~~Impact of~~ Cropping SystemsImpact on Soil ~~Nutrient Profiles in~~chemical properties of Northern Punjab

Abstract

The ~~present~~ study examined ~~the~~ effect of ~~various~~ cropping systems (rice-wheat, maize-wheat, sugarcane, mango, litchi, eucalyptus, poplar, and barren land) on selected soil chemical properties in the northern ~~part of~~ Punjab. Soil samples were collected from different cropping systems at ~~five depths (~~0-15, 15-30, 30-60, 60-90, and 90-120 cmdepths~~)~~ and analyzed for pH, electrical conductivity (EC), soil organic carbon (SOC), available potassium, available phosphorus, and DTPA extractable micronutrients (zinc, iron, manganese, and copper). The study ~~found~~ showedthat soil chemical properties were significantly influenced ~~by~~ du tocropping systems. Higher values of pH, EC, available phosphorus, and potassium were observed in rice-wheat and maize-wheat systems, while higher SOC and DTPA extractable micronutrients were found in poplar and eucalyptus systems. All soil properties showed higher values at the surface layer (0-15 cm) and decreased with depth, except for pH, which increased with depth. Pearson correlation analysis revealed positive and significant correlations among most soil properties, with pH showing a significantly negative correlation with SOC and micronutrients. The study highlights the importance of cropping system choice in maintaining soil health and fertility.

Comment [U1]: Soil properties correlation with factors affecting (depth and cropping systems) may sound the result, that soil properties with soil properties.
May be remove or rewrite

Keywords: Cropping system, micronutrientsSoil depth,~~soil pH, soil organic carbon, available phosphorus, available potassium~~soil chemical properties ~~and micronutrients~~

Introduction

Successful agriculture requires ~~the~~ sustainable use of soil resource. A success in soil management to maintain the soil quality depends on an understanding of how the soil responds to agricultural practices over time. In agricultural systems, soil and crop management decisions affects soil quality, soil nutrient dynamics, and soil chemical properties. These management decisions include crop rotation, residue management, and the intensity and frequency of tillage (Mikha et al., 2006). Cropping system is another approach which influences the soil properties and the cycling and availability of nutrients. The change in cropping system results in variation of soil properties like pH, soil organic carbon (SOC), cation exchange capacity (CEC), soil structure, macronutrients and micronutrients (Alukoand

Fagbenro, 2000, Dhaliwal and Walia, 2008) which leads to variation in the soil fertility and productivity of soil. The availability of important macro and micronutrients in the soil, as defined by Tisdale et al. (1993), is referred to as soil fertility. Distribution and availability of macronutrients to a certain extent are also influenced directly or indirectly by change in crop cultivation, biomass production and soil organic matter (SOM) content (Genxu et al., 2004). Soil micronutrients availability also depends on soil pH, SOM content and various physical, chemical and biological conditions of the rhizosphere. The variation in soil chemical properties and the nutrient availability is affected to a great extent by the change in cropping systems (Jiang et al., 2002; Wasihun et al., 2015). Moreover, crops do not only take nutrients from surface layer but also draw a part of their nutrient requirement from subsurface layer of the soil. Hence, the knowledge of vertical distribution of nutrients is very important in recommending management practices (Sankar and Dadhwal, 2009). Because soil is a vital component of the earth's biosphere and plays a role in maintaining local, regional, and global environmental quality in addition to producing food and fibre, there has been a recent interest in assessing the quality of our soil resource. ~~Therefore, the present study was aimed to assess some selected soil chemical properties under different agricultural cropping systems innorthern part of Punjab which might also be able to enhance the reporting of the study area's soil fertility status and provide potential future research directions.~~ Sustainability of agriculture requires the careful management of soil resources to maintain soil quality and productivity. Cropping systems influence soil properties, nutrient cycling, and availability, impacting soil fertility and crop yields. ~~Therefore, the present study was aimed to assess some selected soil chemical properties under different agricultural cropping systems innorthern part of Punjab which might also be able to enhance the reporting of the study area's soil fertility status and provide potential future research directions.~~ This study aims to assess the impact of various cropping systems on soil chemical properties in the northern part of Punjab, contributing to the understanding of soil fertility dynamics and providing insights for effective soil management practices.

