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Beneficial Bacteria and Organic fertilizer enhance Some Yield attributes and Some Nutrients in the Yielded Grains of Wheat (Triticum aestivum L.) Grown in Sandy Saline Soil.

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ABSTRACT **: This study aimed to appraise the impact of replacing part of the recommended dose of mineral fertilizers (NPK) for wheat (Giza171) with bio and organic fertilizers on some growth parameters, avaliable (NPK) in the yield grains, and phytochemicals (chlorophyll a, b, and carotenoids)at vegetative stage.A pot experiment was done in sandy saline soil during the winter season of 2020/2021 at the agricultural station of Kafr EL- Hamam, Al-Sharkia Governorate, Egypt, the farm is located at 30.59 longitudes and 30.41 latitudes. The experiment comprised fourteen treatments, including minerals, compost or biofertilizers alone, or a mixture of three factors of fertilizers in triplicates placed in a randomized block design. The results revealed that the determined yield attributes of wheat were significantly increased by receiving 90% of the recommended dose (RD) with compost and the inoculation with salinity durable bacteria (T13). A similar trend was observed by the recommended dose of NPK(T2) followed by 75% mineral fertilizers combined with compost, and a mixture of bacteria strains(T12), then 60% mineral fertilizers plus compost and a mixture of bacteria strains(T11).**

KEYWORDS**: salinity durable bacteria, wheat (Triticum aestivum L.,), mineral fertilizers and compost.**

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I. INTRODUCTION

Salt stress in soil is one of the main hazards especially in arid and semi-arid regions which cause severely decrease the plant growth and productivity (Koca et al. 2007). Abdel Latef, (2010) observed that highly physiological and biochemical changes of plants are caused by salinity, which lead to lower in water potential in the soil solution, specific ion effects, and a higher accumulation of reactive oxygen species (ROS). Furthermore, it is expected that 50% of the agricultural area will be salinized by 2050.

Using number of beneficial rhizosphere bacteria increase the ability of salinity tolerance. As the plant growth promoting bacteria can reduce salinity stress by enhancement plant growth by different mechanisms like nitrogen fixation, indole acetic acid (IAA) production, 1-aminocyclopropane-1-carboxylate (ACC) deaminase production (Bhattacharyya and Jha ,2012 ; Shameer and Prasad,2018). Furthermore, biofertilizers are known as microbial inoculants can improve the fertility of soil and crop quality. Biofertilizers increase nutrients through nitrogen fixation, solubilizing phosphorus, solubilizing potassium and motivate the plant growth through produce of growth-promoting substances. There use might also reduce the use of chemical fertilizers (Gupta et al., 2015). On the other hand, some of PGPR belong to genera Azospirillum, Azotobacter, Bacillus, Erwinia, Enterobacter, etc., can enhance tolerance of salt in several crops (Bharti and Barnawal, 2019).Composting is a bio-chemical method in which microorganisms such as bacteria and fungi have the ability to convert organic matter (OM) and raw materials of agricultural wastes into a soil-like product called compost (Rynk, 1992). Compost is vital for improving the physical, chemical properties and increase the soil organic matter status. Addition compost to salt-affected soil helps flocculation of clay minerals, which is an essential condition for the aggregation of soil particles, increasing pores spaces which increase soil air circulation required for growth of plants and microorganisms, (Rasool et al., 2007). The soil pH, EC reduction and increases of NPK available in soil as affected by compost application (Seddik et al., 2016). Sharma and Srivastava (2019) demonstrated that compost have the ability to reduce soil salinity and could be highly potent alternative to mineral fertilizer and increase the growth of wheat plant.

