Effect of bio and organic fertilizations and per-sowing seeds magnetic field combined with mineral nitrogen fertilizer on some soil properties and faba bean productivity and quality under saline soil conditions.

ABSTRACT.

Two filed experiments were conducted at Sahl- El-Hussinia , agricultural research station, El-Sharkia Governorate, Egypt, 31^{o} - 8' – 12.461" N and 31^{o} - 52' – 15.469 E. during two successive winter seasons 2020/2021 and 2021/ 2022 , to study the evaluation of used bio-fertilizer (*Rhizobium radiobacter* sp strain **(**Salt Tolerant PGPR), humate potassium and pre-sowing seeds faba bean magnetic field different times (5, 10 and 15 min) combined with mineral N fertilizer at rates (15, 30 and 45 N kg/fed) on some soil properties and faba bean productivity and quality. The studied treatments were arranged within the experimental units in a split split plot design in three replicates. Results indicated that the all treatments had improved soil properties i.e. decreased soil salinity and soil pH and increase of available N, P, K , Fe , Mn and Zn contents in soil . The soil treated with humat potassium combined the highest N mineral fertilizers rate and magnetic field time than other treatments. On the other hand, the maximum values of weight of yield and other yield components as affected with humat potassium combined with 45 kg mineral N fertilizers under magnetic field at 15 min compared other treatments. The highest values of macro-micronutrients (N, P, K, Fe, Mn and Zn) concentrations in faba bean seeds as affected with bio-fertilizer and potassium humate combined with mineral N fertilizer different rates compared with control. The bio-fertilizer was beast on faba bean quality.

Keyword: Soil properties, faba bean productivity, bio-fertilizer, mineral N fertilizer , pre-sowing seeds magnetic field.

INTRDUCTION

Fifty-five percent of the cultivated lands of the northern Delta region, 20% of the southern Delta and middle Egypt region, and 25% of the Upper Egypt regions are salt-affected soils. Port-Said area parallels to the Suez Canal is one of the newly reclaimed salines that also faces salinity problems. Moreover, the northern regions are mainly saline or saline-sodic soils with heavy texture in Egypt **(Shaban et al., 2012).**

Faba bean (Vicia faba L.) has potential as a source of nutrition for human feed, and as a N_2 – fixing, legume can also play an essential role in enhancing soil fertility. The cultivated area of faba bean decreased in the last ten years in Egypt from 71445 to 32532/ha **FAOSTAT (2017).**

The magnetic fields for 10 min were increase of germination index, germination energy and final germination percentage with increase time **(Iqbal, et al., 2012).** Treating of seeds with a magnetic field considerably increased the amount of indole-3-acetic acid and gibberellic acid in germinating seeds, above-ground parts and in roots of faba bean seedlings. The pre-sowing treatment with a magnetic field had favorable effects on the growth and development of seedlings **(Podleśna et al. 2019).** Magnetic treatments are assumed to enhance seed vigor by influencing of the involve free radicals' production, and by stimulating the activity of carbohydrate and proteins **(Michalak et al., 2019).** The treated with magnetic field led to increase concentration of secondary metabolites, enzymatic activity, and anti-oxidative capacity **(Konefal-Janoca et al., 2019).**

Egypt is considered to be a heavy user of chemical fertilizers especially nitrogen followed by phosphorous then potassium. The consumed amount of NPK in 2002 was 488 kg/ha. The production of chemical nitrogenous fertilizers in 2002 in thousand tons was 1645 Ammonia, 1865 Urea and 1070 Ammonium nitrate, since the production of phosphate fertilizers also in thousand tons was 1670 Rock phosphate, 20 phosphoric acid,940 single Super phosphate 15% P_2O_5 and 50 concentrated Super phosphate (37%P_2O_5),while the imported Potassium Sulfate (48% K_2O) was 80000 tons. The consumed, N: P_2O_5: K_2O ratio was 63:12:1 in 1981 and declined to 36:5:1 in 2002 due to the high consumed SOP in the last 20 years, (**Abd El-Hadi 2004).** Nitrogen, phosphorus and potassium are key nutrients that play a major role in crop production on intensively cultivated soils. The soil fertility is directly influenced by the type of fertilizer inputs, **(Harleen et al .2017).** Sole utilization of chemical fertilizers frequently decays soil fertility and the resultant harvest efficiency because of supplement irregularity in the soil, which has been perceived as a standout amongst the most imperative factors that limit crop yield. Along these lines, the utilization of chemical fertilizer may not keep pace with time in support of soil well-being for maintaining the efficiency, **(Moreira et al., 2014).**

Biofertilizers are play an important role in increasing availability of nitrogen and phosphorus by improving biological fixation of atmospheric nitrogen as well as enhancing phosphorus availability to crop **(Bhat et al., 2013).** The application of Rhizobium Azotobacter and phosphate solubilizing bacteria (PSB) increased pea growth, yield, number of pods/ plant; number of seeds/pod, pod length and1000 grain compared untreated **(Rather et al. 2010).**

Potassium humate (HA) is important component produced by the chemical and biological decomposition of organic material through the help of micronutrients. Potassium humate is a vital component of soil organic matter which improves the growth of many plant species. It enhances soil fertility and improves physical and chemical characteristics of soil, like permeability, aeration, aggregation, water holding capacity, ion transport and availability through pH buffering **(Afifi et al., 2010).**

Humic acid (HA) modifies the physical, chemical, and biological conditions in soil and affect the solubility of many nutrient elements by building complex forms or chelating with metal cations that improve the crop yield by forming aqueous complexes with micronutrients and enzymatically active complexes, which can be carrying on reactions that are usually assigned to the metabolic activity of living microorganisms. **(Verlinden et al., 2009).** Potassium humate application, irrespective of the rate used, increased canopy dry weight and leaves area plant^{-1} over the control **(Barakat et al 2015).** The application of biofertilizers and humic acid were significant increase of available N, P, K, Fe, Mn and Zn in soil **(Alakdar et al 2020).**

MARTIALS AND METHODS

A Field experiment was conducted in clay saline soil at Sahl El-Hussinia , Agric. Res. Station, Centre in El-Sharkia Governorate , Egypt; during the two winter seasons 2020/2021 and 2021/2022 respectively to evaluation using humate potassium or bio-fertilizers and pre-sowing seeds faba bean magnetic field combined with or without mineral N fertilizers different rates on some soil properties and Faba bean (Vicia faba L.) productivity under saline soil conditions. The experimental site is located at Khaled ben El-Waled village, Sahl El-Hussinia 31^{o} - 8' – 12.461" N and 31^{o} - 52' – 15.469 E. The field experiments were arranged in a split split plot design with three replicates.

