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Egypt. J. Agron. **Vol. 46**, No. 2, pp: 411 - 420 (2024)

Egyptian Journal of Agronomy

http://agro.journals.ekb.eg/

Assessment of Rice Quantity and Quality at Different Locations in El-Behira Governorate, Egypt

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EL-BEHEIRA Governorate has diverse soil and irrigation water characteristics influenced by its geographical position, climate, and agricultural practices. Data were collected from ten locations in ten districts in El-Behira Governorate, Egypt. The soil and water samples were collected from ten farmers' fields before planting and mid-season respectively, in the 2022 and 2023 summer seasons. Yield and yield components were studied during harvesting seasons. The cultivated variety was Sakha 108 at all sites in both seasons. The soil in El-Beheira is generally fertile due to the deposits of nutrient-rich alluvium from the Nile River. However, continuous cropping and inadequate management practices can lead to nutrient depletion. Soil salinity is a concern in some areas, particularly in places with poor drainage and high evaporation rates (Edkou and Rachid districts). The quality of irrigation water from the Nile is generally good, with low salinity levels and pollutants. However, water quality can be affected by agricultural runoff, industrial discharges, and other sources of pollution upstream specifically at the end of the River Nile (Edkou and Rachid districts). Understanding and managing the soil and irrigation water characteristics are crucial for sustainable agriculture in El-Beheira Governorate.

Keywords: Soil status, irrigation water quality, salinity, on-farm management.

Introduction

Rice is the world's most important cereal crop and steadily consumes more water than any other crop of similar size in most areas in which it is produced. Rapid population increase, reduction in food poverty, increasing demand for diversified food ingredients, and changes particularly in food habits have increased the demand for rice. Rice is a crucial crop in Egypt for several reasons, encompassing economic, social, and environmental aspects. Rice farming is a significant source of income for many Egyptian farmers, particularly in the Nile Delta region (**Elbasiouny and Elbehiry, 2020**). It provides employment opportunities in rural areas, helping to reduce poverty and improve livelihoods. Rice is a staple food in the Egyptian diet, forming a key part of daily meals. It provides essential calories and nutrients to a large portion of the population. As a major carbohydrate source, rice contributes to the nutritional needs helping to maintain food security (**Metwally et al., 2020**).

Rice farming is a vital agricultural activity in several Egyptian governorates, particularly in the Nile Delta region, where the fertile soil and ample water supply from the Nile River create ideal conditions for rice cultivation (**Elbasiouny and Elbehiry, 2020**). With a focus on sustainable practices and technological advancements, Egypt aims to maintain and enhance its rice production to meet domestic demand and support the livelihoods of its farmers

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Received: 31/07/2024; Accepted: 12/11/2024
DOI: 10.21608/AGRO.2024.308774.1479

(**AbdelRahman et al., 2022**). Evaluating crop varieties under farmers' conditions is essential to ensure that new varieties are suitable for real-world agricultural environments (**AbdelRahman and Metwaly, 2023**). By involving farmers directly in the evaluation process and considering a wide range of performance indicators, this approach ensures that the selected crop varieties are well-suited to the specific conditions and needs of the farming community.

According to the FAO description, soil fertility is the ability of soil to sustain nutrients required by plants in adequate quantities and the correct proportions. **El-Seedy (2019)** indicated that the evaluation of soil fertility is an essential aspect of appropriate decision-making and techniques to acquire a better sustainable agricultural system Moreover, soil fertility is one of the features that influence its productivity potential, and different management techniques have an extreme impact on the level of this fertility. The various physicochemical characteristics of soil (such as soil texture, pH, OM, etc.) are the most significant factors, which reflect the fertility of the soil and its productivity potential. **Havlin et al, 2010** reported that the availability of plant nutrients in the soil and their status in the soil is critical to explaining the fertility of the soil. Last but not least, the fertility of the soil has an influential association with the complex reactions among organic substances, water, and nutrient ions and is primarily influenced by the nature and quality of mineral ores (**Sushanth et al., 2019**). Soil fertility holds farmers’ prospects for agricultural production methods and techniques. Consequently, soil analysis is valuable for a more reasonable interpretation of soil fertility quality to boost crop production and get sustainable yield.

The vital role of soil fertility and nutrient management in agriculture appears to be an important action in the management of proper fertilizers at specific crop production sites (**Bagherzadeh et al., 2018**). Soil fertility evaluation is a considerably important decision-making mechanism for the sustainable management of soil nutrients (**Khadka et al., 2017**). Therefore, it is essential to explore soil fertility and determine the situation of soil characteristics for the cultivation of different crops.

Consumer requirements for rice grain quality differ from country to country mainly due to differences in socio-economic conditions, consumer preferences, and food preparation methods. In developed countries, preference was given mainly for long, slender, aromatic rice which becomes separate when cooked. But, in developing countries, primarily non-aromatic short or medium, slender, normal length, and bold rice are in demand. It is important to give priority to increasing consumer preference, at the same time making sure to meet the food and nutritional needs of consumers. The strength of grain quality depends on the physical, chemical, functional, morphological, and histological properties. These properties can be directly expressed to assess consumers' needs. On the other hand, some properties can be used as indicators to predict quality parameters. These indicators will be important research inputs for researchers. These measurements are of practical importance to various processing industry disciplines.

The objective of this study is to evaluate soil fertility and water characteristics of different sites in El-Behira Governorate cultivated with rice crops.