Inorganic fertilizers can rise productivity of soil but cause harm to structure of soil, besides its costly. The badly effect of chemical fertilizer is not appear on soil immediately. Over time the natural balance of the soil elements and pH become unstable, and the accumulation of toxic chemicals leads to toxication of the food chain and poses human and environmental hazards. The harmful effect of the inorganic fertilizers use can be averted by changing them with bio and organic fertilizers (Setiawan et al., 2018). Glick (2012) recoded that PGPB strains include nitrogen fixing bacteria Azotobacter chroococcum, potassium solubilizing bacteria bacillus circulans and phosphate solubilizing bacteria bacillus megaterium inoculated crops were used to replace at least a part of the chemical nitrogen, phosphorus and potassium that are presently used.

Wheat genotypes is a good example of salt tolerant plants as it accumulates less Na+ than salt sensitive, which sustains the ionic balance in plant tissues (Tahir et al., 2006). Although, wheat (Triticum aestivum L.) is used as a main food grain for human. Its production is not enough to meet the needs of the consumer, which led to increase the need of import from abroad to keep up the food gap and thus, led to the formation of over load on the balance of payments and the exposure of food security of Egypt to many dangers. Therefore, increasing the productivity of wheat is one of the main targets of the Egyptian agricultural policy. This can be achieved through the use of best agricultural systems. So, the aim of this work to evaluate the efficiency of (salinity durable bacteria), compost with minimize the mineral fertilizers (NPK) on some growth yield, NPK contents and chlorophyl content of wheat plant grown in sandy soil..

II. MATERIALS AND METHODS

A pot experiment was carried out under natural conditions at agricultural station of Kaffr EL- Hamam, Al-Sharkia, Governorate, Egypt. The farm is located at 30.59 longitude, 30.41 latitude. This experiment was carried out to study the efficiency of compost and bacterial strains (salinity durable bacteria) with or without mineral fertilizers on wheat grains, straw and biological yield and macro-nutrient contents of wheat (Triticum aestivum L.) cv Giza 171.

Plastic pots were filled with 15 kg soil was collected from Belbeis county,Sharkia Governorate, Egypt, which described as a sandy saline soil, air dried, and ground to pass through a 2 mm sieve and subjected to routine analysis tabulated in Table 1a & b.

Table (1a): Soil size distribution and available NPK as well as calcium carbonate, field capacity and welting point of soil under study

Parameters	C. Sand	F. Sand	Silt	Clay	Soil texture	N	P	k	Calcium carbonate	Field capacity	Welting point
	%					mg/kg			%		
Values	39.2	42.6	13.9	4.3	Loamy sand	28.6	4.35	113.1	4.3	21.3	7.1

Table (1b): pH, EC and OM as well as some cations and anions of soil under study

Parameters	pH 1:2.5	EC (dS/m) Soil-paste	OM	Soluble Cations (meq l-1)				Soluble Anions (meq l-1)			
				Ca+2	Mg+2	Na+	K+	CO-2	HCO-3	Cl-	SO-24
Values	7.79	4.9	1.40	17.20	8.90	22.50	0.35	0.00	8.50	23.50	16.95

Compost as (organic fertilizer): applied as 3 ton/fed on sandy soils. it was added at rate of 135g/15kg soil.

Table 2: Some characteristics of the compost used in this study

Season	pH (1:10)	EC (1:10) dS m-1	Bulk density (g cm-3)	Total N (%)	Total P (%)	Total K (%)	Organic matter (%)
2019/2020	7.15	1.69	0.68	1.64	0.54	1.21	18.89

The mineral fertilizers were added at four dosages (100, 90, 75 and 60%) of the recommended mineral fertilizers (NPK) as follows: (217: 200: 100), (195.3: 180: 90), (162.7: 150: 75) and (130.2: 120:60) kg fed-1, respectively. Application time of superphosphate, potassium sulfate, and compost (see Table 2) were mixed with soil before planting. Nitrogen was applied as 4 doses and divided into1/4dosage at each irrigation in 15, 30, 45 and 60 days from planting. Nitrogen was added as a form of (urea 46% N), phosphorus was added as a (superphosphate 15.0% P2O5), and potassium was applied as a form (potassium sulfate 48% K2O).

