Integrative Application of Organic and Inorganic Fertilizers on Some Soil Properties and Growth of Faba Bean under Different Levels of Irrigation Water.

M. M. El-Badry *, **M. S. Zeid, A. G. Mancy, and S. A. Abdeen**

Department of soils and Water, Faculty of Agriculture, Al-Azhar University, Cairo, Egypt.

*Corresponding author E-mail: mohamedelbadry.205@azhar.edu.eg (M. El-Badry)

ABSTRACT:

A pot experiment was conducted to study the combined effect of fertilization (organic and inorganic sources) under irrigation levels of 100% and 80% of field capacity on clay soil properties, growth parameters, water use efficiency (WUE), and nitrogen uptake efficiency (NUE) by faba bean (Vicia faba cv. Giza 843). Findings demonstrated that, in comparison to the control, the interaction impact of fertilization treatments and irrigation levels significantly improved soil organic matter, cation exchange capacity, and reduced the values of soil bulk density. Additionally, N3 treatment (50% N from chicken manure + 50% N from urea) at 100% of field capacity gave the highest relative increase in plant height (cm), number of branches per plant, fresh weight (g pot-1), dry weight (g pot-1) and chlorophyll value, which recorded 21.24, 52.63, 42.50, 38.87, and 31.60%, respectively. Also, compared to a single application of urea (N1) or ammonium nitrate (N4), integrated organic and inorganic fertilizers at N3 followed by N6 (50% N from chicken manure plus 50% N from ammonium nitrate) recorded the greatest significant values of NPK content and uptake. Principal component analysis (PCA) showed that the most studied soil properties, growth parameters, WUE, NUE and nutritional status of faba bean correlated with the treatments of N3 and N6 under both irrigation levels.Therefore, the integration of organic and inorganic fertilizers under good irrigation management becomes essential for enhancing plant growth, improving and sustainability of soil properties.

Keywords: Organic and inorganic fertilizers; Irrigation; Faba bean; Clay soil; PCA analysis.

INTRODUCTION:

The most crucial practices for plant growth and crop production are irrigation and fertilization, as they have a direct impact on the plant life cycle. Low crop production and profitability may be caused by insufficient irrigation or plant nutrition, resulting in huge losses in many cases. The quickest method of supplying nutrients to plants is through the use of mineral fertilizers. However, many studies has shown that using chemical fertilizers excessively can lower crop yield due to soil nutrient imbalance, loss of soil biological activity and loss of soil characteristics (Mahmood et al., 2017). Chemical fertilizer use frequently results in ecological harm and environmental contamination, which raises the cost of agricultural production. Excessive use of chemical fertilizers costs a lot of money and harms the environment. Thus, adding organic manure as a substitute for chemical fertilizers was advised (Oad et al., 2004). Using organic and inorganic residues that can offer plant nutrients and enhance the physical characteristics of the soil could be a viable choice (Elfishy, 2009). One of the safer possibilities is to apply organic fertilizer, which has a number of benefits, such as supplying plant growth nutrients and being ecologically friendly (Mohamad et al., 2022). Applying organic manures such as chicken manure and compost can help soils to be more productive by enhancing their physical and chemical qualities. The advantages of applying organic fertilizers were observed through improving soil properties, macro-micronutrient availability, and growth of faba bean (Abd-Eladl et al., 2016 and El-Yazal 2020). Organic fertilizers directly contribute to supporting plant growth and improving soil properties by providing essential nutrients in available forms as well as organic compounds through mineralization, thus enhancing the physical, chemical, and biological properties of the soil. (Naveed et al., 2014 and Aboseif et al., 2022). Chicken manure is considered one of the best organic fertilizers due to its nutritional content where, application of chicken manure alone or in combination with urea greatly increased soil fertility and soil CEC (Donatus 2017). Due to the relatively low nutritional content, applying organic fertilizer alone might not be adequate to meet the plant's needs. When combined with chemical fertilizer, the application of organic fertilizer promotes microbial activity, supports the effective utilization of nutrients, and increases the accessibility of surrounding nutrients, resulting in the best possible nutrient uptake by plants (Moharana et al., 2012). The use of

2nd International Scientific Conference "Agriculture and Futuristic Challenges (Food Security: Challenges and Confrontation)", Faculty of Agriculture, Al-Azhar University, Cairo, Egypt, October 10th –11th, 2023.

organic fertilizers is a very important tool to achieve organic farming through high quality products and safe commodities that are also beneficial to the environment (Willer and Lernoud, 2019). According to Pantawat (2012), organic matter reduces greenhouse gas emissions that are often caused by nitrogen fertilizers, which in turn helps to limit global warming. The addition of organic fertilizers efficiently ensures high productivity and continuous crops by enhancing soil characteristics and increase roots development and activity of soil microorganisms (Ayoola and Makinde 2009). After wheat harvesting on clayey soil, the combined application of organic and inorganic fertilizers significantly increased soil moisture content, soil organic matter, and cation exchange capacity in comparison with control (Agegnehu et al., 2016). The combined use of CO (NH2)2 at 50 and 100 kg N ha^{-1} and chicken manure at 5 t ha-1 improved soil organic carbon and cation exchange capacity (Amusan et al., 2011). Furthermore, according to Shaban et al. (2008), the addition of urea (80 and 40 kg fed.-1) and chicken manure (10- and 15-tons $fed^{.-1}$) resulted in a considerable decrease in pH values, an increase in organic material, and a greater availability of macro and micronutrients. The aim of this investigation is to study the relationship between organic and inorganic fertilizers as a source of nitrogen under different levels of irrigation for enhancing plant growth, improving and sustainability of soil properties.

MATERIALS AND METHODS

Experimental design

During the winter season of 2020–2021, a pot experiment was conducted in the experimental farm (30° 3'19.49"N, 31°19'10.19"E) of Soils and Water Department, Faculty of Agriculture, Al-Azhar University, Cairo, Egypt. The pots were arranged in a completely randomized design in two factors with three replicates to examine the effects of nitrogen fertilization (integrated organic and inorganic fertilizers) under two levels of irrigation water on soil characteristics, plant growth, water use efficiency, nitrogen uptake efficiency, and nutritional status of faba bean plants grown in clayey soil conditions.