Some soil physical and chemical properties of studies soil before planting were determined according to the methods described by **Cotteine et al (1982) and Page et al (1982).**

Table (1) Physical and chemical properties in soil study in Sahl El-Hussinia.

<table>
<tr><th>Coarse sand (%)</th><th>Fin sand (%)</th><th colspan="2">Silt (%)</th><th>Clay (%)</th><th colspan="3">Texture</th><th>O.M (%)</th><th>CaCO$_3$ (%)</th></tr>
<tr><td>5.62</td><td>22.50</td><td colspan="2">30.80</td><td>41.08</td><td colspan="3">Clay</td><td>0.57</td><td>13.45</td></tr>
<tr><td rowspan="2">pH (1:2:5)</td><td rowspan="2">EC (dS/m)</td><td colspan="4">Cations (meq/l)</td><td colspan="3">Anions (meq/l)</td><td></td></tr>
<tr><td>Ca^{++}</td><td>Mg^{++}</td><td>Na^{+}</td><td>K^{+}</td><td>HCO^{-}_{3}</td><td>Cl^{-}</td><td>SO^{--}_{4}</td><td></td></tr>
<tr><td>8.16</td><td>11.88</td><td>16.33</td><td>22.40</td><td>80.07</td><td>0.82</td><td>13.55</td><td>72.30</td><td>32.95</td><td></td></tr>
<tr><td colspan="5">Available macronutrients (mg/kg)</td><td colspan="5">Available micronutrients (mg/kg)</td></tr>
<tr><td>N</td><td colspan="2">P</td><td colspan="2">K</td><td>Fe</td><td colspan="2">Mn</td><td colspan="2">Zn</td></tr>
<tr><td>36.77</td><td colspan="2">4.33</td><td colspan="2">185.00</td><td>6.20</td><td colspan="2">3.14</td><td colspan="2">0.55</td></tr>
</table>

Seeds of the faba bean (Vicia faba L.) variety Giza 843 were supplemented from the Field Crop Research Intitule, Agricultural Research center, Giza, Egypt. Bio-fertilizers were *Rhizobium radiobacter* sp strain **(**Salt Tolerant PGPR). The bio- fertilizers were obtained from Department of Microbiology, Soils, Water and Environment Research Institute, Agriculture Research center, Giza, Egypt. Seeds of faba bean was inoculated with *Rhizobium radiobacter* applied at a rate of 100 g for 30 kg seeds wetted with 400 ml of adhesive liquid (Arabic gum) . They were added in the form of solution foliar application on soil and plant after planting in three application times at 21, 50 and 75 days from planting. Each application is 5 L diluted in 400 L water fed^{-1}.

Magnetically treated seeds (M) before sowing were prepared by placing about 30 kg seeds inside a metallic magnetic tube consisted of a permanent magnet surrounding an open-ended tube (70 cm Length × 2-inch diameter, magnetic field strength 1.50 T) for (0, 5 , 10 and 15 min) .

Potassium humate was applied on soil at rate 20 kg /fed in same day of planting .Chemical composition of the used potassium humate is shown in Table (2). The potassium humate analysis was added according to the standard methods described by **Brunner and Wasmer (1978).**

Table 2. Chemical properties of used potassium humate.

pH	EC (dsm^{-1})	O.M (%)	Macronutrients (%)			Micronutrients (mg/kg)		
			N	P	K	Fe	Mn	Zn
7.60	2.14	77.20	2.33	0.45	3.75	420.00	270.00	188.00

Mineral fertilizer was urea (46 % N) was applied as N fertilizer at rates of 15, 30 and 45 kg N fed^{-1} on three equal doses after 21, 42 and 62 days from sowing. Super phosphate calcium (15.5 % P_2O_5) was added at rate 31 kg/fed during tillage for soil. Potassium sulphate was added at rate 75 kg/fed after 21 , 45 and 65 days from planting.

Seeds sowing were carried out at 20 November 2020/2021 and 2021/2022. Three of coated seeds with were sown in hole with 25 cm and 2 cm depth. After 31 days from planting, the plant was thinned to one plant of each hole. Plant sample of three replicates were taken after 75 days from sowing at.A Sample of each experiment plot was prepared for vegetative growth parameters and some physiological determination.

At harvesting stage the plants of the three replicates were harvested. Each fresh plant sample was separated into plant height (cm), No. of branches /plant. No. of pods /plant , weight of 100 seeds (g), weight of pods /(g/ plant), weight of seeds /(g/ plant) weight of shoot yield /plant (ton/fed) and weight of seeds yield (ton/fed) were counted. Both seeds and shoots were air-dried and oven dried at 70C^o for 48 hrs. Ether of oven-dried straw or seeds were ground and kept in plastic bags for chemical analysis. A 0.5 g of each oven dried ground plant sample was digested using $H_2SO^-_4$, $HClO_4$ mixture according to the method described by **Chapman and Pratt (1961)**. The plant content of

N, P, K, Fe, Mn, Zn and Cu was determined in plant digestion using the methods described by **Cottenie et al (1982) and Page et al (1982).**

Total carbohydrates were determined in dry leaves using the method described by **Dubois et al (1956).** Total proline content was estimated according to the methods described by **Bates et al (1963).** Protein percentage of seeds was calculated by multiplying the nitrogen percentage by the factor 6.25**.**

Astatically analysis.

The obtained data were statistically analysis using the COSTAT program and L.S.D. test at the probability levels of 5% was calculated according to **Gomez and Gomez (1984).**

RESULTS AND DISCUSSIONS

Effect of huimat potassium and bio-fertilizer on soil properties.

