OPEN ACCESS
International Journal of Innovations in Science & Technology
IJIST
P ISSN : 2618-1630
E ISSN : 2909-6130

Salinity and Fertility Status of Irrigated soils in District Nankana Sahib, Punjab, Pakistan

Original Article

Fareeha Akram [1], Tahsin Fatimah [2], Tabasum Jamal[3], Dr. Muhammad Usman Saleem[4], M. Hafeez Javed[5], Sana Sharif[5], Kiran yousaf[5], Naveed Iqbal Khan[2], Awais Karamat[1]
[1] Soil and Water Testing Laboratory, Nankana Sahib-Pakistan
[2] Soil and Water Testing Laboratory, Lahore-Pakistan
[3]Department of Geography, Punjab University, Quid e Azam Campus, Lahore
[4] Soil and Water Testing Laboratory, Tobba Taik Singh
[5] Soil and Water Testing laboratory, Okarha
* Correspondence: **Email:** swtlnns@gmail.com

Citation | Akram. F, Fatimah. T, Jamal. T, Saleem. M. U, Javed. H, Sharif. S, Yousaf. K, Khan. N. I, Karamat. A, "*Salinity and Fertility Status of Irrigated soils in District Nankana Sahib, Punjab, Pakistan*". International Journal of Innovation in Science and Technology. Vol 4, Issue 1, pp: 213-221, 2022.
Received | Jan 16, 2022; **Revised |** Feb 24, 2022; **Accepted |** Feb 26, 2022; **Published |** Feb 28, 2022.
DOI:https://doi.org/10.33411/IJIST/2022040116

The soil is the basic medium for growth of plant as it supplies essential nutrients and water required for plant processes. The productivity of crop is highly dependent upon fertility and salinity of soil. Current study was carried out to explore and analyze the soils of Tehsil Nankana Sahib (Nankana, Shahkot, Sangilla) for its salinity, sodicity and fertility status at union council level from 2018-2021. A total 2030 soil samples were collected from three Tehsils of District Nankana Sahib, Punjab, Pakistan. The results indicated that the soil salinity status about 33.9% (690 samples) soils were non-saline, 23.6% (480 samples) saline sodic, 28.5% (580 samples) sodic and only 13.8% (280 samples) were saline. Maximum problematic soil was found in tehsil Nankana Sahib while minimum in Sangilla. As for the soil fertility status of District Nankana Sahib is concerned, 60.1% soils were poor in organic matter (OM) that was observed in 1220 samples, and 39.1% medium range organic matter was observed from the 794 samples while 7.8% from the only 160 samples that were approaching the adequate range. The available phosphorus in soils was found poor among 26.1% (530 samples), 56.1% medium (1140 samples) and the adequate range of available phosphorus was 17.7% (360 samples). Textural class analysis indicated that most of the soils of District Nankana Sahib were loam having 67% soils (1360 samples), followed by 34.8% (708 samples) clay and the least 1.6% (32 samples) were found sandy soils. When the examinations were compared at Tehsil level, Tehsil Nankana had most deficient in organic matter that contributes 60% of total soil under observation while Sangilla had minimum deficiency (58.3%) OM. In

the same way, maximum soils 33%) of Sangilla was deficient in available phosphorus while minimum was in Tehsil Nankana Sahib (21.8%).

Keywords: Organic matter, Saline-sodic soil, Soil properties, Nankana Sahib, Gypsum

Introduction

Salinity is the measure of dissolved salts and minerals in soil [1]. Pakistan has fertile land which is highly suitable for agriculture, the country lies among the largest producers of wheat, Sugarcane, Rice, Cotton and several fruits [2]. Agriculture sector is an ultimate source of earning for the country as it exports the surplus of commodities after fulfilling the domestic needs. Fertile, arable land and water is principal resource required for accurate crop yield. Pakistan has world's largest irrigation system which inundates nearly 25% of land under cultivation. Agricultural sector contributes nearly 21% of the total GDP of country. Nearly 62% of the total rural population is highly dependent on agricultural sector for food which in turn depends upon the quality of soil and availability of water [3]. Nearly 800m ha land has been effected by salinity throughout the world [4], while 6.67 million acre of land is effected in Pakistan [5].