Experimental

Data were collected from ten locations (farmers' fields) in ten districts in El-Behira Governorate, Egypt during the summer season in 2022 and 2023. El-Behira Governorate, located in the northwestern part of Egypt, is one of the country's important agricultural and industrial regions. El-Behira is situated in the Nile Delta region, bordered by the Rosetta branch of the Nile River to the east and the Mediterranean Sea to the north. It shares borders with Alexandria, Kafr El Sheikh, Gharbia, and Menoufia governorates. The governorate is divided into 13 administrative centers (District).

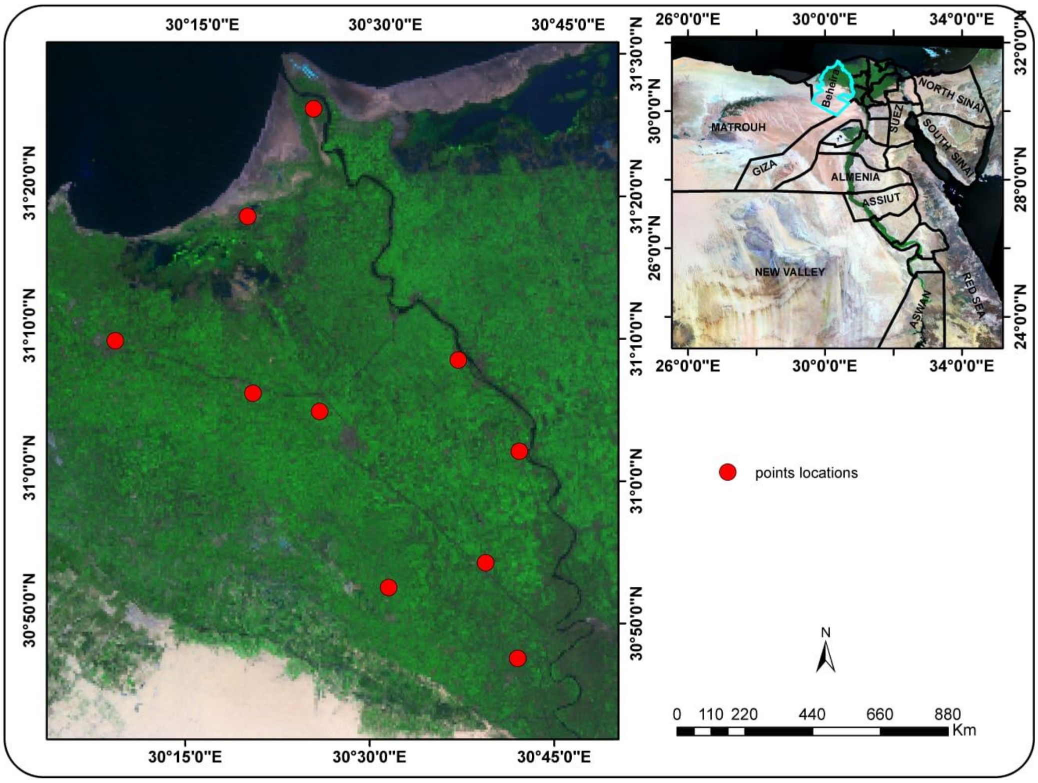

Fig. 1. Location map of the studied area.

Meteorological data (relative humidity (%), wind speed (kmh^{-1}), temperature (°c), and rainfall (mm)) during the summer season are represented in Table 1 (Source: https://www.worldweatheronline.com). In El-Behira Governorate, summer weather is typically hot and dry. Daytime temperatures often range between 30°C (86°F) and 40°C (104°F). Nighttime Lows are usually between 20°C (68°F) and 25°C (77°F). The region experiences abundant sunshine, with long days and clear skies being common. While the region experiences dry heat, the humidity levels can increase, especially in areas closer to the Nile Delta. Rainfall is scarce during the summer months. Most of the precipitation occurs during the winter months. Occasional winds can bring some relief from the heat, but they can also carry dust and sand, particularly from the desert areas.

Table 1. Average of Climate elements data for the study area during rice season (May – September).

Climate elements	2022	2023
Relative Humidity (%)	57	59
Wind Speed (kmh^{-1})	12	11
Temperature (°c) Maximum Minimum	 38 20	 36 21
Rainfall (mm)	0	0

Soil representative samples were collected from different locations before planting at a depth of 0-30 cm from the soil surface, then air-dried, ground to pass through a 2mm sieve, and well-mixed. Irrigation water samples were collected two months after planting (mid-season). Samples from flowing surface water are collected mid-stream and below the surface in the upper-middle depth of flow (EPA, 2006). This location typically had the greatest flow velocity and provided the best mixing of dissolved constituents. A sampling container attached to the end of a pole was used for samples collection (Figure 2). Both the sampling container and shipping container were triple-rinsed in the source water before sample collection. The soil and water analysis techniques are listed in Table 2.