Soil pH.

Data presented in Table (3) show that the decreased of soil pH as affected by all treatments, especially soil treated with humate potassium combined with 45 mineral nitrogen fertilizer after pre-sowing seeds magnetic field at 15 min time compared with other treatments. The effect of all treatments on soil pH was not significant. The slight decrease in soil pH value may be due to the active organic acid production, decompositions and mineralization of nutrients present in the organic material. The application of biofertilizers on soil pH led to decrease because the biofertilizers activate microorganisms in soil and dehydrogenase enzyme production in the soil led to decrease the soil pH compared with control. These results are in agreement by **Alakhdar et al (2020)** found that the slight decrease in soil pH values may reflect the activity of microorganisms in decomposing organic matter and releasing organic acids as affected with bio-fertilizer and humate potassium combined with mineral fertilizers compared with control. **Ahmed et al. (2016)** indicated that the soil pH was decreased slightly due to the application of humic acid. **Shaban and Omar (2006)** suggested that the effect of bio-fertilizer combined with different mineral nitrogen fertilizer rates on soil pH was decreased may be due to Dehydrogenas activity and production of μ moles of H_2 in the rhizosphere of root media had a positive effect on increasing the hydrogen moles which react in root zone to form hydrocarbon acid led to decrease soil pH. **Abou El-Yazed *et al* (2012)** found that the decrease values of soil pH were magnetized treatments of seeds combined with 75 or 100% of the recommended doses of N-P-K fertilizers**. Abdel Fatah and Esmaeil (2022)** reported that the decrease values of pH (7.85 and 7.82) were recorded in magnetized treatments (10 min. and 15 min., respectively).

Soil salinity (EC dSm^{-1}).

Data presented in Table (3) indicated that the significant decreased of soil salinity as affected with pre-sowing faba bean seeds magnetic field different time and increase of mineral nitrogen rate compared with other treatments. The interaction between all treatments and magnetic seeds different times were significant decreased soil salinity. As well as, the effect of interaction between all treatments combined with magnetic seeds times combined with nitrogen mineral fertilizer rates on soil salinity were significant decreased.

Table (3). Soil pH, EC (dSm^{-1}) and macronutrients contents in soil after harvest

Treatments	Rate of N (kg/fed)	Time of magnetic (min)	pH (1:2.5)	EC (dSm^{-1})	Macronutrients (mg/kg)		
					N	P	K

Control	15	0	8.14	9.50	38.60	4.75	183.90
		5	8.12	8.88	39.85	4.83	184.85
		10	8.09	8.40	41.30	4.95	187.50
		15	8.06	7.75	41.88	5.05	188.30
	Mean			8.63	40.41	4.90	186.14
	30	0	8.12	8.60	39.40	4.86	194.30
		5	8.08	7.10	42.40	4.90	184.90
		10	8.05	6.44	44.65	5.04	188.20
		15	8.03	6.29	44.95	5.09	189.30
	45			7.11	42.85	4.97	189.18
		0	8.09	6.97	41.60	4.95	186.40
		5	8.05	5.34	44.68	5.05	188.50
		10	8.04	5.20	46.20	5.12	188.98
		15	8.02	4.30	46.85	5.17	189.48
	Mean			5.45	44.84	5.07	188.34
Bio-fertilizer	15	0	8.11	7.30	43.50	5.01	190.00
		5	8.08	6.53	46.20	5.04	193.20
		10	8.04	5.85	47.83	5.12	193.80
		15	8.03	5.20	47.95	5.14	195.40
	Mean			6.22	46.37	5.08	193.10
	30	0	8.09	6.33	44.20	5.02	192.10
		5	8.06	5.50	47.33	5.13	192.90
		10	8.02	3.90	48.10	5.16	195.40
		15	8.00	3.18	48.70	5.26	197.40
	Mean			4.73	47.08	5.14	194.45
	45	0	8.08	4.85	45.88	5.05	194.20
		5	8.03	3.29	48.30	5.15	196.99
		10	8.00	3.06	49.60	5.30	197.10
		15	7.95	2.88	52.19	5.45	197.50
	Mean			3.52	48.99	5.24	196.45
Humat potassium	15	0	8.10	6.50	44.29	5.05	195.30
		5	8.06	6.11	47.40	5.12	195.88
		10	8.03	5.84	49.99	5.15	197.30
		15	8.00	5.44	52.10	5.22	198.00
	Mean			5.97	48.45	5.14	196.62
	30	0	8.07	5.60	46.30	5.08	196.40
		5	8.04	5.36	48.50	5.25	197.44
		10	8.00	4.95	51.33	5.60	198.20
		15	7.96	4.55	53.20	5.85	198.85
	Mean			5.12	49.83	5.45	197.72
	45	0	8.05	5.44	48.30	5.14	198.30
		5	8.02	4.60	52.10	5.33	198.90
		10	7.97	4.10	53.50	5.85	200.00
		15	7.92	3.65	54.00	5.95	203.00
	Mean			4.45	51.98	5.57	200.05
LSD. 5 % time magnetic			ns	1.02	0.92	ns	1.09
LSD. 5 % rate of N			ns	0.46	0.82	ns	0.73
LSD. 5 % treatments			ns	ns	0.58	ns	0.67
LSD. 5 % Treatment * Time magnetic			ns	**	***	ns	*
LSD. 5 % Treatments * Rate			ns	*	ns	ns	***
LSD. 5 % Interaction			ns	***	***	ns	***

The minimum mean values of soil salinity were 3.52 dSm^{-1} for soil treated with bio-fertilizer combined with nitrogen mineral fertilizer under magnetic seeds compared with other treatments. These results are in agreement by **Ouni et al .,(2014)**The use of humate potassium to soil salinity led to reduction of soil salinity means reducing in the monovalent Na^+ and this is particularly evident when the replace of the monovalent K^+ to the humate (salt) of the humic complex occurred**.** **Sushila et al (2017**) found that the application of biofertilizers on saline soil was decrease salinity because the bio-fertilizers activate microorganisms in soil and dehydrogenase enzyme production in soil led to decrease the soil salinity compared with control. The effect of humate potassium and bio-fertilizer combined with 45 kg N/fed application were decreased of saline soil under magnetic seeds 15 min compared other treatments. **Khafagy et al., (2019)** suggested that the applied of potassium humate and bio-fertilizers combined with mineral fertilizers were significantly by decreased soil salinity. These results may be due to the activation of bacteria in soil caused by potassium humate and bio-fertilizers applied and the effect of bio-fertilizer or potassium humate on total porosity, and improving soil aggregation and possible moving salt soil under irrigation water. **Abdel Fatth and Esmaeil (2022)** indicated that using magnetic treatments of seeds were significantly reduced the soil EC compared with control.