Irrigation treatments

Pots irrigated by I1 (100 % from field capacity, which equal 17.81 liter of applied water per pot = 1062.20 m3 fed^{-1})

Pots irrigated by I2 (80 % from field capacity, which equal 14.41 liter of applied water per pot = 859.41 m3 fed^{-1})

Fertilization treatments

Under the effect of 100% (I1) and 80% (I2) of field capacity, faba bean plants were fertilized by the following treatments :

1.N0: Control treatment (without adding fertilizers)

2.N1: 100% recommended dose of N as urea (46% N)

3.N2: 50% from recommended dose of N as urea (46% N) + 50% from compost (1.74%N)

4 .N3: 50% urea (46% N) + 50% from chicken manure (3.35 %N)

5.N4:100% recommended dose of N as ammonium nitrate (33.5% N)

6 .N5: 50% N from ammonium nitrate (33.5% N) + 50% from compost (1.74%N)

7.N6: 50% from ammonium nitrate (33.5% N) + 50% from chicken manure

Soil samples

Clayey surface soil samples (0-30 cm) were collected from Zagazig region, Sharkia Governorate (30°34′00″N, 31°30′00″E) Egypt. Before cultivation in the pots, soil samples were homogenized by removing unwanted components such as plant roots, leaves, and trash. Soil samples were subjected to routine preparation (air drying, crushing, and sieving through a 2.0 mm sieve). After harvesting faba bean plants, soil samples were also collected from each pot, and subjected to the same steps as the previous preparations and saved for analysis according to Estefan et al. (2013).

Organic fertilizers

Compost and chicken manure as a source of nitrogen were added during preparing the soil for cultivation, while the supplementary amount from chemical nitrogen fertilizers (either urea or ammonium nitrate) was distributed over three times, where the first batch was added after two weeks from complete germination. Some physical and chemical properties of compost and chicken manure were done according to FAO (2015) and Estefan et al. (2013) and presented in Table 2.

Agricultural practices of faba bean

Seeds of faba bean (Vicia faba cv. Giza 843) were obtained from LCRD (Legume Crops Research Department) of Agricultural

Research Center, Giza, Egypt). Plastic pots (32 cm diameter and 28 cm height) were filled with 20 kg of clayey soil for each pot. Mono superphosphate (15.5% P2O5) and K2SO4 (48%K2O) were applied at recommended dose according to Egyptian Ministry of Agriculture. Five seeds of faba beans were planted in each pot. After full germination, faba bean seedlings were thinned to three similar plants in each pot to start the experimental treatments of irrigation and nitrogen fertilization

Data recorded

After 65 days from sowing, the following data of faba bean plants were recorded.

-Plant height (cm)

-Number of branches per plant.

-Fresh weight of shoot (g pot^{-1})

-Dry weight of shoot (g pot^{-1})

-Chlorophyll values (SPAD) in the fifth leaf from the top were recorded using a chlorophyll meter (SPAD-501, Minolta Co., Japan)

-Water use efficiency (WUE) was calculated according to Payeroet al., (2008).

WUE (Kgm^{-3})= (Shoot Dry weight (g/pot.))/(applied water (l/pot)).

-Nitrogen uptake efficiency (NUE) was calculated according to Fernández et al., (2021).

-NUE (%) =(N uptake in fertilized treatment- N uptake in control treatment X100)/(N applied as fertilizer)

Plant analysis

Fresh-weight samples of faba bean were recorded, placed in a drying oven at 70 ℃; and pulverized in a stainless-steel mill. Half gram of dried plant samples of faba bean was digested by HClO4 plus H2SO4 acids at 3:1v/v according to the procedure of Chapman and Pratt (1961). Macronutrients (NPK) were determined in acid digestive solution. In contrast, N, P and K uptake values were calculated per pot.

Statistical analysis

The design of experiment was completely randomized design (CRD). All obtained results were subjected to variance analysis (ANOVA). The least significant difference (LSD) was applied to investigate the differences between means of treatments at 5% level as described by Freeman et al. (1985). Principal component analysis (PCA) was done by Origin Pro program to evaluate the correlation among the tested traits under the effect of fertilization and irrigation treatments.

RESULTS AND DISCUSSION

Effect of the experimental treatments on some soil properties after faba bean harvest:

Soil chemical properties

Soil chemical properties (pH, EC, OM and CEC) as affected by different organic and inorganic fertilizers (N1-N6) under irrigation of 100 (I1) and 80% (I2) of field capacity are shown in Table 3. Treatments caused a little decrease in soil pH. The lowest value of soil pH (8) was observed at N6 treatment. The reduction in soil pH could be attributed to the production of organic acids resulting from the decomposition processes of organic materials by soil microbes. These data are in harmony with those observed by El-Gizawy et al. (2013) who attributed the decrease in soil pH values after faba bean harvesting to the application of organic materials. Also, Khafagi et al., (2017) found that using 50 % poultry manure + 50 % chemical fertilizers decreased soil pH values after harvesting wheat plants. On the other side, the interaction effect between fertilizers and irrigation significantly increased soil properties values including, EC, OM and CEC in comparison with control. The values of EC were fluctuated between 0.85 dS m-1 in control and 1.18 dS m-1 in N6 under 80% of field capacity. This may be due to the dissolving action of soluble organic substances produced during decomposition of organic materials by microbes. In this respect, Talha (2013) and Abd-Allah (2021) reported that the combination of compost and N-fertilizer significantly increased EC of soil extract. Also, the values of OM ranged between 0.95 in control and 1.28% in N6 treatment under 100% of FC. The superiority of N6 on other treatments can be explained by the high content of chicken manure from organic matter and nutrients. These results were coordinated with Shirani et al., (2002) and Abd-Allah (2021) who found that the integrated use of mineral nitrogen fertilizers at 50 % plus50 % from organic manures (farmyard manure, poultry manure or compost) significantly increased soil organic matter content. Additionally, there is a positive relationship between soil OM and CEC, where the highest value of CEC was 48.65cmolc kg-1with N6 treatment under 100% of field capacity. These results could be enhanced by El- El-Maddah et al. (2019) who reported that the combined effect of compost and mineral fertilizers significantly improved cation exchange capacity after maize harvest in clay loam soil. Moreover, Almaz et al. (2017) found that, treatment with 50% NPK plus 50% poultry manure significantly increased cation exchange capacity of sandy loam soil as compared with treatments of 100% NPK or control.

Soil physical properties:

Data presented in Table 3 indicated that soil moisture constant at field capacity, wilting point, and available water were positively improved by the addition of organic and inorganic fertilizers under irrigation level of 100 and 80% from FC. In this concern, the improvement of soil moisture contents were recorded with integrated organic and inorganic fertilizers especially in N6 and N3 treatments. The highest values of FC (37.60%), WP (20.97%), and AW (16.63%) were recorded with N6 treatment under 100% of field capacity. The improvement in soil organic matter, which greatly improves soil permeability and increases total soil porosity, may be the reason for the higher soil moisture constants. These findings supported by Cercioglu (2017), Mancy and Sheta (2021) who found that the organic amendments significantly improved soil moisture content and nutrients retention as well as increased plant growth and production of crops. Integration between organic and inorganic fertilizers, especially with N6, significantly reduced soil bulk density. The decrease in soil bulk density can be attributed to the formation of soil aggregates resulting from the high organic matter content of chicken manure. The lowest significant value of soil bulk density (1.30 Mg m-3) was recorded with N6. The combination of compost and mineral fertilizers boosted the production of soil aggregates and recorded the lowest values of soil bulk density compared to the control (El-Hamdi et al., 2007 and Abd-Allah 2021). Furthermore, Bassouny and Chen (2016) noticed that applying of chicken manure and NPK fertilizer significantly decreased bulk density in clayey soil.