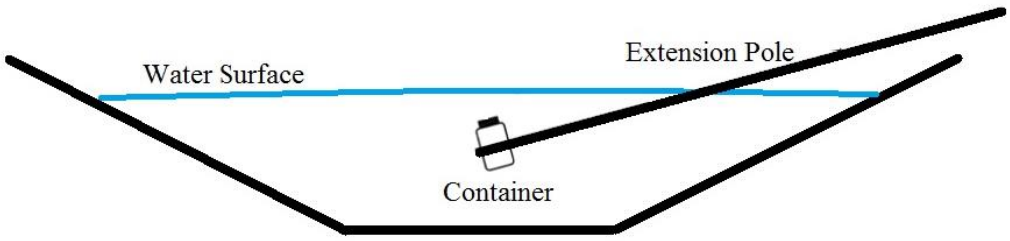

Fig. 2.Water sample collection technique.

Table 2. Parameters and methods adopted for the laboratory analysis.

Parameters	Procedures	Reference
Mechanical analysis	Pipette method	Piper, 2019
Organic carbon (OC)	Walkley and Black	Hesse, 1971
Soil pH	Soil paste	Jackson, 1967
Electrical conductivity (EC)	Soil paste extract	Hesse, 1971
Available nitrogen	Kjeldahl method	Hesse,1971
Available phosphorus	Olsen	Olsen and Sommers,1982
Available potassium	Flame photometer	Hesse, 1971
Total nitrogen (TN)	TN = 0.026 + 0.067*OC	Rashidi and Seilsepour, 2009

All recommended cultural practices were applied to the ten studied sites as follow:

The seedbed had been established and sufficiently ploughed, dry-grounded, irrigated by water, and then wet-leveled. Calcium monophosphate (15.5% P2O5) was added to dry soil at a rate of 37 kg P2O5/ha just before ploughing. Nitrogen in the form of urea (46.5% N) was applied and incorporated into the soil just before flooding. Sakha 108 Egyptian rice variety had been cultivated at all sites in both seasons. Seeds were submerged in fresh water for one day and then incubated for two days in order to accelerate germination. Germinated seeds had been uniformly planted in the recommended area of 624.8 m2/ha for all rice genotypes. The nursery sowing dates were the 6th and 8th of May for 2022 and 2023, respectively.

The permanent plots were sufficiently set as ploughing two times, harrowing one time, removing the crop residues of the previous crop, and dry leveling using a laser device. All plots received the optimum phosphorus and potassium fertilizer doses. Phosphorus was applied just before the second ploughing at 36.9 kg P2O5kg/ha in the form of super-monophosphate $Ca(H_2PO_4)_2$ which contains 15.5% P2O5. The recommended dose of 57 kg K_2O/ha as potassium sulfate (48% K_2O) was used in the permanent field and incorporated into the soil before the second ploughing. Regarding nitrogen fertilization, urea (46.5% N) as a recommended source of nitrogen has been used as two splits. The first split equaled two-thirds of the total amount and was applied and incorporated into the soil just before the first irrigation. The second split equaled one-third and was top-dressed 30 days after the application of the first split. 30-day-old seedlings had been uprooted from the seedbed and sufficiently spread via the experimental units. The transplanting operation was done manually at a planting density of 20 X 20 cm to maintain 25 hills per square meter. Three seedlings were kept at each hill during transplanting. All cultural practices were applied parallel at the selected sites on time to keep the rice plants vigorous.

When 80% of the panicles turned yellowish, harvest processes started mechanically using combine harvester (Kubota AR90- Japan). Ten main panicles were selected at each site just before harvesting to determine yield attributes characteristics. Just after harvest, the rough rice moisture content was measured using a portable grain moisture meter which measures the moisture content of individual rough rice grains by correlating the electrical resistance measured across a grain while it is crushed between two steel rolls. The grain yield weight was adjusted to 14% moisture content.

The milling recovery characteristics had been measured according to **Cruz and Khush (2000)**. A hundred and fifty grams of cleaned rough rice at 14% moisture content was de-hulled by an Experimental Huller Machine (Satake - Japan). The brown rice was collected and weighed, and then the hulling percentage was estimated. The brown rice had been milled by MC GILL Rice Miller No.2. (S.K. Appliances –India). The total milled rice (whole milled grains + broken milled grains) was weighed, and the milled rice percentage was calculated. Whole milled grains (at least 75% of total grain size) were separated from the total milled rice by a rice sizing device SKU: 61-220-50 (Seedburo – USA).

Analysis of variance (One-Way ANOVA) and correlation coefficient analysis were executed per all studied sites using Genstat for Windows Statistical Software (VSN International, 2022). Means of various traits at different sites were compared using LSD test according to Waller and Duncan (1969).

Results

The soil texture and some soil chemical properties of the studied sites are presented in Table 3. Edkou and Rachid have a clay loam soils while the other sites have the clay soils. The electric conductivity (Ec) of the soil solution is varied among the different sites. Ec was high in Rachid and Edkou. No significant variations were detected among the studied sites in terms of pH values. Organic matter was higher in the soils of AlRahmania and Shobrakheet. While organic matter recorded the lowest values at Edkou and Rachid which had high content of sodium and low content of nitrogen, phosphorus, and potassium. Shobrakheet and Eldelengat recorded the lowest values of sodium contents and the highest contents of nitrogen, phosphorus, and potassium in the two seasons.

Table 3. Soil texture and some soil chemical properties of the studied sites.

