Studying The Efficacy Of Some Organic Compounds As A Source of Potassium Fertilization And Their Effect On The Wheat-Peanut Crop System In Sandy Soil

ABSTRACT

To encourage sustainable agriculture and increase net revenue for the agricultural community, the use of expensive chemical fertilizers should be reduced and replaced with locally produced organic byproducts. Waste products may also be used to substitute mineral fertilizers in an ecologically responsible and cost-effective manner since they have adequate macronutrients and organic carbon content. For this reason, a field experiment was conducted on sandy soil at Ismailia Agric. Res. Station in Ismailia Governorate, Egypt to evaluate the impact of various organic potassium doses (50%, 75%, and 100% of the recommended dose) and three different organic potassium sources *i.e.*, seaweed (SWE), yeast sludge (YS), and filter mud cake (FMC), in two successive seasons: wheat (*Triticum sativac.* v. Giza 168) as a winter crop and peanut (*Arachis hypogaeac*. v. Giza 6) as a summer crop season; to study how responsive they are to different potassium rates and sources applied to crop productivity. After both crops were harvested, the chemical features of the soil were also assessed. The current findings state that the use of varied organic K rates and sources boosted the yield components of both wheat and peanut crops, as well as the nutritional total content in straw, grains, or seed of both wheat and peanut, as compared to the control treatment. Furthermore, the application of all treatments improved pH, EC, OM, and cation exchangeable capacity (CEC).The availability of P, K, and soluble K followed a similar pattern after the wheat-peanut crop was harvested. Furthermore, the highest increases resulted from 75% of the recommended K dose and the best organic sources of K were YS and SWE for wheat and peanut, respectively. In conclusion, the use of tested organic potassium sources is a good alternative to mineral potassium fertilizers, is economical, which is reflected in crop yield, and is environmentally friendly. Furthermore, the highest increases resulted from 75% of the recommended K dose and the best organic sources of K were YS and SWE for wheat and peanut, respectively. In conclusion, the use of tested organic potassium sources is a good alternative to mineral potassium fertilizers and is economical, which is reflected in crop yield and is environmentally friendly.

Keyword: Seaweed, Yeast Sludge, Filter Mud, Potassium Fertilizers, Wheat and Peanut.

INTRODUCTION

Maintaining healthy soils is an important component of organic agriculture, since it increases crop system sustainability. At the moment, there is a growing need for agricultural output that not only meets high quality requirements, but also follows ecologically friendly techniques. Previous research has shown that the use of organic fertilizer meets the standards of sustainable agriculture and organic fertilizer offers significant benefits over chemical fertilizer in many ways. According to **El-Gamal *et al.* (2020),** as compared to organic fertilizers, chemical fertilizers are insufficient to provide all of the minerals and nutrients required by plant, namely nitrogen, phosphorus, and potassium. In fact, chemical fertilizers are incompatible with organic farming and have negative effect on both health and the environment. As well, **Hong *et al.* (2007)** revealed that modern agriculture is looking for new biotechnological advances that would allow a reduction in the use of chemical inputs without affecting crop yield or the farmer's income.

Additionally, potassium is the most commonly used plant nutrient in agriculture, playing important roles in the transport of water, nutrients and nitrogen availability, stimulation of early growth, and resistance to insects and diseases (**Brhane et al. ., 2017**). **Boldrin *et al.* (2019)** suggested that one option for countries with low availability of soluble K sources is research to develop new fertilizer technologies, including alternative sources such as algae, organic fertilizer sources such as fermenter sludge, and pressed sludge. It was reported that the aim is to promote Recently, natural algae extracts have been successfully used as bio-stimulants in agriculture. These increase crop productivity and reduce the use of traditional synthetic fertilizers. **Ngoroyemoto (2020)** reported that algae-derived extracts are biodegradable, non-toxic, non-polluting, and harmless to humans, animals, and birds. It also contains alginates, which bind soil particles together to form aggregates, resulting in a soil structure suitable for crop growth. It could help reduce the negative effects of current chemical agriculture. Also, **Shin *et al.* (2019)** found that seaweed sap is a good source of potassium and phosphorus. Potassium helps regulate the plant's water status, controls stomata opening and closing and promotes photosynthesis, while phosphorus supports root growth. Furthermore, **Ali et al. (2021)** found that seaweed extracts are bio-stimulants rather than fertilizers, as they stimulate defense and growth responses when applied to plants. Additionally, **Ngoroyemoto (2020)** found that the active components of seaweed-derived extracts are phytohormones such as auxin, cytokinin, and gibberellin.

Yeast sludge (distillers yeast sludge (DYS)) is excess yeast that accumulates as sludge at the bottom of fermentation tanks during fermentation processes in the sugar and distillery industries. Sometimes called as waste yeast, yeast slurry, or trub. It is classified as a waste that is difficult to handle and dispose of (**Sharif *et al.,* 2018**). Several studies have shown that the nutritional composition of DYS varies greatly depending on the chemicals used, yeast strain used, type of molasses, fermentation time, crude protein, metabolic energy, amount of fat, and NFE (nitrogen-free extract) content. I know it's different. (**Haider, 2010**). Protein variation is primarily determined by the amount of yeast cells present in the biomass. (**Khan *et al*., 2017**) was found to have high biological value and approximately 30% protein, but also has an excellent amino acid profile including lysine, methionine, leucine, isoleucine, valine, and tryptophan. Masu. However, the term "Filter Mud Cake" (FMC), sometimes referred to as "Press Mud" or "Filter Mud FM", refers to the raw material from sugar mills used to produce high-quality, nutrient-rich organic matter. Refers to organic wastewater. fertilizer. The waste from sugar mills is called press sludge or filter cake. It is a fragile, spongy, amorphous substance of dark brown to brown color that controls sugars, fibers, coagulating colloids (such as sugarcane wax), albuminoids, inorganic ions, and dirt particles. Additionally, it contains hormones, vitamins, auxins, enzymes, and plant growth regulators that help keep agricultural soils productive, fertile, and healthy. (**El-Tayeh *et al.,* 2019; Abubakar et al., 2022**). Additionally, filter cake has been used as a biofertilizer and was reported by **Ali *et al.* (2021)** to positively influence soil biochemical and physical parameters and plant development. It is also rich in nutrients and increases organic carbon, clay and water content, which improves crop productivity and maintains soil fertility. **Fantaye (2016)** and **Essa *et al.* (2022)** found that adding treated pressed mud to soil increased key nutrients such as phosphate and nitrogen.

The aim of the current study is to determine the effect of adding different concentrations and sources of organic potassium, such as seaweed, yeast sludge, and press slurry, as alternative sources of mineral potassium fertilizer in order to meet the needs of economically valuable plants, reduce production costs, and save hard currency.

MATERIALS AND METHODS

A field experiment was carried out on sandy soil at the Ismailia Agriculture Research Station in Ismailia Governorate, Egypt to investigate the influence of certain organic potassium sources on reducing the need of mineral potassium fertilizers. The farm is in latitude 30^{o} 35' 41.901" N, longitude 32^{o} 16' 45.834" E. Some physicochemical parameters of the examined soil are shown in Table 1 using the methodology given by **Page *et al.* (1982).** This experiment was conducted over two consecutive seasons, on wheat (*Triticum sativacv*. Giza 168) in the winter (2021-2022) and peanut *(Arachis hypogaeac*.v. Giaz 5) in the summer (2022). The experimental design was a split-plot design with three replications. The main plot was three rates of potassium (50, 75, and 100%) of the recommended dose. The sub-main plots included four treatments: a. Control (recommended dose of K as potassium sulfate), b. Seaweed extract (SWE) (El Anglo Co.) in powder form, c. Yeast sludge (YS) or fermenter sludge (El Hawmdia factory for sugar industry) in powder form, d. Filter mud cake (FMC) or press mud (El Anglo Co.) (it was produced from the organic wastes of Quos Sugarcane Factory). Table (2) shows some of the chemical features of organic compounds used as an alternative to potassium fertilization.

