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Effect of Soil and Foliar Applications on Growth and Yield of Green Bean (*Phaseolus vulgaris* L.) Plants Under Salinity Stress

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ABSTRACT

During the two autumn seasons of 2020 and 2021, two field tests were conducted in the Experimental Farm of El Kassasien Research Station in Ismailia, Egypt in order to study the interaction effects of soil application treatments i.e., *B. subtilis* inoculant, AMF, vermicompost (VC) and corn stalk(CS), and foliar applications treatments, i.e. potassium silicate (4 cm / liter), Salicylic acid(SA) (150 mg / liter) and tap water control treatment, to reduce the negative impact of soil salinity on the growth and yield of snap bean grown in saline soil The foliar spray treatments with SA gave the highest values for all the studied traits, growth characteristics, i.e. plant height, number of branches, number of leaves, dry weight of the plant, as well as leaves or pods pigments, whether for, and the content of plants from NPK, in addition to the yield of pods and its components.The best soil additives had an effect on all the studied traits is the addition of VC + AMF followed by the addition of CS + AMF. These additions caused a substantial increase in plant growth measurements, as well as a significant increase in the leaves and pods pigment, plant's content of elements, also led to a significant increase in pod yield, its composition, as well as its quality The interaction between the study factors had a significant effect on all the studied traits, and the best data for these traits were obtained from the soil application of (VC) + (AMF) with (SA) spraying due to its role in reducing the negative effect of soil salinity. The effect of applied treatments was estimated in terms of the rhizosphere biology, Biologically, AMF root colonization% and dehydrogenase activity recorded increases in their result, especially at soil application, Co-addition of AMF, VC and SA as foliar Decrease the impacts of abiotic salinity stress. Accordingly, a possible reduction in salinity stress can be achieved using AMF, VC with SA as foliar spray in salt affected soil for green bean The cultivation of plants enhanced their growth and photosynthesis and Reduced osmotic stress under salinity conditions. In addition, the oxidoreductase enzyme catalase and accumulation of proline decrease after 30 days of planting in both seasons. This research reveals that higher levels of antioxidant enzymes and proline content, which decrease ion toxicity and cell membrane injury, were principally responsible for the enhanced tolerance to salinity. Antioxidative responses in green bean plants subjected to different osmotic potentials induced by salinity stress were record lower value in our treatment than control.it is may be due to our treatment give the plant the superiority to overcome the osmotic stress due to makes the plant more resistant and tolerant to salinity by increasing microbiota in rhizosphere and the presence of mycorrhizae, making the plant get its need of NPK.so that the plant have more defense and did not need more antioxidant enzyme, Thus, the plant did not need to make proline as a defense system against salinity in green bean, thereby mycorrhizae, VC and SA increasing osmotic adjustment and protection from free radicals in *Phaseolus vulgaris* L .

Keywords: Abiotic stresses, AMF, catalase, dehydrogenase, proline, *Phaseolus vulgaris* L. yield.

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1. Introduction

One of the major environmental factors that negatively affects crop production on a global scale and results in the annual loss of 1.5 million ha of arable land is salinization. Salt-affected soils are ubiquitous, affecting an estimated one billion hectares (ha) and more than 100 countries globally. In addition, 76 million hectares of land are affected by secondary salinization, or the development of salinity due to human intervention (FAO.2015). Salinity has significant negative effects on crop growth and yield according to FAO, (2018). One of the most significant abiotic stressors among the harmful environmental elements affecting the agricultural land sector is soil salinity (Yadav *et al*., 2011). Plants that are widely farmed around the world experience a wide range of molecular, biochemical, and physiological alterations as a result of soil salinity. The two most important agricultural problems, nutrient deficiencies and soil salinity, affect about 20% of the world's agricultural fields (Numan *et al*., 2018). In addition to increasing plants capacity for antioxidants, salicylic acid (SA) controls a variety of cellular and physiological processes in plants, including stomatal closure, ion uptake, inhibition of ethylene biosynthesis, transpiration, cell elongation, cell division, cell differentiation, sink/source regulation, enzymatic activities, protein synthesis, photosynthetic activity, stress tolerance (Sofy *et al*., 2020). It was demonstrated that the SA application could alleviate salinity stress and enhance plant growth, yield, and nutrient content (Khan *et al*., 2010). Exogenous administration of SA is expected to control stomatal opening under stress, hence lowering transpiration and water loss, preserving turgor, and regulating plant growth and production under stress condition (Nour *et al*., 2012). Plants are protected from abiotic challenges by SA because it controls key physiological activities such as photosynthesis, nitrogen metabolism, proline (Pro) metabolism, the antioxidant defense system, and plant water relations when they are under stress (Khan *et al*., 2014; Nazar *et al.,* 2015). The application of SA under salinity and drought conditions improved onion dry matter (Semida *et al*., 2017). This increases plant growth by stimulating cell division and elongation, and possibly by inhibiting chlorophyll oxidase enzymes, thereby preventing chlorophyll degradation and boosting photosynthesis (Hasan *et al*., 2018). The foliar application of salicylic acid causes plant height to increase (Bhasker *et al*., 2020) demonstrates that SA can reduce salinity damage to vegetation. SA mitigates the deleterious effects of salinity on chlorophyll by reducing reactive oxygen species and boosting antioxidant systems.

Silicone improved nutrient assimilation by increasing antioxidant enzyme activity, decreasing plasma membrane permeability, and boosting root activity (Saqib *et al*., 2008). Silicon plays a role in enhancing plants' resistance to salinity stress (Xiang *et al*., 2012). Vermicompost is produced when earthworms and other microorganisms degrade organic materials in a non-thermophilic manner (Sallaku *et al*. 2009). Vermicompost, according to study, can boost plant development and yield while reducing the detrimental impacts of salinity (Rafiq and Nusrat 2009). Vermicompost is a management practice that could contribute to the sustainability of agroecosystems by reducing their reliance on inorganic fertilizer (Amossé *et al*., 2013). Vermicompost (VC) is an excellent source of humus, phosphorus, potassium, and micronutrients. (Zn, Cu, Fe, Mn). Farmers also had a tradition of returning crop stalks, but in recent years the majority of crop stalks have been incinerated for labor savings, resulting in a waste of resources and environmental contamination. corn stalks, as residues from agricultural field processes valuables rather than being an environmental crisis.

Their components of 93.39 Total Solid (%), 6.61 Moisture Content (%), 7.03 Ash (%), 30.62 Lignin (%), 42.41 Cellulose (%), 11.78 Hemicellulose (%). It has been It was acknowledged that extensive cultivation and the return of straw were essential for the enhancement of soil characteristics and agricultural sustainability. Several studies have suggested that salt deposition in the root zone can be mitigated by laying down a layer of grit, gravel, or something similarly coarse in the soil (Jia *et al*., 2006). Similarly, submerging a Stover layer beneath the soil's surface can effectively sever capillaries in the soil and prevent salt from rising (Tumarbay *et al*., 2006). Previous research indicated that tillage and returning straw had a substantial impact on the microbial community and enzyme activity of the soil (Govaerts *et al*., 2008). Establishing a soil interlayer is an efficient method for enhancing saline soil (Akudago *et al*., 2009). Recent studies on Arbsculare Mycorrhizae fungi (AMF) have demonstrated that AMF promote salinity tolerance in plants by developing symbiotic relationships with them. (Shamshiri and Fattahi, 2016). AMF have drawn more attention Since microbial inoculants such arbuscular mycorrhizae fungi (AMF) and Rhizobium are abundant in soil and provide a low-cost, all-natural method of increasing nitrogen uptake in depleted soil under stressful situations, they have been studied in the past (Hack *et al*., 2019). AMF produced as an extracellular secretion in the soil has been shown to increase soil aggregate stability, soil water potential, decrease heavy metal contamination, and increase crop yield overall (Hu *et al*., 2019). The benefits of AMF symbiosis for soil include nutrient cycling, soil quality, and tolerance to abiotic stresses (Zhang *et al*., 2019). *B. subtilis* is applied to soil as Mycorhyzea-assisting bacteria (MHB) and to protect plants against abiotic stress. The term "Mycorrhizae Helper Bacteria" refers to bacteria that can promote the establishment of the "Root Mycorrhizae Fungus" interaction, or bacteria that are associated with roots and Mycorrhizae fungi and will selectively promote the development of this Mycorrhizae symbiosis (Krishnamoorthy, 2015) The combined use of AMF and its associated MHB isolated from a salt-affected soil has substantially increased maize plants' tolerance to soil salinity, according to a study. Osmotic stress and ionic toxicity are caused by high salt accumulations in plants, which hinder plant growth by interfering with a variety of physiological processes, lowering crop production and quality (Liu *et al*., 2016). In an effort to increase agricultural growth and stress tolerance in high salinity-alkalinity environments, many remediation techniques have been researched, including physical (water-conservation techniques), chemical (amendment ameliorants), and biological (adopting salt-tolerant plants) (Zhang *et al*., 2016). Recent research has shown that by developing symbiotic interactions with plants, AMF helps plants tolerate salinity (Lenoir *et al*., 2016). AMF is prevalent in saline soils with effective bio-remediation due to improved nutrient and osmoprotectant levels (Estrada *et al.,* 2013), enhanced photosynthesis and enzyme activities (Pedranzani *et al*., 2016). Soil regeneration and fertility enhancement using organic matter conditioners has grown increasingly common in salt-affected areas during the past several decades. Soil physical, chemical, and biological qualities can all be improved with the addition of organic matter, which is also crucial for soil stability. Due to the lack of organic matter, salt-affected soils are typically structurally unstable. Numerous studies have recommended the incorporation of organic materials (green, farmyard, and poultry manures, compost, food processing residues, etc.) to enhance structural stability (OO *et al*. 2015; Zhao, *et al.* 2014).

Therefore, the purpose of the present study was to evaluate the ability of AMF, Bacillus strains, inoculated with soil application (vermicompost, corn stalk), and spray foliar K-silicate and salicylic acid) alone or in conjunction with one another to promote plant growth and reduce the negative effect of saline stress on green bean.

2. Materials and Methods

The present study was conducted during the two successive autumn plantation seasons of 2020 and 2021 at the experimental farm of El Kassasien Research Station, Ismailia Governorate, Egypt, to investigate the influence of ground additions and spraying foliar with some materials on increasing the ability of bean plants cv Paulista to tolerate salinity and its effect on growth and yield. According to the recommendations of the Egyptian Ministry of Agriculture, a mineral fertilizer (N, P, K) was applied.

2.1. Soil analysis

Soil samples were randomly taken from 25 cm soil surface and chemical analyses of the experimental soil are presented in Table (1) The soil mixture was chemically analyzed before plantation and pH, EC were determined using a Jenway 4310 EC meter and Beckman pH meter. water holding capacity (WHC), organic matter content, NPK, cations and anions were determined to have a complete knowledge about the experimental conditions (Jackson, 1967).

2.2. Soil application

Vermicompost commercial compost obtained from Central Laboratory for Agriculture Climate (CLAC), Agriculture Research Centre. During plot preparation for all treatments, 5 tons fed -1 of compost was dispersed and thoroughly mixed with the soil surface layer (0 to 25 cm). Chemical analysis of the compost used presented in Table (3).

Table 1: Mechanical and chemical analyses of the soil during 2020 and 2021 seasons.

Soil characteristics	**Value**	**Soil characteristics**	**Value**
Particle size distribution %		**Soluble cations (soil paste mmole. L^{-1})**	
Sand	78.68	Ca^{2+}	2.31
Silt	13.47	Mg^{2+}	0.74
Clay	7.85	Na^{+}	4.68
Textural class was Sandy		K^{+}	0.37
Soil chemical properties:		**Soluble anions (soil paste mmole$_c$L^{-1}):**	
pH (1.25 soil water suspension)	7.17	CO_3^{2-}	0.00
$CaCO_3$ (%)	2.21	HCO_3^-	0.25
Organic carbon (%)	0.41	Cl^-	2.02
ECe (dS m^{-1}, soil paste extract)	4.31	SO_4^{2-}	5.84
CEC (cmol$_c$ kg^{-1} soil)	5.21		
Soil physical properties:			
Bulk density (g cm^{3})	1.61	Total porosity (%)	42.56
Hydrulic conductivity (cm h^{-1})	14.0	Avail. Water (%)	5.23
Soil moisture at wilting point (%)	4.34	Soil moisture at field capacity (%)	9.57

Available Nutrients (mg kg^{-1})

N	P	K	Cu	Fe	Mn	Zn
66.98	12.54	60.32	30.6	3.01	0.84	0.68

Table 2: Local meteorological data at Ismailia Governorate region during 2020 and 2021 seasons.

Season	**2021**			**2020**		
Parameter	**Relative humidity %**	**Temperature (°C)**		**Relative humidity %**	**Temperature (°C)**	
Month	Aver.	Min.	Max.	Aver.	Min.	Max.
September	76.75	22.37	26.15	72.69	24	30
October	74.31	20.5	23.46	66	22	26
November	67.38	21.98	23.4	57.19	19	22
December	64.0	15.91	19.31	62	17	20

Table 3: Physical and chemical properties of vermicompost and corn stalk and used.