District	Texture	Ec dS/m		pH		OM%	
		2022	2023	2022	2023	2022	2023
Kom Hamada	Clay	0.320	0.290	8.241	8.146	1.170	1.264
Itay Elbaroud	Clay	0.420	0.470	8.221	8.105	1.186	1.271
Edkou	Clay loam	3.420	3.440	8.174	8.106	0.685	0.574
Rachid	Clay loam	3.360	3.460	8.217	8.119	0.654	0.617
Kafr Eldwar	Clay	0.980	1.110	8.087	8.014	0.801	0.874
Abo Humus	Clay	0.740	0.720	8.160	8.055	0.815	0.895
Damnhour	Clay	0.710	0.650	8.099	8.019	0.764	0.845
AlRahmania	Clay	0.236	0.235	8.184	8.106	1.720	1.786
Shobrakheet	Clay	0.328	0.205	8.194	8.111	1.686	1.682
Eldelengat	Clay	0.320	0.620	8.136	8.008	1.070	1.164
F Test	-	**	**	*NS*	*NS*	*	**
LSD 0.05	-	*0.119*	*0.123*	-	-	*0.116*	*0.121*
LSD0.01	-	*0.060*	*0.063*	-	-	*0.054*	*0.056*

	Na ppm		N ppm		P ppm		K ppm	
	2022	2023	2022	2023	2022	2023	2022	2023
Kom Hamada	40.31	44.48	39.80	40.10	13.90	14.17	591	551
Itay Elbaroud	38.96	42.89	38.70	36.33	14.80	13.91	570	531
Edkou	51.1	54.15	23.60	24.69	10.17	11.56	497	473
Rachid	56.4	59.47	25.80	24.22	10.23	10.07	490	464
Kafr Eldwar	42.39	46.46	33.30	31.26	13.57	12.92	647	614
Abo Humus	45.69	48.67	36.90	34.64	15.77	15.73	633	596
Damnhour	48.76	48.76	36.60	34.36	14.43	12.75	607	570
AlRahmania	11.75	18.36	58.50	59.80	22.03	21.31	760	702
Shobrakheet	12.31	18.52	59.30	55.66	20.70	12.32	728	669
Eldelengat	34.83	39.15	40.90	40.10	14.40	15.03	523	482
F Test	**	**	*	**	*	**	**	**
LSD 0.05	*3.48*	*3.91*	*4.09*	*4.01*	*1.320*	*1.510*	*52*	*48*
LSD0.01	*0.42*	*0.46*	*0.43*	*0.42*	*0.495*	*0.462*	*17*	*16*

Regarding the chemical characteristics of irrigation water, data in Table 4 show that Edkou and Rachid had high EC and sodium content in irrigation water and a low content of potassium. On the other hand, AlRahmania and Shobrakheet had lower Ec and higher potassium levels in irrigation water. The variations in pH values at different sites weren't significant.

Table 4. Average of some chemical properties of the irrigation water

District	Ec dS/m		pH		Na ppm		K ppm	
	2022	2023	2022	2023	2022	2023	2022	2023
Kom Hamada	0.528	0.399	8.563	8.461	31.75	36.02	597	602
ItayElbaroud	0.528	0.464	8.598	8.432	30.36	34.46	581	545
Edkou	2.707	2.866	8.525	8.433	42.58	45.72	489	478
Rachid	2.213	2.422	8.613	8.475	47.79	51	479	488
KafrEldwar	0.319	0.305	8.400	8.313	33.99	38.15	500	513
Abo Humus	0.194	0.201	8.465	8.311	37.23	40.36	554	520
Damnhour	0.232	0.223	8.355	8.251	40.41	40.51	549	515
AlRahmania	0.139	0.273	8.563	8.426	18.32	19.93	678	697
Shobrakheet	0.271	0.290	8.545	8.443	18.38	20.08	690	635
Eldelengat	0.626	0.458	8.420	8.280	26.41	30.87	614	602
F test	**	**	**	**	**	**	**	**
LSD 0.05	*0.085*	*0.087*	*0.936*	*0.923*	*3.60*	*3.93*	*67*	*66*
LSD0.01	*0.042*	*0.043*	*0.440*	*0.434*	*1.70*	*1.85*	*32*	*31*

Yield and yield components at different studied sites are presented in Table 5. Data showed that the mean values of different yield components as well as grain yield were varied significantly among the studied sites. AlRahmania and Shobrakheet showed a significant advance in number of tillers per hill, 1000-grain weight, number of filled grains per panicle, and grain yield. The lowest values of those characteristics were recorded at Edkou and Rachid sites. Number of unfilled grains per panicle showed a reverse trend.

Table 5. Yield and yield components at different studied sites.

District	No. of tillers/hill		1000-grain weight g		Filled grain No.		Unfilled grain No.		Grain yield t/ha	
	2022	2023	2022	2023	2022	2023	2022	2023	2022	2023
Kom Hamada	21.72	20.32	25.06	25.21	104.09	105.59	9.98	9.85	10.11	10.01
ItayElbaroud	23.03	22.09	25.02	25.23	110.12	109.32	9.89	9.23	10.58	10.21
Edkou	14.56	14.65	23.11	23.36	93.56	91.97	13.25	13.25	7.96	7.62
Rachid	15.17	14.65	23.08	23.37	90.83	90.23	11.67	12.07	8.75	8.28
KafrEldwar	19.34	19.10	25.15	25.30	131.78	130.33	7.83	8.78	10.71	10.44
Abo Humus	19.07	19.00	25.52	25.39	131.06	130.36	8.03	8.32	10.49	10.12
Damnhour	18.84	18.69	25.03	26.39	130.12	128.48	8.04	8.48	10.80	10.41
AlRahmania	25.75	24.05	25.78	25.71	145.67	144.67	2.32	3.22	11.35	11.37
Shobrakheet	26.51	26.13	25.77	25.88	156.15	154.67	3.04	4.00	11.56	11.18
Eldelengat	20.36	20.01	25.25	25.29	110.16	108.36	10.03	10.78	10.02	9.55
F test	**	**	**	**	**	**	**	**	**	**
LSD 0.05	*2.25*	*2.19*	*2.74*	*2.76*	*13.25*	*13.14*	*0.93*	*0.97*	*1.13*	*1.09*
LSD0.01	*1.05*	*1.03*	*1.29*	*1.30*	*6.33*	*6.26*	*0.43*	*0.45*	*0.53*	*0.51*