Comment [U2]: Not in reference list

Comment [U3]: Repeated concept

Materials and Methods

Study Site

The investigation was carried out in ~~the~~ Gurdaspur district of Punjab. ~~Soil samples were collected from various sites representing different cropping systems.~~ The region is located in the northernmost part of Punjab state, between latitude 31° 08' and 32° 31' N and longitude

74° 30' and 76° 20' E, at an elevation of about 265 m above mean sea level. Soil samples were collected from various sites representing different cropping systems. The soil texture in the samples varied from sandy loam to loam.

Climate

The region is characterized by high precipitation and high humidity with extremely hot and dry summers. The study area experiences a sub-humid and sub-tropical climate with three distinct seasons; Summer (April to June), Monsoon (July to September), Hot and moist, Winter (November to March). The region receives higher rainfall than central Punjab, with an average annual rainfall of around 1100 mm, two-thirds of which occurs during the monsoon season. Relative humidity remains above 80% throughout the summer season.

~~Selection of cropping~~ Cropping systems and soil sampling design

~~The selected cropping systems for soil sampling included:~~ Rice-wheat, maize-wheat, sugarcane, mango, litchi, poplar, eucalyptus, and barren land were cropping systems used for the study. ~~The soil~~ Soilsof~~sampling locations under the~~ rice-wheat, maize-wheat, sugarcane, mango, and litchi cropping systems ~~had been~~were continuously cultivated for 10 years ~~or~~ andmore, while the ~~locations~~ soilsunder the poplar and eucalyptus systems were 7 years older or more. The barren land was uncultivated and lacked plantation during the sampling period.~~Ten locations were selected from the eight~~ The cropping systems~~,~~ were replicated at eight locationsand soil ~~samples~~ weresampled~~collected~~ at ~~five depths (~~0-15, 15-30, 30-60, 60-90, and 90-120 cmdepths~~)~~. Sampling coordinates were recorded using a Global Positioning System (GPS). Soil samples were collected using a steel auger and ~~were~~ air-dried under shade, then ground to pass through a 2 mm sieve.

Soil Analysis

Soil pH: The potentiometric method was used to determine soil pH in a 1:2 soil-water suspension. Soil pH was measured using a glass electrode pH meter after equilibrating the soil with distilled water for half an hour (Jackson, 1973).

Electrical Conductivity: Soil electrical conductivity was measured in a 1:2 soil-water suspension kept for 24 hours. The soluble salts were measured after obtaining a clear supernatant solution and expressed in decisiemens per meter (dS m^{-1}) (Jackson, 1973).

Organic Carbon: Organic carbon (OC) in soil was determined by the rapid titration method (Walkley and Black, 1934). In a 250 ml conical flask, 2 g of air-dried soil sample was mixed with 10 ml of 1 N potassium dichromate ($K_2Cr_2O_7$) solution and 20 ml of concentrated sulfuric acid (H_2SO_4). Sodium fluoride (0.5 g) and distilled water (100 ml) were added, along with a diphenylamine indicator. The mixture was titrated against 0.5 N ferrous ammonium sulfate solution until the violet color changed to bright green. A blank sample without soil was also run for comparison.

Available Phosphorus: It was determined using 0.5 N sodium bicarbonate ($NaHCO_3$) adjusted to pH 8.5 (Olsen et al., 1954). The filtrate was treated with 5 N sulfuric acid, ascorbic acid solution, and distilled water, then measured using a colorimeter at 760 nm. The phosphorus content was calculated based on color intensity.

Available Potassium

Available potassium was determined using neutral ammonium acetate (pH 7) as an extractant (Merwin and Peech, 1950). The filtrate was aspirated into a flame photometer, and the reading was used to calculate available potassium in kg ha^{-1}.