Available macronutrients contents in soil.

Data presented in Table (3) indicated that the application of bio-fertilizer and humate potassium combined with N mineral fertilizers different rates to soil le to increase available N, P and K under pre-sowing magnetic field different time. The highest mean values of N, P and K contents in soil were soil treated with humate potassium combined different N rates and magnetic field different rates than other treatments. The increase of mineral nitrogen rate combined with humate potassium were increasing available N, P and K contents in soil under magnetic field different time. The significant increase of available N, P and K contents in soil as affected with magnetic field time. The effect of bio-fertilizer, humat potassium and mineral fertilizer were significant of N and K contents in soil while P was no significant. The increase of mineral fertilizer different rate was significant increase of N and K contents in soil while P was no significant. The interaction between all treatments and magnetic seeds different rates were significant increase of available N and K contents in soil compared the K was no significant. The interaction all treatments for study was significant increase of N and K contents in soil, while the P was no significant. These results are in agreement by **Khafagy et al., (2019)** reported that the increase available soil macronutrients i.e. N, P and K in soils treated with biofertilizers and potassium humate with or without mineral fertilizers. **Hassan (2016)** reported that the application of potassium humate led to increase of available N, P and K, contents in soil. **Alakhar et al., (2020)** suggested that the increase in the content of available (mg.kg^{-1}) nitrogen, phosphorous and potassium was may be due to the decomposition of organic materials released acids that reduced soil pH which caused nutrients to be more soluble hence more available in soil. **Ratushnyak et al. (2008)** indicated that the magnetic seed treatment increased the amount of microbial content of the soils such as nitrogen-fixation bacteria; this increase in microorganisms may improve the availability of elements in the soil. It may be concluded, therefore that pre-sowing magnetic treatment combined with mineral N-P-K fertilizers applications decreased soil pH and EC, while increased the soil content of N, P and K **(Abdel- Fattah and Esmaeil 2022).**

Available micronutrients contents in soil.

Data presented in Table (4) show that the all treatments treated were increase of available Fe, Mn and Zn contents in soil. The maximum values of Fe, Mn and Zn available contents in soil as affected with humate potassium combined with mineral N rate under pre-sowing seeds magnetic field at 15 min. Also, the significant increase of Fe, Mn and Zn contents in soil as affected with pre-sowing seeds magnetic field different times. The increase of micronutrients contents in soil was increasing mineral N fertilizer with mineral N fertilizer different rates. On the other hand, the interaction between all treatments and magnetic field different rates were significant increase of Fe and Zn available contents in soil. The interaction between all treatments was increase of Fe, Mn and Zn contents in soil. These results are agreement by **Khafagy et al (2019)** found that the available micronutrients i.e. Fe, Mn and Zn (mg/kg soil) in soils treated with biofertilizers and potassium humate with or without mineral fertilizers were increased with increasing mineral fertilizers (NPK) rates. **Shaban and Attia (2009)** revealed that the content of available Fe, Mn, Zn and Cu (mg/kg) were increased as affected by biofertilizers in combination with chemical fertilizers. **Hussein and Hassan (2011)** reported that potassium humate importance due to their ability to chelate micronutrients, thus increasing their bio-availability **El-Galad et al., (2013)** indicated that application of potassium humate to saline soil gave the highest soil available Fe, Mn and Zn values after harvesting. **Ratushnyak et al.(2008**) revealed that the pre-sowing seeds magnetic field increased the amount of microbial content of the soils , this increase in microorganisms may improve the availability of nutrients in the soil . It may be concluded, therefore that pre-sowing magnetic treatment combined with mineral N-P-K fertilizers applications increased the soil content of Fe, Mn and Zn .

Table (4). available micronutrients contents in soil after harvest.

Treatments	Rate of N (kg/fed)	Time of magnetic min)	Micronutrients (mg/kg)		
			Fe	Mn	Zn
Control	15	0	6.88	3.25	0.58
		5	6.95	3.50	0.64
		10	7.05	3.85	0.69
		15	7.12	3.99	0.72
	Mean		7.00	3.65	0.66
	30	0	6.90	3.35	0.62
		5	7.07	3.88	0.68
		10	7.22	3.98	0.72
		15	7.65	4.05	0.75
			7.21	3.82	0.69
	45	0	6.94	3.44	0.65
		5	7.05	3.90	0.74
		10	7.45	4.03	0.77
		15	7.85	4.14	0.80
	Mean		7.32	3.88	0.74
Bio-fertilizer	15	0	7.00	3.45	0.60
		5	7.33	3.80	0.66
		10	7.85	4.05	0.74
		15	7.90	4.09	0.78
	Mean		7.52	3.85	0.70
	30	0	7.05	3.56	0.65
		5	7.65	4.03	0.71
		10	7.95	4.08	0.76
		15	8.03	4.15	0.83
	Mean		7.67	3.96	0.74
	45	0	7.09	3.64	0.68
		5	7.85	4.13	0.75
		10	8.04	4.33	0.82
		15	8.09	4.53	0.86
	Mean		7.77	4.16	0.78
Humat potassium	15	0	7.03	3.85	0.62
		5	7.55	4.04	0.74
		10	7.94	4.23	0.77
		15	8.05	4.33	0.82
	Mean		7.64	4.11	0.74
	30	0	7.12	3.96	0.66
		5	7.88	4.08	0.76
		10	8.09	4.35	0.83
		15	8.16	4.55	0.88
	Mean		7.81	4.24	0.78
	45	0	7.25	4.04	0.73
		5	7.95	4.12	0.80
		10	8.15	4.65	0.87
		15	8.54	4.85	0.88
	Mean		7.97	4.42	0.82
LSD. 5 % time magnetic			0.25	ns	0.014
LSD. 5 % rate of N			0.11	ns	0.015
LSD. 5 % treatments			ns	ns	0.017
LSD. 5 % Treatment * Time of magnetic			*	ns	***
LSD. 5 % Treatments * Rate of N			*	ns	ns