The milling recovery characteristics of rice grains at different studied sites are varied significantly. The hulling, milling, and head rice percentages were higher at AlRahmania and Shobrakheet. Edkou and Rachid recorded the lowest values of the milling recover characteristics.

Table 6. Milling recovery characteristics of rice grains at different studied sites.

District	Hulling %		Milling %		Head %	
	2022	2023	2022	2023	2022	2023
Kom Hamada	81.710	82.090	71.847	72.448	67.448	68.446
ItayElbaroud	81.560	82.228	71.853	72.762	67.762	68.040
Edkou	71.660	72.150	60.430	60.045	55.045	56.370
Rachid	71.170	71.650	60.337	60.234	55.234	56.401
KafrEldwar	83.180	83.862	73.727	73.050	67.950	68.833
Abo Humus	82.813	83.492	71.980	73.020	65.090	68.940
Damnhour	83.840	84.527	72.590	73.210	65.685	69.014
AlRahmania	84.240	84.930	73.150	74.150	68.075	69.382
Shobrakheet	84.740	85.434	74.080	74.690	68.540	69.994
Eldelengat	81.580	82.249	70.880	72.320	67.320	68.420
F test	**	**	**	**	**	**
LSD 0.05	*8.876*	*8.944*	*7.714*	*7.769*	*7.133*	*7.306*
LSD0.01	*4.172*	*4.505*	*2.921*	*3.946*	*2.343*	*2.427*

The correlation coefficient analysis between grain yield and each of the studied soil characteristics is presented in Fig 3. The correlation coefficients between grain yield and each of the Ec and Na concentrations were significant and negative. In contrast, the correlation coefficient between grain yield and pH was negative but insignificant. The correlation coefficients between grain yield and each organic matter, nitrogen, phosphorus ppm and potassium contents were positive and significant.

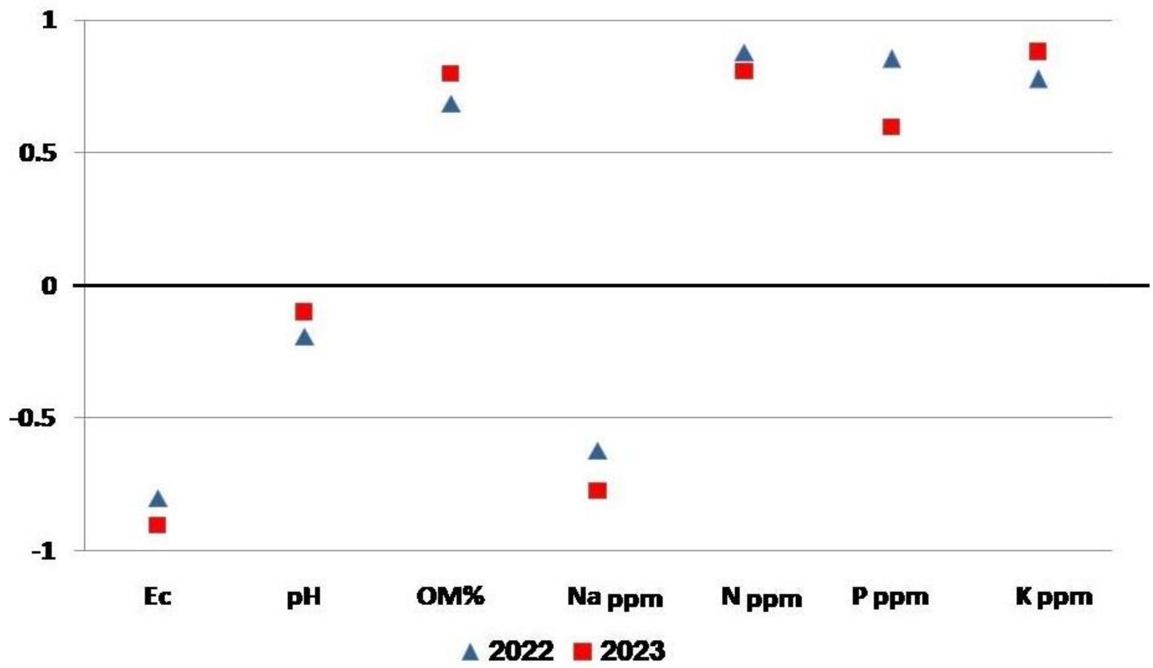

Fig. 3. The correlation coefficient analysis between grain yield and each of the studied soil characteristics.

The correlation coefficient analysis between grain yield and each of the studied irrigation water characteristics is presented in Fig 4. The correlation coefficients were significant and negative between grain yield and each of Ec and Na concentration while the correlation coefficient between grain yield and pH was negative but insignificant. The correlation coefficient between grain yield and potassium content was positive and significant.