Wheat grains were obtained from Wheat Department, Field Crops Research Institute (FCRI), Agricultural Research Center, Giza, Egypt. Healthy and homogenous size of wheat grains were coated by soaking them in a liquid culture media with hybrid strains (nitrogen-fixing bacteria, phosphorus, and potassium solubilizing bacteria) for 2 h, utilizing 10% gum Arabic as adhesive. A single inoculation seed harbored about (108 bacteria).

The experiment utilized a randomized complete block design with triplicates and fourteen treatments;

T1= Control (without any addition), T2= Recommended dose of NPK (RD)

T3= Organic fertilizer (compost) (135 g/15 kg soil), T4= A mixture of bacteria only, T5= 60% of RD and a mixture of bacteria, T6= 75% of RD and a mixture of bacteria, T7= 90% of RD and a mixture of bacteria, T8= 60% of RD with compost

T9= 75% of RD with compost, T10= 90% of RD with compost, T11= 60% of RD and a mixture of bacteria and compost, T12= 75% of RD and a mixture of bacteria and compost

T13= 90% of RD and a mixture of bacteria and compost, T14= A mixture of bacteria and compost.

Wheat grains were demonstrated at a rate of fifteen/pot at equal distances and depths. The grains were sowed on the 30th of November 2020 and harvested on the 6th of April 2021. All agricultural practices during the growing season were applied as the Ministry of Agriculture and Reclamation recommended.

The particle size distribution was determined per the international method (Piper, 1950). Soil pH and electrical conductivity were measured as recommended by Richards (1954). The available nitrogen was tested utilizing the micro Kjeldahl process, as reported by Jackson (1967), and organic matter was assessed utilizing the Walkley and Black method (Page et al., 1982). Calorimetric analysis was used to determine the amount of available phosphorus (Olsen and Dean, 1965). The amount of available potassium was assessed according to the procedure of Jackson (1967).

The weight of plants, grains, and straw g/pot was determined at yield stage, photosynthetic pigment content (chlorophyll a, b, and carotenoids) was determined at vegetative stage (45- days old) (Metzner et al., 1965). The samples of grains were oven dried at 70 °C until constant weight, then finely grounded in an electrical mill to analyze NPK (Cottenie et al., 1982). The modified Micro-Kjeldahl apparatus was utilized for overall N-determination, as shown by Jones Jr et al. (1991).

As Peters et al. (2003) described, the total phosphorus was estimated. Potassium was determined by flame photometry (Peters et al., 2003). The collected data were statistically examined using the analysis of variance approach by Snedecor and Cochran (1980). A multiple range test at a 0.5 level was used to contrast differences between the mean (Duncan, 1955).

III. RESULTS AND DISCUSSION

Mutual effect of mineral, compost and bio-fertilizers on grain, straw, and biological yield of wheat

Referring to the results in Table (3), there were significantly increases among all treatments compared with control treatment in grain, straw and biological weight but the highest significant values were occurred in the (addition of recommended dose of NPK) T2 which recorded (138.0, 145.9 and 283.8 g/pot) respectively. The second order of grains weight was obtained by the application of 90, 75% RD combined with compost and the mix of bacteria T13 and T12 were (133.3 and125.1 g/pot), respectively. On the other hand, the T12 (combination of 75% from recommended dose of mineral fertilizer (RD) with compost inoculated by mix of bacteria) gave the same trend of straw weight (143.8g/pot) with the treatment of T2 and followed by T11(129.9g/pot) the combination of 60%of RD with compost and mix of bacteria) . While the increase in the weight of biological yield followed by(268.9g/ pot) the treatment T12 (the combination of 75% RD with compost plus mix of bacteria), then T11 (247.4g/pot) the combination of 60% RD with compost and mix of bacteria. Conversely, the lowest values of grains, straw and biological weight (41.40, 67.97 and 109.4 g/pot) were noticed in control treatment T1 followed by (54.97, 86.03 and 137.0 g/pot) T4 (mix of bacterial strains only) then T3 (compost only) were (59.20, 87.10 and 146.3 g), respectively.

