend was noted toward the eastern to central followed by southern part of the study area (Fig. 3b). Whereas, low soil moisture percentage was determined toward the north-west part of study area which was reliable on rainfall. According to map increase in organic matter was seen in the center followed by eastern and southern part of study area (Fig. 3c). While the decreasing trend was observed from north to western side. The spatial distribution map of TOC concentration was higher towards center to eastern and southern side of study area. Whereas, lowest concentration was seen towards the western part of study area (Fig. 3d).

Micronutrient Zn concentration map was shown in (Fig. 3e). which includes highest concentration of Zn from center toward the southern part of the study area. Whereas western part shows the lowest concentration of the soil Zn. Spatial distribution map shows higher accumulation of boron in the center whereas, least difference had been observed in eastern and southern part of the study area. While the lowest concentration of B was seen towards the western side (Fig. 3f). Variability map shows greater amount of Fe towards the

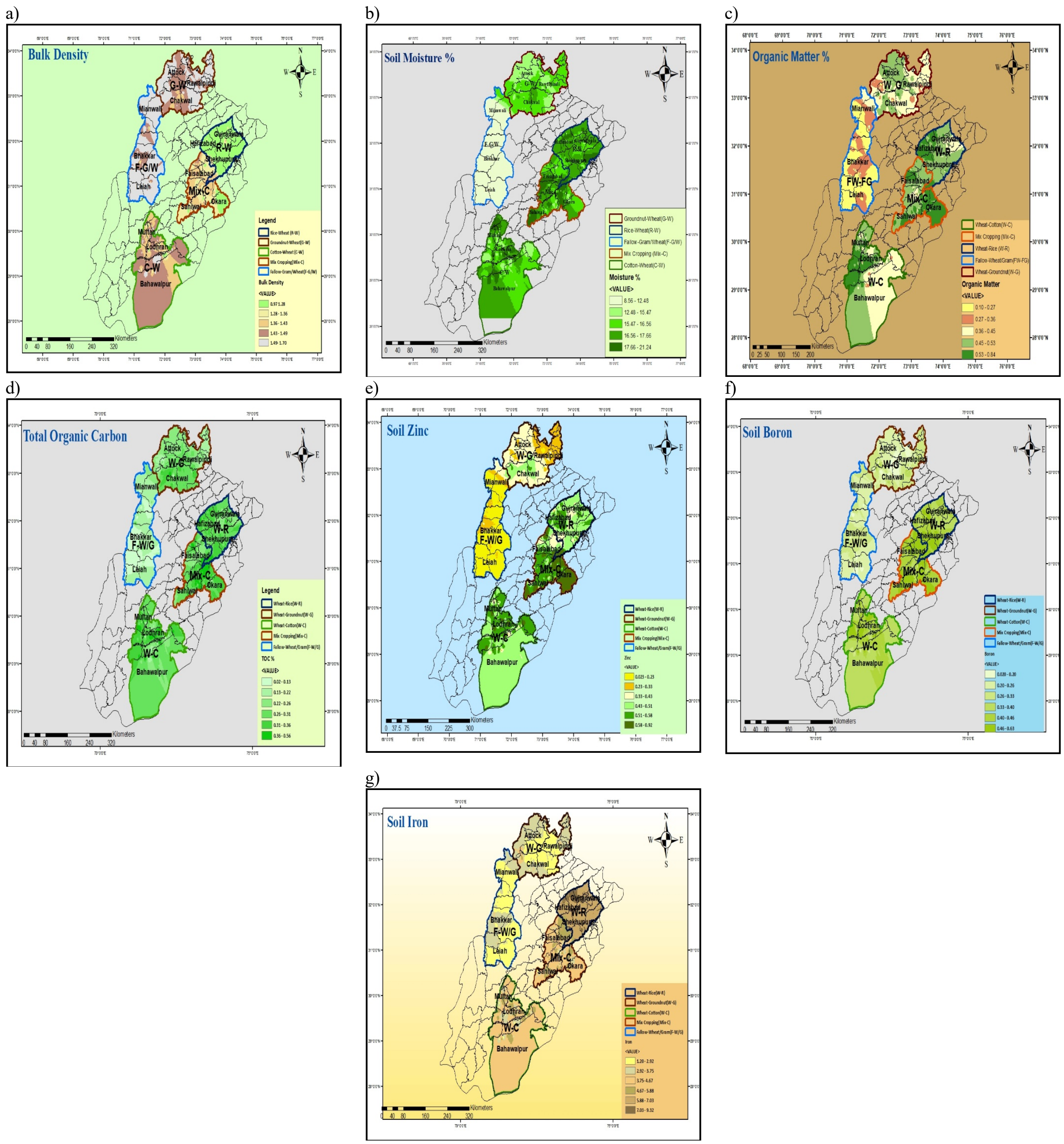

Fig. 3: Spatial varability maps of soil. a) bulk density (BD), b) soil moisture (SM %), c) organic matter (OM %), d) total organic carbon (TOC %), e) zinc (Zn), f) Boron (B), g) Iron (Fe) under different cropping system of Punjab

eastern part which was at par with center and southern part of the study area (Fig. 3g). While the less amount of Fe was seen toward the western side of study area.