B. D	**OM**	**C/N**	**pH**	**EC**	**N**	**N-NH$_4$**	**N-NO$_3$**	**P**	**K**	**Fe**	**Mn**	**Zn**	**Cu**	**pb**	**Cd**
Kg/m^3	**%**	**Ratio**		**ds/m**	**%**	**ppm**	**ppm**	**%**	**%**			**ppm**			
715	33.22	01:16.5	8.17	6.67	1.57	65	81	1.27	0.59	802	143	37	14	9	n.d.

Bulk density (B.D) Organic matter (O.M)

2.3. Bacterial Culture:

Bacillus sp. [OM760515] was dispersed on (NB) agar plates and incubated for 24 hours at 28°C without light. (The bacterium strain was isolated from mangrove soil) (Mohy Eldin *et al*., 2022) .The bacteria were grown in liquid N media after being extracted from nutrient agar plates and grown at 28°C with 250 rpm rotation to yield 109 CFU per milliliter, as measured by optical density and serial dilutions (Zhang *et al*., 2008a). *B. subtilis* application was done by adding 10L/fed as a bio-stimulant. Biologically active organisms Three doses of addition were spread out during the entire planting period, per the regimen. arbuscular mycorrhizae Fungi (AMF) spores were originally extracted from the Egyptian soil. AMF spores, from genera such as Glomus, Gigaspora, and Acaulospora, were sown in the soil before planting. Fifty grams each bag of a mixture of spores (250 spores/gram) from different AM fungus genera was prepared and mixed with soil before the seedlings were planted (Massoud, 2005). Obtained from the strain provided by department of microbiology /SWERI/ARC, Egypt. This study included 27 treatments which were the combinations of foliar applications treatments, i.e. K-silicate (4 cm / liter), SA (150 mg / liter) and tap water control treatment, and nine soil applications treatments, i.e. CS (9.5 ton/ fed), VC (5 ton/ fed), *Bacillus species*, AMF, CS + *Bacillus species*, CS + AMF, VC+ *Bacillus species*, VC + AMF and control (without any soil additives). Three duplicates of each treatment were set up in a split plot design. Treatments for soil applications were randomly distributed in sub spots, whilst treatments for foliar applications were scattered in main plots. Paulista cultivar snap bean seeds were sown in 5th of September during the growing seasons. Each experimental plot contained 3 rows; each row was 5 m length and 0.7 m width. So the area of each plot was 10.5 m^2 . The ground treatments were added before planting by making trenches under the planting lines at a depth of 40 cm, then adding the treatments and backfilling them with a layer of soil. Snap bean plants were sprayed three times at 21,27and 34 days after sowing with foliar spray treatments. According to the Ministry of Agriculture's advice, the appropriate agricultural methods for the commercial production of snap beans were followed.

2.4. Plant chemical and physical analysis

Five plants from each plot were randomly taken after 50 days after sowing to estimate chemical and physical parameters. Vegetative growth: plant growth, plant length (cm), plant dry weight (g), leaves area (cm^2), number of plant leaves, number of branches and plant dry weight (g). Chemical constituents in snap bean leaves: Nitrogen, potassium and phosphors in leaves Plant leaves were oven dried at 70 C^o till a constant weight and N, P and K was determined by the methods described by Black (1983), Trough and Mayers (1939) and Brown and Lilliland (1946) for N, P and K, respectively. Chlorophyll content of snap bean pods. Chlorophyll in both seasons according to the method described by Wettestein (1957) Chlorophyll a, b and Carotenoids (mg/100 g FW) snap bean pods. Pods yield and its components: plant pods yield /gm. number of pods/plant, average pod length, pod diameter pod weight (gm.) marketable yield (ton/fed) and total yield (ton/fed). Leaf proline content (mg/g) was calorimetrically estimated on fresh weight basis according to the method of Bates *et al.* (1973).

2.4. Soil and plant biological activities

Samples were taken after 45 days of planting for carrying out determinations in both soil rhizosphere and *Phaseolus vulgaris* L. Catalase activity (CAT) mentioned by Beers, R. F., Jr, & Sizer, I. W. (1952). The method steps were done according to Pine *et al*. (1984), as 0.1 ml of sample was added to freshly prepared 1.4ml H_2O_2 (13.2M). The mixed solution was detected for loss in absorbance at 240nm. Using a molar absorbance index for H_2O_2 of 43.6, catalase units were determined. The amount of enzyme needed to break down 1.0 µmol of H2O2 per min was known as one unit of catalase. Dehydrogenase activity (µgTPF.g^{-1} dry soil day^{-1}) was determined according to Thalmann (1967). AMF root colonization (%) according to (Trouvelot *et al.,* 1986).

Statistical Analysis:

Duncan's multiple range test was used to compare treatment means, and the analyses of variance approach described by Snedecor and Cochran (1980) was used to tabulate and analyze the data. (Duncan,1955) level of 5% for one factor at a time (one way analysis) using CoStat 6.45 program (CoHort software 6.311).

3. Results and Discussion

3.1. Vegetative growth:

3.1.1. Effect of foliar spraying treatments :

Results in (Table 4a) show the effect of three foliar spraying treatments (tap water, K-silicate and SA) on vegetative growth (plant length, plant dry weight, leaves area (cm) ², number of leaves / plant and number of branches / plant) on snap bean plants it is obvious from the data that spray treatments had a significant effect during both seasons of study. In this respect the best spray treatment that gave the highest values of plant length, plant dry weight, leaves area (cm) ², number of leaves, and number of branches was SA then K- silicate while tap water recorded the lowest values of vegetative growth.

Such increments in studied morphological characters during study may be due to the positive effect of salicylic acid and potassium silicate on reducing the effect of salinity on growth by increasing the physiological activity in the plant and also improving the photosynthesis process. The obtained result is in accordance with that obtained by Al-Zohiri, (2009) on garlic crop SA also stimulates various physiological processes involved in plant growth (Basit *et al*., 2018). SA is a potential non-enzymatic antioxidant that modulates a wide range of physiological processes in plants, including stomatal closure, ion uptake, inhibition of ethylene biosynthesis, transpiration, cell elongation, cell division, cell differentiation, enzymatic activities, protein synthesis, photosynthetic activity, and stress tolerance, as well as enhancing the ability of plants to produce antioxidants (Sofy *et al*. 2020). The application of SA under salinity and drought conditions improved onion dry matter (Semid, *et al*., 2017).

SA increases plant height when applied foliarly. Bhasker *et al*. (2020) demonstrates that SA can reduce salinity damage to vegetation. Exogenous administration of SA is anticipated to control stomatal opening under stress, thereby reducing transpiration and water loss, maintaining turgor, and regulating plant growth and productivity under stress conditions (Nour *et al*., 2012). SA decreases the harmful effects of salinity on chlorophyll by lowering ROS and enhancing antioxidant defenses. By promoting cell division and elongation and perhaps by blocking chlorophyll oxidase enzymes, which prevent chlorophyll breakdown and increase photosynthesis, this promotes plant development (Hasan *et al*., 2018).

Table 4a: Effect of foliar spray and soil applications on snap bean growth parameters collectively among all spraying types under salinity conditions during 2020-2021seasons.

	Plant length (cm)		**Plant dry weight g/Plant**		**Leaves area (cm)²/ Plant**		**Number of leaves / plant**		**Number of branches / plant**	
	S1	**S2**	**S1**	**S2**	**S1**	**S2**	**S1**	**S2**	**S1**	**S2**
					Foliar spray application					
Tap water (control)	37.63 c	39.23 c	11.00 c	13.11 c	643c	675 c	13.28 c	15.27 c	4.34 b	5.88 b
K- silicate	38.96 b	40.74 b	12.18 b	13.95 b	661 b	695 b	14.20 b	16.89 b	5.17 a	6.61 a
Salicylic acid	39.27 a	42.05 a	12.67 a	15.21 a	743 a	780 a	15.78 a	18.68 a	5.25 a	6.71 a
					Soil application					
Control	33.31 g	34.42 g	9.87 f	11.59 f	541e	568 e	12.28 g	14.07 g	3.66 e	4.83 e
CS	36.25 f	38.42 f	11.23 e	13.25 e	634 d	666 d	13.82 f	16.38 f	4.02 de	5.16 de
VC	38.57 d	40.74 d	11.95 d	14.10 d	695 b	730 b	14.45 c-e	17.06 c-e	5.18 b	6.66 b
B. subtilice	37.72 e	39.88 e	11.78 d	13.89 d	669 c	703 c	14.12 ef	16.71 ef	4.55 cd	5.83 cd
AMF	38.36 d	40.53 d	11.97 d	14.12 d	714 ab	749 ab	14.34 d-f	16.93 d-f	4.94 bc	6.33 bc
CS+ *B. subtilice*	39.61 c	41.77 c	12.36 c	14.58 c	714 ab	750 ab	14.78 b-d	17.41 b-d	4.93 bc	6.23 bc
VC+ *B. subtilice*	40.57 b	42.74 b	12.57 bc	14.83 bc	719 a	752 a	15.01 bc	17.65 bc	5.32 ab	6.83 b
CS+AMF	41.06 b	43.23 b	12.81ab	15.11 ab	725 a	765 a	15.34 ab	18.00 ab	5.84 a	7.60 a
VC+AMF	42.13 a	44.30 a	13.01 a	15.34 a	730 a	780.65 a	15.65 a	18.32 a	5.84 a	7.86 a

Control: Without any soil addition **CS:** Corn stalk **VM:** Vermicompost ***B. subtilice*:** *Basilluc subtilis* **AMF**: Arbusculare Mycorrhizae Fungi.

3.1.2. Effect of soil application treatments:

Results in (Table 4a) show the effect of nine soil application treatments control, CS, VC, *B. subtilis*, AMF, CS + *B. subtilis*, VC + *B. subtilice*, CS + AMF, and VC + AMF. All treatments caused significant effects on studied vegetative growth characteristics, i.e. Plant length, plant dry weight, leaves area, number of leaves and number of branches. All treatments led to a significant increase in the vegetative characteristics under study compared to the control treatment.

The highest values were obtained from VC +AMF treatment, followed by CS + AMF treatment. Due to its ability to retain water and the microorganisms, including Mycorrhizae fungi, vermicompost increases the quantity of water that roots absorb. Height of Cicer and Pisumpalant increased as a result of vermicomposting (Sinha *et al*., 2010) and also dry weight of soybean (*Glycine max* L.) and oat (Avenaludoviciana) (Atiyeh *et al*., 2001) is shown in a medium containing vermicompost (Muscolo *et al*., 1999). It is believed that the stimulation of auxin-like chemicals produced by vermicompost is what causes plants to grow taller. In addition to other organic acids, vermicompost also contains humic and fulvic acids (Arancon *et al*. 2007), in addition to the frequency of nutrients, particularly nitrogen (Samiran *et al*., 2010) can stimulate plant growth (Arancon *et al*., 2004). The increased leaf area of strawberries treated with vermicompost has been attributed to an increase in vermicompost's microbial population. The vermicompost contains Auxin and additional plant growth hormones. In general, it seems (Taiz and Zeiger 2002). that the use of vermicompost has improved water and nutrient absorption conditions (Matos and Arruda 2003). Due to the presence of negatively charged functional groups, it's believed that humic materials in vermicompost have a high metal absorption capacity. The mechanism of salinity tolerance in plants may entail biological factors such as Mycorrhizae fungi. Mycorrhiza fungi utilize plant carbohydrates for their metabolism; consequently, it may increase stress tolerance due to the osmolytic effects of carbohydrates (Oliva *et al*., 2008).

The beneficial effect of vermicompost on growth characteristics may be the result of improved soil structure conditions, which promoted the plant's root development by enhancing the soil's water-holding capacity. As a result, the plant was better supplied with water and nutrients, which led to an increase in plant biomass. (Joshi *et al*., 2014).) Vermicomposting improves plant growth and soil structure (Ceritoğlu *et al*., 2018)

3.1.3. Interaction effect between foliar spraying and soil application treatments:

The (table 4b) presents the data resulting from the interaction between three foliar spraying treatments (tap water, potassium silicate and salicylic acid) and nine soil application treatments (control, CS, VC, *B. subtilise*, AMF, CS + VC + *B. subtilise*, CS+ AMF, VC+ AMF). The data showed significant differences in the interaction effect between soil additives and foliar spraying. And the best values were obtained from the interaction between the additions of vermicompost + AMF spraying with SA, followed by the addition of CS + AMF and spraying with SA as well. This is due to the effect of the contents of vermicompost and micro-fertilizer on soil structure (Ceritoğlu *et al*. 2018), in addition to the effect of spraying with salicylic acid and its effect on reducing the effect of salinity (Bhasker *et al*., 2020).

3.2. Chemical constituents in snap bean leaves:

3.2.1. Effect of foliar spraying treatments :

The results show in (Table 5a) the effect of three spraying treatments (tap water, potassium silicate and salicylic acid) on % nitrogen, % potassium, % phosphorous and chlorophyll (SPAD) in the leaves of snap beans. The data showed a significantly affected by foliar spray treatments during the two study seasons. In this regard, it was observed that the highest values of nitrogen, potassium, phosphorous and chlorophyll were obtained from spraying with SA followed by K- silicate compared to plants sprayed with tap water (control treatment). Soil salinity inhibits the growth and productivity of plants by reducing the availability of water to plant roots, which disrupts the water status and metabolic processes of plant tissues, resulting in a decrease in meristematic activity and cell enlargement.