Effect of the experimental treatments on growth parameters of faba bean plants

Data in Table 4 demonstrated that different nitrogen treatments (N1-N6) and irrigation water levels (I1 and I2) had a significant impact on the measured vegetative parameters of faba beans, including plant height (cm), number of branches per plant, fresh weight (g pot-1), dry weight (g pot-1), and chlorophyll values (SPAD), as compared to the control treatment. Concerning the effect of different nitrogen treatments (N1-N6) on faba bean growth parameters, it is clear that, the greatest mean values of plant height (cm), number of branches per plant, fresh weight, dry weight and chlorophyll recorded 48.07 cm, 4.78, 369.00 g, 74.00 g and 55.49 SPAD that obtained from N3, while the corresponding minimum mean values were 40.13 cm, 3.93, 265.14 g, 53.55 g and 42.82 SPAD that recoded with control treatment, respectively. The following order list shows the effects of various nitrogen treatments (N1-N6) on the faba bean growth parameters: N3<N6<N2<N5<N1<N4 which recorded the percentage increase over control as the following:19.79, 19.49, 18.16, 16.55, 12.21, 11.11 % for plant height, 41.00, 32.74, 26.25, 19.76, 6.49, 5.01% for no. of branches,39.17, 35.52, 30.81, 28.11, 16.42, 11.39% for fresh weight, 38.19, 34.60, 32.59, 29.17, 21.81, 21.70% for dry weight, and 29.59, 27.21, 22.44, 21.60, 12.68, 9.13% for chlorophyll values (SPAD). In addition, compared to a single application of fertilizers in N1 and N4 or control treatment, the combined effect of organic and inorganic fertilizers, particularly in N3 and N6, boosted growth parameters of faba bean.

The superiority of studied growth parameters of faba bean in N3 treatment (50% N from urea plus 50% N from chicken manure) compared to other treatments could be attributed to the synergistic effect between urea and chicken manure in improving soil fertility by synchronizing nutrient release (short-term effect) as well as improving physical and chemical soil properties (long-term effect).These findings could be enhanced by Ghaly et al. (2020); Hossain et al. (2018); and Soremi et al. (2017), who found that the most significant values of measured vegetative growth, including plant height, number of leaves plant-1, number of branches plant-1, and dry weight of soybean and mungbean plants, occurred when chicken manure and chemical fertilizers were combined in varied ratios. Moreover, organic fertilizer increases plant growth by improving soil properties due to the presence of humic substances (humic and fulvic acids), macro and micro nutrients required for plant growth, and the activity of soil organisms.

The suitable moisture content at 100% of field capacity supported growth of faba bean in comparison with 80% of field capacity. The growth parameters (number of branches 〖

plant〗^(-1), fresh and dry weights and chlorophyll values) of faba bean irrigated by 100% field capacity recorded the highest significant mean values compared to plants watered by 80% field capacity. These findings are in harmony with those obtained by Fayed et al. (2021) and Yousry et al. (2021), who found that 100% of irrigation requirements (IR) gave the greatest vegetative growth traits of faba bean compared to 60% and 80% of IR, respectively. The positive effects of water availability on increasing vegetative growth parameters of plants were supported by many researches (Monneveux et al., 2006; Marschner 2012; Khalifa 2019; Shalaby et al., 2020 and Wanas et al., 2022), who attributed the improvement of growth parameters with optimal irrigation water level to increasing the availability of soil moisture content, thus increasing the absorption of water and nutrients, also they found that the improvement were recorded not only in the morphological traits of plant growth but also in the physiological processes, where photosynthesis, transpiration and nutrient uptake processes are the most important metabolic processes affected by the level of soil moisture content. In contrast, under conditions of water shortage, the efficiency of many processes is negatively affected such as absorption of water and nutrients, photosynthesis, cell wall and cell membrane damage (Erdem et al., 2006; Taiz and Zeiger, 2006 and Huseynova 2012).

Furthermore, irrigation (I1=100% FC) and fertilization (N3=50% N from urea + 50% N from chicken manure) recorded the maximum significant interaction effect on increasing of plant height (48.8 cm), number of branches (〖5.22 plant〗^(-1)), fresh weight〖 (389.67 g pot〗^(-1)), dry weight (76.67 g pot -1) and chlorophyll value (57.85 SPAD) as compared to other treatments. As illustrated in Fig.1, the relative increase for plant height, branches number, fresh weight, dry weight, chlorophyll recorded 21.24, 52.63, 42.50, 38.87, and 31.60 % under the influence of irrigation and fertilization (I1X N3), respectively. Also, the relative increase under the influence of irrigation and fertilization (I2X N3) reached 18.30, 28.78, 35.63, 37.46, and 27.50 % for plant height, branches number, fresh weight, dry weight, chlorophyll, respectively, as shown in Fig. 2.

Effect of the experimental treatments on NPK content and uptake

Data in Table 5 showed that NPK content (%) and their uptake (mg pot-1) by faba bean plants were significantly affected by nitrogen treatments (N1:N6) and irrigation water levels (I1:I2).The increases in NPK status occurred under nitrogen treatments (N1:N6) in comparison to control plants, showing that the available nitrogen under control treatment was insufficient to face the requirements of faba bean plants. In contrast, nitrogen fertilizers (N1:N6) application caused a significant increase in NPK status, as above mentioned with faba bean growth parameters in Table 4. Integrated use of organic and inorganic fertilizers at treatments of N2, N3, N5 and N6 caused a significant increase in NPK content and uptake compared with singly application of urea at N1 or ammonium nitrate at N4. These results could be supported by El-Sebaey (2006), Verma et al., (2006); Madisa et al., (2013); Fawy et al., (2016); Vidyavathi et al., (2012), Ghimire et al., (2019) and Aboseif et al.,(2022), who indicated that the combined effect of organic fertilizers with chemical fertilizer gave higher uptake of NPK than full dose of inorganic N-fertilizers. The superiority of NPK uptake by faba bean plants under the integrative application of fertilizer treatments (N2, N3, N5, and N6) could be attributed to the improving effect of these treatments on soil physical properties. Also, the presence of fast-release fertilizers (chemical sources) along with slow-release fertilizers (organic sources) that increased soil nutrient supply, reduced nutrient loss from soil solution, and thus increased nutrient uptake. These findings could be supported by Ayeni and Adetunji (2010), Dubey et al. (2012) and Rizk et al. (2016). N3 treatment recorded the highest mean values of NPK content (2.35, 0.26, 2.05%) and uptake (1739.27, 189.27, 1514.24 mg kg-1), followed by the descending order of N6 (2.30, 0.21, 2.02 %) and 1658.68, 152.17, 1453.60 mg pot-1), respectively. These results indicated that superiority of chicken manure with nitrogen fertilizers (N3 and N6) compared to compost with nitrogen fertilizers (N2 and N5). This might be a result of a large amount of organic matter, nutrients and functional groups of chicken manure (Adediran et al., 2005; Ojeniyi et al 2006 and Huang et al., 2017). Also, Ewees et al. (2008) indicated that the superiority of nutrient tissues of bean plants under the addition of organic manure may be attributed to the high relatively and enough quantity of macronutrients that required for a good growth and yield of bean plants.