Cluster analysis is comprised of a multivariate methods series that are used to find true groups of data or stations, grouping samples on the basis of their similarities. The result of the Q-mode cluster analysis can be displayed in a tree like structure, called a dendrogram. The dendrogram obtained from the agglomerative hierarchical clustering (AHC) showed that all investigated cropping systems were grouped into different clusters (Fig. 4). The AHC has highlighted 2 large main cluster A and B. Cluster A include samples located in the western Punjab area, which corresponds to a well-defined and narrow sector. These samples are characterized by the low values of soil nutrients. While all other area was group into Cluster B. Three cluster of lower hierarchical order may be recognized in cluster B (2, 3 and 4). Sample group B4 considered as distinct sub environment. Cropping system C4 and C5 in sub group B4 have minimum differences due to least values of divergence.

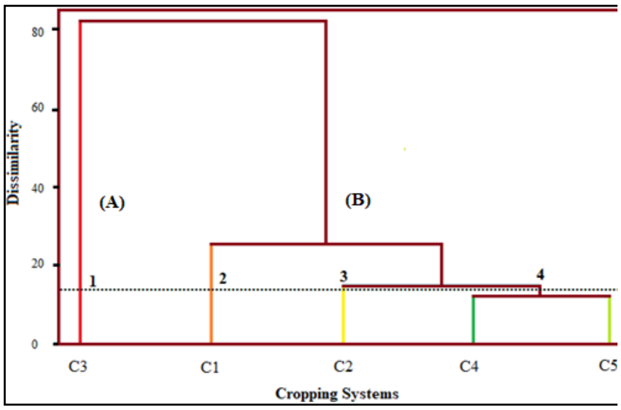

Fig. 4: Dendogram of soil properties and yield under different cropping system of Punjab. Here C shows the cropping systems, C1 (wheat- groundnut), C2 (wheat-rice), C3 (fallow- wheat/gram), C4 (mix cropping) and C5 (wheat-cotton)

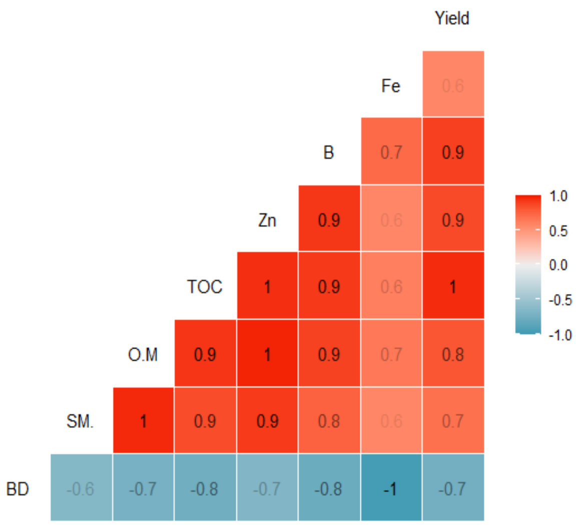

Fig. 5: Correlation between soil properties bulk density (BD), soil moisture (SM), organic matter (OM), total organic carbon (TOC), zinc (Zn), boron (B), iron (Fe) and yield under different cropping system of Punjab

The correlation matrix for soil parameters in different cropping system reveals significant interactions with crop yield as well as soil properties (Fig. 5). Soil parameters i.e, soil moisture, organic matter, total organic carbon, available zinc, boron and iron show positive correlation with crop yield. While bulk density was only soil parameter that shows strong negative correlation with yield. Among soil properties significant correlation was observed except bulk density.