Table 1. Some physicochemical properties of the experimental soil

Particle size distribution		**Soil physical properties**		**Soil chemical properties**	
Coarse sand %	**69.00**	**Bulk density g cm^{-3}**	**1.73**	**Organic matter %**	**0.36**
Fine sand %	**24.65**	**Total porosity %**	**34.7**	***pH**	**7.73**
Silt %	**3.52**	**SP**	**23.0**	****EC dSm^{-1}**	**0.44**
Clay %	**2.83**				
Soil texture	**sandy**				
Soluble cations (meq L^{-1})		**Soluble anions (meq L^{-1})**		**Available nutrients (mg kg^{-1})**	
Ca^{2+}	**1.02**	**CO^{--}**	**Nd**	**N**	**39**
Mg^{2+}	**0.99**	**HCO_3^-**	**1.92**	**P**	**8.1**
Na^+	**1.30**	**Cl^-**	**1.20**	**K**	**50**
K^+	**1.00**	**SO_4^-**	**1.19**		

***pH (Soil-water suspension ratio, 1:2.5)** ****EC (soil paste extract)**

Table 2. Some chemical properties of tested organic materials are used as an alternative to potassium fertilization.

Organic K sources	Chemical properties					
	N%	P%	K_2O%	pH*	EC** dSm^{-1}	OM %
Seaweed extract	**0.50**	**0.28**	**16.0**	**8.95**	**5.03**	**1.35**
Yeast sludge	**1.46**	**0.18**	**16.0**	**7.38**	**7.24**	**0.37**
Filter mud	**0.42**	**0.14**	**14.8**	**6.99**	**7.61**	**0.15**

***pH (1:2.5 suspension)** ****EC (1:5 water extract)**

Before cultivation, the usual agricultural practices were applied according to agricultural guidance for each crop. All treatments received mineral fertilizers (N and P) at the recommended doses for both wheat and peanut crops. Calcium super phosphates (P_2O_5 15%) in rate of 200 kg $fed^{-1}$was applied on soil surface during preparation soil for cultivation of both wheat and peanut plants, respectively. In addition, wheat plant received 120 kg fed^{-1} N in the form ammonium nitrate (33% N) in four equal doses every 15 days from planting whereas peanut plant received 100 kg fed^{-1} N in two split equal doses at sowing and after one month from planting. Potassium fertilizer was applied at a rate of 50 kg fed^{-1} K_2O as potassium sulphate (K_2SO_4) for the control treatment, as well as (SW, YS, and FM) for tested organic K sources at different rates of 50, 75, and 100% of the recommended dose for both cultivated crops as an alternative to potassium fertilization. Throughout both seasons, all types of K were applied twice (30 and 60 days after planting).

Evaluations of the experiment

Soil examination

Soil samples were taken after harvested, air-dried, and passed through 2 mm sieve for analysis according to **Cottenie *et al.* (1982)** as follow:

1- Electrical conductivity (EC) dSm^{-1} in soil water extract at ratio (1:5).
2- pH in soil water suspension at ratio (1:2.5).
3- Organic matter (OM) content.
4- Cation exchange capacity (CEC).
5- Available P and K forms (soluble and available).

Plant examination

When the plants reached maturity, they were harvested. Samples of harvested wheat and peanut plants were obtained in one-square meter increments to calculate the yield components based on the weight of the straw and the grain or seed yield for each plant, respectively. In order to determine the nutritional status, plant samples were oven dried for 48 hours at 70 ^{0}C, up to a constant dry weight, and then crushed and digested using a combination of H_2SO_4 and H_2O_2. This process was reported by **Page *et al.* (1982).**

Statistical analysis

All data were statistically analyzed by season using the approach outlined by **Snedecor and Cochron (1980)**. The significance of differences between treatments was determined using the Least Significant Differences (LSD) test at the 0.05 probability level. Finally, all statistical analyses were carried out using the "MSTAT-C" computer software program, as described by **Freed et al. (1989)**. The correlation coefficient (R^2) was obtained using the Microsoft Excel program.

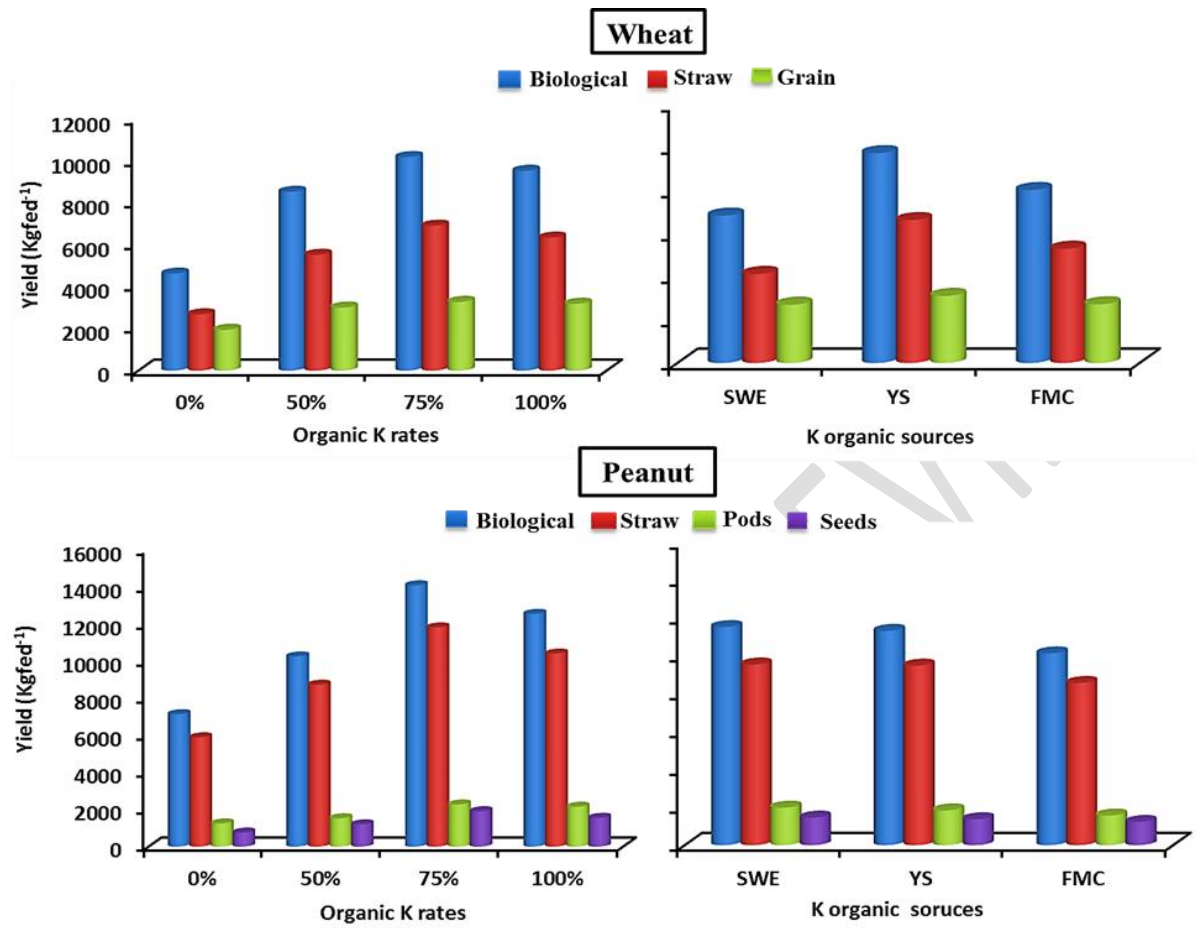
RESULTS AND DISCUSSION

One of the minerals that is fundamentally needed for plant growth and development is potassium. There have been reports of potassium depletion in agricultural soils and low potassium levels have a detrimental impact on crop production. Some organic K sources can be used as substitutes for commercial K fertilizers to counteract the negative impacts of mineral K fertilizers. Their effects on the following parameters should be investigated.