Table 3. Mutual effect of compost, bio and mineral fertilizer rates on grain, straw and biological yield of wheat plant

Treatments	plant w g/pot	Straw w g/pot	Grain w g/pot
T1=Control (without any addition)	109.4 K	67.97 I	41.40 J
T2=Recommendation dose of N,P,K (RD)	283.8 A	145.9 A	138.0 A
T3=Organic fertilizer(compost)(135g/15kg soil)	146.3 I	87.10 GH	59.20 GH
T4=Mix of bacteria only	137.0 J	84.93 H	52.07 I
T5=60% of RD plus mix of bacteria	141.0 J	86.03 GH	54.97 HI
T6=75% of RD plus mix of bacteria	146.0 I	88.57 G	57.40 H
T7=90% of RD plus mix of bacteria	155.6 H	92.07 F	63.57 G
T8=60% of RD with compost	182.6 G	97.40 E	85.20 F
T9=75% of RD with compost	188.5 F	100.4 D	88.13 EF
T10=90% of RD with compost	214.7 E	124.4 C	90.30 E
T11=60% of RD +mix of bacteria+ compost	247.4 C	129.9 B	117.6 D
T12=75% of RD +mix of bacteria+ compost	268.9 B	143.8 A	125.1 C
T13=90% of RD +mix of bacteria+ compost	233.6 D	100.3 DE	133.3 B
T14=mix of bacteria+ compost	186.3 FG	100.3 DE	85.97 EF
LSD at 0.05	4.685	2.907	4.545

Mutual effect of mineral, compost and bio-fertilizers on NPK in wheat grains

Generally, there were increases in nitrogen, phosphorus and potassium percentage of wheat grains in all treatments containing the combination of mineral and compost with bio fertilizers more than each fertilizer individually and/ or compared with control treatments.

Data presented in Table (4) clearly showed that the treatments of RD from mineral fertilizers (T2) gave the highest significant values of N % of wheat grain comparing to control treatment (T1). Similar trend was recorded by 90% of RD with compost and bacteria (T13) also, 75%of RD with compost plus biofertilizers (T12). Their relatively increase in nitrogen content in wheat grains in the treatment (T2), (T13) and (T12) compared with control (T1) which ranged by (52.6, 51.4 and 51.37 %), respectively. Moreover, the slightly significant increase noticed in the treatment of adding compost only (T3), their relatively increase in N% content compared with control treatment (T1) ranged by (25.5 %).

Table 4: Effect of mineral, compost and bio-fertilizers as well as their interactions on NPK % of wheat grains in sandy soil

Treatments	N % of grain	P % of grain	K % of grain
T1=Control (without any addition)	1.167 E	0.1433 L	0.2367 M
T2=Recommendation dose of N,P,K (RD)	2.4670 A	0.3733 A	0.5500 A
T3=Organic fertilizer(compost)(135g/15kg soil)	1.567 D	0.1733 K	0.3500 I
T4=Mix of bacteria only	1.333 E	0.1733 K	0.3067 L
T5=60% of RD plus mix of bacteria	1.633 CD	0.2067 J	0.3200 K
T6=75% of RD plus mix of bacteria	1.700 CD	0.2433 I	0.3333 J
T7=90% of RD plus mix of bacteria	1.800 C	0.2600 G	0.3533 H
T8=60% of RD with compost	2.233 B	0.2800 E	0.3700 G
T9=75% of RD with compost	2.200 B	0.2700 F	0.3967 D
T10=90% of RD with compost	2.333 AB	0.2867 D	0.4067 C
T11=60% of RD +mix of bacteria+ compost	2.233 B	0.2867 D	0.3700 G
T12=75% of RD +mix of bacteria+ compost	2.400 AB	0.3367 C	0.3800 E
T13=90% of RD +mix of bacteria+ compost	2.400 AB	0.3600 B	0.4533 B
T14=mix of bacteria+ compost	1.800 C	0.2467 H	0.3733 F
LSD at 0.05	0.2056	0.001678	0.001678