Saline soils are mostly developed as a consequence of accumulation of salt over an extensive period of time naturally in arid or semiarid regions. Due to unavailability of sufficient canal system and water scarcity, saline and saline sodic soils are increasing as a consequence of irrigation via salt water [6]. On the other hand the high concentration of salt results in stunt growth and ultimately death of plant. The fertility of soil also decreases gradually because of continuous utilization of food nutrients by plants which results in limited crop yield. Moreover, the improper use of chemical fertilizers also reduce the soil efficiency and limits the production of crop [7]. Over usage of fertilizers amend the concentration of salts in soil.

Malik et al. (1987) reported that Potash deficiency is found in soils which are usually irrigated by tube wells only[8]. The potassium deficiency causes yellowing of leave margins consequently causing necrosis. Recent studies have revealed that soils in Pakistan are highly deficient in several major and minor plant nutrients[9]. Most of the soils were found nitrogen deficient because of lack of utilization of organic fertilizers. Shahzada Sohail Ijaz (2001) reported that soils in Pakistan comprises of carbon up to 0.5- 1.38% this range varies in different soils [10]. According to certain reports approximately all analyzed soil samples has shown nitrogen deficiency due to low organic content. Moreover the zinc and phosphorous deficiencies were found higher as compared to boron, iron and potassium [11]. Nutrient deficient soils results in stunted growth of crop, yellowing of leaves and plant death as well. These deficiencies may result in reduction of chlorophyll content in plant which is necessary for photosynthesis. Nutrient deficiencies can significantly reduce the productivity of soil and crop yield as well. Moreover, it makes the crop more vulnerable for diseases [12].

The deficiencies of nutrients can be fulfilled by the balanced use of fertilizers. The combined use of organic as well as chemical fertilizers enhance the productivity of soil [13]. The fertilizers are usually applied to enhance the stock of nutrients in soil and limit their loss to environment [14]. However excessive applications of fertilizers may have drastic effects on soil as well as the environment. The over usage of fertilizers results in production of greenhouse gases which increases the global temperature and eutrophication of water bodies. Excessive utilization of fertilizers can also harm the plant growth. It can lead to salinity of soil which in turn can burn the plant root due to excessive water soluble salts in soil [15].

The current study aims to analyze the salinity and fertility of soil in District Nankana Sahib. In this paper different parameters of soils of all tehsils were analyzed and compared to examine the salinity and nutritional level of District Nankana Sahib.

Materials and Methods

Study site

This study is conducted in Nankana Sahib; District of province Punjab. This city is located at 91 km in the western boarder of metropolitan city Lahore. According to population census of 2017, Nearly 79,540 people are inhabitant of this city.

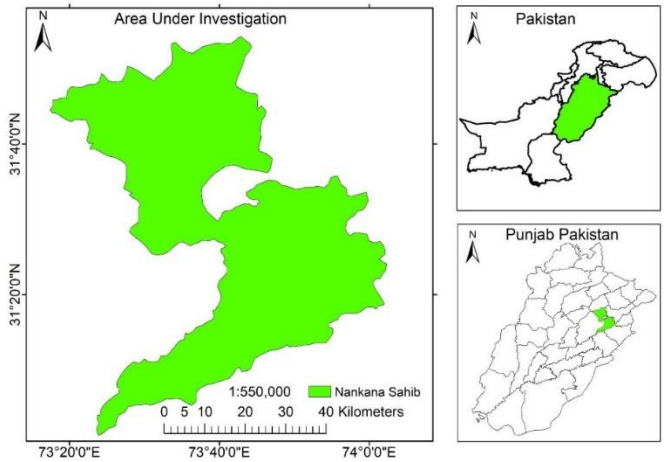

Figure 1. Map representing the sampling site in district Nankana-Sahib, Punjab-Pakistan.

Materials and Method

Fertility and salinity of soil was analyzed using sampling technique.

Soil sampling and processing

A total number of 2030 samples of soil were collected from farms of 3 different tehsils in the study site within two years from 2019-2021utilizing soil auger. Before the physio chemical analysis these samples were mixed, ground, air dried and passed through 2mm sieve [16].

Physico-chemical analysis

The saturation percentage of soil was measured to determine the texture of soil. A pH meter was used to measure pH of soil through Schofield and Taylor (1955) method. An EC meter was used to measure electrical conductivity of soil. The availability of phosphorous was determined using spectrophotometer [17]. The criteria used for categorization of soils for salinity/sodicity and fertility status is given in Table 1.

Table 1. Criteria for determining salinity-sodicity and fertility status of soil samples.