Regarding the impact of irrigation levels, data in Table 5 showed that NPK content (%) and their uptake (mg pot-1) by faba bean plants declined with decreasing soil moisture content from 100 (I1) to 80 % (I2) of field capacity. Moreover, faba bean plants irrigated by I1 recorded the highest mean values of NPK content (2.00, 0.19, and 1.94%) and uptake (1402.10, 135.46, and 1346.91mg pot-1). While the corresponding minimum mean values of NPK content (1.95, 0.18, and 1.87%) and uptake (1294.59, 122.43, 1230.35 mg pot-1) were recorded with I2, respectively. The superiority of the nutritional status of NPK with irrigated faba bean plants at I1 level compared to I2 level can be attributed to the higher availability of soil moisture content. The optimum soil moisture content is necessary for solubility and nutrient availability, absorption and translocation of nutrients to play metabolic roles within plants; moreover, soil moisture level and nutrient availability play key roles in sustainable plant growth and vital processes such as photosynthesis, gas exchange, transpiration, and yield for each plant (Qiu et al, 2008, Marschner, 2012, and Wang, 2017). On the other hand, water shortage led to decreased plant photosynthesis, which in turn affected growth characteristics and decreased the number of nodules, which serve as symbiotic sites for gaseous N fixation (Siam et al. 2017).

Concerning the interaction impact of irrigation water levels (I1-I2) and nitrogen treatments (N1-N6) on NPK status, it is seen that, the maximum values of NPK content (2.36, 0.26, 2.08 %) and uptake (1809.41, 201.64, 1594.74 mg pot-1) were recorded at I1XN3. The corresponding minimum values of NPK content (1.26, 0.132, 1.58 %), and 653.81, 68.49, 819.86 mg pot-1) were recorded with control treatment (no fertilizers added) at irrigation levels of 80 % of field capacity.

Effect of the experimental treatments on water use efficiency (WUE) and nitrogen uptake efficiency (NUE) by faba bean plants grown in clayey soil

Results displayed in Table 5 revealed a significant effect of irrigation water levels (I1 and I2) and fertilizer treatments (N1 to N6) on the water use efficiency (WUE) and nitrogen uptake efficiency (NUE) of faba bean plants growing in clayey soil conditions. The following order describes the impact of various nitrogen treatments on WUE and NUE: N3<N6<N2<N5<N1<N4. On the other hand, irrigation water levels (I1 and I2) affected on WUE as the following order I2> I1, while NUE arranged in the following descending order: I1> I2. The highest significant values of WUE (5.44, 5.42, 5.37, 4.99, 4.13 and 4.04 kg m-3) were recorded with following fertilization treatments: N3, N6, N2, N5, N1, N4, while the highest significant values of NUE (40.10, 39.06, 35.29, 34.92, 19.98, and 18.98%) were recorded with the treatments of N6, N3, N5, N2, N4, N1, respectively. Additionally, irrigation water level (I2) recorded the maximum significant mean of WUE (5.07 kg m-3) compared with irrigation level I1 (4.28 kg m-3), respectively. The superiority of combined fertilization treatments (N3, N6, N2, and N5) as compared with single chemical fertilization (N1and N4) on increasing WUE and NUE could be attributed to the beneficial effect of organic fertilizer on increasing water and nutrient stored in the effective root zone, consequently increasing water and nutrient uptake which significantly increased growth and dry matter yield of faba bean plants. Therefore, addition organic fertilizers mitigated water stress. These findings are agreement with Abd-Allah (2021), Bandyopadhyay et al., (2010) and El-Sodany et al., (2015) who mentioned that integrated organic and mineral fertilizers significantly increased water use efficiency compared to the control. Also, Iqbal et al., (2019) and Xiaobin et al., (1999) who found that the combined organic manure and inorganic fertilizers significantly increased nitrogen uptake efficiency (NUE) compared to control. Moreover, organic manure application enhanced the nutrient preserving capability of the soil and reduced N leaching (Ren et al., 2014 and Lanna et al., 2018).The results of irrigation levels agreed with Fayed et al. (2021), who reported that 60% irrigation requirements (IR) gave the maximum WUE of faba bean under sandy loam condition compared to the control, while the application of 80% and 100% of IR led to a decrease of WUE values. Also, El-Noemani et al., (2010) found that the application of irrigation level (80% of ETo) led to an increase in WUE of snap bean (Phaseolus vulgaris L.) grown in sandy clay loam soil in comparison with control.

Concerning the interaction effect of fertilization and irrigation on WUE and NUE by faba bean plants, the results in Table 5 indicated that, the highest significant values of WUE (5.90 kg m-3) was recorded with N3 (50% urea + 50% chicken manure) at irrigation levels of 80 % of field capacity (I2). On the other side, the control (without fertilizers added) at irrigation levels of 100% field capacity had the lowest significant value of WUE (3.10 kg m-3). Additionally, the highest significant values of NUE than control (40.23%) was recorded with N6 (50% ammonium nitrate + 50% chicken manure) at irrigation levels of 80 % of field capacity (I2). Also, the lowest significant values of nitrogen uptake (653.81 mg pot-1) recorded with control treatment (no fertilizers added) at irrigation levels of 80 % of field capacity. These results agreed with Zein El-abdeen et al., (2018), who found that a combination of organic and mineral-N fertilizers under 75% of irrigation requirements (IR) led to increasing water use efficiency of faba bean grown in silty clay soil compared to control (100% of IR). Also, Mandal et al., (2006) indicated that application of organic fertilizers and mineral-N fertilizers under irrigation level at 60% of ET significantly increased water use efficiency compared to control.