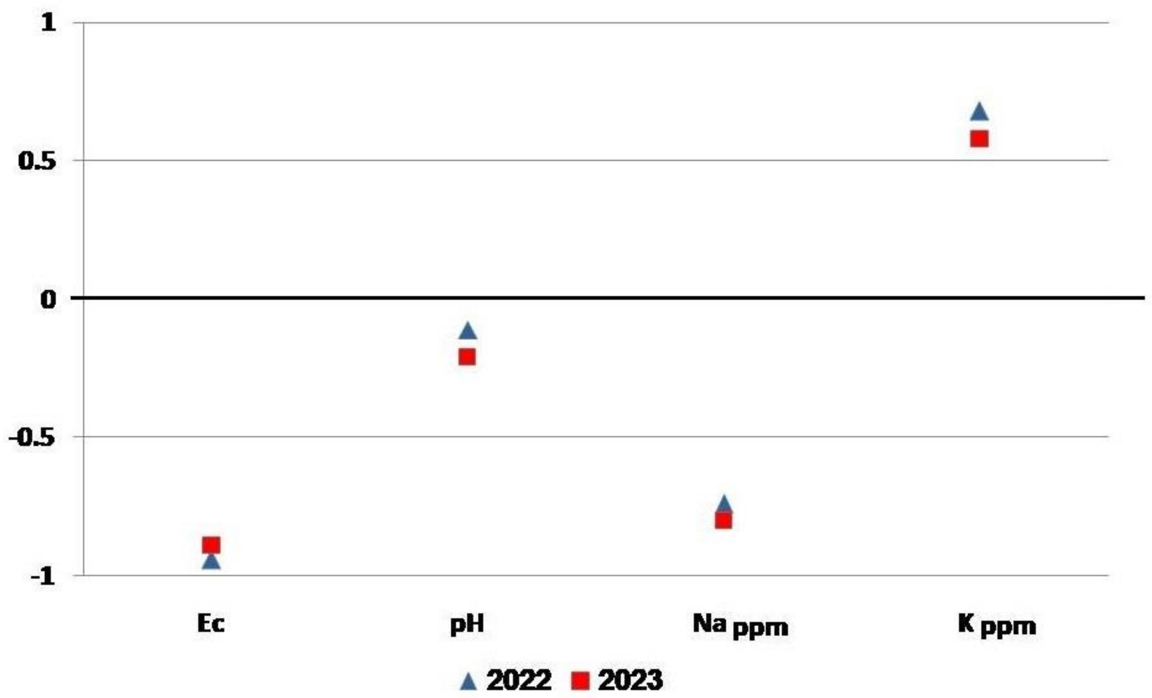

Fig. 4. The correlation coefficient analysis between grain yield and each of the studied irrigation water characteristics.

The correlation coefficient analysis between grain yield and each of the grain yield attributes is presented in Fig 5. The correlation coefficients were significant and positive between grain yield and each of all grain yield components.

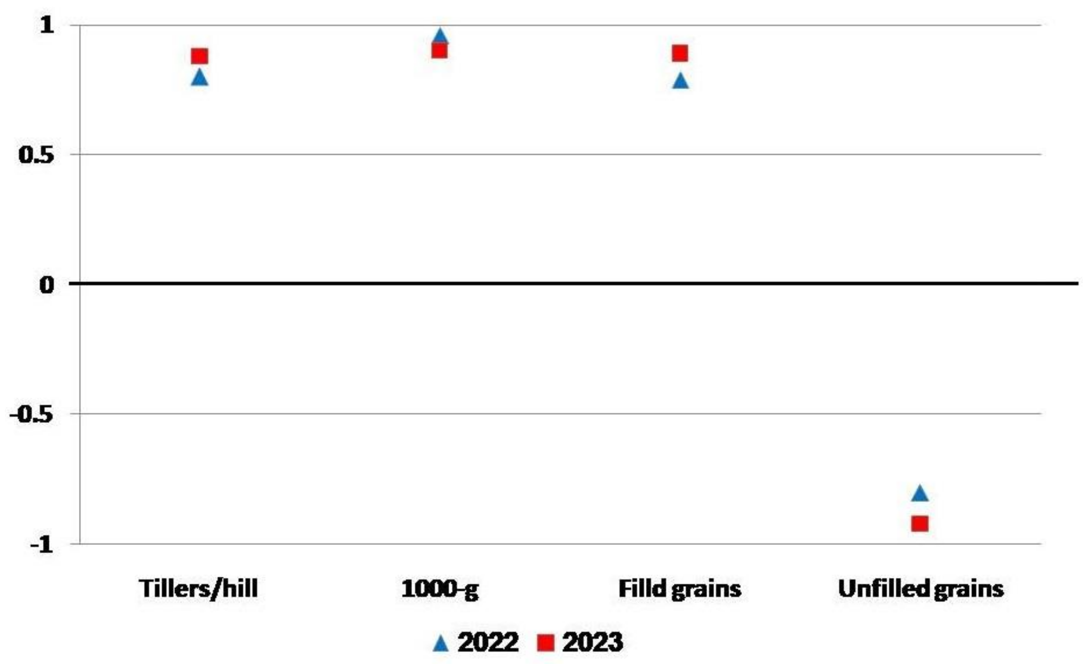

Fig. 5. The correlation coefficient analysis between grain yield and each of the grain yield components Discussion.