Soil Texture Saturation Percentage	Class	Soil salinity/sodicity Status	EC (dSm^{-1})	pH	Soil fertility Status	Organic matter (%)	Available P (mg kg^{-1})
0-20	Sand	Normal	< 4	< 8.5	Poor	< 0.86	< 7.0
	Sandy				Satisfactor		
21-30		Saline	> 4	< 8.5	y	0.86-1.29	7-14
	Loam						

31-45	Loam	Saline-Sodic	> 4	> 8.5	Adequate	> 1.29	> 14
46-65	Clay loam	Sodic	< 4	> 8.5			
66-100	Clayey						

Source: Malik et al. (1984)

Statistical analysis

A statistical Software statistix 8.1 was used to analyze the datasets obtained through sampling technique to determine the salinity and nutritional parameters of soil [18]. A probability level of nearly 5% was found in statistical analysis of datasets.

Results and Discussion

Salinity status of soils

The data pertaining to salinity/sodicity status of District Nankana Sahib (Tehsil wise) is presented in Table 2.

Table 2. Salinity/sodicity status of 3 of tehsil District Nankana Sahib.

Sr. No.	Name of Tehsil	No. of Samples	Salinity Status of Soils			
			Normal	**Saline**	**Saline Sodic**	**Sodic**
1	Nankana Sahib	960	300	150	240	270
			31%	15%	25%	29%
2	Shahkot	590	210	70	140	170
			35.6%	11.8%	23.8%	28.8%
3	Sangilla	480	180	60	100	140
			37.5%	12.5%	20.8%	29.2%
Total		**2030**	**690**	**280**	**480**	**580**
			33.9%	13.7%	23.6%	28.5%
Mean			230	93.3	160	580

The means with different letters in mean row are significant at 5 % probability level. According to the analysis nearly 690 out 2030 samples were normal, 580 were sodic, 480 were saline sodic while 280 were saline. The presence of normal soils in the district was higher than sodic, saline and saline sodic soils. Comparatively the proportion of sodic soils was higher than the saline sodic soils while the saline soils were in least proportion but statistically there was no significant differences. The saline to saline sodic soils require nutritional amendments including gypsum. A soil with 13.7% salinity can be reclaimed through flooding the soil with

good quality nutritional water. Among all tehsils of Nankana Sahib 25% soil was found saline-sodic while 29% was found sodic, overall 53.1% problematic soil was found which required gypsum for the reclamation. However, in tehsil Sangilla 49.9% soil was found problematic out of which 20.8% was saline-sodic while 29% sodic. The soil salinity can be reclaimed by flooding the soil with good quality canal water. A portion of 37.5% normal soil was found in the tehsil sangilla, this portion was fit for cultivation.

From site survey it was found that the district Nankana Sahib is suffering salinity of soil due to the low availability of canal water. Mostly the underground saline water which caused sodicity and salinity in overall district. NanKana Sahib is located in semi-arid region and receives low rainfall annually.

The prevalence of salinity and sodicity in soil is also caused by low rainfall. This problem can be minimized by limiting the use of saltish underground and tube well water and improvising the balanced and accurate use of soil nutrients for instance gypsum, proper use of chemical as well as organic fertilizer and modern farming techniques.

Fertility status of soils

The datasets obtained from 3 tehsils of District Nankana Sahib is presented in table 3. The results indicate that a high proportion of District Nankana Sahib soils (60.1%) are deficient in the organic matter, the most prevalent category of OM content including medium (39.1%) and adequate (7.8%). This research indicates that the soils of all tehsil of Nankana district requires the addition of OM in the form of FYM, green manure, and compost to sustain the soil quality and better crop production. Comparison of soils of all tehsils showed that the soils of tehsil Nankana (62%) were most deficient in organic matter having least proportion (1%) of soils in adequate range. While the tehsil Sangilla recorded the OM content soils having 41.05% soils falling in adequate range and 0.62% soils in medium range. OM requirements of soil must be fulfilled in order to obtain appropriate crop yield, this requirement can be fulfilled by growing of nitrogen fixing legume crops including dhaincha (*Sesbaniaaculeata*).

Table 3. Fertility status of 3 tehsil of District Nankana Sahib.