Soil salinity inhibits the growth and productivity of plants by reducing the availability of water to plant roots, which disrupts the water status and metabolic processes of plant tissues, resulting in a decrease in meristematic activity and cell enlargement. It also causes an increase in respiration rate as a result of the increased energy demands (Qados, 2015). In the case of salt stress, a similar conclusion was reached because the increase in growth and grain yield caused by the application of SA was also accompanied by an increase in photosynthetic capacity that was not caused by stomata limitations but rather by metabolic factors other than photosynthetic pigments and leaf carotenoids (Arfan *et al*., 2007).

Particular attention has been paid to SA application because it elicits protective effects in plants exposed to salinity. (Simaei *et al*., 2012). The role of SA in the chlorophyll levels was mentioned by Abreu and Munne-Bosch (2009) who discovered a link between reduced damage to the photosynthetic apparatus and chlorophyll levels and SA deficit (Babar *et al*., 2014) In fenugreek, the salinity of the growth medium decreased the photosynthetic components chlorophyll a and chlorophyll b significantly. The decrease in chlorophyll content in salt-affected fenugreek plants may be a result of the oxidation of chlorophyll and other chloroplast pigments, as well as the instability of the pigment protein complex.

The foliar application of SA attenuated the decrease in chlorophyll content by increasing the concentrations of proline and AsA, which protect plants from ROS production and membrane damage or may result in the synthesis of other substances with a protective effect on plants grown under salt stress (Xu *et al*., 2008). Treatment of mungbean plants with 0.5 mmol/L SA causes a maximum drop in Na+ and Cl- contents under non-saline and saline environments, while increasing N, P, K, and Ca

Table 4b: Interaction effect between foliar spraying and soil applications on snap bean growth parameters during 2020 and 2021seasons.

Treatment		**Plant length (cm)**		**Plant dry Weight g/Plant**		**Leaves area (cm)² / plant**		**Number of Leaves / Plant**		**Number of branches / plant**	
		S1	**S2**	**S1**	**S2**	**S1**	**S2**	**S1**	**S2**	**S1**	**S2**
Tap water	**Control**	32.44 p	33.80 q	9.47 n	10.61 n	510.05n	535.55 n	10.83 k	11.60 k	3.53 g	4.50 e
	CS.	35.40 n	36.90 p	10.58 lm	12.70 lm	611.71 lm	642.29 lm	12.96 ij	15.09 j	3.66 g	5.00 de
	VC	37.83 jk	39.33 l-n	10.93 j-l	13.12 j-l	653.89 h-k	686.59 h-k	13.30 h-j	15.43 j	4.76 c-f	6.50 bc
	Bsubtilis	36.10 mn	37.60 op	10.84 kl	13.01 kl	644.48 i-l	676.70 i-l	12.96 ij	15.09 j	3.66 g	5.00 de
	AMF	37.40 kl	38.90 mn	10.95 j-l	13.14 j-l	660.44 g-j	697.66 g-j	13.63 h-j	15.77 ij	4.03 e-g	5.50 c-e
	CS+*B.subtilis*	38.50 h-k	40.00 k-m	11.11 jk	13.34 i-k	665.19 f-j	698.45 f-j	13.63 h-j	15.77 ij	4.40 d-g	6.00 b-d
	VM+*B.subtilis*	39.73 e-g	41.23 h-j	11.37 ij	13.64 h-j	673.48 e-j	707.15 e-j	13.63 h-j	16.10 h-j	4.76 c-f	7.00 ab
	CS+AMF	40.10 d-f	41.60 g-i	11.78 hi	14.14 f-h	677.25 e-i	711.11 e-i	13.96 f-h	15.77 ij	5.13 b-d	6.50 bc
	VC+AMF	41.20 b-d	42.70 e-g	11.92 h	14.31 e-g	689.30 e-h	723.76 e-h	14.63 d-g	16.78 g-i	5.18 b-d	7.00 ab
Potassium Silicate	**Control**	33.80 o	35.97 p	10.07 m	12.08 m	521.90 n	547.99 n	12.30 j	15.23 j	3.66 g	5.00 de
	CS.	36.60 lm	38.60 no	11.36 i-k	12.95 kl	619.66 k-m	650.64 k-m	13.43 hi	16.14 h-j	4.40 d-g	5.50 c-e
	VC	38.80 g-j	40.80 i-k	12.28 e-h	14.00 f-h	674.99 e-i	708.74 e-i	14.16 e-h	16.94 f-h	4.80 c-e	7.00 ab
	Bsubtilis	38.36 i-k	40.00 j-l	11.99 gh	13.66 h-j	636.19 j-l	668.00 j-l	13.78 g-i	16.57 g-i	5.60 a-c	6.00 b-d
	AMF	39.20 f-i	41.20 h-j	12.18 f-h	13.88 g-i	694.95 d-g	729.70 d-g	13.83 g-i	16.57 g-i	5.20 b-d	6.50 bc
	CS+*B.subtilis*	39.53 f-h	41.53 hi	12.66 d-f	14.43 d-g	693.82 d-g	718.51 d-g	14.16 e-h	16.94 f-h	5.20 b-d	6.50 bc
	VM+*B.subtilis*	40.76 c-e	42.76 d-f	12.75 de	14.54 c-f	700.24 d-f	738.40 d-f	14.80 d-f	17.66 e-g	5.60 a-c	7.00 ab
	CS+AMF	41.40 bc	43.40 c-e	13.07 b-d	14.90 b-e	703.13 de	743.54 de	14.83 d-f	17.66 e-g	6.00 ab	8.00 a
	VC+AMF	42.23 ab	44.23 bc	13.28 a-c	15.14 bc	711.99 de	739.19 de	15.43 cd	18.32 de	6.00 ab	8.00 a
Salicylic acid	**Control**	33.70 o	36.90 op	10.07 m	12.09 m	592.12 m	621.73 m	12.73 j	15.37 j	3.80 fg	5.00 de
	CS	36.76 lm	39.76 k-m	11.76 hi	14.11 f-h	672.25 e-j	705.87 e-j	15.06 c-e	17.92 d-f	4.00 e-g	5.00 de
	VC	39.80 f-i	42.10 f-h	12.65 d-f	15.18 b	752.34 bc	775.21 bc	15.90 bc	18.81 b-d	5.30 b-d	7.00 ab
	Bsubtilis	38.30 g-j	41.70 g-i	12.50 e-g	15.0 b-d	728.13 cd	764.54 cd	15.56 cd	18.45 c-e	5.21 b-d	6.50 bc
	AMF	39.60 h-k	41.92 hi	12.77 c-e	15.32 b	783.17 ab	822.32 ab	15.56 cd	18.45 c-e	5.60 a-c	6.50 bc
	CS+*B.subtilis*	40.80 cd	43.80 b-d	13.31 ab	15.98 a	785.28 ab	824.55 ab	16.50 ab	19.42 a-c	5.40 b-d	6.50 bc
	VM+*B.subtilis*	41.23 bc	44.23 bc	13.58 ab	16.30 a	787.52 ab	838.99 ab	16.56 ab	19.55 a-c	5.60 a-c	7.00 ab
	CS+AMF	42.70 bc	45.70 b	13.65 ab	16.33 a	789.40 ab	846.77 ab	16.90 a	19.88 ab	6.40 a	8.00 a
	VC+AMF	43.96 a	46.96 a	13.82 a	16.85 a	797.14 a	858.99 a	17.23 a	20.24 a	6.40 a	8.00 a

contents. Based on the findings, it was concluded that the SA treatment may be responsible for reducing salt stress and enhancing plant growth, yield, and nutritional content (Khan *et al*., 2010). which under the challenging circumstances of the studied salty soil enabled a respectable translocation of the digested nutrients into healthy cells for utilisation in various metabolic processes, resulting in strong growth and a satisfactory output (Semida *et al*., 2014). SA can enhance plant growth under B-toxicity and salinity stress by promoting the accumulation of mineral elements such as N, P, and K. (Gunes *et al*., 2005).

Table 5a: Effect of foliar spraying and soil applications on nitrogen, potassium, phosphorus % and chlorophyll (SPAD) in plant of snap bean under salinity conditions during 2020-2021seasons

	Nitrogen %		**Potassium %**		**Phosphorus %**		**Chlorophyll (SPAD)**	
Season	**S1**	**S2**	**S1**	**S2**	**S1**	**S2**	**S1**	**S2**
Foliar spray treatments								
Tap water	1.551 c	2.115 c	1.358 c	1.929 **c**	0.392 c	0.427 c	37.30 c	37.43 c
Potassium silicate	2.329 b	3.624 b	2.049 b	2.525 b	0.483 b	0.540 b	38.77 b	40.31 b
salicylic acid	3.411 a	4.064 a	2.564 a	2.961 a	0.603 a	0.667 a	42.40 a	43.79 a
Soil application								
Control	2.290 g	2.552 g	1.379 f	2.181 h	0.408 f	0.404 g	37.70 e	38.96 d
CS.	2.321 f	2.940 f	1.820 e	2.350 g	0.465 e	0.491 f	38.45 d	39.54 d
VC	2.352 e	3.130 e	1.960 cd	2.388 f	0.478 e	0.529 e	39.26 c	40.52 c
B. subtilis	2.396 d	3.239 de	1.922 d	2.394 f	0.466 e	0.530 e	39.31 c	40.56 c
AMF	2.399 d	3.313 cd	2.003 cd	2.473 e	0.503 d	0.564 d	39.67 bc	40.80 bc
CS+*B. subtilis*	2.450 c	3.460 bc	2.047 c	2.528 d	0.514 cd	0.568 cd	39.82 bc	40.52 c
VM+*B. subtilis*	2.508 b	3.406 cd	2.196 b	2.566 c	0.523 bc	0.588 bc	40.57 ab	41.06 a-c
CS+AMF	2.577 a	3.746 a	2.280 ab	2.662 b	0.538 ab	0.605 ab	41.22 ab	41.41 a
VC+AMF	2.582 a	3.626 ab	2.306 a	2.706 a	0.551 a	0.623 a	41.55 ab	41.24 ab

Control: Without any soil addition **CS:** Corn stalk **VM:** Vermicompost ***B. subtilice*:** *Basilluc subtilis* **AMF**: Arbusculare Mycorrhizae Fungi.

SA, which plays a role in the regulation of photosynthesis, nitrogen metabolism, proline (Pro) metabolism, production of glycinebetaine (GB), the antioxidant defense, and plant water relations, protects plants from abiotic stresses (Khan *et al*., 2014). Numerous crops, like Viciafaba, have provided ample evidence of SA's significance in bolstering salt stress-tolerance systems Azooz, (2009). As a result of increased chlorophyll content and the activity of antioxidant enzymes, which ultimately triggered the photosynthetic process and reduced oxidative stress, salicylic acid was found to increase Torreyagrandis salt tolerance and biomass (Li *et al*., 2014). Improved growth and development in abiotically challenged plants can be achieved by SA's ability to drastically regulate the absorption and metabolism of crucial mineral elements. Nazar *et al*. (2015) was also noted that foliar spray contributes to absorption of NPK and increases assimilation of photosynthates, leading to abundant vegetative growth. (Bhasker *et al*., 2020) AM fungus may boost dry matter development because of their ability to absorb more nutrients.

3.2.2. Effect of soil application treatments

Results in (Table 5a) show the effect of nine soil application treatments, i.e. control, CS, VC, *B. subtilis*, AMF, CS + *B. subtilis*, VC + *B. subtilis*, CS+ AMF, and VC + AMF on the percentage of the leaves content of nitrogen, phosphorous and potassium in addition to chlorophyll(SPAD). All treatments led to a significant increase in the chemical analyses under study compared to the control treatment. The highest values resulted from the addition of VC + AMF, followed by the result of adding CS + AMF physic chemically, VC is advantageous to the photosynthetic system and helps mitigate the detrimental effects of salinity on photosynthesis because it contains minerals and plant growth hormones like auxin and other plant growth regulators like humic acids. Because of its high water-holding capacity and the presence of microorganisms like AMF, VC enhances the quantity of water reaching the roots (Sinha *et al*., 2010). Tomato plants treated with vermicompost showed a substantial elevation in cellular K+ content. He thinks that higher K+ content is due to better microbial activity, the presence of plant growth regulators, and better mineral absorption. Pistachio seedlings grown in the presence of vermicompost at weight ratios of 10 and 20 significantly increased their chlorophyll content and photosynthetic rate was reported by Jat and Ahlawat (2006) Increased plant growth after being treated with vermicompost has been attributed to an uptick in soil enzyme activity such urease, phosphatase, nutrient solubilization, and the creation of 1-aminocyclopropylate (ACC) deaminase. Under situations of salt stress, cucumber seedlings grown in vermicompost grow at a faster pace. (Sallaku *et al*., 2009).

Low levels of nitrogen, phosphorus, and potassium are typical in salty soils. Composting soil may compensate for nutrient deficiencies by enriching the rhizosphere with macro and micronutrients. (Lakhdar *et al*., 2008). AM fungi enhance the sink capacity of the root system and thus, in turn, increase the photosynthetic performance of the plant leading to improved plant growth (Bresinsky *et al*.,2008). Other authors have observed that AM can alleviate the salt stress on plants by inhibiting the high uptake of Na^+ and Cl and their transfer to the shoot (Al-Karaki, 2006). Mycorrhizae inoculation increased the concentration of $K^+$and N in pepper plants. It is well known that Mycorrhizae formation commonly increases plant nutrient acquisition, particularly that of P and N (Giri *et al*., 2007).