Principal component analysis (PCA)

Under the nitrogen fertilization treatments and irrigation water levels, the correlations between soil properties, plant growth, water use efficiency (WUE), nitrogen uptake efficiency (NUE) and nutritional status (NPK content and uptake) of faba bean plants were evaluated using principal component analysis (PCA). The principle components were able to explain 90.21% (PC1= 84.32% and PC2= 5.98%) of the total variance as shown in Fig. 3. The PC1 had the highest variance (%) and positive correlation with all studied variables except pH and bulk density (BD) in soil, while the PC2 is positively correlated with all studied variables except P%, WUE, NUE, EC, OM and CEC. These results indicated that PC1 can be referred to as the weighting component for soil properties, plant growth parameters, WUE, NUE and nutritional status of faba bean plants, thus PC1 is important to faba bean growth during nitrogen fertilization treatments (N1-N6) and irrigation water levels (I1 and I2).

Using a biplot diagram as illustrated in Fig. 3, a sharp angle (below 90-degree) among all soil properties, plant growth parameters, WUE, NUE and nutritional status (NPK content and uptake) of faba bean plants were observed exception pH and BD in soil (obtuse angles), indicating the positive association between these variables, yet, they varied in correlation degree. The evaluated variables and treatments were primarily divided and distributed into four groups using PC1 and PC2. The first group (GI) was located in the first quarter (the highest PC1 and the highest PC2) and includes WP, EC, AW, PH (plant height), DW, CHL, FW, NB/P (no of breeches plant -1), K%, K-up, N%, N-up and P-up, which are strongly positively associated with irrigation levels of I1 and N3 (100-N3), irrigation levels of I1 and N2 (100-N2) and irrigation levels of I1 and N5 (100-N5) treatments. These results indicated that these treatments recorded the best growth traits of faba bean and other variables compared to other treatments under study. The second group (GII) was found in the second quarter (the highest PC2 and the lowest PC1), including pH and BD, which are positively associated with 100-N1, 100-N4, 80-N1 and 80-N4 treatments. The third group (GIII) was recorded in the third quarter (the lowest PC1 and the lowest PC2), including 100-N0 and 80-N0 treatments, indicating the negative effects of irrigation water of 100% field capacity without fertilization (100-N0) and irrigation water of 80% field capacity without fertilization (80-N0) on the growth traits of faba bean plants and other variables. The fourth group (GIV) was observed in the fourth quarter (the highest PC1 and the lowest PC2) including P%, NUE, WUE, OM, CEC and EC, and positively correlated with 100-N6, 80-N6, 80-N3, 80-N2 and 80-N5 treatments that increased P%, NUE, WUE, OM, CEC and EC under study .

Generally, PCA results showed that PC1 had the highest loading of most soil properties, plant growth, WUE, NUE and nutritional status of faba bean plants with N3 and N6 treatments across both irrigation water levels, indicating that these variables could give high values under N3 and N6 treatments in both irrigation water levels, but highest under 100% of field capacity

CONCLUSION:

Based on the abovementioned results, it can be concluded that the use of different sources of nitrogen fertilizers (organic and inorganic sources) is a more effective way to increase not only the growth of faba bean but also improve soil properties compared to conventional chemical fertilizers. Enhancement of faba bean growth, WUE, and nutritional status as well as improvement of soil properties and sustainability can be achieved through the complementary interaction of fertilizers (organic plus inorganic source of nitrogen) under optimal irrigation water level. Finally, the application of the recommended dose of nitrogen (50% from chemical fertilizers) plus 50% from organic fertilizers (chicken manure) is recommended to improve faba bean growth parameters and soil properties and also increase water use efficiency (WUE) and nitrogen uptake efficiency (NUE).

Statement of conflicting interest

The authors affirm that they have no known financial or interpersonal conflicts that would have appeared to have an impact on the research presented in this study.

Acknowledgments

In order to access field and laboratory facilities, the authors would like to thank all staff at the Faculty of Agriculture, Soils and Water Department at Al-Azhar University in Cairo, Egypt.

Participation of the authors

The planning and execution of the study, the analysis of the findings, and the creation of the publication were all done by the authors.

Funding sources

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

REFERENCES

Abd-Allah, Y.A. 2021: The prediction of the combination effect of compost, nitrogen and phosphorus fertilizers on some soil properties and productivity of wheat and maize yields. Menoufia Journal of Soil Science, 6(2): 49-71.

Abd-Eladl, M., Fouda, S., Abou-Baker, N. 2016: Bean yield and soil parameters as response to application of biogas residues and ammonium nitrate under different water requirements. Egypt. J. Soil Sci. 56 (2): 313-326. https://doi.org/10.21608/EJSS.2016.603

Aboseif, E.M., Abdel –Mottaleb, M.A., Rizk, A.H., Shawer, S.S. 2022: Effect of organic and inorganic fertilizers on yield of broad bean plant grown on West Delta region. Al-Azhar Journal of Agricultural Research, (47) 2: 121-132. DOI: 10.21608/AJAR.2022.277842

Adediran, J.A., Taiwo, I.B., Sobulo, R.A. 2005: Comparative nutrients level of some solid organic wastes and their effect on tomato (Lycopersicum esculentus) yield. African soils 33, 100 – 113.

Agegnehu, G., Nelson, P.N., Bird, M.I. 2016: Crop yield, plant nutrient uptake and soil physicochemical properties under organic soil amendments and nitrogen fertilization on Nitisols. Soil and Tillage Research, 1(60): 1-13.

Almaz, M.G., Halim, R.A., Martini, M.Y., Samsuri, A.W. 2017: Integrated application of poultry manure and chemical fertilizer on soil chemical properties and nutrient uptake of maize and soybean. Malaysian Journal of Soil Science, 21(1): 13-28..

Amusan, A.O., Adetunji, M.T, Azeez, J.O., Bodunde, J.G. 2011: Effect of the integrated use of legume residue, poultry manure and inorganic fertilizers on maize yield, nutrient uptake and soil properties. Nutrient Cycling in Agroecosystems.90(3): 321-330.

Ayeni, L.S., Adetunji, M.T. 2010: Integrated application of poultry manure and mineral fertilizer on soil chemical properties, nutrient uptake, yield and growth components of maize. Nature and Science, 8(1):60-67.

Ayoola, S.R., Makinde, E.A. 2009: Maize growth, yield and soil nutrient changes with N-enriched organic fertilizers. African J. Food Agric. Nut. and Develop.,9(1): 580-592.

Bandyopadhyay, K.K., Misra, A.K., Ghosh, P.K., Hati, K.M. 2010: Effect of integrated use of farmyard manure and chemical fertilizers on soil physical properties and productivity of soybean. Soil and Tillage Reseach, 110: 115-125.

Bassouny, M., Chen, J. 2016: Effect of long-term organic and mineral fertilizer on physical properties in root zone of a clayey Ultisol. Archives of Agronomy and Soil Science, 62(6): 819-828.11.