Yield components of the wheat-peanut crop system

The data in Fig. 1 show the effect of different organic K rates (50, 75, and 100% of the recommended dose of both studied plants) and organic K sources (SWE, YS, and FMC) on the growth parameters of wheat (biological yield, straw and grains) and peanut (biological yield, straw, pods and seed yield) in sandy soil conditions. Generally, the application of different rates from organic K sources increased the plant growth parameters of wheat and peanut as compared to the control treatment. In addition, the superior rate of organic K was 75% from recommended doses of plants, which increased by 120, 158, and 69% for the biological, straw yield, and grain yield of wheat, respectively. While it was (97, 101, 82, and 152%) for the biological, straw, pods, and seed yield of peanuts, respectively. Also, results indicate that there is no significant difference between the 75% and 100% rates of organic K application. In contrast to inorganic fertilizer, which improved only nutrient supply. **Akrawi (2018)** found that the highest increase in yield parameters was obtained with 100% K in organic fertilizer. He relates these findings to the organic K source being an improved soil physical condition for plant growth, along with increasing availability of nutrients at the early stage of crop growth. **Wu *et al.* (2022)** reported that the application of filter mud at different rates (3%, 5%, 7%, 9% and 13%) enhanced plant productivity and the maximum increase was observed at 7%.

Moreover, results in Fig. 1 showed that, regardless of the different concentrations, the application of organic K sources (SWE, YS, and FMC) increased the crop productivity of the wheat-peanut crop system as compared to the control treatment. The highest treatment for the wheat crop was the YS treatment, as well as the SWE treatment for the peanut crop, compared to other sources. These outcomes are probably attributable to organic sources' capacity to improve soil fertility and nutrient availability. Therefore, various nutrients and fatty acids that promote development may be found in organic wastes, which benefit plant characteristics and productivity. In addition to potassium's beneficial effects, which are seen in both wheat and peanut growth and productivity, this mineral is also essential for several fundamental activities, including protein synthesis, enzyme activation, material transport, and osmosis control. These data are consistent with the findings of **Chen *et al.* (2021),** who found that seaweed extract contains a significant amount of gibberellic acid, which activates the genes encoding amylase in aleurone cells and functions to provide a signal during seed germination. Furthermore, as seaweeds have vital fatty acids, vitamins, amino acids, minerals, and growth-promoting compounds, they can increase plant development and productivity. Additionally, **Yousef *et al.* (2019)** and **El-Kamar (2020**) indicated that yeast waste treatment may have a good influence on plant development, yield and yield quality since it includes plant-growth-enhancing amino acids, trace elements, auxins, gibberellins, and cytokinins. **Rathore *et al.* (2009)** reported similar results, stating that the use of seaweed extract considerably boosted straw and grain yields with the highest value reached with seaweed extract plus filter mud treatment.



SWE Seaweed YS Yeast sludge FMC Filter mud

Fig.1: Yield components of the wheat-peanut crop system as a response to the application of different rates of potassium organic and three different organic potassium sources under sandy soil conditions.

The interaction between potassium rates and potassium organic sources on wheat-peanut crop productivity

Data in Table 3 showed the effect of different rates (50, 75, and 100% of the recommended K dose) with SWE, YS, and FMC as organic K sources on the yield components of wheat and peanut. In general, the application of all treatments increased the growth parameters of the studied plants as compared to the control treatment. As well, the growth parameters of wheat and peanut increased with the increasing K rate, which was applied from three organic K sources. The best rate of K from organic sources, according to the data was 75% for wheat and was acquired from the YS organic K source. A similar trend was shown for peanuts when employing organic K sources in the form of SWE. These findings corroborate those of **Zein El-Abdeen (2018),** who found that the application of YS, SWE, and FMC typically resulted in a considerable increase in the growth parameters of wheat and peanut when compared to the control treatment. **Wu *et al.* (2022) and Essa *et al.* (2022**) refer to the increasing sugar beet yield with filter mud due to increasing physiological activity by the enhancement of the activity of the photosynthesis enzyme and the enhancement of CO_2 assimilation as well as stomata conductance and Phosphoenolpyruvate Carboxylase (PEPC) activity reaching the maximum value at rates of 7%, more than 3%, 9%, and 13% which was consistent with the proportion of filter mud when the biomass of sugar beet leaves reached the maximum value. Also, press mud increases the amount of light energy intercepted by leaves, increases photosynthetic pigments and photosynthesis, and in turn, increases synthesized metabolites and consequently leaves and grains. The stomatal conductance of sugar beet seedling leaves did not change significantly in several treatments, with the percentage of filter mud exceeding 7% due to the limitation of stomatal opening. Furthermore, seaweeds are known to include a variety of organic elements such as polysaccharides, proteins, and fatty acids which help to retain moisture and nutrients in the soil, boosting microbial activity and enhancing soil texture. Seaweed-based fertilizers have been shown to promote root development by increasing microbial diversity and activities such as nutrient mineralization and mobilisation **(Raghunandan *et al*., 2022).**

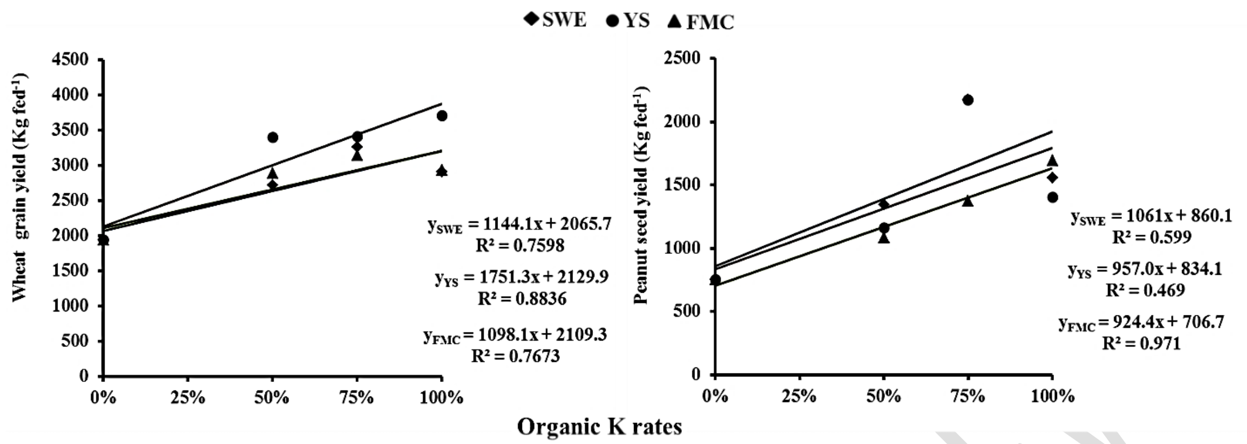
Table 3. Response of wheat-peanut yield to the interaction between various K rates and three different organic K sources under sand soil conditions.

K Rates	Organic K form	Wheat (Kg fed^{-1})			Peanut (Kg fed^{-1})			
		Biological yield	Straw	Grain	Biological yield	Straw	Pods	Seeds
Control		4620	2679	1941	7140	5893	1247	755
50 %	**SWE**	6840	4124	2716	11025	9252	1773	1343
	YS	11040	7642	3398	10500	9021	1479	1161
	FMC	7680	4789	2891	9240	7923	1317	1086
75 %	**SWE**	8312	5046	3266	15260	12575	2685	2172
	YS	11675	8261	3414	14980	12501	2479	2172
	FMC	10546	7405	3141	12040	10388	1652	1373
100 %	**SWE**	7608	4694	2914	12740	10515	2225	1558
	YS	11665	7958	3707	12740	10587	2153	1402
	FMC	9294	6359	2935	12180	10122	2058	1693
LSD at 5%		1773	2103	714.8	3086	2972	31734	399.1

SWE Seaweed YS Yeast sludge FMC Filter mud

Correlation analysis between organic K rates and grain or seed yield of the wheat-peanut crop system

Data on the wheat-peanut crop system's grain or seed production was gathered for this study. After that, an analysis was done on these data to see how they are related to organic K rates. For this reason, the association between two variables was assessed using simple linear regression. The analysis findings are displayed in Fig. 2, which also depicts the link between the two variables that were previously discussed. The findings demonstrated a good correlation between the organic K rates and wheat grain yield (R^2 = 0.76, 0.88, and 0.77 for SWE, YS, and FMC, respectively). However, for FMC alone, there was a considerable positive correlation (R^2 = 0.97) between the seed production of peanuts and organic K rates. The application of different rates of K from different organic sources was found to be a reliable indicator of grain or seed yield in this study, which may be helpful in determining the best organic rates and sources of K to increase grain or seed yield of wheat and peanut in sandy soil conditions.