Table 2 shows the principal component analysis (PCA) that group into five principal components (PC) with eigen value greater than one. The eigenvalue PC1, PC2, PC3, PC4 and PC5 are 6.62, 8.49, 4, 1.23 and 3.31 respectively that shows greater variability in soil properties and crop yield among cropping systems. The final analysis only took first two PCs in consideration which accounts 93.4% total variability (Fig. 6). First PCA explained 82.8% of total variance with highest contribution from iron and boron, whereas, F-W/G cropping system adversely positioned on PC1 can be differentiated by their higher bulk density or other soil and yield parameters. Whereas, the cropping systems (wheat-groundnut, mix cropping and wheat-cotton) were distributed along in PC1 which indicated variation in soil properties and crop yield. The second PCA accounted 10.6% of total variation. The variables i.e. OM, TOC, Zn and crop yield shows moderate correlation among cropping systems and a close clumping at the origin which reflect equal contribution.

Table 2: Results of principal component analysis of soil properties and crop yield under different cropping systems of Punjab

Principal component, (PC)	PC1	PC2	PC3	PC4	PC5
Eigenvalue	6.62	8.49	4.00	1.23	3.31
Variance percent	8.28	1.06	5.01	1.54	4.14

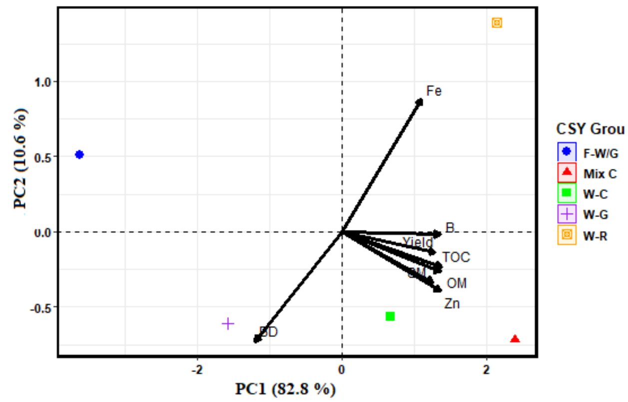

Fig. 6: Principal component analysis (PCA) bi-plot of soil properties bulk density (BD), soil moisture (SM), organic matter (OM), total organic carbon (TOC), zinc (Zn), boron (B), iron (Fe) and yield under different cropping system wheat- groundnut (W-G), wheat-rice (W-R), fallow- wheat/gram(F-W/G), mix cropping (Mix C), wheat-cotton (W-C) of Punjab

Discussion

The geographic variability of soil is determined by a combination of inherent characteristics such as parent material and soil texture, as well as external factors such as previous field management (Long *et al.* 2018). Crop management measures such as fertilization, irrigation timing and rate, as well as crop rotation system, all have a substantial impact on the geographical distribution of soil attributes. According to long term research, cropping systems influence soil characteristics intensify with time (Sainju *et al.* 2022).

The physical integrity of soil is compromised by compaction, which alters porosity and prevents the movement of gases, water, and nutrients as well as the growth of roots in the soil profile (Zijian *et al.* 2024). In our study bulk density was higher in fallow/wheat-gram cropping system while lowest BD was observed in W-R cropping system. Zhao *et al*. (2018) reported that more residue incorporation can decrease the bulk density of soil. Same finding was reported by (Xu *et al*. 2018). Higher amounts of organic carbon can result in lesser soil BD in some cases because of its lower particle density than mineral particles (Logsdon and Karlen, 2004). Soil Organic matter is essential for agricultural production systems to remain resilient, restore ecosystem services, and sustain soil health (Bhatt *et al.* 2023). Organic matter was lower in most of Pakistan soil due to which nutrients were low in soil. Organic matter is rapidly lost when input is reduced (Salahin *et al*. 2017). Therefore, the difference in organic matter in different cropping system might be due to difference in input rate. Cover crops and leguminous crop rotations can greatly raise soil carbon input and SOM concentrations (King and Blesh 2018). Similar findings were also reported by (Yousra *et al.* 2023).