LSD. 5 % Interaction	***	***	***

Abdel-Fattah and Esmaeil (2022) found that the soil available micronutrients (Fe, Mn and Zn mg/kg) contents in soil were increased by increasing the pre-sowing seeds magnetic time (magnetized seeds 5 min., 10 min. and 16 min.), respectively and rate of mineral fertilizers addition.

Plant morphology.

Data result in Table (5) raveled that the effect of bio-fertilizer and humate potassium and N mineral fertilizer rates on plant length (cm) was significant increase after 75 days from planting and harvest while the No. branches /plant were significant increase after 75 days from planting but no significant after harvest as affected by magnetic field different times. Also, the application of bio- fertilizer or humat potassium and magnetic field on pods /plant were no significant, while the mineral N fertilizer different rates were significant increase. The interaction between all treatments plus mineral N fertilizer rates and magnetic field different time were significant increase of plant length (cm), No. branches /Plant and pods /plant respectively. The role of bio-fertilizer application to soil was increasing faba bean morphology parameters may be due to have resulted from endogenous growth promoters produced by microorganism which enhance the mobilization of nutrient through increasing cell divisions and/or increasing the differentiation of the vascular connection between the axillary buds and the main stem. The increase of mineral N fertilizer rates and magnetic field time were increasing morphology parameters. These results are in agreement by **Abdel Fatah and Esmaeil (2022)** found that the combination between magnetic field and different rates of N-P-K fertilizers were significant on plant height (cm).

Table (5). Morphology of faba bean after 75 and harvest

Treatments	Rate of N (kg/fed)	Time of magnetic (min)	after 75 days from planting		After harvest		
			Plant length (cm)	No. of branches	Plant length (cm)	No. of branches	No. of pods/plant

Control	15	0	48.52	2	69.30	5	17
		5	53.41	4	73.85	6	19
		10	55.95	4	75.88	6	25
		15	57.43	4	78.55	7	20
	Mean		53.83	3.50	74.40	6.0	20.25
	30	0	49.70	3	71.98	7	19
		5	54.69	5	75.40	7	23
		10	58.52	6	78.45	8	27
		15	61.00	3	83.98	7	29
	45		55.98	4.25	77.45	7.25	24.50
		0	53.42	4	72.16	6	20
		5	57.63	4	77.50	7	23
		10	62.48	5	80.54	8	28
		15	64.58	4	85.90	7	25
	Mean		59.53	4.25	79.03	7.00	24.00
Bio-fertilizer	15	0	52.85	3	73.20	7	19
		5	61.85	5	78.40	8	27
		10	64.39	6	82.10	7	30
		15	65.82	5	86.40	7	22
	Mean		60.23	4.75	80.03	7.25	24.50
	30	0	56.32	4	78.40	8	23
		5	63.89	6	86.40	9	29
		10	67.25	7	93.80	8	33
		15	68.20	4	96.40	7	27
	Mean		63.92	5.25	88.75	8.00	28.00
	45	0	56.75	4	74.99	6	19
		5	62.14	5	76.80	7	25
		10	64.95	6	85.80	7	27
		15	66.52	5	83.90	7	32
	Mean		62.59	5.00	80.37	6.76	25.75
Humat potassium	15	0	50.88	3	71.88	7	23
		5	55.34	5	75.49	7	28
		10	57.65	5	80.76	8	33
		15	60.43	4	83.77	8	36
	Mean		56.08	4.26	77.98	7.50	30.00
	30	0	53.61	4	73.60	8	25
		5	59.74	6	82.96	8	32
		10	63.42	6	85.90	7	36
		15	65.43	5	89.60	8	38
	Mean		60.55	5.25	83.02	7.75	32.75
	45	0	54.63	5	77.80	7	22
		5	62.95	6	85.86	8	27
		10	65.14	6	89.70	7	32
		15	67.32	7	94.88	8	36
	Mean		62.51	6.00	87.06	7.50	29.25
LSD. 5 % time magnetic			0.38	0.25	0.72	ns	ns
LSD. 5 % rate of N			0.76	0.23	0.72	ns	1.43
LSD. 5 % treatments			0.75	0.22	0.81	ns	ns
LSD. 5 % Treatment * Time			***	***	***	ns	ns
LSD. 5 % Treatments * Rate of N			ns	***	***	ns	ns
LSD. 5 % Interaction			***	***	***	*	***

This may be attributed to hormones such as gibberellic acid-equivalents, indole-3-acetic acid and trans-zeatin as well as activation of the bio-enzyme systems which leads to enhanced morphology paramters and development as well as increase in the yield of the crop. **Balouchi and Sanavy (2009)** indicated that the pre-sowing seeds magnetic field influences the structures of cell membranes and in this way increases their permeability and the modification of binding properties of seed water and increased seed membrane integrity in magnetically exposed seeds might have enhanced the germination traits and early seedling growth of maize. **Alakhdar et al., (2022)** reported that the highest values of Plant length (cm) and No. of pods/ plant were achieved by seeds exposed to 30 min. magnetic field. **Montaser *et al.*, (2011)** revealed that the application of potassium humate on plant morphology and plant growth stimulant was increased cell division, as well as optimizing uptake of nutrients and water and stimulating soil microorganisms for enhancing natural resistance against plant diseases and pest infestations. On the other hand, they increase the permeability of plant membranes and enhance the uptake of nutrients that improve soil uptake of macro and microelements, making these nutrients more mobile and available to plant root systems. Also, **Khalil *et al.* (2013)** found application of biofertilizer *Azospirillum brasilense* was increase in wheat growth parameters. **Awaad et al., (2020)** suggested that the humate potassium application to faba bean plant led to increase of the growth parameters i.e. plant height, number of branches/plant, number of pods /plant and number of seeds /pod of faba bean plants, may be the application of humate potassium increased the synthesis and activity of IAA, which played a significant role in promoting the plant growth and application of potassium humate like organic fertilizers which mobilized, solubilized, fixed and retained P in the soil.