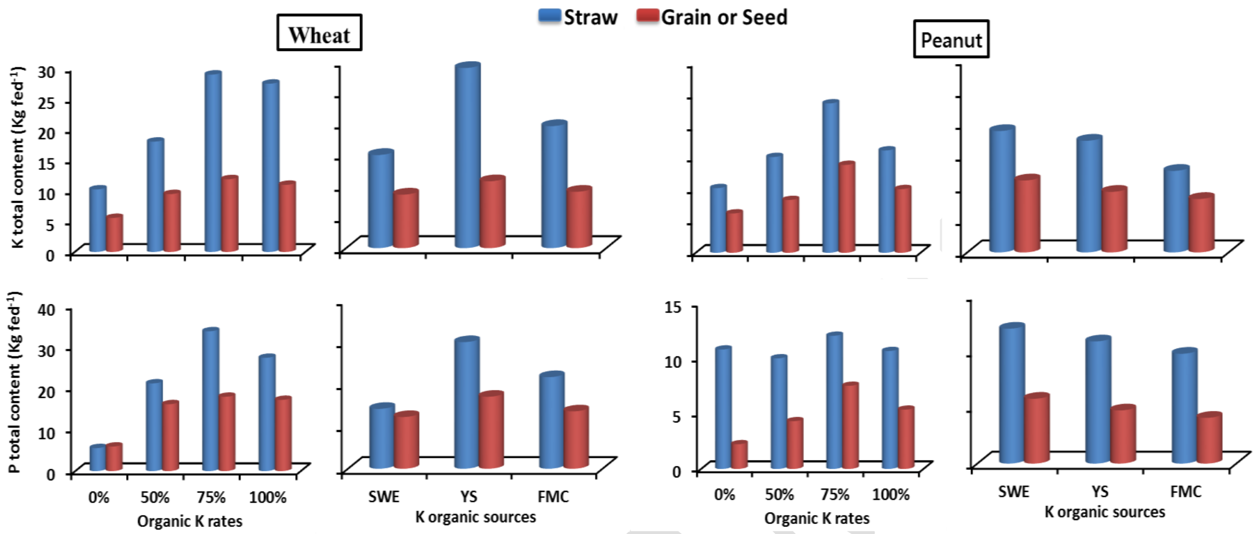


SWE Seaweed **YS** Yeast sludge **FMC** Filter mud

Fig. 2. Relationship between organic K rates and grain or seed yield of wheat - peanut crop system.

Nutrient total content in yield of wheat-peanut crop system

The data in Fig. 3 illustrates the reaction of the plant nutrient total content to the application of various potassium rates and organic K sources, as well as their interaction. The results show that applying K at different rates (50, 75, and 100% of the recommended dose) or from different organic K sources (SWE, YS and FMC) enhanced the total K and P content of straw, grain or seeds for wheat and peanut when compared to the control treatment. The greatest increases were observed at 75% of the prescribed K dosage and the best organic sources of K were YS and SWE for wheat and peanut, respectively (for straw and grain or seed K content). This might be because organic potassium fertilizers provide nutrients that plants require, such as nitrogen, potassium and phosphorus. It also helps plants absorb these components more effectively, which is evident in plant development, as demonstrated by the results. These results are confirmed by **Marzauk *et al.* (2014), Nasser *et al*. (2016), and Yousef *et al.* (2019).** Also, these findings are consistent with those of **Zein El-Abdeen (2018),** who discovered that in comparison to the control treatment, the overall content of N, P and K rose considerably in both straw and grains and/or seeds of wheat and peanut crops. Furthermore, seaweed treatment is the best followed by filter mud and yeast sludge. An increase in seaweed nutrients may be the cause of this since it makes up for soil deficiencies in N, P and K **(Singh *et al*., 2016; Vyomendra and Kumar, 2016). Eisa (2016)** also mentioned that applying seaweed extract greatly raised the percentages of K and P in the plant leaves. Furthermore, yeast waste has been shown to include a variety of nutrients, growth regulators and amino acids that promote root development and enhance soil nutrient absorption **(Yousef *et al*., 2019; El-Kamar, 2020).** Additionally, **Kubar *et al.* (2019)** found that as the rate of K application rose, so did the K content of grain and straw, as well as the grain yield of wheat.



SWE Seaweed YS Yeast sludge FMC Filter mud

Fig. 3. Total phosphorus and potassium content in both wheat and peanut crops as a response to different K rates and organic K sources applied under sandy soil condition

The interaction between potassium rates and potassium organic sources and its influence on total K and P content in the wheat-peanut crop system.

The total K and P contents in straw, grain or seed for wheat and peanut, respectively are shown in Table 4 as a response to the interaction between potassium at varying rates (50, 75, and 100% of the plant's recommended dose) and its various organic sources (SWE, YS and FMC) in sandy soil conditions. When compared to the control treatment, the collected results generally indicate an increase in the total K and P content in straw, grain or seed for wheat and peanut, respectively. When YS was given at a rate of 75% of the recommended dose for wheat and SWE was applied at a rate of 75% of the recommended dose for peanuts, the highest values of the studied plants were achieved.

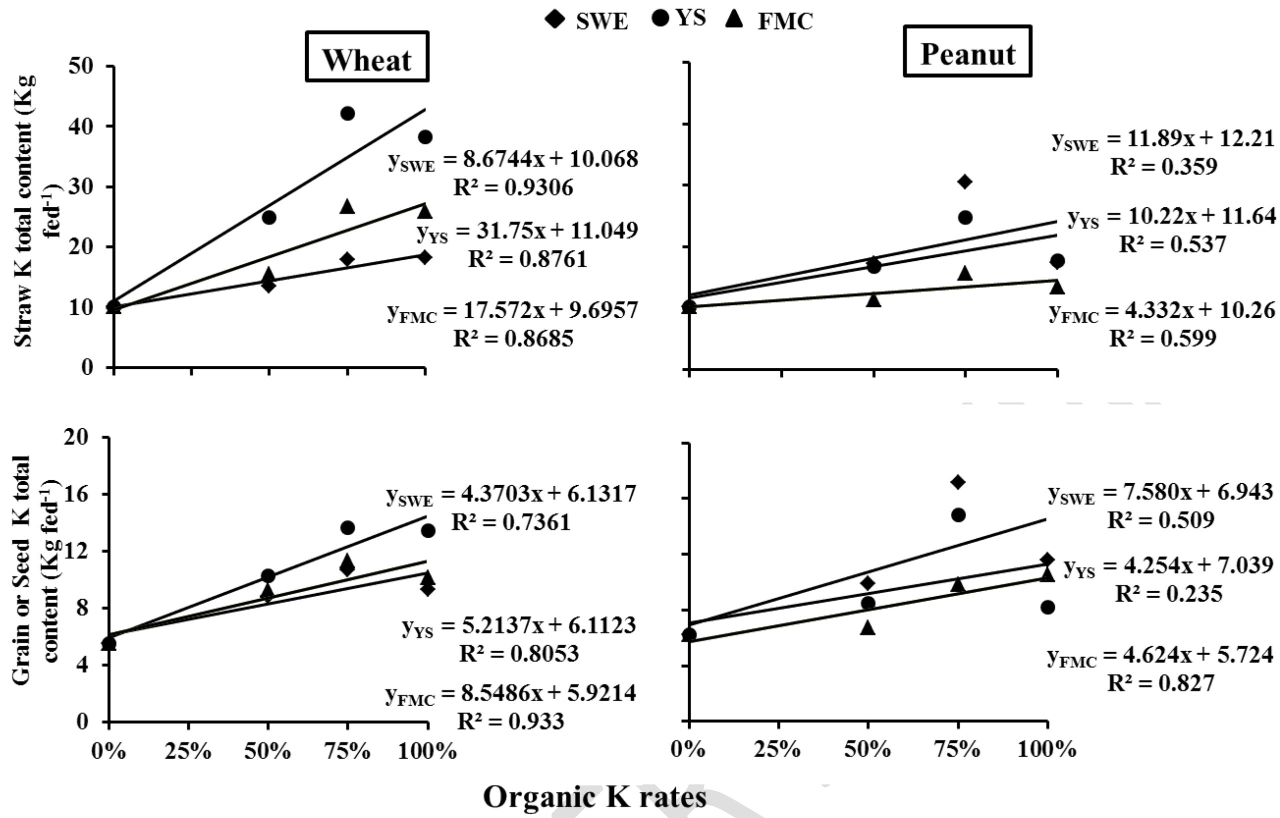
Table 4. Effect of interaction between various potassium rates and different organic sources on the K and P total content of straw, grain, or seeds for wheat and peanuts under sandy soil.