The soils in El-Beheira range from sandy to clayey. The composition can vary significantly across different areas. Generally, the northern parts closer to the Mediterranean Sea have more loamy soils, while the southern parts have more clayey soils. The soil in El-Beheira is typically fertile due to the deposits of nutrient-rich alluvium from the Nile River. However, continuous cropping and inadequate management practices can lead to nutrient depletion (**AbdelRahman et al., 2022**). Soil salinity is a concern in some areas, particularly in places with poor drainage and high evaporation rates (Edkou and Rachid districts). Saline soils can adversely affect crop productivity. The pH of the soil varies but is generally slightly alkaline to neutral, which is typical for soils in the Nile Delta region (**AbdelRahman et al., 2022**). High soil salinity (high EC) can lead to changes in soil pH. Saline soils often tend to have a neutral to alkaline pH because salts such as sodium chloride can increase the pH. Organic matter content varies but is generally low due to intensive agricultural practices (**Jin et al., 2011**). Farmers often use organic and inorganic fertilizers to enhance soil fertility.

High soil salinity at Edkou and Rachid districts can inhibit the activity of soil microorganisms responsible for decomposing organic matter. This can lead to slower decomposition rates, resulting in the accumulation of undecomposed organic material (**Radha et al., 2023**). The reduced microbial activity is often due to osmotic stress and specific ion toxicities caused by high concentrations of salts. Elevated salinity levels at Edkou and Rachid districts can negatively affect the diversity and abundance of soil microbial communities. Salt stress can reduce the efficiency of microbial processes, including the breakdown of organic matter (**Jin et al., 2011**). High levels of soluble salts can lead to nutrient imbalances and toxicity, which can affect plant growth and the input of organic residues into the soil. Reduced plant growth means less organic material (such as roots, leaves, and crop residues) is returned to the soil, potentially reducing soil organic matter over time. **AbdelRahman et al., 2022** indicated that the physical and chemical properties of soil, including texture, structure, and pH, affect root development and nutrient availability. Nutrient-rich soils support better growth. Key nutrients include nitrogen, phosphorus, and potassium.

The primary source of irrigation water in El-Beheira is the Nile River. The water is distributed through a network of canals and ditches. Groundwater is also used in some areas, especially where surface water is not readily available. The quality of irrigation water from the Nile is generally good, with low salinity levels and pollutants. However, water quality can be affected by agricultural runoff, industrial discharges, and other sources of pollution upstream (**AbdelRahman and Metwaly, 2023**), especially at the end of the River Nile (Edkou and Rachid districts). Irrigation water salinity is a critical factor for agricultural productivity. Water from the Nile is generally low in salinity, but improper irrigation practices can lead to soil salinization as shown in Edkou and Rachid districts. The pH of the irrigation water is typically neutral to slightly alkaline, which is suitable for most crops grown in the region.

Saline soil and irrigation water can have a significant impact on rice yield components, affecting both the quantity and quality of the crop. Salinity can inhibit cell division and elongation, resulting in shorter plants. Salt stress often leads to smaller leaves, reducing the overall photosynthetic area and thus the energy available for growth and development (**Mohamed et al., 2023**). Salinity can reduce the number of tillers per plant, which directly affects the number of potential panicles and, subsequently, the yield. High salinity can delay or reduce panicle initiation, leading to fewer and smaller panicles. Salinity during the flowering stage can increase spikelet sterility, reducing the number of filled grains. Saline conditions can impair nutrient uptake, leading to smaller and lighter grains. The combined effect of reduced tillering, increased spikelet sterility, and poor grain filling results in a lower number of grains per panicle.

Salinity can interfere with the uptake of essential nutrients like potassium, calcium, and magnesium, while increasing the uptake of sodium and chloride, which are detrimental in high concentrations (**Mohamed et al., 2023**). This imbalance often manifests as nutrient deficiency symptoms, further impairing plant growth and yield. Saline soil causes osmotic stress, making it harder for the plant to absorb water. This can lead to dehydration and reduced physiological functions. Even in the presence of adequate soil moisture, salinity can cause a physiological drought condition, stressing the plants as if they were experiencing actual drought.

Radha et al., 2023 confirmed that the quality of soil and irrigation water can significantly influence rice milling characteristics. High nitrogen percentage in the soil can increase grain protein content, potentially leading to harder grains that can affect milling yield. Adequate parentages of phosphorus and potassium support grain development, which can improve the overall quality of the rice **(El-Hity et al., 2020 and Metwally et al., 2020**) . Soil and water quality that support healthy plant growth generally result in higher head rice yield (percentage of whole kernels after milling). Poor soil or water quality can lead to grains that are more prone to breakage during milling, reducing the quality and market value of the rice (**Metwally et al., 2020**). Optimal soil and water conditions promote uniform grain development, resulting in better milling performance and higher quality rice (**Mohamed et al., 2023**).

Conclusion

Maintaining good soil health and ensuring high-quality irrigation water are crucial for achieving high yield and optimal rice milling characteristics. Regular soil testing, water quality monitoring, and appropriate management practices can help in producing high-quality rice with better milling properties. Understanding and managing the soil and irrigation water characteristics are crucial for sustainable agriculture in El-Beheira Governorate. Continuous monitoring and adoption of best practices can help maintain soil health and ensure the long-term productivity of agricultural lands in the studied region.