Phosphorus content in grains was significantly increased in the treatment of addition the recommended dose of NPK (T2) followed by the treatment of (90% RD with compost plus biofertilizers (salinity durable bacteria) T13, then T12 (75% RD + compost + mix of bacteria) and T11 (60% RD+ compost + biofertilizers) compared with control treatment (T1). Their relative increase ranged by (61.6, 60.2, 57.5 and 50%), respectively.

Furthermore, from results in the same Table, it was obvious that the highest significant value of potassium content of wheat grains was recorded with the recommended dose of mineral fertilizers (NPK) (T2) followed by the application of (90% RD + compost +mix of bacteria (T13) compared with the other treatments. Their relatively increasing ranged by (57.1 and 47.9%), respectively, compared with control (T1). The second order was observed by the application of 90% and 75%of RD combined with compost (T10) and (T9) respectively, their relative increase ranged by (41.8 and 40.40%), respectively compared with control (T1).

Mutual effect of mineral, compost and bio-fertilizers on Chlorophyll (a & b) as well as carotenoid concentrations (mg g-1 f.w.).

The changes in the concentrations of chlorophyll a, b and total carotenoid in the fresh samples of wheat leaves at the vegetative stage after 45 days from planting.

In Table (5) results revealed that the high significant values of chl a, b and carotenoid concentrations were obtained at T2 (RD of mineral fertilizers) were (5.493, 4.253 and 1.730 mg g-1 f.w.).

Table (5): Chlorophyll ″a″ and ″b″ (mg/g. f.w.) in wheat leaves and carotenoid concentrations in cultivated in sandy soil

Treatments	CHL, A	CHL,B	Cartenoid
T1=Control (without any addition)	0.6100 K	0.5367 I	0.3367 H
T2=Recommendation dose of N,P,K (RD)	5.493 A	4.253 A	1.730 A
T3=Organic fertilizer(compost)(135g/15kg soil)	0.9400 J	0.7500 H	0.4500 G
T4=Mix of bacteria only	0.9067 J	0.8633 H	0.4267 G
T5=60% of RD plus mix of bacteria	2.037 H	1.460 G	0.6733 F
T6=75% of RD plus mix of bacteria	2.600 G	1.473 G	0.6900 F
T7=90% of RD plus mix of bacteria	2.650 FG	1.813 F	0.7367 EF
T8=60% of RD with compost	2.687 FG	1.457 G	0.7300 EF
T9=75% of RD with compost	2.860 EF	1.543 G	0.7733 E
T10=90% of RD with compost	2.963 DE	1.937 E	0.9267 D
T11=60% of RD +mix of bacteria+ compost	3.117 D	2.067 D	1.290 C
T12=75% of RD +mix of bacteria+ compost	3.450 C	2.217 C	1.560 B
T13=90% of RD +mix of bacteria+ compost	4.707 B	3.830 B	1.737 A
T14=mix of bacteria+ compost	1.397 I	0.8133 H	0.7400 EF
LSD at 0.05	0.2374	0.1187	0.07506

Followed by the application of 90, 75 and 60 % RD with compost and inoculation of biofertilizers (T13),(T12) and (T11) were (4.707; 3.830 and 1.737 mg g-1 f.w.) (3.450, 2.217 and 1.560 mg g-1 f.w.) (3.117, 2.067 and 1.290 mg g-1 f.w.) , respectively. On the other hand, T1 recorded the lowest values in chl"a"; chl"b" and carotenoid concentrations were (0.6100; 0.536 and 0.3367 mg g-1 f.w) , respectively.