K Rates	Organic sources	Wheat				Peanut			
		P content ($Kg\ fed^{-1}$)		K content ($Kg\ fed^{-1}$)		P content ($Kg\ fed^{-1}$)		K content ($Kg\ fed^{-1}$)	
		Straw	Grain	Straw	Grain	Straw	Seed	Straw	Seed
Control		5.56	5.93	10.2	5.6	10.82	2.24	10.25	6.23
50 %	SWE	13.67	14.6	13.5	8.8	11.0	5.19	17.36	9.91
	YS	30.02	17.8	25.0	10.3	10.2	4.21	16.79	8.48
	FMC	19.94	16.1	15.6	9.2	9.0	3.57	11.39	6.71
75 %	SWE	18.72	13.6	17.9	10.7	14.0	9.9	30.57	17.13
	YS	46.71	24.5	42.2	13.6	12.3	7.86	24.81	14.84
	FMC	35.99	15.8	26.7	11.3	9.9	4.83	15.66	9.82
100 %	SWE	18.89	15.0	18.2	9.3	12.3	5.78	17.43	11.56
	YS	37.87	20.1	38.3	13.5	10.3	4.65	17.73	8.18
	FMC	25.43	16.6	25.9	10.1	9.5	5.68	13.51	10.54
LSD at 0.05%		7.746	6.315	10.49	1.278	3.66	1.98	4.71	4.015

SWE Seaweed YS Yeast sludge FMC Filter mud

Correlation analyses between organic K rates and K contents in straw and grain or seed for wheat and peanut

The correlation studies between organic K rates and K total content in wheat and peanut straw, grain or seed, respectively are displayed in Fig. 4. The findings clarify that there was a good correlation between the K contents in wheat straw and grain and organic K rates with an R^2 ranging from 0.736 to 0.933. It suggests that wheat grain and straw have noticeably greater K levels. Plants that get organic K treatments are able to absorb more K. Furthermore, the R^2 values for wheat were greater than the R^2 values for peanuts, despite the fact that there was a marginally positive connection between the K contents in the grain and straw for peanuts and the organic K rates.

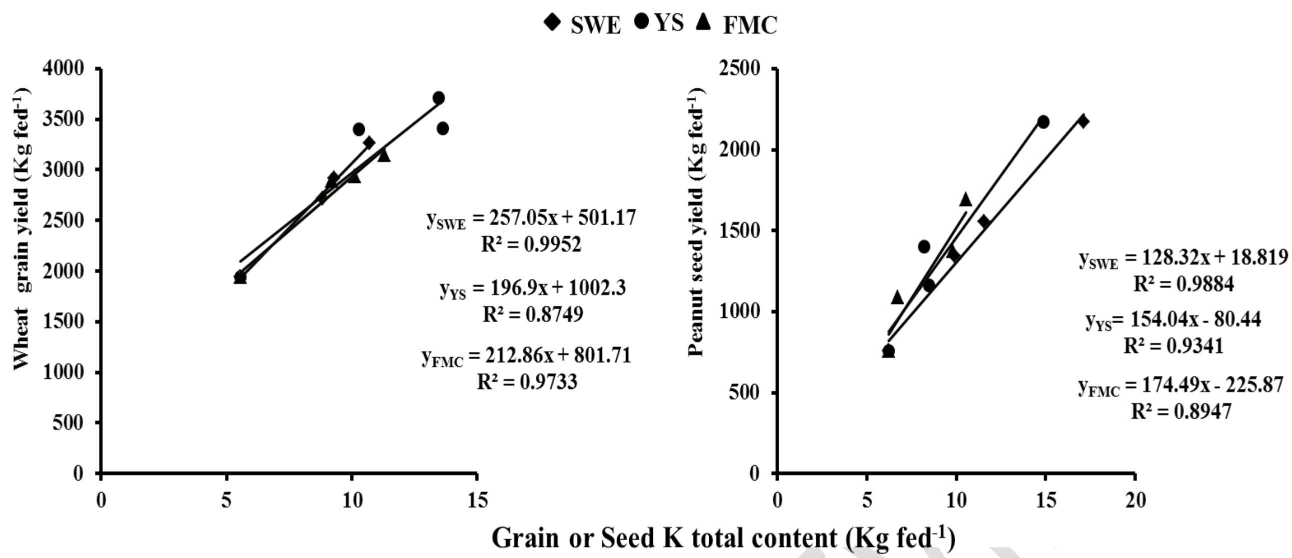


SWE Seaweed **YS** Yeast sludge **FMC** Filter mud

Fig. 4: Correlation analyses between organic K rates and K content in straw and grain or seed for wheat and peanut crop system.

Correlation analysis between K total content and yield (grain or seed) of the wheat-peanut crop system

The results in Fig. 5 showed a substantial positive connection between grain or seed K total content and grain or seed production in the wheat-peanut crop system. The strongest correlation was found in SWE treatments for both plants, R^2 = 0.995 for wheat and R^2 = 0.988 for peanuts. Furthermore, Fig. 5 demonstrated that the association between the two aforementioned factors was greater for wheat plant than peanut.



SWE Seaweed YS Yeast sludge FMC Filter mud

Fig. 5 Relationship between K total content of grain or seed and their yield of wheat or peanut crop

Chemical properties for experimental soil

Table 5 displayed data indicating several soil chemical characteristics that were altered by various potassium rates (50, 75, and 100% of the plant's required dosage) and sources (SWE, YS, and FMC) in sand soil. The results showed that, when compared to the control treatment, applying different K rates and sources enhanced soil attributes such as pH, EC, OM and CEC under sandy soil conditions following wheat and peanut harvesting. Furthermore, the data showed that applying varying rates of organic K had relatively small impacts on pH, EC, OM and CEC across both seasons. The maximum soil OM value (0.91% for wheat and peanut) was attained by applying 75% (from the required dose of plant) organic K sources. Additionally, findings indicate that using various sources of organic K did not significantly alter pH or EC. The results for organic matter show a trend that differs from those for pH and EC, with an increase in OM content following the administration of various sources of organic K. For both of the examined plants, SWE was the best organic K source. The highest OM values were 1.1% for peanuts and 0.92% for wheat. **Zein El-Abdeen's (2018)** study results show that applying different organic amendments (yeast waste, seaweed extract, or filter mud) enhanced soil organic matter content and some macronutrient availability after harvesting wheat and peanut plants. This increase could be attributed to the presence of carboxylate groups, which have a direct effect on nutrients released into the soil (**Abubakar *et al.*, 2022 and Ali et al., 2021**) and a variety of organic acids are produced during organic residue decomposition **(Dotaniya and Meena, 2015),** which mobilize nutrients from fixed sites and make them easily available to plants **(Dotaniya *et al.*, 2013).** According to **De Sosa *et al*. (2023),** adding composted materials with the greatest ratio of seaweed to the control marginally raised pH values. This is likely because the raw material, which was rich in Na and came from a marine source, was assimilated in a larger amount. Furthermore, these increases were demonstrated by **Kumar and Chopra (2016),** who concluded that the higher EC values of the filter-mud-treated soil might be due to the presence of more cations and anions in the soil suspension as well as the soil's higher pH. It was also shown that there was a positive correlation between the different filter mud treatments and the values of the soil's EC, OC, certain cations and anions. These soil parameters increased steadily as a result of the filter mud treatments. According to **Paul *et al.* (2005),** adding filter mud to an area raised its pH, EC, and total organic carbon (TOC). Given that yeast sludge and seaweed are alkaline, the same reaction may be taking place with both. According to **El-Kamar (2020),** yeast includes amino acids like glycine and glutamine, which may be the reason for the waste's health benefits. The polar amino acids release protons and retain a negative charge when the pH of the soil is higher than that of the amino acids. This draws Ca_2^+ ions from calcium carbonate and raises the calcium ion concentration in the soil clay, replacing Na^+ **(Raspor and Zupan, 2006).**