3.2.3. Interaction effect between of foliar spraying and soil application treatments

Results in (Table 5b) show the interaction between spraying three spray treatments, i.e. tap water, potassium silicate and salicylic acid, and nine soil application treatments, i.e. without any soil applications, CS, VC, *B. subtilis*, AMF, CS+ *B. subtilis*, VC + *B. subtilis*, CS+ AMF, and VC + AMF on nitrogen %, potassium %, phosphorus % and chlorophyll (SPAD). All treatments led to significant effects in the chemical analyses of nitrogen %, potassium %, phosphorus % and chlorophyll (SPAD) compared to the control. The highest reading was for plants treatment by vermicompost, mycorrhizae fungi and spraying with salicylic acid followed by plants obtained CS, AMF and foliar spray with SA. Salicylic acid (SA) foliar addition with either vermicompost or corn stalk limited the inhibitory effect of salinity on the formation of chlorophy ll.

3.3. Chlorophyll content of snap bean pods

3.3.1. Effect of foliar spraying treatments :

Results in (Table 6a) show the effect of three spray treatments (tap water, K. silicate and SA) on Chlorophyll a, Chlorophyll b and Carotenoids in pods it is obvious from the data that spray treatments had a significant effect during both seasons of study.

The results showed that the best values of the studied traits were obtained from spraying with salicylic acid, followed by spraying with K- silicate. SA plays a crucial role in plant development, floral induction, and ion uptake. It counteracts the effects of ABA on leaf abscission and alters ethylene production and stomatal movement. Other functions attributed to SA include increasing chlorophyll and carotenoid levels, speeding up photosynthesis, and regulating the activity of key enzymes (Hayat *et al*., 2007 and 2008).

By increasing the activities of antioxidant enzymes such as SOD, CAT, GPX, APX, and GR, SA-pretreatment was shown to mitigate the negative effects of salt stress on photosynthesis and growth in V. radiata. (Khan *et al*., 2014) Exogenous SA has been shown to protect plants against a variety of stressors, and this resistance may be shown in increased photosynthetic capability (Sasheva *et al*. 2013) found that carotene levels in tomatoes were dramatically raised after being sprayed with salicylic acid (Tari *et al*. 2015).

The negative effects of salt on chlorophyll concentration (mg/g) were mitigated when foliar salicylic acid was applied (Bhasker *et al*., 2020). Si was shown to improve antioxidant defenses, keeping physiological activities like photosynthesis running even in salty soils (Saqib and Schubert, 2008).

Table 5b: Effect of interaction between foliar spraying and soil applications on nitrogen %, potassium %, phosphorus % and chlorophyll **(**SPAD**)** in plant of snap bean under salinity conditions during 2020-2021.

Treatment		**Nitrogen %**		**Potassium %**		**Phosphorus %**		**Chlorophyll (SPAD)**	
		S1	**S2**	**S1**	**S2**	**S1**	**S2**	**S1**	**S2**
Tap water	**Control**	1.233 j	1.380 n	1.060 n	1.413 o	0.326 n	0.366 l	35.00 o	36.02 m
	CS.	1.433 ij	1.620 mn	1.283 m	1.850 mn	0.380 lm	0.418 jk	36.63 mn	36.46 lm
	VC	1.653 i	1.718 m	1.295 lm	1.833 n	0.366 m	0.403 kl	37.63 j-m	37.50 kl
	Bsubtilis	1.763 hi	1.839 lm	1.330 k-m	1.900 m	0.353 m	0.388 kl	37.23 l-n	37.13 l
	AMF	2.033 gh	2.136 kl	1.402 k-m	2.003 l	0.392 lm	0.418 jk	37.93 j-l	38.34 jk
	CS+*B.subtilis*	2.200 g	2.320 k	1.435 k-m	2.050 kl	0.406 kl	0.447 h-j	37.36 k-n	37.33 kl
	VM+*B.subtilis*	2.223 g	2.345 k	1.458 kl	2.083 jk	0.413 kl	0.454 h-j	38.16 j-l	39.22 h-j
	CS+AMF	2.676 f	2.844 j	1.470 k	2.100 jk	0.440 i-k	0.484 h	38.30 jk	39.05 h-j
	VC+AMF	2.576 f	2.833 j	1.493 k	2.133 j	0.423 jk	0.465 hi	37.43 k-n	39.22 h-j
Potassium Silicate	**Control**	2.736 ef	3.184 ij	1.378 k-m	2.296 i	0.442 jk	0.419 jk	36.46 n	38.78 ij
	CS.	2.796 d-f	3.256 i	1.880 i	2.350 h	0.452 h-j	0.453 h-j	37.70 j-m	39.86 gh
	VC	3.056 c-e	3.568 h	2.002 g-i	2.383 h	0.467 g-i	0.537 g	37.63 j-m	39.69 g-i
	Bsubtilis	3.270 bc	3.824 d-h	1.960 hi	2.333 hi	0.447 g-i	0.530 g	38.13 j-l	40.09 gh
	AMF	3.196 c	3.736 f-h	2.072 f-h	2.466 g	0.497 fg	0.572 fg	38.53 ij	40.46 g
	CS+*B.subtilis*	3.246 bc	3.796 e-h	2.171 e-g	2.585 f	0.478 gh	0.550 g	39.76 gh	41.67 f
	VM+*B.subtilis*	3.180 c	3.716 f-h	2.240 d-f	2.666 e	0.493 fg	0.567 fg	40.46 f-h	41.87 f
	CS+AMF	3.336 bc	3.904 d-g	2.366 cd	2.833 d	0.516 f	0.593 ef	39.53 hi	42.05 ef
	VC+AMF	3.116 cd	3.640 gh	2.380 cd	2.816 d	0.549 e	0.632 de	40.73 e-g	42.18 ef
Salicylic acid	**Control**	3.193 c	3.093 ij	1.700 j	2.833 d	0.426 jk	0.426 i-k	41.63 c-e	42.22 de
	CS.	3.126 cd	3.946 d-g	2.285 de	2.850 d	0.563 e	0.600 ef	41.03 d-f	42.82 de
	VC	3.260 bc	4.104 b-e	2.596 b	2.950 c	0.601 cd	0.646 d	42.53 bc	43.86 b-d
	Bsubtilis	3.233 c	4.053 c-f	2.478 bc	2.920 c	0.578 de	0.664 d	42.56 bc	43.76 cd
	AMF	3.243 c	4.066 c-f	2.537 bc	2.900 c	0.632 bc	0.704 c	42.83 b	43.93 bc
	CS+*B.subtilis*	3.396 bc	4.265 a-c	2.537 bc	2.950 c	0.628 c	0.708 bc	42.33 bc	44.91 ab
	VM+*B.subtilis*	3.313 bc	4.157 b-d	2.891 a	2.950 c	0.663 ab	0.743 ab	42.03 b-d	45.08 a
	CS+AMF	3.583 ab	4.405 ab	2.992 a	3.054 b	0.663 ab	0.752 a	43.56 bc	45.78 a
	VC+AMF	3.916 a	4.491 a	3.060 a	3.168 a	0.674 a	0.756 a	44.06 a	45.28 a

Table 6a: Effect of foliar spraying and soil applications on Chlorophyll a, Chlorophyll b and Carotenoids in pods of snap bean under salinity conditions during 2020- 2021 seasons.

Parameter	**Chlorophyll a (mg/100 g FW)**		**Chlorophyll b (mg/100 g FW)**		**Carotenoids (mg/100 g FW)**	
Season	**S1**	**S2**	**S1**	**S2**	**S1**	**S2**
Treatment						
			Foliar Spray treatments			
Tap water	1.48 c	1.47 c	1.94 a	1.60 c	0.98 c	0.89 b
Potassium silicate	1.84 b	2.05 b	2.02 a	2.05 b	1.21 b	0.82 b
Salicylic acid	2.21 a	2.60 a	2.36 a	2.77 a	1.46 a	1.00 a
			Soil application			
Control	1.59 d	1.73 h	1.76 b	1.77 h	1.18 bc	0.86 b-d
CS.	1.69 cd	1.81 g	1.89 b	1.86 g	1.49 a	1.061 a
VC	1.81 b-d	1.88 f	2.00 ab	1.93 f	1.00 c	0.84 cd
B. subtilis	1.80 b-d	1.95 e	2.01 ab	2.08 e	1.19 bc	0.91 b
AMF	1.79 b-d	2.05 d	2.08 ab	2.18 d	1.20 bc	0.86 cd
CS+*B. subtilis*	1.99 ab	2.11 cd	2.26 ab	2.25 cd	1.33 ab	1.03 a
VM+*B. subtilis*	1.83 bc	2.15 bc	2.06 ab	2.29 bc	1.20 bc	0.88 bc
CS+AMF	2.00 ab	2.21 b	2.21 ab	2.36 b	1.30 ab	0.88 bc
VC+AMF	2.11 a	2.44 a	2.68 a	2.53 a	1.09 c	0.82 d

Control: Without any soil addition **CS:** Corn stalk **VM:** Vermicompost ***B. subtilice*:** *Basilluc subtilis* **AMF**: Arbusculare Mycorrhizae Fungi.

3.3.2 Effect of soil application treatments

Results in (Table 6a) shows the effect of nine soil application treatments, on Chlorophyll a, Chlorophyll b and Carotenoids in pods.

The results showed a significant effect of soil application treatments. The highest values were obtained from the addition of VC + AMF treatment followed by addition of CS+ AMF treatment. The negative effects of salty soil on plant morphological and physiological characteristics may be greatly attenuated by the use of vermicompost by decreasing the damaging impacts of toxic components and producing an anti-stress effect (Moghdam, 2020). Results in (Table 6a) show the effect of nine soil application treatments, i.e. without any floor addition (control), corn stover, Vermicompost, bacteria bacillus, mycorrhizal fungi, corn stover + bacteria, vermicompost, bacteria, corn stover, mycorrhizal fungi, vermicompost + mycorrhizal fungi on Chlorophyll a, Chlorophyll b and Carotenoids in pods. Vermicompost improved the quality and growth of strawberries, which they attribute to the soil's increased enzymatic activity, increased rate of photosynthesis, and reduction of free radicals. Their findings demonstrated that adding these substrates to the soil enhanced growth characteristics (an increase in biomass) and chlorophyll content in salinity-prone environments (Yanan *et al*., 2018). Because of improvements in photosynthesis, free radical removal, and soil enzymatic activity, vermicompost was shown to have a beneficial effect on green bean quality and growth.

3.3.3. Interaction effect between foliar spraying and soil application treatments

Results in (Table 6b) show the interaction between spraying three spray treatments, (tap water, K- silicate and SA) and nine soil application treatments solo or inoculated on Chlorophyll a, Chlorophyll b and Carotenoids in snap bean pods.

Table 6b: Effect of interaction between foliar spraying and soil applications on Chlorophyll a, Chlorophyll b and Carotenoids in pods of snap bean under salinity.

	Parameter	**Chlorophyll a (mg/100 g FW)**		**Chlorophyll b (mg/100 g FW)**		**Carotenoids (mg/100 g FW)**	
Treatment	**Season**	**S1**	**S2**	**S1**	**S2**	**S1**	**S2**
Tap water	**Control**	1.59 e-h	1.17 u	1.49 de	1.28 q	1.34 c-g	1.22 b
	CS.	1.39 g-i	1.26 tu	1.73 c-e	1.39 pq	1.93 a	1.45 a
	VC	1.50 f-i	1.30 st	1.27 e	1.43 op	0.84 lm	0.65 k-m
	B. subtilis	1.39 g-i	1.38 s	1.73 c-e	1.52 o	1.02 f-m	1.37 a
	AMF	1.56 f-h	1.51 r	1.76 b-e	1.67 n	0.86 j-m	0.73 i-k
	CS+*B. subtilis*	1.52 f-h	1.58 qr	2.52 a-e	1.74 mn	1.09 f-l	1.03 de
	VM+*B. subtilis*	1.27 hi	1.61 qr	2.42 a-e	1.78 mn	0.98 g-m	0.98 ef
	CS+AMF	1.72 d-g	1.68 pq	2.59 a-d	1.84 lm	1.34 c-f	0.80 g-i
	VC+AMF	1.40 g-i	1.74 op	1.92 b-e	1.80 m	0.94 h-m	0.82 g-i
Potassium Silicate	**Control**	1.11 i	1.77 op	1.41 de	1.77 mn	0.72 m	0.61 m
	CS.	1.44 g-i	1.86 no	1.76 b-e	1.86 lm	0.92 i-m	0.99 de
	VC	1.51 f-i	1.93 mn	1.52 c-e	1.93 kl	0.93 i-m	0.79 hi
	B. subtilis	1.97 b-e	1.99 lm	2.04 b-e	1.99 jk	1.29 c-h	0.72 i-l
	AMF	1.97 b-e	2.08 kl	3.07 ab	2.08 ij	1.55 b-d	0.69 j-m
	CS+*B. subtilis*	2.24 bc	2.14 jk	1.81 b-e	2.14 hi	1.33 c-g	1.02 de
	VM+*B. subtilis*	2.10 b-d	2.17 i-k	2.18 a-e	2.17 hi	1.35 c-f	0.96 ef
	CS+AMF	1.99 b-e	2.22 h-j	1.73 c-e	2.22 gh	1.21 d-k	1.0 de
	VC+AMF	2.23 bc	2.25 h-j	2.61 a-d	2.25 gh	1.59 a-c	1.37 a
Salicylic acid	**Control**	1.77 d-g	2.27 hi	1.58 c-e	2.27 gh	1.89 ab	1.15 bc
	CS	2.22 bc	2.33 gh	2.17 b-e	2.33 fg	1.49 c-e	1.18 bc
	VC	1.86 c-f	2.42 fg	2.50 a-e	2.42 f	1.22 d-j	1.08 cd
	B. subtilis	2.04 b-d	2.48 ef	2.24 a-e	2.73 e	1.26 c-i	0.60 m
	AMF	2.21 bc	2.55 de	2.81 a-c	2.81 de	1.18 e-l	0.63 lm
	CS+*B. subtilis*	2.11 b-d	2.60 cd	2.45 a-e	2.86 cd	1.58 a-c	0.63 lm
	VM+*B. subtilis*	2.29 b	2.67 bc	1.68 c-e	2.94 bc	1.26 c-i	1.08 cd
	CS+AMF	2.74 a	2.73 b	2.32 a-e	3.00 b	0.92 i-m	0.73 i-k
	VC+AMF	2.70 a	3.34 a	3.49 a	3.55 a	0.85 k-m	0.89 fg

Control: Without any soil addition **CS:** Corn stalk **VM:** Vermicompost ***B. subtilice*:** *Basilluc subtilis* **AMF**: Arbusculare Mycorrhizae Fungi.