Table (3) showed that the increase in grain, straw and biological yield could be attributable to adding mineral fertilizer at a rate of 100% recommended dose of NPK mineral fertilizers. That were due to increase nitrogen (N) nutrition which enhanced the metabolic processes that effect on the physicochemical environment at the soil-root interface, adjusted rhizosphere conditions, interfered with the cations and anions' uptake, and improved the activity of many enzyme systems. This increased nitrogen (N) nutrition considerably enhanced grain, straw, and biological yields. It also influenced the seeds' development patterns, protein levels, and quality (Fernandes and Rossiello,1995). Additionally, it is known that phosphorus controls various enzymatic processes, such as an enzyme activator, and promotes the growing of new cells and metabolism (Dillon, 1987). It is important for protein synthesis and protoplasm production, which increases cell size and promotes vegetative growth. Besides, it contributes to evolving a deeper root system by manufacturing energy-dense phosphate molecules such as adenosine triphosphate (ATP) involved in ion absorption (Stewart, 1988). Furthermore, potassium is a vital nutrient for the meristematic growth of plants and their physiological processes, which comprises the control of water and gas exchange, protein synthesis, enzyme activation, carbohydrate translocation, and photosynthesis. Potassium helps in phloem transport, energy transfer, cation-anion balance, metabolism of nucleic acids, vitamins, and growth factors, and their ability to fend off pests and illnesses (Wang et al., 2013). These results agreed with (Abdel – Lateef,2018) who demonstrated that the addition of recommended dose of mineral fertilizers achieved a significant increase in wheat yield cultivated saline sandy soil for. On the other hand, mineral fertilizers' application at a rate of 90% of the recommended dose of NPK with compost and biofertilizers gave the highest values for grain,straw and biological yeild, followed by T12 (75% mineral fertilizers, compost, and the mix of bacteria) then T11 (60% mineral fertilizers, compost, and the mix of bacteria) were consistent with Abd Elrahman and Bakr (2022). They demonstrated that the reduced application of NPK mineral fertilizers by partially substituting them with vermicompost and biofertilizers recorded the highly significant production and fruit quality of fine grapevines, increased the quality of the physical and chemical features of the soil, and decreased the environmental pollution. This is due to the benefit of organic matter (compost), which acts as salt ion binding agents detoxifying the toxic ions, particularly Na^+ and $Cl^–$. So

decreasing the salinity in this soil (Zahid and Niazi, 2006) and decreasing EC in soil treated with OM, enhancing productivity in the reproductive stage (Murtaza et al., 2009).
Also, the results in Table (3) were harmony with (Attia and Abd El Salam, 2016) who found that the interaction between the three factors mineral fertilizations, amount of applied organic fertilizer (0rganic manure) and the application of bio-fertilizer achieved the highest value of wheat yield in saline soil. Moreover, Nadeem et al. (2012) demonstrated that adding a mixture of bacteria such as PGPR, especially B. megaterium, decreased salinity, and alleviated the negative impacts of high salinity stress on cucumber growth. These findings agreed with Meena et al. (2015). They found that adding organic and biofertilizers had an effective role in plant metabolism as they are sources of vital substances such as protein, amino acids, nucleic acids, enzymes, coenzymes, and alkaloids. Additionally, Chandra et al. (2002) proved that PGPR have the ability to increase seedling development and produce 1-aminocyclopropane-1-carboxylate (ACC) deaminase to alleviate the adverse effects of biotic and abiotic stress, facilitating crop growth. ACC deaminase has a critical role in improving plants' ability to withstand stress, by converting the plant's ethylene precursor into ammonia and ketobutyrate. Therefore, bacteria which produce ACC deaminase can lower ethylene levels in stressed plants (Yoolong et al., 2019). The current findings agreed that various ACC deaminase-producing Bacillus species (Tahir et al., 2019). Additionally, the fact that Azotobacter could adapt in a saline environment because it requires sodium ions for growth (Page et al., 1988). On the other hand adding compost, the most commonly used to increase the essential nutrients (NPK) for restoring microbial population activity and recovering soil physicochemical qualities (Lakhdar et al., 2008; Hanay et al., 2004).