Gadd (1993) pointed out that yeast interaction with cations in soil, effect on their chemical and physical properties. The organic acid release from the biochemical activity of yeast can affect cations speciation and mobility in the soil. Organic acid provides both sources of protons for solubilizing and metal chelating anion to complex the metal cations **(Devever *et al*., 1996)**. They have the double function: (1) to acidify the substrate thus enhancing ion solubility, (2) to form complexes with solubilized ions which lead to ion mobilization **(Gadd, 1999)**. These data confirmed with the data obtained by **Nasser *et al.* (2016), and Xi *et al.* (2019)**. Surface charge on yeast cell and carboxylate and phenolate group gives yeast waste and humic acid, the ability to form complex with nutrients prevent them from leaching through profile **(Piccolo, 2002).**

Furthermore, results in Table 5 represent that the interaction between different rate of organic K and different organic K sources had a little effect on pH, EC, and OM of soil for two seasons. In addition, the application of 100% recommended dose of K from SWE organic source was highest value of OM of wheat as compared to other dose. The highest value of OM content was 0.97 % while the lowest value of pH and EC were 7.2 and 0.12, respectively. Similar trend was observed for peanut which received to 75% recommended dose of K from SWE organic source which increased soil OM content by 1.01 %.

Jamil *et al*., (2011) revealed that extremely important changes in soil characteristics as a result of press mud application. It resulted in improving the organic matter content of soil, which increased macro and micronutrient contents of the soil. **Bokhtiar and Sakurai (2005); Nehra and Hooda (2002)** also reported similar trends during their experiments. They found that press mud application increased organic matter content in soil, improved soil physical conditions, reduced soil bulk density and increased porosity These are extremely important changes because reduction in bulk density helps in better roots development and proliferation. On the other hand, increased porosity helps in better soil aeration and water retention **(Kumar *et al*., 1985)**.

Table 5. Some chemical properties of sand soil after wheat and peanut harvested.

K Rates	Organic sources	Wheat							Peanut						
		pH	EC (dSm^{-1})	OM %	CEC meq /100g soil	P mg Kg^{-1}	Ava. K*	Sol. K**	pH	EC (dSm^{-1})	OM %	CEC meq /100g soil	P (mg Kg^{-1})	Avail. K*	Sol. K**
Control		6.76	0.116	0.80	3.70	3.7	99	25.4	7.20	0.177	0.78	6.70	6.7	33.0	106
50 %	**SWE**	7.38	0.113	0.81	7.10	71.5	118	29.3	7.87	0.122	1.14	8.60	46.0	142	24.3
	YS	7.39	0.120	0.78	6.40	70.3	114	29.3	7.87	0.18	0.80	7.00	44.0	129	23.4
	FMC	7.38	0.126	0.73	4.20	67.0	105	27.3	7.22	0.203	0.68	5.40	36.0	109	23.4
Mean		**7.38**	**0.120**	**0.77**	**5.90**	**5.90**	**113**	**28.6**	**7.65**	**0.17**	**0.87**	**7.00**	**7.00**	**42.0**	**127**
75 %	**SWE**	7.31	0.111	0.96	8.60	77.7	133	33.2	7.81	0.166	1.03	6.60	73.0	145	25.4
	YS	7.30	0.121	0.92	7.00	72.8	130	33.2	7.79	0.184	0.88	6.40	72.0	136	23.4
	FMC	7.19	0.138	0.84	5.40	66.0	113	31.2	7.41	0.202	0.81	5.50	59.0	126	22.0
Mean		**7.27**	**0.123**	**0.91**	**7.00**	**7.00**	**125**	**32.5**	**7.67**	**0.18**	**0.91**	**6.20**	**6.20**	**68.0**	**136**
100 %	**SWE**	7.27	0.108	0.97	6.20	97.5	137	33.2	7.58	0.204	0.87	8.60	62.0	125	23.4
	YS	7.25	0.124	0.74	6.10	84.2	120	31.2	7.33	0.432	0.81	7.90	55.0	106	21.5
	FMC	7.25	0.138	0.61	6.10	78.8	111	27.3	7.21	0.544	0.76	6.60	38.0	103	21.0
Mean		**7.25**	**0.123**	**0.78**	**6.1011**	**6.10**	**122**	**30.6**	**7.37**	**0.39**	**0.81**	**7.70**	**7.70**	**51.7**	**111**
Mean	**SWE**	7.32	0.111	0.92	7.30	82.2	129	31.9	7.75	0.164	1.01	8.00	60.3	137	26.0
	YS	7.31	0.122	0.81	6.50	75.8	121	31.2	7.66	0.265	0.83	7.10	57.0	124	22.8
	FMC	7.27	0.134	0.73	5.20	70.6	110	28.6	7.28	0.316	0.75	5.90	44.3	113	22.1
LSD at 5%		0.13	0.0173	0.09	0.250	18.16	23.88	1.08	0.22	ns	ns	0.094	3.375	4.99	1.52

*Available potassium (mg Kg^{-1}) **Soluble potassium (mg Kg^{-1}) **SWE** Seaweed **YS** Yeast sludge **FMC** Filter mud

Available P, K and soluble K

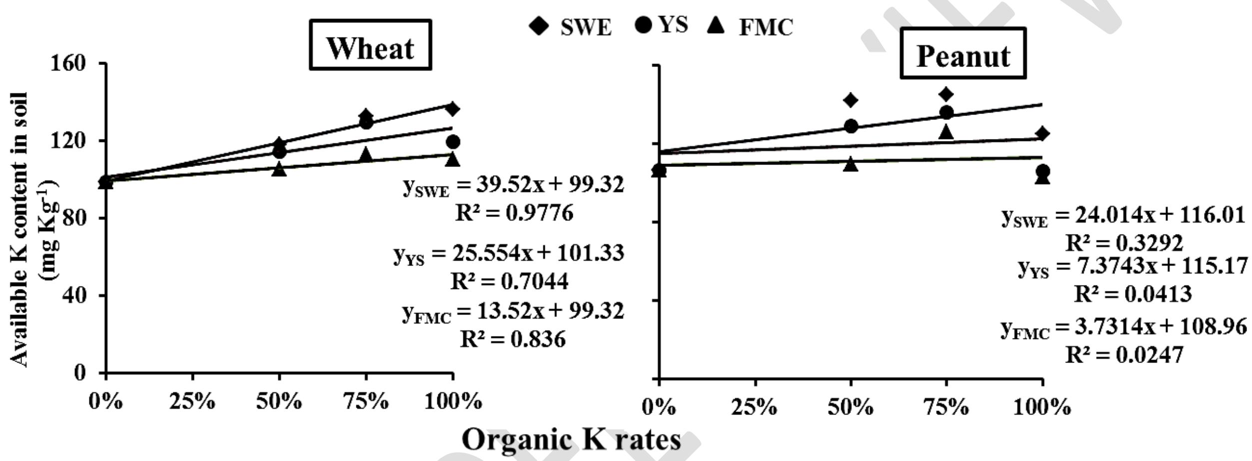
The results of a study examining the impact of varying organic K rates (50, 75, and 100% of the recommended plant dosage) and/or its organic sources (SWE, YS and FMC) on the availability of P, K and soluble K are shown in Table 5. The results indicated that applying various organic K concentrations and/or K organic sources to wheat and peanut plants enhanced their availability of P, K and soluble K in comparison to the control treatment. According to **El-Tayeh *et al.* (2019),** greater microbial activity was noted as a result of the soil's improved filter mud amendment, which also boosted root dispersion and nutrient availability and absorption. Additionally, **Aboyeji *et al.* (2019)** found that applying K fertilizer considerably raised the concentrations of N, P and K in the soil when compared to the control.