Sr. No.	Name of tehsil	No. of samples	Fertility status of Soils					
			Organic Matter			Available Phosphorus		
			Poor	Medium	Adequate	Poor	Medium	Adequate
1	Nankana Sahib	960	590	360	10	210	550	200
			62%	37%	1.0%	21.8%	57.4%	20.8%
2	Shahkot	590	350	237	03	160	320	110
			59%	40%	5%	27.2%	54.2%	18.6%
3	Sangilla	480	280	197	03	160	270	50
			58.3%	41.05%	0.62%	33.3%	56.2%	10.4%

Total	**2030**	**1220**	**794**	**16**	**530**	**1140**	**360**
		60.1%	39.1%	7.8%	26.1%	56.1%	17.7%
Mean		406	264	5.3	176.6	380	120

The means with different letters in mean row are significant at 5 % probability level. The results indicate that most of the soils of District Nankana Sahib have low OM content that most of the soils in Pakistan have carbon content up to 0.52 to 1.38% in different soil series with most of them falling in the range of <1%. Addition of OM (organic matter), for instance the green manure also facilitates the uptake of nutrients by plants. It enhances the content of carbon and nitrogen in soil which in turn improves the chemical properties of soil. The results indicate that the level of phosphorous is satisfactory. Nearly 57.4% of the soils had medium while 21.8% of soils had poor range of phosphorous content. It represents that there phosphorous depletion might occur in future. Thus, a balanced use of fertilizers is required in order to secure phosphorous content in soil. Comparison of soils at tehsil level indicated that maximum deficiency of phosphorous was found in Sangilla up to 33.3% while tehsil nankana had minimum phosphorous deficiency up to 21.8%.Studies suggest that quality of soils can be improved by the application of fertilizers, organic matter, green manuring and poultry wastes.

Textural pattern of soils

The soil textural pattern of District Nankana Sahib soils indicated that most of its soils fell in medium range also named as loam (Table 4).

Table 4. Textural pattern of 3 tehsil of District Nankana Sahib.

Sr. No.	**Name of tehsil**	**No. of Samples**	**Texture**		
			Light	**Medium**	**Heavy**
		960	15	680	265
1	Nankana Sahib				
			1.56%	70.8%	27.7%
		590	10	390	260
2	Shahkot				
			1.69%	66%	44%
		480	7	290	183
3	Sangilla				
			1.4%	60.4%	38.2%
	Total	**2030**	**32**	**1360**	**708**
			1.6%	67%	34.8%
	Mean		10.6	453	236

The means with different letters in mean row are significant at 5 % probability level Out of 2030 soil samples analyzed, 67% had medium texture (loam), 34.8% were found to have heavy texture (clayey) and 1.6% were in light range (sandy). The most of soils were loamy as reported by Pervaiz et al. (2002) for the soils of District Gujrat. At tehsil level, Shahkot had maximum proportion (1.69%) of light textured soils however, Nankana tehsil had maximum (70.8%) medium textured soils. The maximum prevalence (38.2%) of heavy textured soils was observed in tehsil Sangilla and minimum prevalence (27.7%) was in tehsil Nankana.

The prevalence of loam textured soil indicated good quality soil in Nankana Sahib. Clay content plays vital role in enhancing the quality of soil as it is nagetiviely charged and helps in ion uptake, significantly increases the fertility of soil. The productivity of soils can be enhanced by effective utilization of resources. Jalota et al. (2010), reported that silt loam & sandy loam textured soils yielded more wheat and maize grains along with conserving more soil moisture as compared to loamy sand textured soil. Soil texture significantly maintains proper soil moisture, soil porosity, infiltration and soil aggregation that is vital for seedling emergence leading towards better crop production.

Conclusions.

This research revealed that 33.9% soil of tehsil Ahmadpur Sial is free from salinity while 66.1% have salinity/sodicity problem, out of which 13.7% soil is saline and can be reclaimed by application of good quality canal water, and 52.4% require gypsum and other nutritional amendments to minimize the sodicity in order to enhance the productivity of soil. The soils of District Nankana Sahib are highly deficient in organic matter which can be enhanced by manuring and proper use of gypsum. Most of the soils of District Nankana sahib are loam, rich in clay content (active material) which can be made productive by the balanced use of chemical as well as organic fertilizers in combination with organic matter amendments.

Author's Contribution. All the authors contributed equally in this work.

Conflict of interest. Authors claim that there exists no conflict of interest for publishing this manuscript in IJIST

REFERENCES

[1] "Fertilizer use by crop in Pakistan." https://www.fao.org/3/y5460e/y5460e0e.htm (accessed Feb. 27, 2022).

[2] " Ministry of Finance, Government of Pakistan." https://www.finance.gov.pk/survey_1314.html (accessed Feb. 27, 2022).