Moreover, compost with the inoculation of biofertilizers enhanced the uptake and translocation of most nutrients in plant, and that was reflected in improving carbohydrate and protein synthesis, encouraging cell division, and developing tissues. It also induced resistance of the plant to root diseases and increased the production of natural hormones (IAA, GA3, and cytokinins), which improved root development and vegetative plant growth, improving productivity (Kannaiyan, 2002). According to Table (4) the rise in NPK% in wheat grains might be attributed to the microorganism activity and an elevation in the facility of essential nutrients to bind to surfaces and prevent leaching. These Azotobacter species, can fix atmospheric nitrogen and convert it into forms that plants can use by changing nitrogen to ammonia using a complex enzyme system recognized as nitrogenase (The genes for nitrogen fixation) (Gaby and Buckley, 2012). Moreover, Azotobacter could create IAA and cytokinins that increased the surface area of root length and increased of root hair branching, which eventually improved the uptake of nutrients from the soil (El-Kouny et al., 2004). From different reports, rhizobacteria that supported plant growth by solubilizing potassium rock through secretion organic acids could release potassium from potassium-bearing rocks in soils (Liu et al., 2012).

Additionally, combining mineral and organic fertilizer enhanced the mineralization of organic N. These findings agreed with Alakhdar et al. (2020), which found that using organic (humic acid) and biological (N-fixing bacteria) fertilizers increased the availability of NPK significantly. This might be because the decomposition of the organic material released acids that decreased the pH of the soil, making nutrients more soluble and consequently, more available to plants for uptake.

Also, the availability of NPK in grains, as in Table (4), agreed with Taha et al. (2016) and Al-Erwy et al. (2016), who observed that mineral, bio, and organic fertilization improved the nutrients content of wheat and induced a raise in their concentrations even in the salt-stressed environment. According to Mohamed et al. (2015), organic matter was critical for improving soil fertility in several ways, including storing nutrients (phosphorus, calcium, potassium, and magnesium). Therefore, their dynamics were dependent on those of organic material and the rise in cation exchange capacity (CEC) since they were released during the breakdown of organic matter. This function was associated to the cation and anion exchange capacity, physical and chemical adsorption, and desorption characteristics of the organic mineral soil constituents' surfaces. These characteristics defined the soil's structural stability advancement, some macro and micronutrients' accessibility, cation balance, the effectiveness of fertilizers, and xenobiotic molecules. These characteristics also identified the microbial and enzymatic activity stimulation that controlled the carbon, nitrogen, phosphorus, and sulfur cycles.

Therefore, applying organic and biofertilizers increased the availability of NPK and organic matter and decreased the soil pH (Yang et al., 2019). Additionally, the enhanced bacterial activity of Azotobacter chroococcum led to increase nitrogen fixation by converting atmospheric nitrogen to ammonia, the production of several growth hormones, as well as the capacity to produce large amounts of amino acids such as glutamic acid and lysine, which controlled the enhancement of root development and plant growth, particularly vegetative growth. Moreover, this bacterial activity was linked to enhanced root development (Wani et al., 2016). Also, Sandeep et al. (2011) found that the numerous Bacillus megaterium strains effectively solubilized the unsolvable phosphate and were considered plant growth-promoting bacteria whose secretion of plant growth promoting substances such as malic and quinic acid could prove that B. megaterium might dissolve phosphate. Because the organic acids have chelating capabilities, adding more organic acids to the soil improved plant phosphorus uptake.