Furthermore, the findings in Table 5 demonstrated that the suggested dose of 75% K resulted in enhanced soil availability of P, K and soluble K, independent of the organic K source. Furthermore, regardless of K concentration, the SWE K organic source application outperformed both examined plants in terms of the aforesaid characteristics. Furthermore, the interference between different concentrations of organic K and different organic K sources had a significant effect on the soil availability of P, K and soluble K for two seasons, and the highest treatment was the application of a 100% K recommended dose of SWE as a K organic source for wheat, while it was a 75% K recommended dose of SWE as a K organic source for peanut. The use of organic K sources (press mud) may have improved soil structure, which in turn has improved microbial activity in the wheat rhizosphere **(Moharam, 1999),** hence enhancing crop nutrition. This might account for some of the evidence observed. For crop yield to increase and remain stable, the aforementioned changes in soil conditions are crucial. In addition, the addition of K enhanced the availability of phosphate and nitrogen **(Sahai, 2004).**

.

Correlation analysis between applied organic K (rates and forms) and available K in soil

Fig. 6 represents the relationship between applied organic K (rates and forms) and available K in the soil after both wheat and peanut crops were harvested. Results indicated a significant positive correlation (R^2 = 0.98, 0.70, and 0.84 for SWE, YS, and FMC respectively) between organic K rates and sources with available K in soil after wheat harvest. For the peanut crop, a comparatively different pattern was noted; there was no significant correlation found between the organic K rates and forms and the available K in the soil.



SWE Seaweed **YS** Yeast sludge **FMC** Filter mud

Fig. 6. Correlation analysis between organic K (rates and forms) and available K in soil after the wheat-peanut crop system is harvested.

Conclusion

One way to encourage sustainable agriculture and increase net profitability for farmers is to gradually replace expensive chemical fertilizers with locally produced organic byproducts. Since waste products include organic carbon and macronutrients, they may also be used to substitute mineral fertilizers in a cost- and environmentally-friendly manner. Based on the aforementioned findings, it can be deduced that, in comparison to the control treatment, the application of diverse organic K rates and sources (seaweed extract, yeast sludge, and filter mud) enhanced the growth parameters of the wheat crop (biological, straw, and grain yield) and the peanut crop (biological, straw, pods, and seed yield). In sandy soil conditions, a comparable pattern was noted for the overall K and P content of wheat and peanuts. Also, the application of organic compounds from various rates and sources as potassium fertilizers enhanced soil chemical properties (pH, EC, OM, and CEC), and soil fertility (P and K availability and K solubility). The greatest organic sources of K were YS for wheat and SWE for peanuts, respectively. The largest increases came from 75% of the recommended K dose. Finally, in order to achieve plant safety, lower environmental pollution, and high production for peanuts and wheat, chemical K fertilization should be replaced. Additionally, there is a growing tendency in agriculture to use organic fertilizers due to the high cost of mineral fertilizers and the rising trends in their costs, particularly in the country's arid and semi-arid regions. Consequently, it might be cost-effective and sustainable to apply them to agricultural soils.

REFERENCES

Aboyeji C. M., A. O. Adekiya, O. Dunsin, O. T. V. Adebiyi, C. O. Aremu, T. A. J. Olofintoye, B. O. Ajiboye and I. O. Owolabi. Response of Soil Chemical Properties, Performance and Quality of Sweet Potato (*Ipomoea Batatas* L.) to Different Levels of K Fertilizer on a Tropical Alfisol. The Open Agric. J., 2019, 13, 58-66. DOI: 10.2174/1874331501913010058.

Abubakar A. Y., M. M. Ibrahim, C. Zhang, M. Tayyab, N. Fallah, Z. Yang, Z. Pang and H. Zhang . Filtered mud improves sugarcane growth and modifies the functional abundance and structure of soil microbial populations. Peer J 2022; 10:e12753**.**

Akrawi, H. S. Y. Effect of organic and inorganic fertilizer on availability of potassium in soil and yield of chickpea (*cicer arietinum l.*). Iraqi J. of Agri. Sci., 2018; 49(2): 295- 301.

Ali A. M., · S. A. Hegab · A. M. Abd El Gawad · M. Awad. Integrated effect of filter mud cake combined with chemical and biofertilizers to enhance potato growth and its yield. J. of Soil Sci. and Plant Nutr. 2021.V (22), 10.1007/s42729-021-00661-3

Ali, O.; A. Ramsubhag and J. Jayaraman. Biostimulant properties of seaweed extracts in plants: implications towards sustainable crop production. Plants, 2021; 10: 531.

Bokhtiar M. and K. Sakurai Integrated use of organic manure and chemical fertilizer on growth, yield, and quality of sugarcane in high ganges river floodplain soils of Bangladesh. Communications in Soil Science and Plant Analysis, 2005; 36:13-14.

Boldrin, P. F.; H. F. Souto; L. S. Salles and A. E. Furtini. Alternative sources of potassium for maize cultivation**.** Ciência e Agrotecnologia, 2019; 43: e023619

Brhane H., Mamo T., Teka K. Potassium fertilization and its level on wheat (*triticum aestivum*) yield in shallow depth soils of Northern Ethiopia. J. Fertil. Pestic., 2017; 8: 182.

Chen D., W. Zhou, J. Yang, J. Ao, Y. Huang, D. Shen, Y. Jiang, Z. Huang and H. Shen. Effects of seaweed extracts on the growth, physiological activity, cane yield and sucrose content of sugarcane in china. Front. Plant Sci. 12: 659130.doi: 10.3389/fpls.2021.659130

Cottenie A, M.; L.Verloo; Kiekens, G.Velgh; and R.Camerlynch. Chemical analysis of plants and soils. Lab. Anal. Agrochem, State Univ Ghent, Belgium 1982; 63.

De Sosa, L. L. ; M. Carmen; Navarro-Fernández ; M. Panettieri; P. Madejón; A. Pérez-de-Mora and E. Madejón. Application of seaweed and pruning residue as organic fertilizer to increase soil fertility and vine productivity. Soil Use Manage., 2023; 00:1-11.

Devevre O., Garbaye J., Botton B. Release of complexing organic acids by rhizosphere fungi as a factor in Norway Spruce yellowing in acidic soils. Mycol. Res., 1996; 100:1367-1374.

Dotaniya, M. L. and V. D. Meena. Rhizosphere effect on nutrient availability in soil and its uptake by plants-a review. Proc. Natl. Acad. Sci., India, Sect. B. Biol. Sci., 2015; 85(1):1-12.

Dotaniya, M. L.; S. C. Datta; D. R. Biswas and B. P. Meena. Effect of solution phosphorus concentration on the exudation of oxalate ions by wheat (Triticum aestivum L.). Proc. Natl. Acad. Sci., India, Sect. B Biol. Sci., 2013; 83(3): 305-309.

Eisa, E. A. Effect of some different sourses of organic fertilizers and seaweed extract on growth and essential oil of sweet fennel (foeniculumvulgare mill.) Plants. J. Plant Production, Mansoura Univ., 2016;7: 575- 584.

El-Gamal B. A.; Hanan M. Abu El-Fotoh and Mervat A. Hamed. Impact of organic and bio-fertilizers on soil health and production of quinoa and soybean. Middle East Journal of Agriculture Research., 2020; 09(04): 828-847.

El-Kamar, A. Faten. Effect of humic acid and yeast waste application on fababean (vicia faba) yield, yield components and some soil properties of salt affected soil. J. of Soil Sciences and Agricultural Engineering, Mansoura Univ., 2020; 11 (9):483- 488.

El-Tayeh A. Noha; Fawzy M. Salama; Naglaa Loutfy and Mona F. Abou Alhamd. Effect of sandy soil amendment with filter mud cake on growth and some ecophysiological parameters of daucus carota and beta vulgaris plants. Catrina: The International Journal of Environmental Sciences, 2019;18 (1): 97-103.

Esmail, H. M. S. Single cell protein in poultry nutrition. Poult. Int., 1999; 38: 12-16.