DTPA-Extractable Micronutrients

DTPA-extractable Zn, Fe, Mn, and Cu were determined using the method by Lindsay and Norvell (1978). Soil samples were shaken with DTPA solution for 2 hours, then filtered and measured using an atomic absorption spectrophotometer. The micronutrient content was expressed in mg kg^{-1}.

Statistical Analysis

Data were analyzed using factorial randomized block design and Pearson correlation analysis with MS Excel.

Comment [U4]: Indicate the mean separate model or procedure selected for the data

Results and Discussion

Soil pH

The soil pH varied significantly among different cropping systems (~~figure1~~Figure1), with thehighest values observed in the surface soil layer, decreasing with depth. pH of ~~The~~ the cropping systems ranked in order of ~~pH from highest to lowest were:~~decreasing from rice-wheat, maize-wheat, sugarcane-based, mango-based, litchi-based, eucalyptus-based, barren land, and poplar-based systems. The increased pH levels in the rice-wheat and maize-wheat

Comment [U5]: State the anova result for soil depth ahead as like cropping system systems ~~can be~~ attributed ~~to the~~with continuous application of fertilizers and a reduction in organic matter content due to regular tillage practices. Conversely, the lower pH in mango, litchi, poplar, and eucalyptus-based systems ~~is~~ waslikely due to the addition of organic matter through leaf litter and crop residues. As these organic materials decompose, ~~they~~ andrelease organic acids, which lower the soil pH (Chandel et al., 2018; Maini et al., 2020). The observed increase in soil pH with depth may be due to a corresponding decrease in organic carbon (OC) content (Datta et al., 2015).

Comment [U6]: But the result saif decreasing pH, check the discussion

Soil Electrical Conductivity (EC)

Soil EC values, presented in ~~figure~~Figure1, were highest in the rice-wheat and maize-wheat cropping systems, followed by sugarcane-based, litchi-based, poplar-based, mango-based, eucalyptus-based, and barren land systems. EC values were statistically higher in surface soils compared to lower depths and decreased with increasing depth across all cropping systems. The higher EC in surface soils can be attributed to the accumulation of salts due to continuous fertilizer application, particularly in systems with intensive agricultural practices (Mandal et al., 2013).

Comment [U7]: Present the anova first to discussion

Comment [U8]: Discuss the reason

Soil Organic Carbon (OC)

OC levels were highest in poplar, eucalyptus, litchi, and mango-based cropping systems (~~figure~~Figure1), followed by sugarcane-based, maize-wheat, rice-wheat, and barren land systems. The highest OC values were found in surface soils, with content decreasing with depth. The increased OC in poplar, eucalyptus, litchi, and mango-based systems can be linked to the addition of organic matter from leaf litter and dead roots. In contrast, lower OC levels in rice-wheat and maize-wheat systems may result from the lower return of organic matter to the soil and a higher oxidation rate due to continuous cultivation (Singh et al., 2017).

Comment [U9]: Was it part of the cropping system?

Soil available Phosphorus and Potassium

Available phosphorus and potassium were higher in rice-wheat and maize-wheat cropping systems (~~figure~~Figure1) and lower in sugarcane, litchi, mango, poplar, and eucalyptus-based systems, with barren land having the lowest values. The content of these nutrients decreased with soil depth. Higher phosphorus levels in rice-wheat and maize-wheat systems ~~can be~~ attributed to the greater application of phosphatic fertilizers compared to other systems (Dhaliwal and Singh, 2013; Kaur and Bhat, 2017). The higher organic matter in surface soils contributes to the decrease in available phosphorus with increasing depth (Uthappa et al., 2013; Mandal et al., 2018).