Cercioglu, M. 2017: The role of organic soil amendments on soil physical properties and yield of maize (Zea mays L.). Communications in soil science and plant analysis, 48(6): 683-691.6.

Chapman, H.D., Pratt, P.F. 1961: Methods of Analysis for Soils, Plants and Water. Agric. Publ. Univ., of California, Riverside, U. S. A.

Donatus, E.O.A. 2017: Effect of poultry manure and urea on soil chemical properties, nodulation and yield of groundnut (Arachish hypogaeac) in Akanu Ibiam Federal Polytechnic, Unwana Afikpo Ebonyi State. Asian Journal of Advances in Agricultural Research, 3(3): 1–8. https://doi.org/10.9734/AJAAR/2017/37677.

Dubey, P., Pandey, C., Shakoor, S., Khanday, A., Mishra, G. 2012: Effect of integrated fertilization on nutrient uptake, protein content and yield of fenugreek. International Journal of Food, Agriculture and Veterinary Sciences. 2(1): 1-12.

Elfishy, M.A.A. 2009: Effect of different sources of organic fertilizers and irrigation water on availability of some nutrients in soil. Ph. D. Thesis, Fac. of Agric., Menofiya Univ., Egypt.

El-Gizawy, E.S.A., Atwa, A.A.I., Talha, N.I., Mostafa, R.A.I. 2013: Effect of compost and compost tea application on faba bean crop and some soil biological and chemical properties. Journal of Soil Sciences and Agricultural Engineering,4(9): 863-874 .

El-Hamdi, K.H., Hammad, S.A., El-Soud, A., El-Sanat, G.M.A. 2007: Effect of some soil amendments application on some soil physical and chemical properties. Journal of Soil Sciences and Agricultural Engineering, 32(9): 7967-7978.

El-Maddah, H.A., Mahmoud, Y.A., Elsodany, M.E. 2019: Effect of nitrogen fertilizer and compost rates addition at different depths on some soil chemical properties. Arab Universities Journal of Agricultural Sciences, 27(3): 2007-2022.

El-Noemani, A.A., El-Zeiny, H.A., El-Gindy, A.M., El-Sahhar, E.A., El-Shawadfy, M.A. 2010: Performance of some bean (Phaseolus vulgaris L.) varieties under different irrigation systems and regimes. Aust. J. Basic Appl. Sci, 4(12): 6185-6196.

El-Sebaey, M.M. 2006: Effect of inorganic, organic and bio-fertilizer on wheat plant grown in new cultivated land. Zagazig J. Agric. Res.,33 (5): 863-867.

El-Sodany, M., El-Maddah, E., Khalil, H.M. 2015: Tetra-factorial computer model for evaluating some natural soil conditioners and its effects on some physical and hydrophysical properties of clay loam soil. The 2nd Minia International Conference "Agriculture and Irrigation in the Nile Basin Countries" 23rd-25th March 2015, El-Minia, Egypt. pp. 728-756.

El-Yazal, M.A.S. 2020: Impact of some organic manure with chemical fertilizers on growth and yield of broad bean (Vicia faba L.) grown in newly cultivated land. Sustainable Food Production, 9, 23-36.

Erdem, Y., Seshril, S., Erdem, T., Kenar, D. 2006: Determination of crop water stress index for irrigation scheduling of bean (Phaseolus vulgaris L.). Turk J Agric. 30: 195-202.

Estefan, G., Sommer, R., Ryan, J. 2013: Methods of soil, plant, and water analysis. A manual for the West Asia and North Africa region, 3, 65-119.

Ewees, M.S., Osman, A.S., El-Sowfy, D.M. 2008: Significance of applied organic manure combined with N-mineral fertilizer to alleviate the possible risks of chemical pollution for broccoli. Egypt J. Soil. Sci. 48(3): 343-366.

FAO. 2015: Farmer's Compost. Handbook: Experiences in Latin America. Food and Agriculture Organization of the United Nations, Santiago.

Fayed, M.H., Mohamed, H.S., Mancy, A.G. 2021: Improving the growth and productivity of faba bean (Vicia faba L.) under deficit irrigation conditions by spraying of potassium selenate and potassium silicate. Egypt. J. Soil Sci. 61 (1): 95-111.

Fawy, H.A., Ibrahim, S.M., Hussein, M.F.A. 2016: Effect of Mineral Fertilization and Some Organic Compounds on Faba Bean Crop in some Soils at the New Valley, Egypt. Egypt. J. Soil Sci., 56 (1):69-91.

Fernández-Escobar, R., Antonaya-Baena, F., Almeida-Lavado, S. 2021: Nitrogen Uptake Efficiency of Olive Cultivars. Horticulturae. 7:136.https://doi.org/10.3390/ horticulturae7060136.

Freeman, G.H., Gomez, K.A., Gomez, A.A. 1985: Statistical Procedures for Agricultural Research., Biometrics. John Wiley & Sons. https://doi.org/10.2307/2530673.

Ghaly, F.A., Abd-Elhamied, A.S., Shalaby, N.S. 2020: Effect of bio-fertilizer, organic and mineral fertilizaters on soybean yield and nutrients uptake under sandy soil conditions. Journal of Soil Sciences and Agricultural Engineering, 11(11): 653-660.

Ghimire, S., Nainabasti, A., Sharma, M.D., Marahatta, S., Giri, H.N. 2019: Effect of urea and poultry manure combination on yield and quality of different lettuce (Lactucasativar L.) varieties in chitwan, nepal. SAARC J. Agric., 17(1): 201-210 (2019) DOI: https://doi.org/10.3329/sja.v17i1.42773.

Hossain, M.E., Islam, M.S., Rahaman, M.S. 2018: Growth performance and development attributes of mungbean (Vigna radiata L.) as influenced by organic manure and inorganic fertilizer. Asian Journal of Advances in Agricultural Research, 7(2): 1-13.

Huang, J., Yu, Z., Gao, H., Yan, X., Chang, J., Wang, C. 2017: Chemical structures and characteristics of animal manures and composts during composting and assessment of maturity indices. PLoS ONE 12(6): e0178110.https://doi.org/10.1371/journal.pone.0178110.

Huseynova, I. 2012: Photosynthetic characteristics and enzymatic antioxidant capacity of leaves from wheat cultivars exposed to drought', Biochimicaet Biophysica Acta (BBA)-Bioenergetics, 1817(8):1516-1523.

Iqbal, A., He, L., Khan, A., Wei, S., Akhtar, K., Ali, I., Jiang, L. 2019: Organic manure coupled with inorganic fertilizer: An approach for the sustainable production of rice by improving soil properties and nitrogen use efficiency. Agronomy, 9(10): 651.