Yield and yield components.

Data show in Table (6) the maximum values of weight of 100 seeds (g); weight of pods /plant (g); weight of seeds /plant (g); weight of shoot yield (ton/fed) and weight of seeds yield (ton/fed) were 88.50 (g) , 145.20 (g), 136.40 (g), 136.40 (g) , 3.38(ton /fed) and 2.95 ton/fed as affected with humat potassium combined with 45 kg mineral N fertilizers under magnetic field at 15 min compared other treatments. These results are in agreement by **Nassar et al., (2021)** found that the application of humat potassium to seed nutritive and biochemical contents were significantly increase of plant growth parameters , yield components as well as seed nutritive and biochemical contents . The humic substances can directly or indirectly affect the physiological processes of plant growth by promoting the uptake of macro-and micronutrients and affecting the biochemical substances, carrying nutrients and growth regulators and acting as hormone like substances. On the other hand, the significant increase for weight of pods /plant (g) and weight of seeds /plant (g) , while the 100 seeds (g) , weight shoot yield (ton/fed) and seeds yield (ton/fed) respectively , were no significant as affected seeds with magnetic field at times. Also, the applied of mineral N fertilize different rates to faba bean plant was significant increase for weight of 100 seeds (g), weight of pods/plant (g), weight of seeds /plant (g) and weight of shoot yield (ton/fed) respectively , while the weight of seeds yield (ton/fed) was no significant. The interaction all treatments combined with mineral N fertilizer and magnetic field different time were significant increase of weight of 100 seeds (g); weight of pods /plant (g); weight of seeds /plant (g); weight of shoot yield (ton/fed) and weight of seeds yield (ton/fed) respectively. **Malik et al. (2006)** found that seed

Table (6). Faba bean productivity at harvest affected by PGP, N rate, magnetic time and interaction between them.

Treatments	Rate of N (kg/fed)	Time of magnetic (min)	Weight of 100 seeds (g)	Weight of pods/plant (g)	Weight of seeds /plant (g)	Weight of Shoot yield (ton/fed)	Weight of seeds yield (ton/fed)
Control	15	0	61.77	89.40	82.10	2.50	1.95
		5	67.90	98.30	95.38	2.75	2.08
		10	72.80	109.29	103.20	2.89	2.24
		15	76.10	113.20	105.55	2.95	2.29
	Mean		69.64	102.55	96.56	2.77	2.14
	30	0	71.83	94.20	88.20	2.63	2.05
		5	72.37	106.30	99.30	2.88	2.18
		10	76.74	115.30	110.20	3.10	2.25
		15	77.80	123.40	112.59	2.98	2.20
			74.69	109.80	102.57	2.90	2.17
	45	0	64.79	98.75	93.20	2.70	2.12
		5	68.30	113.10	110.22	2.98	2.35
		10	74.90	118.90	115.30	3.07	2.44
		15	77.00	12288	119.88	3.12	2.49
	Mean		71.25	113.41	109.65	2.97	2.35
Bio-fertilizer	15	0	70.47	105.85	78.40	2.80	2.10
		5	75.85	115.20	83.60	2.95	2.30
		10	77.47	120.43	105.30	3.09	2.52
		15	80.44	117.90	94.20	3.01	2.44
	Mean		76.06	114.85	90.38	2.96	2.34
	30	0	77.54	109.00	82.96	2.95	2.25
		5	83.95	122.60	92.10	3.10	2.55
		10	86.80	134.20	115.00	3.25	2.75
		15	82.18	127.90	110.77	3.06	2.66
	Mean		82.62	123.43	100.21	3.09	2.55
	45	0	80.17	106.88	80.33	2.88	2.28
		5	82.49	119.60	90.50	2.98	2.50
		10	85.77	124.20	108.00	3.15	2.68
		15	84.34	120.56	95.30	3.22	2.75
	Mean		83.19	117.81	93.53	3.06	2.55
Humat potassium	15	0	70.55	102.30	98.40	2.48	2.25
		5	74.41	112.50	106.39	2.88	2.50
		10	74.12	118.77	112.77	2.94	2.77
		15	80.24	125.80	119.39	3.10	2.85
	Mean		74.83	114.84	109.24	2.85	2.59
	30	0	68.49	105.00	103.90	2.55	2.33
		5	78.91	118.30	109.88	2.89	2.65
		10	79.16	123.85	113.80	3.20	2.80
		15	82.18	133.89	120.43	2.95	2.88
	Mean		77.19	120.26	112.00	2.90	2.67
	45	0	65.18	110.40	107.54	2.57	2.38
		5	70.10	125.30	119.87	2.90	2.69
		10	84.61	136.70	120.78	3.22	2.88
		15	88.50	145.20	136.40	3.38	2.95
	Mean		77.10	129.40	121.15	3.02	2.73
LSD. 5 % time magnetic			ns	1.10	1.52	ns	ns
LSD. 5 % rate of N			2.54	1.11	0.10	0.14	ns
LSD. 5 % treatments			ns	1.32	0.93	ns	ns
LSD. 5 % Treatment * Time			ns	***	**	ns	ns
LSD. 5 % Treatments * Rate of N			*	***	**	ns	ns

LSD. 5 % Interaction	***	***	***	*	*

inoculation with Rhizobium significantly increases plant height, seed yield and harvest index in soybean. **Podlesny et al., (2004)** indicated that the used of pre-swing seeds magnetic field led to positive increase the germination and emergence of both seasons. The magnetic treatment of broad bean seeds prior to sowing a significant influence on the increase of seed yield. The increase seed yield was resulting from the pre-sowing treatment of seeds with a magnetic field for broad bean. The application of bio-fertilizers and humate potassium to soil was increase in total green pod yield, number of pod and weight of pods and seeds yield. It was clearly that pea plants treated only with chemical fertilizers gave lower values of yield and its components **(Khafagy et al. 2019). Afzal et al (2021)** indicated that magnetic seed treatment for 10 min significantly reduced the mean germination time and gave maximum value of final germination percentage compared with control.