DTPA Extractable Micronutrients (Zn, Fe, Mn, and Cu)

DTPA extractable micronutrients were significantly higher in poplar, eucalyptus, litchi, and mango-based cropping systems (~~table~~Table1), and lower in rice-wheat, maize-wheat, and sugarcane-based systems. The higher levels of micronutrients in poplar, eucalyptus, litchi, and mango-based systems ~~can be~~ attributed to the higher organic matter content from decomposed tree leaves and root biomass (Sidhu and Sharma, 2010; Chander et al., 2014; Dhaliwal et al., 2019; Dhaliwal et al., 2022). In contrast, lower micronutrient levels in rice-wheat, maize-wheat, and sugarcane-based systems ~~are~~ weredue to nutrient depletion from continuous crop cultivation (Singh et al., 2018; Dhaliwal et al., 2019). The decrease in DTPA extractable micronutrients with soil depth is linked to the reduction in OC content with depth (Behera and Shukla, 2013; Dhaliwal et al., 2022).

Comment [U10]: Tense of expression

Correlations Between Soil Chemical Properties

Comment [U11]: What does this worth? Rather the correlation between nutrients and cropping system recommended to select the system of cropping suiting the nutrient

Otherwise, run the same correlation with cropping system

Pearson correlation analysis revealed mostly positive and significant correlations among the different soil chemical properties across cropping systems (Table 2). A significant negative correlation was found between soil OC and pH and EC. Available phosphorus and potassium positively correlated with EC and soil OC. Among DTPA extractable micronutrients, there was a significant negative correlation with pH, whereas significant positive correlations were observed with other soil properties.These results highlight the complex interactions among soil chemical properties and the influence of different cropping systems on soil health. The continuous application of fertilizers and intensive agricultural practices significantly affect soil pH, EC, OC, and nutrient availability, emphasizing the need for sustainable soil management practices to maintain soil fertility and productivity.

Conclusion:

The study underscores the importance of understanding how different cropping systems influence soil chemical properties. The findings highlight the need for sustainable soil management practices to mitigate the adverse effects of intensive agricultural practices on soil ~~chemical properties~~fertility management. Enhancing organic matter content through practices such as adding leaf litter and crop residues ~~can help~~observed to improve soil fertility and maintain long-term productivity from… . Future research should focus on developing and implementing strategies that balance crop productivity with soil health preservation.