Essa R. E.; El-Ashry M. Soad; Gobarah E. Mirvat and Reda M. Marwa. Impact of sugarcane press mud application on the productivity of some legumes under salt water irrigation. Egypt. J. Chem. 2022; V. 65, No. 7, pp. 131 -138

Fantaye, A., Abebe Fanta and Assefa M. Melesse. Effect of filter press mud application on nutrient availability in aquert and fluvent soils of wonji/shoa sugarcane plantation of Ethiopia, Landscape Dynamics, Soils and Hydrological Processes in Varied Climates, pp. 2016; 549-563.

Freed, R.S.P., S. Eisensmith, D. Goetz, V. Reicosky, W. Smail and P. Wolberg. User's Guide to MSTAT-C: A Software program for the design, management and analysis of agronomic research experiments michigan state university, East Lansing, ML, USA. Frontiers in Plant Science, 1989;5: 376.

Gadd G. M. Fungal production of citric and oxalic acid: importance in metal speciation, physiology and biogeochemical processes. Adv Microb Physiol., 1999; 41: 47-92.

Gadd, G. M. Interaction of fungi with toxic metals. New Phytol, 1993; 124:25-60.

Hadad H.M., El-Desoky M.A., Basha A.A.A., Usman A.R.A. Nitrogen,P and K in soils amended with organic wastes and their uptake by corn and wheat plants. Assiut J Agric Sci 2015; 46:193–209

Haider, I.; J. I. Sultan; A. Javaid and M. Yaqoob . Impact of replacing canola meal with distillery yeast sludge on growth perfomance, haematology, histopathology and growth performance of broilers. Poult. Sci., 2010; 90: 1-7.

Hong, D. D.; Hien, H. M. and Son, P. N. Seaweeds from Vietnam used for functional food, medicine and biofertilizer. J. Appl. Phycol., 2007; 19:817-826.

https://doi.org/10.1007/s42729-021-00661-3

Jamil, K., Bakhtiar, M., Khan, A.R., Rubina, F., Rehana, R., Wajid, R., Qaisar, M., Khan, A.F., Khan, A.K., Danish, M., Awais, M., Bhatti, Z.A., Rizwan, M. Naveed, A., Hussani, M. and Pervez, A.. Synthesis, characterization and antimicrobial activities of novel organotin compounds. African Journal of Pure and Applied Chemistry, 2011; 3: 66-71.

Khan M. U., **M. A. Shariati , Y. Kadmi, H. Elmsellemh, M. Majeedi, M. R. Khan, M. Fazel and S. Rashidzadeh.** Design, development and performance evaluation of distillery yeast sludge dryer. Process Safety and Environmental Protection 2017; 1 1 1 , 733–739

Kubar G. M., K. H. Talpur , M. N. Kandhro , S. Khashkhali , M. M. Nizamani , M. S. Kubar, K. A. Kubar and A. A. Kubar . Effect of potassium (K^+) on growth, yield components and macronutrient accumulation in Wheat crop. Pure Appl. Biol., 2019; 8(1): 248-255.

Kumar, S., Malik, R.S. and Dahia, I.S. ‘Influence of different organic wastes upon water retention, transmission and contact characteristics of a sandy soil’, *Australian Journal of Soil Research*, 1985; V. 23, pp.131–136.

Kumar V. and A. K. Chopra. Effects of sugarcane press mud on agronomical characteristics of hybrid cultivar of eggplant (*Solanum melongena* L.) under field conditions. Int J Recycl Org Waste Agricult., 2016; 5:149-162.

Marzauk, N. M., Shafeek, M. R., Helmy, Y. I. Ahmed A. A. and Magda, Shalaby A. F. Effect of vitamin E and yeast extract foliar application on growth, pod yield and both green pod and seed yield of broad bean (*Vicia faba* L.). Middle East Journal of Appl. Sci., 2014; 4(1): 61-67.

Moharram, T.M.M.; M.S.A. Effect of soil ammments with composted filter mud and inoculation with aztobacter spp. On the yield of wheat plants in newly reclaimed soils‘, Annals of Agric. Sci., 1999; V (44), pp. 15-26

Nasser, R. H., Shanan, N. T. and Reda, F. M. (2016). Active yeast extract counteracts the harmful effect of saline soil stress on the growth of leucaena plant. Sci. Hortic., 201:61-67.

Nehra, A. S. and I. S. Hooda (2002). Influence of integrated use of organic manures and inorganic fertilizers on lentil and mung bean yields and soil properties. J. Res. Crops. 3(1): 11-16.

Ngoroyemoto, N.; Manoj G. Kulkarni ; Wendy A. Stirk ; S. Gupta , Jeffrey F. Finnie, and Johannes van Staden . Interactions between microorganisms and a seaweed-derived biostimulant on the growth and biochemical composition of *Amaranthus hybridus* L. Natural Product Communications, 2020; 15(7): 1-11.

Page, A. L.; R. H. Miller and D. R. Keeny. Methods of soil analysis part 2 chemical and microbiological properties. 2nd Ed. ASS. A-Midison Wise, USA. 1982**.**

Paul, G. C.; S. M. Bokhtiar; H. Rehman; R. C. Kabiraj and A. B. M. M. Rahman. Efficacies of some organic fertilizers on sustainable sugarcane production in old Himalayan piedmont plain soil of Bangladesh. Pak Sug J., 2005; 20(1): 2- 5.

Piccolo, A. The supramolecular structure of humic substances: a novel understanding of húmus chemistry and implications in soil science. Advances in Agronomy, 2002; 75: 57-134.

Raghunandan B. L., R. V. Vyas, H. K. Patel, and Y. K. Jhala. Perspectives of Seaweed as Organic Fertilizer in Agriculture. Springer nature chapter. 2022; 267-290. DOI: 10.1007/978-981-13-5904-0_13

Raspor, P. and Zupan, J. Yeast in extreme environments. Yeast Handbook, Biodiversity and Ecophysiology of yeast. Springer-Verlag, Berlin, 2006; 371-417.

Rathore S. S.; D.R. Chaudhary; G. N. Boricha; A. Ghosh; B.P. Bhatt ; S.T. Zodapeand J.S. Patolia. Effect of seaweed extract on the growth, yield and nutrient uptake of soybean (Glycine max) under rainfed conditions. South African Journal of Botany., 2009**;** 75: 351- 355.

Sharif M., M. Shoaib, M. Aziz Ur Rahman, F. Ahmad and S. U. Rehman. Effect of distillery yeast sludge on growth performance, nutrient digestibility and slaughter parameters in Japanese quails. Scientific Reports**,** 2018; 8:8418 | DOI:10.1038/s41598-018-26741-6

Sahai V.N. (). Mineral Nutrients. In Fundamentals of Soil. 3rd Edition. Kalyani Publishers, New Dehli, India**.** 2004**;** pp:151-155.

Singh, Shikha. Efficacy of seaweed (*Kappaphycusalvarezii*) sap on growth and productivity of wheat (*Triticum aestivum*). Ph.D.Thesis, Birsa Agricultura University, Kanke, Ranchi(JH). 2016;

Vyomendra, C. and N. Kumar. Effect of algal biofertilizer on the Vignaradiata: A critical review. Int. J. Eng. Res. Appl., 2016; 6: 85-94.

Wu J., H. Chen, L. Wang, G. Geng, G. Fan, L. Yu, and Y. Wang. Effects of filter mud applications on growth, physiological characteristics, and nutrient transfer pattern of sugar beet seedlings, Chilean J of Agri. Research. 2022; P. 217-227. doi: 10.4067/S0718-58392023000200217

Xi Q., Lai W., Cui Y., Wu H., Zhao T. Effect of Yeast Extract on Seedling Growth Promotion and Soil Improvement in Afforestation in a Semiarid Chestnut Soil Area. *Forests*., **2019**; 10(1):76.

Yousef, S. H., Korditan, Y. H. and Sana, S. H. Effect of bread yeast and humic acid on growth and yield traits of broad bean (Visia faba L.). J. of Univ. of Duhok, 2019**;** 22 (11): 98-106.

Zein El-Abdeen A. Hanaa. Interference between organic soil conditioners mixed with synthetic soil conditioners to improve sandy soil productivity. J. Soil Sci. and Agric. Eng., Mansoura Univ., 2018; 9 (12): 723 - 734.