All treatments led to a significant increase in the chemical analyses of Chlorophyll a, Chlorophyll b and Carotenoids in snap bean pods compared to the control. The greatest values were found for the mutual influence of additions VC+AMF and spraying with SA followed by interaction between addition CS+ AMF and spraying with salicylic acid.

3.4 Characteristic of pod length, pod weigh and pod diameter of snap bean:

3.4.1 Effect of foliar spraying treatments :

Results in (Table 7a) show the effect of three spray treatments (tap water, K- silicate and SA) on pod length, pod weigh and pod diameter it is obvious from the data that spray treatments had a significant effect during both seasons of study. In this respect the best spray treatment that gave the highest values of pod length, pod weigh and pod diameter from the treatment resulting from spraying with salicylic acid followed by k- silicate compared to plants sprayed with water (control). Multiple salinity stresses had a substantial effect on pod mass and diameter. Possible causes include salt stress's disruptive influence on water availability and absorption, which lowers plant tissues' water content and alters metabolic activities inside the cell (Latif and Mohamed, 2016). Application of salicylic acid as foliar spray caused increase in vegetative growth, yield and quality (Abd El-Mageed *et al*., 2016).

Table 7a: Effect of foliar spraying and soil applications on pod length, pod weigh and pod diameter of snap bean under salinity conditions during 2020-2021 seasons.

Parameter	**Pod length**		**Pod weight**		**Pod diameter**	
Season	**S1**	**S2**	**S1**	**S2**	**S1**	**S2**
			Foliar spray treatments			
Tap water	10.43 c	10.95 c	3.01 c	3.21 c	0.69 c	0.73 c
Potassium silicate	12.05 b	12.79 b	3.32 b	3.59 b	0.75 b	0.82 b
Salicylic acid	12.89 a	13.44 a	3.49 a	3.75 a	0.80 a	0.87 a
			Soil application treatments			
Control	10.01 d	10.98 f	2.83 g	3.05 g	0.67 c	0.76 d
CS.	11.50 bc	12.15 de	3.16 ef	3.39 ef	0.76 ab	0.84 a
VC	11.96 b	12.43 cd	3.27 de	3.51 de	0.79 a	0.81 b-d
B. subtilis	11.01 c	11.84 e	3.04 f	3.27 f	0.75 ab	0.79 cd
AMF	11.92 b	12.63 bc	3.32 cd	3.57 cd	0.76 ab	0.80 cd
CS + *B. subtilis*	11.88 b	12.60 bc	3.28 d	3.53 cd	0.75 ab	0.78 d
VM + *B. subtilis*	11.98 b	12.70 bc	3.40 bc	3.66 bc	0.79 a	0.82 a-c
CS+AMF	12.02 a	12.93 ab	3.49 b	3.75 b	0.73 b	0.84 ab
VC+AMF	13.74 a	13.28 a	3.67 a	3.94 a	0.74 ab	0.79 cd

Control: Without any soil addition **CS:** Corn stalk **VM:** Vermicompost ***B. subtilice*:** *Basilluc subtilis* **AMF**: Arbusculare Mycorrhizae Fungi.

Strawberry fruit length and fruit quality indicators were protected from the negative effects of salt stress after being treated with SA. The salicylic acid foliar application not only mitigated the negative effects of salt stress, but also yielded the best results across the board in terms of the physical fruit quality parameters that were evaluated. This may be because its antioxidant properties have allowed it to grow more efficiently and produce higher-quality fruit (Jamali *et al*., 2015). Faba bean pod quality, chemical composition, and yield all improved when silicon was added to the growing medium (Abou-Baker *et al*., 2011).

3.4.2 Effect of soil application treatments :

The results of nine soil application treatments (control, CS, VC, *B. subtilis*, AMF, CS + *B. subtilis*, VC + *B. subtilis*, CS + AMF, VC + AMF) as affecting snap bean pods quality (pod length, pod weigh and pod diameter) are given in table (7a). Mean values of pod length, pod weigh and pod diameter revealed highly significant differences under the studded soil application treatments in both two growing seasons. It is evident that the addition of VC + AMF to soil in both seasons, resulted in significant increase pod snap bean characteristic followed by addition of CS + AMF treatment compared to the other soil application treatments.

If you want to guarantee the quantity and quality of your crops without resorting to the use of agrochemicals, consider using vermicompost instead. The exogenous administration of humic acid increases plant development under salt stress conditions by increasing the accumulation of critical nutrients, as has been shown in a number of studies, for example, in bean (*Phaseolus vulgaris* L.) (Cimrin *et al*. 2010). Previous reports have shown that vermicompost moderates the detrimental effects of salinity stress on several crops (Ayyobi *et al*., 2014).

3.4.3 Interaction effect between of foliar spraying and soil application treatments

Results in (Table 7b) shows the interaction between spraying three spray treatments (tap water, K- silicate and SA) and nine soil application treatments on snap bean pods quality, i.e. pod length, pod weight and pod diameter of snap bean.

Table (7b): Effect of interaction between foliar spraying and soil application on pod length, pod weight and pod diameter of snap bean under salinity conditions during 2020-2021 seasons.

	Parameter	**Pod length**		**Pod weight**		**Pod diameter**	
	Season	**S1**	**S2**	**S1**	**S2**	**S1**	**S2**
Tap water	**Control**	8.56 o	9.73 l	2.65 n	2.83 n	0.65 i	0.67 g
	CS	9.83 n	10.23 kl	2.79 mn	2.99 mn	0.68 hi	0.70 e-g
	VC	10.36 mn	10.76 i-k	3.00 j-m	3.21 j-m	0.71 f-i	0.70 fg
	B. subtilis	9.80 n	10.20 kl	2.88 k-m	3.11 k-m	0.72 f-i	0.72 e-g
	AMF	10.70l mn	11.10 ij	3.05 i-k	3.26 j-l	0.70 g-i	0.73 d-f
	CS+*B. subtilis*	10.90 k-m	11.30 hi	2.99 j-m	3.20 j-m	0.70 f-i	0.74 d-f
	VM+*B. subtilis*	10.93 k-m	11.33 hi	3.16 g-j	3.42 g-j	0.72 f-i	0.75 d-f
	CS+AMF	11.46 i-l	11.86 gh	3.19 f-j	3.38 h-j	0.72 f-i	0.78 cd
	VC+AMF	11.30 j-m	12.10 e-g	3.34 e-g	3.57 f-h	0.66 i	0.78 d
Potassium silicate	**Control**	9.83 n	10.50 j-l	2.82 l-n	3.17 l-n	0.65 i	0.78 cd
	CS	11.83 h-k	12.50 d-g	3.38 e-g	3.64 e-g	0.76 b-h	0.78 cd
	VC	12.00 g-j	12.66 c-f	3.28 f-h	3.53 g-i	0.81 a-c	0.85 ab
	B. subtilis	10.93 k-m	11.93 f-h	3.07 h-k	3.31 i-k	0.72 e-i	0.78 d
	AMF	12.10 f-j	13.10 b-d	3.38 e-g	3.64 e-g	0.80 a-e	0.83 bc
	CS + *B. subtilis*	12.70 c-h	13.36 a-c	3.25 f-i	3.50 g-i	0.72 d-i	0.75 de
	VM + *B. subtilis*	12.40 e-i	13.40 a-c	3.39 d-f	3.66 d-g	0.84 ab	0.84 ab
	CS+AMF	13.00 b-f	13.66 ab	3.59 b-d	3.87 b-e	0.68 hi	0.86 ab
	VC+AMF	13.66 a-c	13.76 ab	3.76 ab	4.06 ab	0.75 c-h	0.86 ab
Salicylic acid	**Control**	11.63 i-l	12.73 c-e	3.03 i-l	3.26 j-l	0.69 hi	0.88 ab
	CS	12.83 b-g	13.73 ab	3.30 f-h	3.54 g-i	0.85 a	0.88 ab
	VC	13.53 a-d	13.86 ab	3.52 c-e	3.79 c-f	0.86 a	0.88 ab
	B. subtilis	12.30 e-i	13.40 a-c	3.18 f-j	3.42 g-j	0.81 a-d	0.88 ab
	AMF	13.16 a-e	13.70 ab	3.54 b-e	3.80 c-f	0.78 a-g	0.82 ab
	CS + *B. subtilis*	12.06 f-j	13.13 b-d	3.61 b-d	3.80 b-e	0.70 a-c	0.85 ab
	VM + *B. subtilis*	12.63 d-h	13.26 a-c	3.66 bc	3.91 b-d	0.75 a-c	0.87 ab
	CS+AMF	13.76 ab	13.36 a-d	3.71 a-c	3.99 a-c	0.82 a-f	0.89 a
	VC+AMF	14.10 a	14.00 a	3.95 a	4.20 a	0.83 a-c	0.89 a

Control: Without any soil addition **CS:** Corn stalk **VM:** Vermicompost ***B. subtilice*:** *Basilluc subtilis* **AMF**: Arbusculare Mycorrhizae Fungi.

All treatments led to a significant increase in the chemical analyses of pod length, pod weight and pod diameter of snap bean compared to the control. The highest reading was for pods treatment by VC, AMF and spraying with SA followed by plants obtained CS, AMF and spraying with SA.

3.5. Total snap bean yield and its components :

3.5.1. Effect of foliar spray treatments :

Results in (Table 8a) show the effect of three spray treatments (tap water, K-silicate and SA) on total yield, marketable yield, plant yield /g and number of pods/plant it is obvious from the data that spray treatments had a significant effect during both seasons of study. In this respect the best spray treatment that gave the highest values of total yield, marketable yield, plant yield /g and number of pods/plant from the treatment resulting from spraying with salicylic acid followed by k- silicate compared to plants sprayed with tap water (control).

Salicylic acid has a profound effect on stressed plants in saline environments, increasing physiological parameters and production normally associated with salinity treatment. This may be due to an increase in CO2 incorporation and photosynthetic rate as well as an enrichment of mineral uptake. (Szepesi *et al*., 2005).in the same trend application of Salicylic acid in salt treated Mung bean plants were beneficial which may be due to its influence on translocation of CO_2 (Karlidag *et al*., 2009). (Hayat *et al*., 2010) proved that SA helps the plants to increase the yield under stress conditions. This increase of yield by SA may be due to its physiological role such as absorption of ions (Simaei *et al*, 2012). The increased growth vigor of bean plants under salt stress was reflected positively in green pod and dry seed yields, which may be attributable to a greater assimilate partitioning to developing consumable portions and was correlated with exogenous SA in the treatments (Rady *et al*.,2013). Treatment with SA greatly boosted production since it has been shown to trigger flowering in plants under salinity stress, which is a major factor that directly affects plant productivity and yield (Jamali *et al*., 2015). The integrated application of SA as a foliar spray substantially enhanced growth characteristics (i.e., shoot length, leaf number per plant, and plant dry weight), green pod and dry seed yields. (pod weight per plant and per hectare, and seed weight per plant and per hectare) (Mostafa *et al*., 2015). Natural salicylic acid (SA) is involved in plant tolerance to environmental stressors as an endogenous signal molecule (Sofy *et al*., 2020). SA application on plant affected foliar spray with salicylic acid caused increase in vegetative growth, yield and quality (Abd El-Mageed *et al*., 2016; AL-Rubaye and Atia, 2016) .Tahir *et al*. (2006) demonstrating that the addition of Si increased grain yield from 50% to 225%. Silicon amendment improves the translocation of minerals and metabolites necessary for seed setting, as evidenced by an increase in seed yield under saline conditions. Silicon application substantially enhanced the 100-seed weight and yield of faba bean in saline conditions. The use of Si in salinity conditions mitigated the detrimental effects of salinity on the yield component of the bean plant. (Fakher *et al*., 2013).