Khafagi, O.M.A., Ragab, A.A.M., Moursy, M.M., Kenawy, S.K., Elliethy, M.Z. 2017: Effect of some organic fertilizers on soil properties and wheat plant growth and yield. African Journal of Mycology and Biotechnology, 22(2): 23-38.31.

Khalifa, R. 2019: Response of Faba bean to alternate irrigation and cut-off irrigation combined with mineral phosphorus levels and Biofertilizer at North Nile Delta soils. Egypt. J.

Soil Sci. 59 (2): 175–191. https://doi.org/10.21608/ejss.2019.11931.1266.

Lanna, N.B., Silva, P.N.L., Colombari, L.F., Corrêa, C.V., Cardoso, A.I.I. 2018: Residual effect of organic fertilization on radish production. Hortic. Bras. 36, 47–53. https://doi.org/10.1590/S0102-053620180108.

Madisa, M.E., Mathowa, T., Mpofu, C., Stephen, N., Machacha, S. 2013: Effect of chicken manure and commercial fertilizer on performance of jute mallow (Corchorusolitorius). Agriculture And Biology Journal of North America, 4(6): 617-622.

Mahmood, F., Khan, I., Ashraf, U., Shahzad, T., Hussain, S., Shahid, M., Abid, M., Ullah, S. 2017: Effect of organic and inorganic manure on maize and their residual impact on soil physico-chemical properties. Journal of Soil Science and Plant Nutrition,17(1): 22-32.

Mandal, K.G., Hati, K.M., Misra, A.K., Bandyopadhyay, K.K. 2006: Assessment of irrigation and nutrient effects on growth, yield and water use efficiency of Indian mustard (Brassica juncea) in central India. Agricultural water management, 85(3): 279-286.

Mancy, A.G., Sheta, M.H. 2021: Evaluation of biochar and compost ability to improve soil moisture content and nutrients retention. Al-Azhar Journal of Agricultural Research, 46 (1): 153-165.

Marschner, H. 2012: Mineral Nutrition of Higher Plants.Academic Press Limited Harcourt Brace and Company, Publishers, London, ISBN: 978-0-12-384905-2.

Mohamad, N.S., Kassim, F.A., Usaizan, N., Hamidon, A., Safari, Z.S. 2022: Effects of organic fertilizer on growth performance and postharvest quality of Pak Choy (Brassica rapa subsp. chinensis L.). AgroTech-Food Science, Technology and Environment, 1(1): 43-50 . https://doi.org/10.53797/agrotech.v1i1.6.2022.

Moharana, P.C., Sharma, B.M., Biswas, D.R., Dwivedi, B.S., Singh, R.V. 2012: Long-term effect of nutrient management on soil fertility and soil organic carbon pools under a 6-year-old pearl millet–wheat cropping system in an Inceptisol of subtropical India. Field Crops Research, 136, 32-41.

Monneveux, P., Rekika, D., Acevedo, E., Merah, O. 2006: Effect of drought on leaf gasexchange, carbon isotope discrimination,transpiration efficiency and productivity infield grown durum wheat genotypes. PlantSci. 170: 867-872. https://doi.org/10.1016/j.plantsci.2005.12.008.

Naveed, M., Moldrup, P., Vogle, H., Lamande, M., Wildenschild, M.T., de Jonge, L.W. 2014: Impact of long-term fertilization practice on soil structure evolution. Geoderma, 217-218, 181-189.

Oad, F.C., Buriro, U.A., Agha, S.K. 2004: Effect of organic and inorganic fertilizer application on maize fodder production. Asian J. Plant Sci.,3(3):375-377.

Ojeniyi, S.O., Adesoye, S.O., Awodun, M.A., Odedina, S.A. 2006: Effect of oil palm bunch refuse ash on soil and plant nutrient composition, and yield of maize. In Proceeding 36th annual conference of soil science society of Nigeria makurdi (pp. 177-181.(

Pantawat, S. 2012: Effect of organic fertilizers use in rice paddy to reduce greenhouse gases. Science Asia, 38, 323-330. http://www.doi.org/10.2306/scienceasia1513-1874. 2012.38. 323.

Payero, J.O., Tarkalson, D., Irmak, S., Davison, D.R., Petersen, L.J. 2008: Effect of irrigation amounts applied with subsurface drip irrigation on corn evapotranspiration, yield, water use efficiency and dry matter production in a semiarid climate. Agric. Water Management, 95(8):895–908.

Qiu, G.Y., Wang, L.M., He, H.X., Zhang, X.Y., Chen, S.Y., Chen, J., Yang, Y.H. 2008: Wateruse efficiency and evapotranpiration of winterwheatand its response to irrigation regime inthe north China plain. Agric. For. Meteorol.148:18481859.https://doi.org/10.1016/j. agrformet.2008.06.010.

Ren, T., Wang, J., Chen, Q., Zhang, F., Lu, S. 2014: The Effects of Manure and Nitrogen Fertilizer Applications on Soil Organic Carbon and Nitrogen in a High-Input Cropping System. PLoS ONE 9(5): e97732. https://doi.org/10.1371/journal.pone.0097732.

Rizk, A.H., Mashhour, A.M., Abd- Elhady, E.E., Sherif, M.M. 2016: Effect of organic and inorganic residues on sandy soil properties and plant growth. Middle East Journal of Agriculture Research, 5(1): 117-122.

Shaban, K.A., Khafaga, E.E.E., Saied, H.S. 2008: Effects of organic manure and mineral n on some soil properties and spinach (Spinacia olerasea L.) productivity under saline soil conditions. Journal of Soil Sciences and Agricultural Engineering, 33(5): 3865-3879.

Shalaby, E.M.M., Galall, E.H., Ali, M.B., Amro, A., El Ramly, A. 2020: Growth and yield responses of ten wheat (Triticum aestivum L.) genotypes to drought. SVU-International Journal of Agricultural Sciences, 2(2): 1-17.

Shirani, H., Hajabbasi, M.A., Afyuni, M., Hemmat, A. 2002: Effect of Farmyard manure and tillage system on soil physical proportion and corn yield in central Iran. Soil and Tillage Research. 68: 101- 108.

Siam, H.S., Mahmoud, S.A., Taalab, A.S., Hussein, M.M., Mehann, H. 2017: Growth, yield of faba bean (vicia faba L.) genotypes with respect to ascorbic acid treatment under various water regimes ii-chemical composition and water use efficiency (WUE). Middle East J. Agric.Res.6(4):1111–1122. http://www.curresweb.com/mejar/mejar/2017/1111-1122.pdf.

Soremi, A.O., Adetunji, M.T., Adejuyigbe, C.O., Bodunde, J.G., Azeez, J.O. 2017: Effects of poultry manure on some soil chemical properties and nutrient bioavailability to soybean. J. Agric. Ecol. Res. Int, 11, 1-10.