[3] "Azam, F., Iqbal, M.M., Inayatullah, C., Malik, K. A., 2001. Technologies for sustainable agriculture. Nuclear Institute for Agriculture and Biology, Faisalabad. - (accessed Feb. 27, 2022).

[4] S. A. Shahid, M. Zaman, and L. Heng, "Soil Salinity: Historical Perspectives and a World Overview of the Problem," *Guidel. Salin. Assessment, Mitig. Adapt. Using Nucl. Relat. Tech.*, pp. 43–53, 2018, doi: 10.1007/978-3-319-96190-3_2.

[5] A. M. Phambra and S. Tahir, "Small Farms and the Current Structure of Farmland Holdings in Pakistan," vol. 3, no. 1, pp. 47–64, 2020.

[6] J. Hassink, "The capacity of soils to preserve organic C and N by their association with clay and silt particles," *Plant Soil*, vol. 191, no. 1, pp. 77–87, 1997, doi: 10.1023/A:1004213929699.

[7] S. Jalota *et al.*, "Soil texture, climate and management effects on plant growth, grain yield and water use by rainfed maize-wheat cropping system: Field and simulation study Climate change View project Remote Sensing View project Soil texture, climate and management effects on plant growth, grain yield and water use by rainfed maize-wheat cropping system: Field and simulation study," doi: 10.1016/j.agwat.2009.08.012.

[8] "(PDF) SALINITY AND FERTILITY STATUS OF TUBEWELL IRRIGATED SOILS IN TEHSIL SHORKOT, PAKISTAN." https://www.researchgate.net/publication/319136702_SALINITY_AND_FERTILITY_STATUS_OF_TUBEWELL_IRRIGATED_SOILS_IN_TEHSIL_SHORKOT_PAKISTAN (accessed Feb. 28, 2022).

[9] "(PDF) Establishment and management of micronutrient deficiencies in Pakistan: A review." https://www.researchgate.net/publication/285502136_Establishment_and_management_of_micronutrient_deficiencies_in_Pakistan_A_review (accessed Feb. 28, 2022).

[10] "PAKISSAN.com; Organic matter status of Pakistan soils and its management." https://www.pakissan.com/english/advisory/organic.farming/organic.matter.status.of.pakistan.shtml (accessed Feb. 28, 2022).

[11] X. Xie, W. Hu, X. Fan, H. Chen, and M. Tang, "Interactions Between Phosphorus, Zinc, and Iron Homeostasis in Nonmycorrhizal and Mycorrhizal Plants," *Front. Plant Sci.*, vol. 10, p. 1172, Sep. 2019, doi: 10.3389/FPLS.2019.01172/BIBTEX.

[12] "Plant-Soil Interactions: Nutrient Uptake | Learn Science at Scitable." https://www.nature.com/scitable/knowledge/library/plant-soil-interactions-nutrient-uptake-105289112/ (accessed Feb. 28, 2022).

[13] T. B. Roba and T. B. Roba, "Review on: The Effect of Mixing Organic and Inorganic Fertilizer on Productivity and Soil Fertility," *Open Access Libr. J.*, vol. 5, no. 6, pp. 1–11, Jun. 2018, doi: 10.4236/OALIB.1104618.

[14] J. Frouz, "Soil biodiversity conservation for mitigating climate change," *Clim. Chang. Soil Interact.*, pp. 1–19, 2020, doi: 10.1016/B978-0-12-818032-7.00001-1.

[15] M. Koutli, N. Theologou, A. Tryferidis, and D. Tzovaras, "Abnormal behavior detection for elderly people living alone leveraging IoT sensors," *Proc. - 2019 IEEE 19th Int. Conf. Bioinforma. Bioeng. BIBE 2019*, pp. 922–926, Oct. 2019, doi: 10.1109/BIBE.2019.00173.

[16] "Resource Management :: Soil :: Soli Sampling Procedure." https://agritech.tnau.ac.in/agriculture/agri_soil_sampling.html (accessed Feb. 28, 2022).

[17] P. Anschutz and J. Deborde, "Spectrophotometric determination of phosphate in matrices from sequential leaching of sediments," *Limnol. Oceanogr. Methods*, vol. 14, no. 4, pp. 245–256, Apr. 2016, doi: 10.1002/LOM3.10085.

[18] "Measuring soil salinity | Agriculture and Food." https://www.agric.wa.gov.au/soil-salinity/measuring-soil-salinity (accessed Feb. 28, 2022).