3.5.2. Plant yield, number of pods, total yield and marketable yield of snap bean

Effect of soil application treatments:

Results in (Table 8a) show the effect of nine soil application treatments (control, CS, VM, *B. subtilis*, AMF, CS + *B. subtilis*, VC + *B. subtilis, CS*+ AMF, VC + AMF) plant yield /g, number of pods/plant on total yield, and marketable yield. All treatments showed that a significantly effects on total pods snap been and its components, i.e. Total yield, marketable yield, plant yield /g and number of snap beans. All treatments led to a significant increase in total snap pods yield and its components under study compared with the control treatment.

The highest reading was for plants obtained from VC and AMF treatment followed by plants obtained from CS and AMF treatment. Several studies have demonstrated that the favorable effects of VC on crop growth under salt stress conditions are due to the fact that it increases the accumulation of essential nutrients, for example, in bean (*Phaseolus vulgaris* L) (Cimrin *et al*., 2010). The use of VC was able to increase the vegetative characteristics, yield of pods and P, Ca, K, total proteins, and total soluble phenols in green pods in bean plants (Ahmed *et al*., 2018). Vermicompost humates enhance crop quality and yield while reducing the use of chemical fertilizers, thereby fostering more sustainable agricultural practices. (Chiquito-Contreras *et al*. 2018). Vermicompost its application in the soil improves the productivity of crops in the presence of salinity (Ruiz-Lau *et al*., 2020). (Bezabeh *et al*., 2021) are also reported to increase the growth with vermicompost and increase of 40% for the flowering rate and 35% for the marketable fruit and yield of the strawberry plant .Our data presented that due to its porous structure, high water storage capacity, hormone-like substances and plant growth regulators, and high levels of macro and micronutrients, vermicompost can play a significant role in plant growth and development, as well as in mitigating the negative effects of salinity stress on plants. Which results in increased growth and yield of bean plants, this is consistent with (Abdollah *et al*., 2016). Soil water storage and crop productivity were both shown to increase with the addition of a buried stover layer, as shown in the research (Zhao *et al*., 2014). The increase in sunflower yield could be attributed to the positive effects of returning stover to the soil, which increased soil porosity and aeration, thereby enhancing plant growth (Tejada *et al*., 2008).

Table 8a: Effect of foliar spraying and soil application on total yield, marketable yield, plant yield / g and number of pods/plant of snap bean under salinity conditions during 2020-2021 seasons.

Parameter	**Total yield (ton/fed)**		**Marketable yield (ton/fed)**		**Plant yield /g**		**Number of pods/Plant**	
Season	**S1**	**S2**	**S1**	**S2**	**S1**	**S2**	**S1**	**S2**
				Foliar Spray treatments				
Tap water	3.577 c	3.714 c	3.07 b	3.23 b	58.55 c	64.99 c	17.9 c	19.3 c
K- silicate	4.009 b	4.258 b	3.51 a	3.68 a	65.19 b	72.36 b	18.9 b	20.0 b
Sali cylic acid	4.173 a	4.460 a	3.59 a	3.77 a	67.13 a	74.52 a	19.3 a	20.9 a
				Soil application treatments				
Control	3.363 f	3.639 f	2.76 e	2.93 e	56.04 f	62.20 f	17.0 e	18.4 e
CS	3.679 e	3.884 e	3.09 d	3.53 c	59.91 ef	66.50 ef	18.8 bc	20.2 bc
VC	3.987 cd	4.209 cd	3.46 c	3.52 c	64.69 cd	71.81 cd	19.0 bc	20.3 bc
B. subtilis	3.594 e	3.793 e	3.05 d	3.64 c	59.52 ef	66.06 ef	18.3 d	19.6 d
AMF	3.906 d	4.123 d	3.37 c	3.20 d	61.30 de	68.05 de	18.8 bc	20.0 bc
CS + *B. subtilis*	3.882 d	4.098 d	3.35 c	3.81 b	63.96 cd	70.99 cd	18.6 cd	20.0 cd
VM + *B. subtilis*	4.124 bc	4.353 bc	3.63 b	3.94 b	66.70 bc	74.03 bc	19.1 a-c	20.4 a-c
CS+AMF	4.234 b	4.469 b	3.75 b	3.81 b	69.65 ab	77.31 ab	19.2 ab	20.6 ab
VC+AMF	4.508 a	4.729 a	4.03 a	4.23 a	70.85 a	78.64 a	19.5 a	20.9 a

Control: Without any soil addition **CS:** Corn stalk **VM:** Vermicompost ***B. subtilice***: *Basilluc subtilis* **AMF**: Arbusculare Mycorrhizae Fungi.

3.5.3. Interaction effect between of foliar spraying and soil application treatments:

Results in (Table 8b) show the interaction between spraying three spray treatments (tap water, K-silicate and SA) and of nine soil application treatments on snap bean pods yield / plant(g), number of pods/plant, total yield and marketable yield.

Table 8b: Effect of foliar spraying and soil applications on total yield, marketable yield, plant yield / g and number of pods/plant of snap bean under salinity conditions during 2020-2021 seasons.

Parameter	**Total yield (ton/fed)**		**Marketable yield (ton/fed)**		**Plant yield / g**		**Number of Pods/Plant**	
Season	**S1**	**S2**	**S1**	**S2**	**S1**	**S2**	**S1**	**S2**
				Spray treatment				
Tap water	3.577 c	3.714 c	3.07 b	3.23 b	58.55 c	64.99 c	17.9 c	19.3 c
Potassium silicate	4.009 b	4.258 b	3.51 a	3.68 a	65.19 b	72.36 b	18.9 b	20.0 b
Salicylic acid	4.173 a	4.460 a	3.59 a	3.77 a	67.13 a	74.52 a	19.3 a	20.9 a
				Soil application treatments				
Control	3.363 f	3.639 f	2.76 e	2.93 e	56.04 f	62.20 f	17.0 e	18.4 e
CS	3.679 e	3.884 e	3.09 d	3.53 c	59.91 ef	66.50 ef	18.8 bc	20.2 bc
VC	3.987 cd	4.209 cd	3.46 c	3.52 c	64.69 cd	71.81 cd	19.0 bc	20.3 bc
B. subtilis	3.594 e	3.793 e	3.05 d	3.64 c	59.52 ef	66.06 ef	18.3 d	19.6 d
AMF	3.906 d	4.123 d	3.37 c	3.20 d	61.30 de	68.05 de	18.8 bc	20.0 bc
CS + *B. subtilis*	3.882 d	4.098 d	3.35 c	3.81 b	63.96 cd	70.99 cd	18.6 cd	20.0 cd
VM + *B. subtilis*	4.124 bc	4.353 bc	3.63 b	3.94 b	66.70 bc	74.03 bc	19.1 a-c	20.4 a-c
CS + AMF	4.234 b	4.469 b	3.75 b	3.81 b	69.65 ab	77.31 ab	19.2 ab	20.6 ab
VC + AMF	4.508 a	4.729 a	4.03 a	4.23 a	70.85 a	78.64 a	19.5 a	20.9 a

Control: Without any soil addition **CS:** Corn stalk **VM:** Vermicompost ***B. subtilice***: *Basilluc subtilis* **AMF**: Arbusculare Mycorrhizae Fungi.

All treatments led to a significant increase in total yield, marketable yield, plant yield and number of pods of snap bean compared to the control. The highest reading was for pods treatment by VC+ AMF and spraying with SA followed by plants obtained CS+ AMF and SA (Kassem *et al.*, 2018). It has been demonstrated that the application of vermicompost supplemented with silicates (foliar application) mitigates the detrimental effects of a salty soil. When applied separately, it diminishes the concentration of Na+ and proline in the plant's branches and improves growth, nutrient content, and yield; however, when applied together, it improves these parameters and nutrient content. (N, P and K). These results demonstrated that vermicomposting and the application of silicates could be used to reduce the harm caused by plant stress on saline soils.

3.6. Soil Properties

Soil analyses were done after the first and second seasons have concluded (2021& 2022). Regarding soil electric conductivity (EC) data in Fig. (1) showed a slight decreasing in soil EC and the highest values were recorded from control treatment under salt stress in the first and second seasons. As for soil pH it was observed that, all treatments decreased slightly in soil pH and no obvious trend was observed during two seasons. Meanwhile, salicylic acid and potassium silicate treatments increased K+ and reduced Na$^{+,}$ Cl^{-} values in the root rhizosphere as compared with control treatment (Badia, 2000).

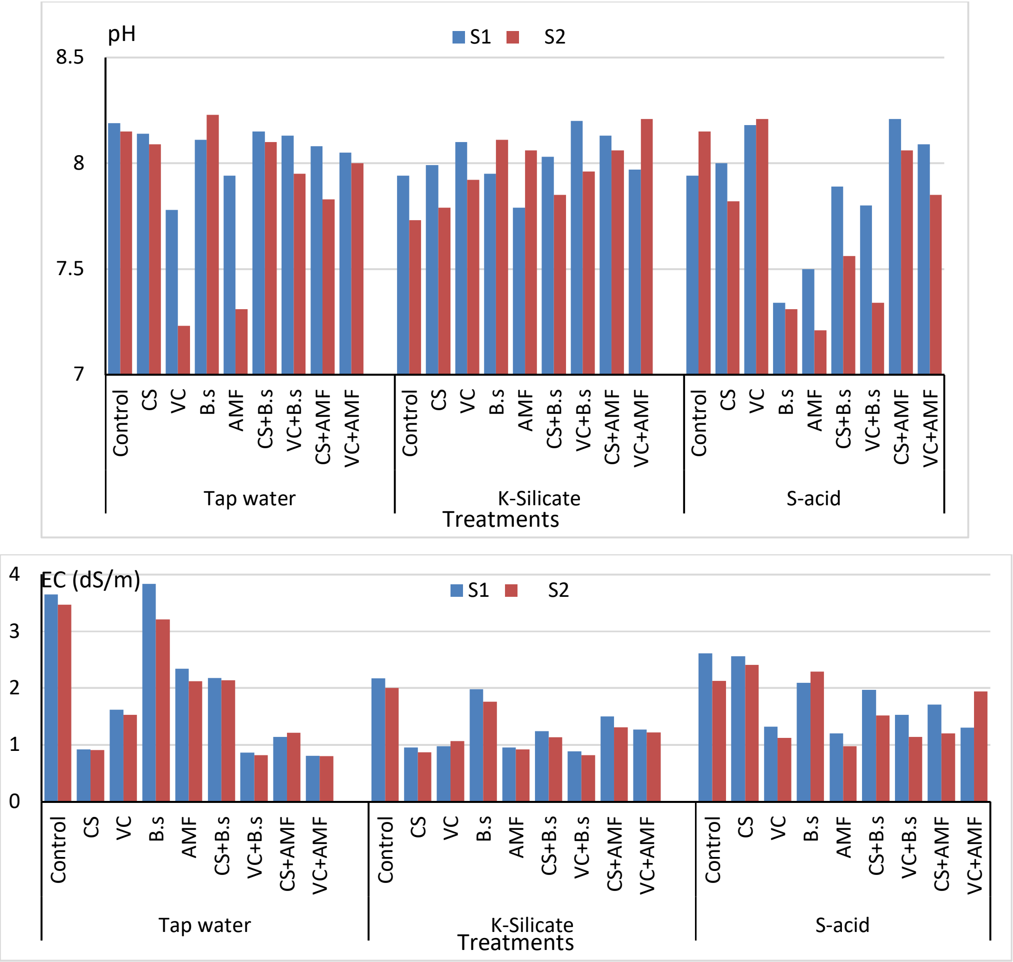

Fig. 1: Effect of foliar and soil application Permutations and combinations on soil pH and EC at harvest of *Phaseolus vulgaris* L.

pH-EC

Soil EC values differed significantly among treatments on soil under studying. In saline soil, the application of corn stalk and vermicompost led to lower EC than other treatments; the lowest values were reported in the vermicompost applications with AMF and salicylic acid in the first and second seasons, respectively. (1.3,1.9 dSm^{-1}). In contrast, the application of individual application of ground additive.

There is no significant difference, whereas VC application decreased it. There was an interaction for EC between the soils and treatments, showing that the application of CS and VC had an impact on EC in each treated soil Fig (1).

In conclusion, managing soil organic matter affected soil salinity, and vice versa, soil salinity affected how soil organic matter mineralized. In relation to physico-chemical properties, the relevance of these interactions varied for saline soil in comparison to non-saline soil. An osmotic action is revealed by the rapid change in EC associated with salt intent. The pH also has a significant impact on the nutrients that are available to plants. Elemental deficiencies can be caused by either an acidic or basic environment. Soil pH in areas of high salinity and alkalinity was reportedly balanced by compost (Ozenc *et al*., 2001). As a result of nitrification, compost frequently causes a pH decrease in soil (Harrison *et al*., 1994).