Macro- Micronutrients concentration in seeds faba bean.

Data presented in Table (7) show that the increase of macro-micronutrients ie. (N, P, K, Fe, Mn and Zn) concentrations in seeds faba bean as affected with bio-fertilizer and humate potassium combined with mineral N fertilizer different rates compared with control. These results may be due to the application of biofertilizer and humate potassium combined with mineral N rates to cowpea crop was increased the soil microbial population (bacteria, fungi and actinomycetes) and enzyme activities. Use of biofertilizer increased the macro-micronutrients concentrations and provided substrate essential for microbial growth and activity which probably responsible for this increase in soil microbial population led to decrease of soil pH. An increase of N, P, K, Fe, Mn and Zn concentrations in seeds faba bean with increasing magnetic field for seeds combined all treatments. The significant increase of P, Fe, Mn and Zn concentrations in seeds faba bean , while , the N and K concentrations was no significant as affected by magnetic field different time. On the other hand , the application of mineral N fertilizers different rates led to

Table (7).Macro- micronutrients concentrations contents in seeds faba bean after harvest .

Treatments	Rate of N (kg/fed)	Time of magnetic (min)	Macronutrients (%)			Micronutrients (mg/kg)		
			N	P	K	Fe	Mn	Zn
Control	15	0	2.96	0.29	2.40	60.21	40.32	29.80
		5	3.16	0.33	2.44	65.40	44.40	31.30
		10	3.47	0.36	2.48	69.90	46.85	35.66
		15	3.75	0.39	2.51	72.18	48.55	39.87
	Mean		3.34	0.34	2.46	66.02	45.03	34.16
	30	0	3.05	0.34	2.43	63.20	43.50	31.50
		5	3.32	0.40	2.49	67.88	47.85	33.76
		10	3.65	0.46	2.56	69.50	50.44	39.10
		15	3.88	0.50	2.59	74.20	54.30	43.20
	Mean		3.48	0.43	2.52	68.70	49.02	36.89
	45	0	3.07	0.36	2.46	65.40	45.60	33.55
		5	3.54	0.46	2.54	71.33	49.59	35.87
		10	3.76	0.53	2.59	78.90	53.20	43.29
		15	3.88	0.55	2.64	83.20	57.89	48.70
	Mean		3.56	0.48	2.56	74.71	51.57	40.35
Bio-fertilizer	15	0	3.14	0.35	2.50	64.79	45.99	33.20
		5	3.74	0.38	2.57	68.40	48.30	35.98
		10	4.03	0.43	2.64	72.10	49.55	39.54
		15	3.89	0.45	2.67	73.58	54.30	43.20
	Mean		3.70	0.40	2.60	69.72	49.54	37.98
	30	0	3.16	0.36	2.53	66.50	48.20	36.22
		5	3.84	0.45	2.65	74.20	56.87	38.77
		10	4.12	0.48	2.73	75.90	58.20	43.20
		15	4.07	0.54	2.77	77.19	63.40	48.90
	Mean		3.80	0.46	2.67	73.45	56.67	41.77
	45	0	3.24	0.39	2.55	70.66	52.10	38.00
		5	3.88	0.49	2.75	78.40	64.30	43.88
		10	4.06	0.57	2.84	80.34	68.48	47.85
		15	3.97	0.58	2.89	87.30	75.30	53.20
	Mean		3.79	0.51	2.76	79.18	65.35	45.73
Humat potassium	15	0	3.11	0.34	2.54	68.40	48.50	36.00
		5	3.25	0.37	2.64	75.40	53.30	38.50
		10	3.55	0.46	2.68	78.39	55.89	42.29
		15	3.82	0.52	2.74	83.20	58.00	45.66
	Mean		3.43	0.42	2.65	76.35	53.92	40.61
	30	0	3.13	0.37	2.57	71.90	51.40	39.80
		5	3.77	0.48	2.77	77.49	55.60	43.40
		10	3.89	0.54	2.83	80.10	59.60	48.60
		15	4.10	0.56	2.89	83.20	64.32	49.99
	Mean		3.72	0.49	2.77	78.17	57.73	45.45
	45	0	3.17	0.40	2.59	73.20	53.20	42.10
		5	3.80	0.52	2.79	79.55	58.40	46.33
		10	3.85	0.57	2.86	83.20	64.30	50.30
		15	3.92	0.59	2.91	85.60	68.77	51.40
	Mean		3.69	0.52	2.79	80.39	61.17	47.53
LSD. 5 % time magnetic			ns	0.006	ns	1.55	0.30	1.41
LSD. 5 % rate of N			0.19	0.008	0.06	1.19	0.61	0.77
LSD. 5 % treatments			ns	0.011	ns	ns	0.56	0.91
LSD. 5 % Treatment * Time			ns	***	ns	***	***	***
LSD. 5 % Treatments * Rate of			ns	***	ns	***	*	ns