References

Abdel Rahman, A.E., Engel, M.B., Eid, S.M.M., Aboelsoud, H.M. (2022) A new index to assess soil sustainability based on temporal changes of soil measurements using geomatics–an example from El-Sharkia, Egypt. *All Earth*, **34(1),** 147-166.

Abdel Rahman, M.A., Metwaly, M.M. (2023) Digital soil characteristics mapping for aiding site-specific management practices in the West Nile Delta, Egypt. *Discover Sustainability*, **4(1)**, 47.

Bagherzadeh, A., Gholizadeh, A., &Keshavarzi, A. (2018) Assessment of soil fertility index for potato production using integrated Fuzzy and AHP approaches, Northeast of Iran. *Eurasian Journal of Soil Science*, ***7*(3),** 203-212.

CRUZ N.D., and KHUSH G.S. (2000) Rice Grain Quality Evaluation Procedures – In: Primlani M (ed) Aromatic Rices Oxford &IBH Publishing, New Delhi, pp. 15, 2000.

Elbasiouny, H., and Elbehiry, F. (2020) Rice production in Egypt: The challenges of climate change and water deficiency. Climate change impacts on agriculture and food security in Egypt: Land and water resources—Smart farming—Livestock, fishery, and aquaculture, 295-319.

El-Hity, M. A., Metwally, T. F., Mohammed, A. A., Elsaka, M. A., Hassan, F., Hafez, Y. M., & Abdelaal, K. A. (2020) Integrated fertilizer management on growth and nutrient uptake of Egyptian hybrid rice. *Fresenius Environmental Bulletin*, **29**, 11588-11597.

Elseedy, M. (2019) Soil fertility evaluation using ASLE, nutrient index models and GIS techniques: A case study on some soils of Dakahlia Governorate, Egypt. *Egyptian Journal of Soil Science*, ***59*(4)**, 403-415.

EPA, U.S. Environmental Protection Agency. (2006) Chapter 17: Bacterial indicators of potential pathogens. In *Voluntary estuary monitoring manual*, EPA-842-B06-003. 2nd ed. https://www.epa.gov/sites/default/files/2015-09/documents/2009_03_13_estuaries_monitor_chap17.pdf

Havlin, H.L., J.D. Beaton, S. L. Tisdale; and W. L. Nelson (2010) Soil Fertility and Fertilizers: An Introduction to Nutrient Management. Seventh edition. PHI Learning Private Limited, New Delhi.

Hesse, P.R. (1971) *"A Text Book of Soil Chemical Analysis".* John Murry (Publishers) Ltd, 50 Albermarle Street, London.

Jackson, M.L. (1967) *Soil Chemical Analysis".* Printice Hall of India, New Delhi.PP.144-197.

Jin, J. W., Xu, Y. F., Ye, H. C., Shen, C. Y., Huang, Y. F. (2011) Effect of land use and soil management practices on soil fertility quality in North China cities' urban fringe. *African Journal of Agricultural Research*, **6(9)**, 2059-2065.

Khadka D, S. Lamichhane; S. R. Shrestha; and B. B. Pant (2017) Evaluation of soil fertility status of Regional Agricultural Research Station, Tarahara, Sunsari, Nepal. *Eurasian Journal of Soil Science*. **6(4)**, 295.

Metwally, T. F., Mohamed, A. A. E., Sorour, S. G. R., & Elsayed, G. A. (2020) Stimulating compounds affect the grain quality characteristics and the nutritional value of rice (Oryza sativa). *Applied Ecology & Environmental Research*, **18(5)**, 6829-6840.

Mohamed, S. A., Metwaly, M. M., Metwalli, M. R., AbdelRahman, M. A., & Badreldin, N. (2023) Integrating active and passive remote sensing data for mapping soil salinity using machine learning and feature selection approaches in arid regions. *Remote Sensing*, **15(7)**, 1751.

Olsen, S. R. and L. F. Sommers (1982) "Methods of soil analysis". Part 2.Chemical Microbiological Properties. *Agron. J. Amer. Soc. Agron.* Madison, Wiss, USA: 403-430.

Piper, C. S. (2019) Soil and plant analysis. Scientific Publishers. Inter. Science Publishers Inc. New York.

Radha, B., Sunitha, N. C., Sah, R. P., TP, M. A., Krishna, G. K., Umesh, D. K., ... & Siddique, K. H. (2023) Physiological and molecular implications of multiple abiotic stresses on yield and quality of rice. *Frontiers in Plant Science*, **13**, 996514.

Rashidi, M., & Seilsepour, M. (2009). Modeling of soil total nitrogen based on soil organic carbon. *ARPN J. Agric. Biol. Sci*, **4(2)**, 1-5.

Sushanth, K. ,R. Kumar; and A.Bhardwaj (2019) Soil mapping of Patiala-Ki-Rao watershed in Shivalik Foot-Hills using GIS. *International J. of Agri. Sci. Res. (IJASR)* **9(2)**, 1-8.

VSN International (2022) Genstat for Windows 22nd Edition. VSN International, Hemel Hempstead, UK. Web page: Genstat.co.uk

Waller, R. A., and Duncan, D. B. (1969) A Bayes rule for the symmetric multiple comparisons problem. *Journal of the American Statistical Association*, ***64*(328)**, 1484-1503.