Heterogeneous cropping has been determined to be an essential management technique for improving arable land quality and boosting soil organic carbon storage (Chen *et al.* 2024). Total organic carbon was higher under mix cropping system. Higher biomass of maize under mix cropping system than W-R system as well as more residue recycling also contributed to higher TOC in soil (Chen *et al*. 2014). Disturbs/breaks soil aggregates and increases soil temperature and soil organic matter decay which results in decline of soil C content (Aziz *et al*. 2013). TOC level could be attributed largely to root biomass. Zinc was 1st known essential element for crops, humans and livestock Ali *et al.* (2024) in spite of these knowledge zinc its deficiency still exist now. Most of soil Zn in our study area were low to medium in range. Our result is in line with (Perveen *et al*. 2010) and (Nazir *et al.* 2021). However, in Pakistan, Zn shortage is regarded as the third most important crop nutrition issue. Joy *et al*. (2017), also the alkaline pH and poor organic matter of Pakistani soils contribute to Zn insufficiency (Rafique *et al*. 2015).

Higher plants require the trace element boron (B) for healthy physiology (Zaib 2024). Boron was low to medium in range under different cropping systems. Most soil in Pakistan were deficient in soil B. Our result was lined with Ahmad *et al*. (2017) who reported a far reaching insufficiency in Pakistani soil. There is a considerable danger of B deficiency in our crops because Pakistani soils are calcareous, with a high prevalence of free carbonates, a high pH, and low organic matter contents, all of which are related with low soil B availability to plants (Rafique *et al*. 2012). Soil iodine content shows balance between iodine inputs, which are frequently obtained from precipitation and marine sources, and outputs from crop uptake and leaching (Fuge and Johnson 2015). On the other hand, soil conditions can affect how much iodine is retained in the soil (Dobosy *et al.* 2020). Fe were low to medium and adequate in range under different cropping system of Punjab Pakistan, our result was lined with Arain *et al*. (2017) who reported sufficient iron in Pakistani soil. However, due to the high pH and calcium concentration, iron availability in alkaline calcareous soil is limited (Ahmad *et al*. 2014).

Conclusion

Knowledge of cropping systems and the most distinctive intrinsic soil characteristic on soil health indicators are necessary to comprehend how agricultural management affects soil functioning. Selected area for study in Punjab was deficient in macro and micronutrients. It has been observed that there is greater variability in soil even within same cropping systems. Soil status under different cropping systems of Punjab province shows the relationship between soil health and crop yield. Mix cropping system was environmentally friendly for existing cropping system in Punjab province. Soil nutrient maps for different cropping system were designed. It helps in future planning and give awareness to the different stake holders about the ongoing scenario. Cultivation of short duration leguminous crop is highly recommended to overcome the deficiency of macro as well as micronutrients. In order to enhance crop yield and improve soil quality it is necessary to counter check soil fertility after 2 to 3 years.

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Author Contribution

Fahad Ali Fayyaz, prepared the overall manuscript, contributed significantly to the data analysis and interpretation of the results and substantially to the conceptualization of the study; Irfan Aziz, designing survey methodology, interpretation of results and critical review of whole manuscript; Muhammad Akmal, review and editing the whole manuscript; Muhammad Ansar**,** critical review of whole manuscript; Rafique Ahmed, data collection; muslim data analysis; Abdullah A. Alarfaj and Sulaiman Ali Alharbi Funding; Yawen Zeng, review whole manuscript.

Conflict of Interest

The authors declare that they have no competing interests.

Data Availability

Data presented in this study will be available on a fair request to the corresponding author.

Ethics Approval

Not applicable.

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