N						
LSD. 5 % Interaction	*	***	***	***	**	***

significant increase of N, P, K, Fe, Mn and Zn concentrations in seeds faba bean. Also, the applied of humate potassium and bio-fertilizer were significant increase of P, Mn and Zn concentrations in seeds faba bean, while the N, K and Fe concentrations in seeds were no significant. As well as, the interaction between all treatments combined with magnetic field times were significant increase of P, Fe, Mn and Zn concentrations in seeds while, the N and K concentrations no significant. The significant increase of P, Fe and Mn concentrations in seeds, while N, K and Zn concentration in seeds were no significant as affected all treatments and mineral N fertilizer different rates. The interaction between all treatments were significant increase of N, P, K, Fe, Mn and Zn concentrations in seeds faba bean .These results are in agreement by **Ratushnyak et al. (2008)** showed that the magnetic seed treatment increased the amount of microbial content of the soils such as nitrogen-fixation bacteria, this increase in microorganisms may improve the availability of elements in the soil to plant uptake**. Awaad et al,. (2020)** reported that the combined with the high level of potassium humate (10 kg fed^{-1}) caused the highest percentage of N, P and K contents as well as uptake in the faba bean seeds. **Nassar et al (2021)** found that the application of potassium humate improve the concentrations of photosynthetic pigments,, contents of seed nutrients and biochemical constituents could be explained on the basis of that humic substances can directly or indirectly affect the physiological processes of plant growth by promoting the uptake of macro-and micronutrients and affecting the biochemical substances, carrying nutrients and growth regulators and acting as hormone like substances. **Afifi et al (2017)** reported that the increase of N, P and K concentration in seeds faba bean as affected by potassium humate application. **El-Naggar (2010)** revealed the applied mineral fertilizer in the highest rate with bio-fertilizer inoculation led to significant increases in nutrients (N, P and K) content especially nitrogen and this may be led to an increase in cell division. **Rizk and Mashhour (2008)** found that the content and uptake of N, P and K of wheat and broad bean plants significantly increased with increasing potassium humate (KH) concentration. **Rathore et al (2010)** indicated that the applied bio-fertilizer was increase of N, P and K uptake compared to control. **DeKhane et al., (2011)** indicated that applied bio-fertilizer Rhizobium inoculation were significantly increased protein and N, P content as well as uptake of N and P by grain and stover of cowpea.

Faba bean quality.

Data presented in Table (8) show that the effect of humat potassium and bio-fertilizer and interaction combined mineral N fertilizer different rates under pre-sowing seeds magnetic field different time on protein, carbohydrate and proline contents in seeds faba bean were significant increase. The highest mean values of **23.74** proteins (%) for plant treated with bio-fertilizer combined with 30 kg/fed N mineral fertilizer under magnetic field different time than other treatments. The increase of mean value of carbohydrate contents in seeds as affected with inoculation bio-fertilizer plus 45 kg/fed under magnetic field times compared with other treatments. These results are in agreements by **Zaghlol et al., (2015)** indicated that the effect of bio-fertilizers on protein and carbohydrate contents in pea seeds were significant increase. The decrease of mean values of proline contents in seeds was plant treated with bio-fertilizer plus 30 kg /fed under magnetic field different times compared with other treatments. These results could be attributed to the indirect effects of biofertilizer + humate potassium in the induction of systematic resistance thus enhancing by the synthesis of physical and chemical barriers in the host plant. Moreover, these substances help to improve the phosphorus and nitrogen uptake assimilation and growth-regulating phytohormone activities which help the faba bean plants to uptake and translocate the nutrients as well as improve the plant health in a better way. Moreover, the most consistent increases in the percentages of protein, carbohydrate and decrease of proline contents in seeds. **Verma and Maurya (2013)** found that the increase in protein content with increasing potassium humate

Table (8). Effect of all treatments on seeds faba bean quality after harvest.

Treatments	Rate of N (kg/fed)	Time of magnetic (min)	Protein (%)	Carbohydrate (%)	Proline (mg g^{-1} D.W.)
Control	15	0	18.50	46.58	58.62
		5	19.75	47.63	54.36
		10	21.69	49.12	48.96
		15	23.44	53.14	45.32
	Mean		20.85	49.12	51.82
	30	0	19.06	48.35	55.96
		5	20.75	50.69	50.32
		10	22.81	54.31	47.35
		15	24.25	58.41	44.63
	Mean		21.72	52.94	49.57
	45	0	19.19	52.16	53.26
		5	22.13	54.62	47.32
		10	23.50	59.32	44.62
		15	24.25	60.10	40.96
	Mean		22.27	56.55	36.54
Bio-fertilizer	15	0	19.63	52.69	40.32
		5	23.38	56.34	34.26
		10	25.19	59.84	33.14
		15	24.31	62.14	26.13
	Mean		23.13	57.75	33.46
	30	0	19.75	55.63	36.42
		5	24.00	58.94	28.14
		10	25.75	62.31	22.16
		15	25.44	63.75	20.65
	Mean		23.74	60.16	26.83
	45	0	20.25	57.36	35.49
		5	24.25	60.14	37.62
		10	25.38	63.82	24.32
		15	24.81	65.73	21.85
	Mean		23.67	61.76	29.82
Humat potassium	15	0	19.44	49.75	50.32
		5	20.31	54.31	46.32
		10	22.19	56.89	44.52
		15	23.88	59.84	40.19
	Mean		21.46	55.20	45.34
	30	0	19.56	53.14	46.52
		5	23.56	55.21	40.32
		10	24.31	59.45	37.46
		15	25.63	61.34	33.20
	Mean		23.27	57.29	39.38
	45	0	19.81	54.85	44.36
		5	23.75	58.63	39.52
		10	24.06	61.35	32.15
		15	24.50	63.85	28.95
	Mean		23.03	59.67	36.25
LSD. 5 % time magnetic			ns	ns	7.14
LSD. 5 % rate of N			0.91	1.52	1.28

LSD. 5 % treatments	**ns**	**ns**	**ns**
LSD. 5 % Treatment * Time	**ns**	*	*
LSD. 5 % Treatments * Rate of N	**ns**	**ns**	**ns**
LSD. 5 % Interaction	***	***	***

Shafeek et al (2015) suggested that the application of humat potassium to plant was increase of carbohydrate and protein contents. **Yamika et al., (2018)** reported that the proline content in seeds soybean was increase under saline stress condition than soil decrease salinity.

CONCLUSION

Treatment of soil and faba bean plants by biofertilizer (*Rhizobium radiobacter* sp strain **(**Salt Tolerant PGPR)) and with humate potassium led to improvement of saline soil properties, increase of macro-micronutrients available contents in soil and concentrations contents in seeds plants, as well as the increase of faba bean productivity under increase of pre-sowing magnetic field time**.**

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