3.6.1. Snap bean photosynthetic pigment concentration.

Chlorophyll concentration in snap beans, a key physiological measure of a plant's photosynthetic potential, was profoundly influenced by the aforementioned three primary components (salinity, AMF, *B. subtilis*, ground and foliar additive compound) Table (6 a,b). Snap bean chlorophyll concentration was considerably decreased by salinity, most likely because of inhibition of certain enzymes of the photosynthetic system and decreased uptake of nutrients like Magnesium (Mg) and Nitrogen (N) for chlorophyll biosynthesis. These findings are consistent with those reported by Murkute *et al*. (2006) and Selvakumar *et al*. (2011).

The concentration of snap chlorophyll increased noticeably after AMF treatment. Increased nutrient uptake and decreased Na concentrations in the plants are likely responsible for this effect, which manifests itself as more chlorophyll in the final product. Data represent that pre-inoculated with Glomus sp. had higher snap chlorophyll concentration than the other ground additives, and that there was a significant effect in some combinations of salicylic acid as foliar and AMF species, while in others a significant decline was observed with individual additive vermicompost 37.5 and corn stalk. vermicompost inoculated with AMF and *B. subtilis* had higher chlorophyll concentration 48.3, 49.2 respectively, compared to other AMF treatments.

3.6.2. Leaf proline concentration

Plant stress tolerance may be improved through endogenous proline supplementation, alterations in proline levels caused by water and salt stress, or the accumulation of free amino acids (Ashraf and Foolad, 2007). Plants can protect themselves from free radical damage by accumulating proline in salty environments, where it acts as an osmolyte to regulate osmotic balance, stabilize proteins and membranes, and prevent cell death (Aggarwal *et al*., 2012 and Sannazzaro *et al*., 2007).

According to our findings, leaf proline concentrations were considerably influenced by all main therapy (AMF, VC and CS) (Fig.3). Proline concentrations decreased with co-inoculation of AMF with ground additive CS and VC and were higher in non-inoculated seedlings compared with control plants, At the foliar and ground additive in presence of AMF there were significant differences between varieties, with VC, AMF and SA Showing lowest proline concentration at 1st and 2sd seasons respectively (2.51,1.55 mg/g) and untreated treatment(control) Showing highest concentrations.

Vermicompost and corn stalk pre-inoculated with AMF as a ground additive and SA as a foliar had considerably lower proline concentrations across all treatments when exposed to salinity stress. (Fig. 2). Total chlorophyll concentrations and proline concentrations were correlated negatively (-0,7) (Fig. 2). Apparently, higher nutrient uptake, antioxidant enzyme and chlorophyll content due to the mycorrhizal symbiosis constitute an alternative way to alleviate salt Stress without increasing proline production.in the same trend considerable effect of AMF on proline as show in Fig (2) (corrl-0.4).

Many authors have reported that proline concentrations increased in AMF plants compared to non-AMF plants (Azooz *et al*., 2004) Nonetheless, other authors have found that non-AMF plants, such as *Ocimum basilicum* L. and *Arachis hypogaea* L., accumulate more proline than AMF plants (Al-Karaki, 2006; Elhindi *et al*., 2017). The underlying mechanisms deserve further study. We conclude from this treatment ultimately lead to adopting salt-tolerant plants. Plant metabolism of nitrogen directed to anabolism of protein molecules needed more than nitrogen conservation (storage) as proline.

It is noted that the previous results achieved the goal of these treatments, which is to increase the production of bean plants grown under salinity stress.

Correlations between total AMF% and Chlorophyll, proline concentration.
****Significant at *P* < 0.05 at probability level.**

Tap water has a weak effect on carotenoid and total chlorophyll, while in treatment of K-silicate plant developed carotenoid synthesis to face stress had appositive impact (+0.9) as chlorophyll synthesis so carotien faced stress. On contrary the data showed significant differences in the interaction effect between soil additives and salicylic acid spray which plant did not need to synthesis of carotien while chlorophyll increased due to removable of stress effect. This can be as indicator for carotien did not need to face stress.

Additionally, Chla and Chlb tend to decline while the chlorophyll a/b ratio tends to rise as a result of Chlb greater reduction than Chla's. Any plant has a higher Chla content than Chlb. Keeping Chla levels higher than Chlb levels is essential for survival. Therefore, Chlb may be transformed into Chla throughout the process of Chl degradation, increasing the amount of Chla. In contrast there is strong positive impact between AMF% and total chlorophyll especially at salycilic acid treatment (+0.88).

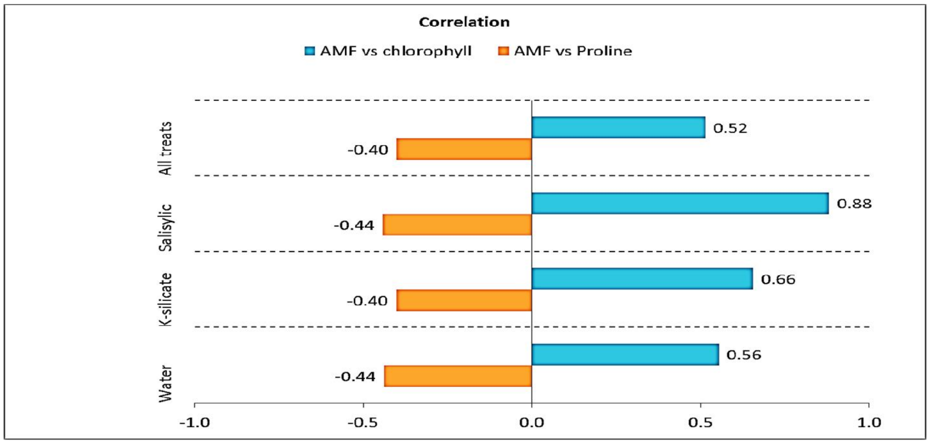

Fig. 2: Correlations between arbuscular michrohyzae Fungi % and chlorophyll, proline concentration. **Significant at *P* < 0.05 at probability level

3.6.3 Catalase enzyme

The current inquiry was carried out to investigate the effect of salinity on green bean antioxidative defense mechanism. In this study we have analyzed antioxidative enzyme catalase activity in green bean with different treatment under salt stressed conditions. As can be seen in fig. (3) Without any addition in ground or foliar spray there is a significant increase in (CAT), in contrary a significant decrease in the activity of (CAT) was found in VC inoculated with (AMF and *B. subtilise*) spray foliar with SA and CS with AMF in the same line proline is decreased in two seasons respectively. Thus, results suggest that (CAT) plays a significant role in redoxhomeostasis while Redox homeostasis is the continuously challenged oxidative/nucleophilic balance during salt stress in Green bean plant (Ghada *et al.*2019).

There may be a correlation between the elevation of catalase activity in green bean leaves in response to salt in untreated soil and the formation of hydrogen peroxide (H2O2) as a result of enhanced superoxide dismutase activity. Increased CAT activity under salinity likely resulted from a greater ability to scavenge oxygen radicals and preserve cellular membranes, revealing a connection between salt tolerance and the antioxidant defense system. While initial decrease at vermicompost inoculated with (AMF and *B. subtulise*) foliar spray with salicylic acid (9.85,8.75 mole H_2O_2/g fw) at two seasons respectively and then an increase at corn stalk spray by tape water 24.03 , 26.00 mole H_2O_2/g fw) (still the values were below those in the control 36.17 , 45.63 mole H_2O_2/g fw) shows that the leaves have adapted well to the increasing salt levels.

Salinity's effect on catalase activity in *Phaseolus vulgaris*, L leaf tissue is shown in Fig. (3). It is clear from the results that the activity of this enzyme was considerably decreased especially at vermicompost and cornstalk inoculated with AMF and higher in the other treatment. However, it was lower than control. The decrease in the activity of catalase in the leaves of the *Phaseolus vulgaris, L* under salinity stress may be regarded as there is no need of stimulated secondary metabolism. It may also does not need a defense system against the reactive oxygen species, particularly in plants grown under stress condition with ground and foliar additive especially salicylic acid more than K-silicate.

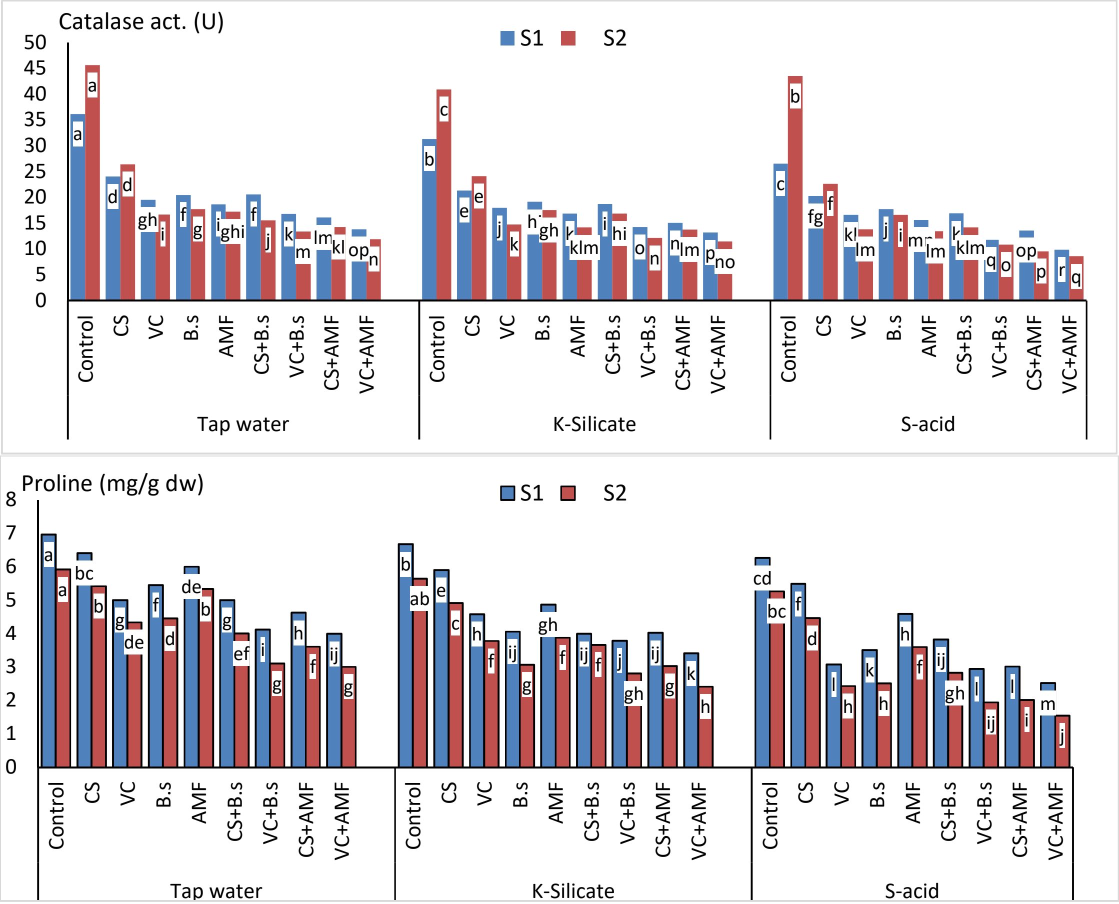

Fig. 3: Effect of foliar and soil application Permutations and combinations on catalase activity and proline content in leave of *Phaseolus vulgaris, L* cultivated in saline soil.

Finally, the antioxidant system has been affected by different additive treatments and they developed the performance of green bean. Untreated soil (control) enhanced the activity of catalase enzymes of green bean. This result like-minded with (Husen *etal*.,2018), which found that the function of SA in yields is probably due to its fundamental role in stress tolerance. It decreases oxidative damage and increases plant growth and yields under salinity stress and it also improves nutrient uptake and increases the levels of chlorophyll and carotenoid pigments, modulates the activities of several enzymes. It also plays a role in balancing plant hormones (Shakirova, 2007). Per *et al*. (2017) and Dietz *et al*. (2016) Confirms that green bean plant may be perform a consequence of reduction of the phytohormones product and that has been developed defense system of plant. This reinforces our findings from decrease in enzymes activities in green bean plant under ground and foliar additive treatments.

Thus, it was concluded that green bean is sensitive towards osmotic stress of salt our treatment makes the plant more health and enhanced osmotic pressure.

3.7 Soil Microbial Activities

The most likely reason contributing to the detected increases in biomass C was the addition of readily metabolizable C in organic waste products, as previously found by Blagodatsky *et al.* (2000) and Tejada and Gonzalez (2004) reported that the addition of easily available C causes the biomass of soil microbes to react quickly. The application of vermicompost in this study supplied additional bacterial substrates, which could be the cause of the observed rise in soil microbial biomass and respiration (Fig.4). Additionally, more substrates can improve the physical and chemical properties of the soil while reducing osmotic and salinity stress on microorganisms (El-Dakak *et al*., 2021). The presence of organic matter in the soil solution can serve as a buffer for the activities of soil microorganisms when salinity rises or, as in this study, when salt levels are already high. The lowest levels of AMF colonization and dehydrogenase activity were seen in unmodified soils, where microbial development was delayed, and EC remained high.