Moreover, a rise in potassium content might be caused by Bacillus circulans, one of the microorganisms that solubilize potassium. Bacillus circulans increase the production of low-molecular-weight organic acids such as citric, tartaric, and oxalic acids, which lowers soil pH. It also provides protons and promotes the chelation of the cation bound to potassium, which increases the potassium compounds' solubility. These organic acids stick to the mineral's surface forming biofilms so increasing the organic acids' concentration surrounding the metal, speed up weathering and create a protective layer over the mineral-water-hyphal/root hair (Liu et al., 2006). Besides, bacteria release organic acids, polysaccharides, and proteins that This increases the weathering of potassium-rich shale and releases potassium, silicon, and aluminum into the rhizosphere (Man et al., 2014). According to results in Table (5), these findings demonstrated that the high salt content such as in T1(control treatment) prevent protein synthesis and affects the chlorophyll's structural component due to reducing the synthesis of the significant chlorophyll pigment complexes encoded by the chl. gene family (Nikolaeva et al., 2010). This might be due to the damaging of pigment-protein complexes that protect the photosynthetic system or the oxidative damage of chloroplast lipids and proteins. On the other hand the most beneficial variation for leaf chlorophyll concentration was N fertilization and biofertilizers, especially those from the genus Azotobacter.

Furthermore, the positive impact of bio-fertilizer medications on chlorophyll a and b might be associated with their N-fixing activity and the production of plant growth-promoting substances, including IAA, gibberellins, and cytokinin-like substances (Nabila et al., 2007). These substances have stimulatory effects on cell division, proteins, and nucleic acid synthesis, consequently improving vegetative growth and activation of photosynthesis and chlorophyll formation, which enhances the number of metabolites necessary for building plant organs. This was consistent with a study that showed nitrogen had the most significant impact on chlorophyll content. Nitrogen impacts the formation of chloroplasts and the accumulation of chlorophyll within them since it is a component of both protein and chlorophyll molecules (Tucker, 2004). Also, the availability of P is necessary for photosynthesis and part of its numerous functions in plants, potassium stimulates more than sixty enzymatic systems in the plant cell and synthesizes proteins, starch, vitamins, and cellulose that ensure normal plant metabolism, growth, and strong tissue development. Inorganic phosphate (Pi), CO2, and H2O are the main building blocks for photosynthesis, which uses light energy to produce carbohydrates that make chlorophyll and ATP. Pi combines with ADP during the initial phase of photosynthesis, known as photophosphorylation, to produce ATP. The plant uses this ATP as a driving force to carry out numerous metabolic processes, and sugars assist in the production of additional structural and storage components (Flügge and Benz, 1984). ALnaass et al. (2021) declared that potassium enabled photosynthesis through which the plant sugars and energy required for development are established. These findings were consistent with those of Al-Erwy et al. (2016) and Taha et al. (2016), who showed that mineral, bio, and organic fertilizers improved the formation of the pigments (chlorophyll and carotenoid contents) and increased their concentrations even in salt stress for wheat. According to Rady et al. (2016), adding compost enhanced the uptake of K+ and other nutrients, leading to a matching rise in the chlorophyll content of phaseolus vulgaris cultivated in saline soil. This might be a sign of the stress brought on by changes in the hormone balance in the plant (Marschner, 1995).

Rashid et al. (2022) revealed that the inoculated bacterial strains helped photosynthetic pigments' synthesis (Chlorophyll a and b and carotenoids) and encouraged wheat growth in drought-stressed plants. This could result from decreased stress-related changes in the chloroplast structure, increased CO2 availability, and photosynthesis enzyme repair (Danish and Zafar-ul-Hye, 2019). This was supported by comparing the inoculation control to the study (Zhang et al., 2020). B. megaterium, under drought, confirmed that increasing of chlorophyll content the planta assay, as evidenced by principal component analysis (PCA).

V –CONCLUION

The inoculation of salinity durable bacteria (Azotobacter chroococcum, Bacillus megaterium and Bacillus circulans) with the addition of organic fertilizer as (compost) to the soil can be rationalized the using of mineral fertilizers and produce a high wheat yield of optimum quality.

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