Comment [U12]: Indicate the cropping system recommended

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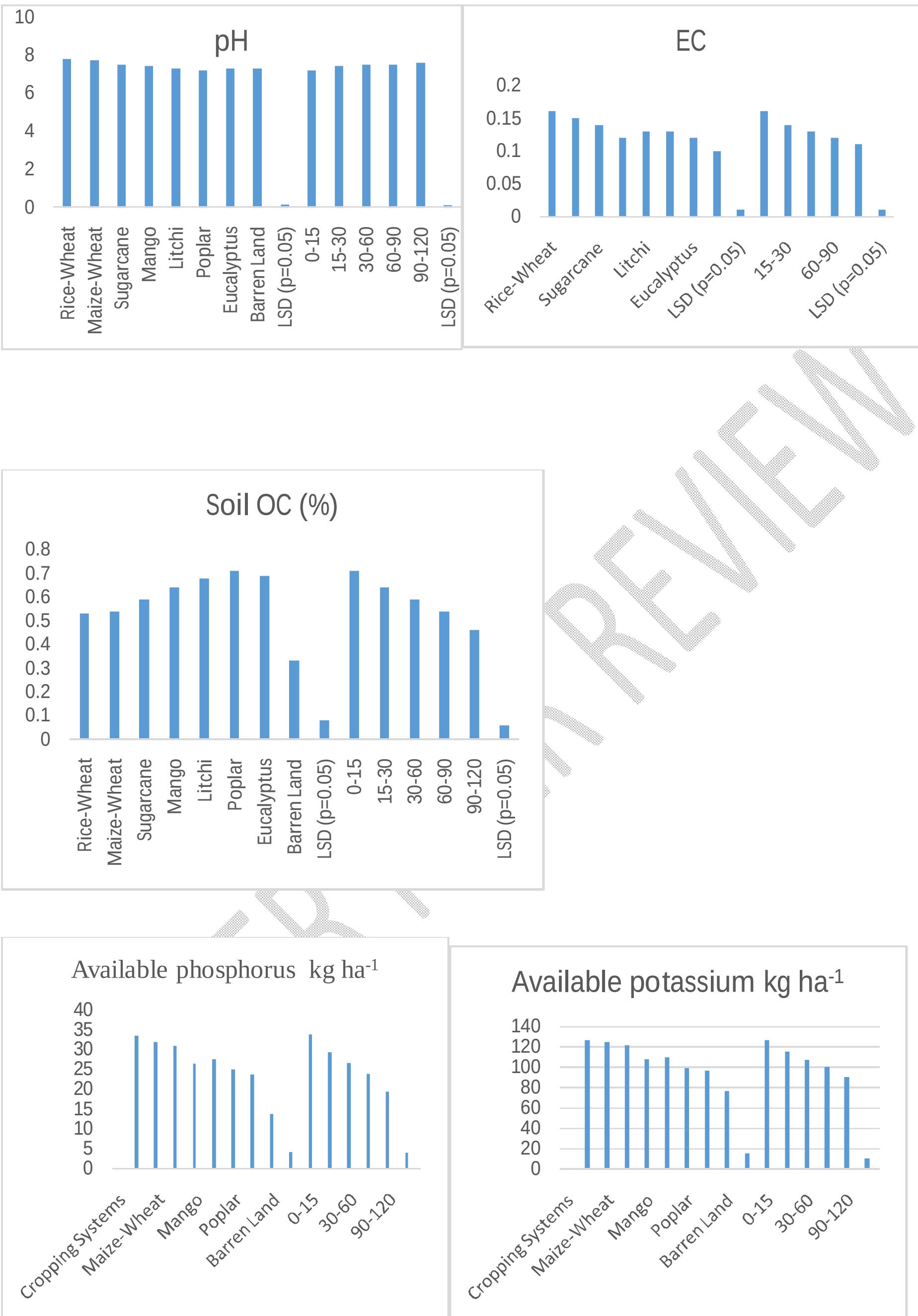

Figure 1: Effect of change in cropping systems on soil chemical properties.

Table 1: Effect of change in cropping systems on soil chemical properties

Cropping Systems	DTPA Zn	DTPA Fe	DTPA Mn	DTPA Cu
(mg kg^{-1})				
Rice-Wheat	0.63	12.2	3.60	0.97
Maize-Wheat	0.60	12.0	3.46	1.01
Sugarcane	0.58	13.8	3.73	1.03
Mango	1.79	15.2	6.26	1.15
Litchi	1.90	16.1	6.52	1.18
Poplar	2.07	18.0	7.66	1.27
Eucalyptus	1.99	17.2	7.37	1.24
Barren Land	0.31	8.42	1.90	0.66
LSD (p=0.05)	0.16	1.10	0.63	0.13
Soil depth (cm)				
0-15	1.56	18.1	6.20	1.20
15-30	1.32	16.3	5.27	0.13
30-60	1.20	14.2	4.97	1.06
60-90	1.12	12.2	4.69	1.01
90-120	0.99	9.76	4.17	0.93
LSD (p=0.05)	0.12	0.87	0.50	0.11

Table 2: Pearson correlation coefficients among soil chemical properties

	pH	EC	Soil OC	Available phosphorus	Available potassium	DTPA Zn	DTPA Fe	DTPA Mn	DTPA Cu
pH	1								
EC	-0.02	1							
Soil OC	-0.544**	-0.540**	1						
Available phosphorus	0.084	0.923**	0.626**	1					
Available potassium	0.150	0.917**	0.532**	0.984**	1				
DTPA Zn	-0.646**	0.032	0.814**	0.131	0.015	1			
DTPA Fe	-0.632**	0.514**	0.939**	0.565**	0.469**	0.942**	1		
DTPA Mn	-0.617**	0.144	0.876**	0.255	0.133	0.907**	0.857**	1	
DTPA Cu	-0.319*	0.347*	0.757**	0.472**	0.376*	0.965**	0.924**	0.926**	1