3.7.1 Development of the AMF

AMF colonization control plants (those that were not pre-inoculated) were also colonized by AMF as a result of the experiment, which was conducted in non-sterile field soil following pre-inoculation or not in sterilized soil, colonization levels were significantly lower than in the pre-inoculated seedlings. With various treatment additions, fractional root colonization considerably (P 0.05) increased. (fig.4). When compared to conditions under salinity and alkalinity stressors, the percentage of mycorrhizae colonization ratio and the number of entrance points on roots were both significantly lower after AMF injection. Similarly, the number of arbuscular was also significantly decreased compared to that under the salinity-alkalinity stresses. As expected, no AMF colonization was found in the roots of the non-inoculated green bean seedlings. AMF establishes mutualistic interactions with more than 80% of all plant species, providing a direct physical link between soils and plant roots to reach a regional nutrient-rich zone (Lenoir *et al*., 2016). AMFs have been implicated in boosting plant growth, photosynthesis, and tolerance to biotic and abiotic stresses (Cavagnaro *et al*., 2015).

Nevertheless, the regulatory mechanisms driving AMF-mediated tolerance under salinity-alkalinity stressors are still unknown and poorly understood. In the present study, we studied how the AMF treatment affected green bean plant growth, photosynthesis, antioxidant enzymes, and proline as a salt defense under salinity and alkalinity conditions. Our results indicated that inoculation with AMF could enhance the tolerance of salinity-alkalinity stresses of green bean seedlings by improving photosynthesis and dehydrogenase preventing damage to the chloroplast structure. Chloroplasts contain the pigment chlorophyll to absorb light energy and enhancing soil microbial rhizosphere. Promotion of plant growth by AMF has been documented in some plant species.

We observed that AMF affected proline, catalase, and carotenoid in a variety of ways. (Table 4). Roots of green bean seedlings are able to take in more nutrients and water because the extraradical mycelium takes more nutrients through the large hyphal network of AMF in the soil, transports nutrients into the fungal intraradical mycelium, and releases nutrients at arbuscular (Zhang *et al*., 2014; Lenoir *et al*., 2016; Hashem *et al*., 2018). This may help to explain why the AMF-inoculated green pean seedlings under salinity-alkalinity stress conditions had a better growth status than the non-inoculated seedlings.

This confirms the role of mycorrhizea in reducing the salinity stress on the plant, so it did not need proline and catalase as defense of ROS formed. Our findings are consistent with previous research demonstrating that salinity inhibits spore germination, inhibits the growth of hyphae after initial infection, and decreases the number of arbuscules (Latef and He, 2011).

3.7.2 Quantitative determination of dehydrogenase activity in salinity rhizosphere under study

Soil enzymes are considered sensitive indicators of soil health but are not well understood in saline-sensitive vegetable systems. One of the important The activities of soil enzyme involved in nutrient cycling dehydrogenase was evaluated during Two consecutive agriculture seasons2020-2021, ground additive of vermicompost, corn stalk and co inoculation with AMF and foliar additive with (salicylic acid, potassium silicate), winter cover crop frequency annually, and cover crop type (*Phaseolus vulgaris,* L). Results of the analysis of variance correlation are provided in Fig (4). In almost all treatment Effect on plant under salinity (AMF, VC, CS, SA and K-silicate) were significant sources of variation. Interactions between AMF with ground and foliar additive. All interactions were significant sources of variation for a correlation of parameters as well.

On average, dehydrogenase activity after first season increased incrementally with increasing organic matter inputs (vermicompost, cornstalk inoculate with mychorrhizea (Fig.4). Although the comparisons between these treatments included control, the correlation coefficient of these differences and raw data provide more evidence that dehydrogenase activity (mg TPF g dry soil^{-1} h^{-1}) was increased by (vermcompost inoculated with mycorrhiza) than by (vermicompost inoculated with bacteria) (Fig.4). Among the two annually ground and foliar addition,

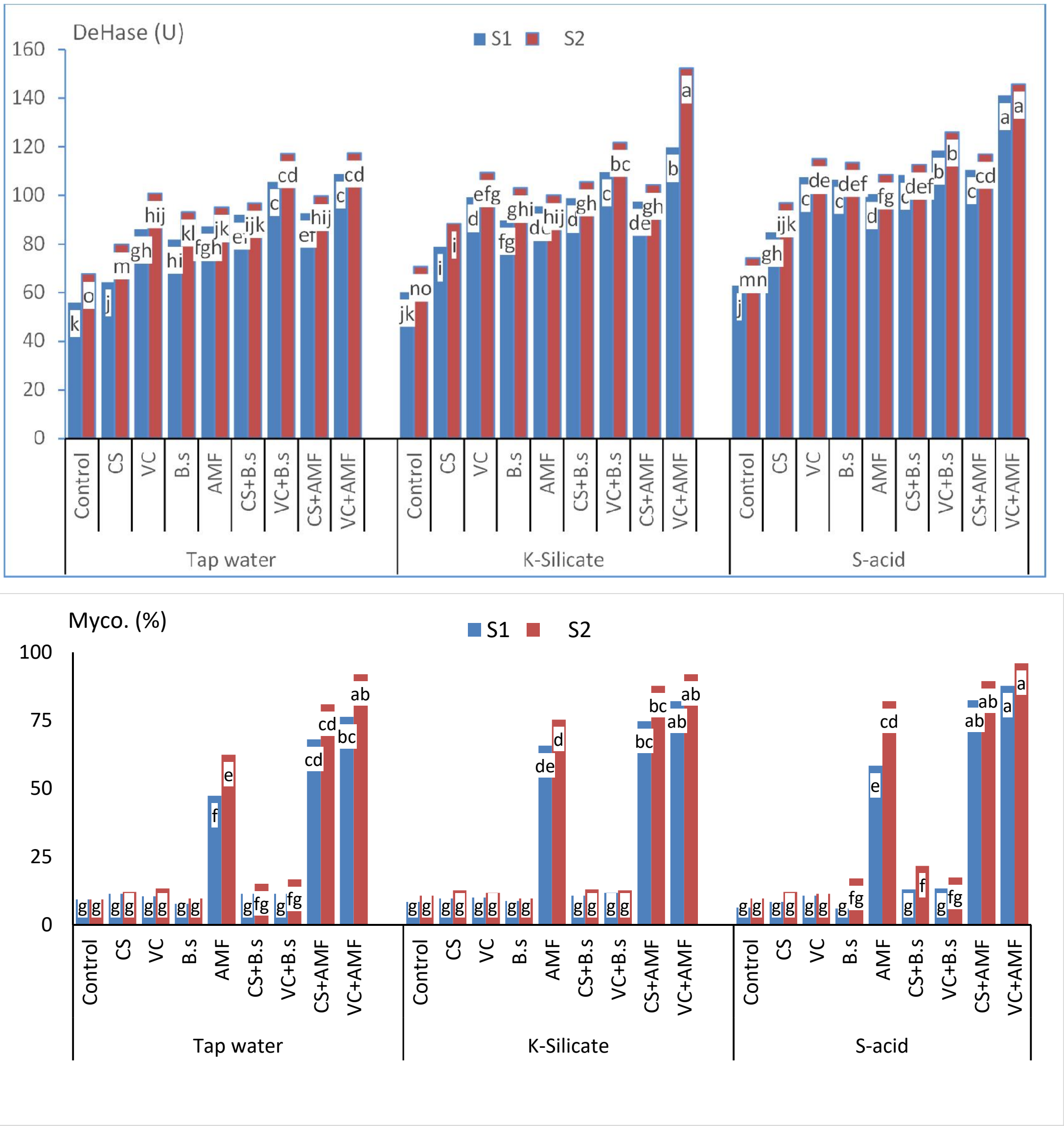

Fig. 4: Dehydrogenase activity and Percentage of mycorrhizae fungi colonizing roots of *Phaseolus vulgaris,* L cultivated in saline soil treated with different soil and foliar applications.

Dehydrogenase activity was greatest on average in salicylic acid and K-silicat as foliar spray and lowest in Treatment Foliar spray with tap water but the majority of the various data points and large amount of overlap with control of the statistical analysis of comparisons of these treatments between two consecutive seasons indicate that planting *Phaseolus vulgaris,* L under organic ground and salicylic acid had relatively consistent effect on the activity of this enzyme and considerable correlation with other parameter (Fig.4).

Dehydrogenase activity is an excellent proxy for soil respiration, which in turn reflects the availability of organic matter and serves as a direct signal of microbial activities. (Vermicompost, corn stalk). Similar to the findings of that study, the incorporation of organic amendments into the soil increased basal respiration (Cevheria *et al*., 2022). They believed that the results they observed were the result of either a combined effect from microorganisms in the soil and the amendments, or the promotion of microbial development by organic substrates in the amendments. The majority of the carbon supplied by these amendments is already in a partially degraded form, making it easy for soil microbes to break down and utilize for energy and nutrients. Soil microbes are breathing more heavily as a result.

Here, dehydrogenase activity was employed to evaluate how stress affected the microbial population. Soils that had been treated with a ground and foliar organic material additive and infected with AMF had significantly greater dehydrogenase levels. The soil's chemical and physical qualities are improved by the presence of both additives, but the synergy between AMF and salicylic acid is likely responsible for the plant's improved health and resistance to salt stress. It is likely that adding corn stalk, vermicompost, and potassium silicate, particularly when co-inoculating with mycorrhizae, reduces stress on the microbial population by supplying extra substrate, as previously documented. Therefore, we can conclude that the microbial biomass increased because of the additional substrate provided by the organic material and co- inoculation with mycorrhizae improves salinity soil properties and increases microbial community in the rizosphere. The preceding results demonstrated the beneficial effect of Vermicomposting and corn stalk application, both with and without foliar spray, on microbial community growth.

Final correlation

In all cases yield are in strong positive significant correll with total chlorophyll and dehydrogenase in tap water, K-silicate and salicylic acid (0.7, 0.9) and (+0.9) respectively. In contrast carotinoied strong negative corell in case of tap water and salycilic acid Generally, the results indicate that total chlorophyll as evidence of plant health and dehydrogenase are an indicator of microbiological redox system are more important than carotenoid (defence against stress) in bean yield of plant in agricultural saline soils.

The correll of catalase (as antioxidant enzyme) and proline as (N-protective store) was strong significant (+0.9). While when they correll with yield give inverse relation (-0.8,-0.9). In case of using K-silicate and salicylic acid with all soil treats, so there is strong stress due to higher EC and osmosis property due to salinity .so that catalase and proline positively related as defense against Salinity stress. Finally, there is no significant correll between AMF and dehydrogenase, catalase and total microbial count Soybean cropping patterns in saline soil have been studied, but the mechanisms influencing soil microbial populations and the relationship between those communities and bean output are still unclear. AMF interact negatively with the proline and catalase enzymes. The effectiveness of mycorrhizae in resisting salt increases as a result. Therefore, this study aims to highlight the important variables that affect the bacterial and fungal communities in soil as opposed to the oxidoreductase enzymes. Generally, the results indicate that salicylic acid with biofertilizer AMF beside ground additive are more effective than K-silicate in defense against salinity stress.

Table 9: Correlation coefficient analysis between the investigated biological and enzymatic parameters for the different treatments over the track of the study.

Foliar	Variables	AMF	DeHase	Total Chl	A/B	Carot	Proline	Catalase
Tap water	**Yield**	0.7	0.9	0.7	-0.4	-0.6	-0.9	-0.8
	AMF		0.5	0.6	-0.2	-0.4	-0.4	-0.5
	DeHase			0.6	-0.5	-0.7	-0.9	-0.9
	Total Chlo				-0.8	-0.3	-0.7	-0.6
	A/B					-0.1	0.6	0.5
	Carotenoids						0.5	0.5
	Proline							0.8
K	**Yield**	0.7	0.9	0.7	0.3	0.9	-0.8	-0.8
	AMF		0.5	0.6	-0.2	0.6	-0.4	-0.5
	DeHase			0.8	0.2	0.9	-0.9	-0.9
	Total Chlo				-0.1	0.9	-0.8	-0.8
	A/B					0.1	-0.4	-0.2
	Carotenoids						-0.8	-0.8
	Proline							0.9
Sa	**Yield**	0.7	0.9	0.9	-0.1	-0.7	-0.8	-0.9
	AMF		0.5	0.9	-0.1	-0.7	-0.4	-0.6
	DeHase			0.8	-0.3	-0.8	-0.9	-1
	Total Chlo				-0.2	-0.8	-0.7	-0.8
	A/B					0.3	0.2	0.1
	Carotenoids						0.7	0.8
	Proline							0.9

The numbers display the Pearson's correlation coefficient (r). green and orange indicate positive and negative correlation, respectively. The color density and numbers reflect the scale of correlation. *Significant level ($P < 0.05$).

Conclusion

Considering the importance of green beans as a staple food is supposed of great economic importance, as Egypt is the largest Arab country producing green beans. Several physiological and metabolic processes are disrupted by salinity, causing negative impacts on crop growth and yield. Current agricultural practices contribute to the accumulation of salts in the soil, which is harmful to agricultural land. This study schemed to investigate the potential of soil application and foliar spray to support and stimulate the growth of green bean plants in saline soil. The development of green bean roots, leaves, microbial activity, oxidative damage (proline and catalase), photosynthesis, and AMF% were achieved, thus all other pH and EC correlated among uninoculated and inoculated green bean plants subjected to different application superiority to vermicompost, AMF as soil application and salicylic acid as a foliar spray in saline soil.

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