Taiz, L., Zeiger, E. 2006: Plant physiology. Sinauer Associates, Sunderland, Mass.

Talha, N.I. 2013: Evaluation of different compost sources to improve some soil properties under wheat and maize crops rotation. Journal of Soil Sciences and Agricultural Engineering, 4(8): 677-693.

Verma, A., Nepalia, V., Kanthaliya, P.C. 2006: Effect of integrated nutrient supply on growth, yield and nutrient uptake by maize-wheat cropping system. Indian Journal of Agronomy.51 (1): 3-6.

Vidyavathi, G., Dasog, S., Babalad, H.B., Hebsur, N.S., Gali, S.K., Patil, S.G., Alagawadi, A.R. 2012: Influence of fertilization practices on crop response and economics in different cropping systems in a Vertisol. Karnataka Journal of Agricultural Sciences. 24(4):455-460.

Wanas, M.A., Rizk, A.H., Mashhour, A.M. 2022: Effect of deficit irrigation on some growth parameters, yield and water productivity of broad bean crop. Al-Azhar Journal of Agricultural Research, (47) 2: 113-120. DOI: 10.21608/AJAR.2022.277839

Wang, D. 2017: Water use efficiency and optimal supplemental irrigation in a high yield wheat field. Field Crop Res 213:213–220.

Willer, H., Lernoud, J. 2019: The world of organic agriculture: statistics and emerging trends 2019. Research Institute of Organic Agriculture FiBL: Frick, Switzerland; IFOAM Organics International: Bonn, Germany, pp. 1–336.http://www.organic-world.net/yearbook/yearbook-2019.html.

Xiaobin, W., Dianxiong, C.A.I., Jingqing, Z. 1999: Land application of organic and inorganic fertilizer for corn in dryland farming region of North China. In Sustaining the Global Farm–Selected papers from the 10th International Soil Conservation Organization Meeting (pp. 419-422).

Yousry, M.M., Moussa, M.S.A., Abdel-Nasser, G. 2021: Response of some faba bean genotypes to irrigation water deficit grown in sandy soil. Alexandria Science Exchange Journal, 42(3): 677-693.

Zein El-Abdeen, H., Khalil, F., El-Etr, W. 2018: Effect of Calcium Humate, Nitrogen Fertilizer Rates and Irrigation Regime on Soil Chemical Properties and Faba Bean Productivity. Journal of Soil Sciences and Agricultural Engineering,9 (11): 575-586.

Table 1: Some physical and chemical properties of the studied soil before cultivation.

Soil physical analysis							
Practical size distribution (%)			Texture class	Moisture constants (%) @			BD (Mg m^{-3})
Sand	Silt	Clay		FC	PWP	AW	
12.50	31.18	56.32	Clay	36.74	20.57	16.17	1.42
Soil chemical analysis							
EC dS m^{-1} (Soil extract 1: 2.5)		pH (Suspension 1: 2.5)	CEC ($cmol_c$ kg^{-1})		O.C (%)	O.M (%)	$CaCO_3$ (%)
0.82		8.12	46.10		0.59	1.01	2.94
Soluble ions (mmolc l^{-1})							
Ca^{++}	Mg^{++}	Na^{+}	K^{+}	$CO_3^{=}$	HCO_3^{-}	Cl^{-}	$SO_4^{=}$
1.62	1.43	4.74	0.37	0.00	5.04	1.71	1.41
Available macronutrients (mg kg^{-1})							
	N			P			K
	102.08			47.25			182.44

Field capacity; PWP: Permanent wilting point; AW: Available water; BD: Bulk density, EC: Electrical conductivity of soil extract; pH: 1:2.5 w/v soil water suspension; CEC : Cation exchange capacity; OC: organic carbon and OM: organic matter.

Table 2: Some physical and chemical properties of compost and chicken manure which used**:**

Characters	Values	
	Compost	Chicken manure
pH (1:10 suspension)	7.84	7.4
EC dS m^{-1}(1:10 extract)	2.84	3.78
Bulk density Mg m^{-3}	0.74	0.59
Organic matter%	56.34	58.60
Organic carbon%	32.80	34.07
C.N ratio	18.85	10.17
Total N %	1.74	3.35
Total P %	0.19	0.63
Total K %	1.37	1.41
Available micronutrients (mg kg^{-1})		
Fe	168.37	542.60
Zn	116.09	132.63
Mn	82.35	91.58
Cu	1.53	3.07

Table 3: Table 3: Effect of the experimental treatments on some physical and chemical properties of clay soil after faba bean harvest:

Treatments		Chemical properties				Physical properties			
Irrigation water levels	Fertilization	pH (1:2.5 soil suspension)	EC (1:2.5 soil extract) dS m^{-1}	OM (%)	CEC (cmolc kg^{-1})	FC (%)	WP (%)	AW (%)	BD (Mg m^{-3})
I_1	N_0	8.07	0.90	0.95	45.30	35.60	19.55	16.05	1.45
	N_1	8.08	0.91	1.05	46.25	36.94	20.70	16.24	1.41
	N_2	8.04	0.99	1.15	46.46	37.18	20.84	16.34	1.37
	N_3	8.03	1.08	1.21	46.62	37.36	20.92	16.44	1.36
	N_4	8.09	0.89	1.05	46.27	36.94	20.67	16.27	1.40
	N_5	8.05	0.98	1.14	46.47	37.25	20.85	16.40	1.34
	N_6	8.00	1.10	1.28	48.65	37.60	20.97	16.63	1.30
	Mean	8.05	0.98	1.12	46.57	36.98	20.64	16.34	1.38
I_2	N_0	8.07	0.90	0.90	45.00	35.25	19.40	15.85	1.41
	N_1	8.06	0.93	1.04	46.21	36.90	20.66	16.24	1.40
	N_2	8.03	1.01	1.12	46.40	37.13	20.77	16.36	1.38
	N_3	8.02	1.11	1.17	46.55	37.29	20.88	16.41	1.34
	N_4	8.08	0.92	1.03	46.19	36.96	20.71	16.25	1.38
	N_5	8.04	1.00	1.14	46.45	37.32	20.87	16.45	1.35
	N_6	8.00	1.18	1.15	48.15	37.34	20.93	16.41	1.33
	Mean	8.04	1.01	1.08	46.42	36.89	20.60	16.28	1.37
Mean of nitrogen treatments	N_0	8.07	0.90	0.93	45.15	35.43	19.48	15.95	1.43
	N_1	8.07	0.92	1.05	46.23	36.92	20.68	16.24	1.41
	N_2	8.04	1.00	1.14	46.43	37.16	20.81	16.35	1.38
	N_3	8.03	1.10	1.19	46.59	37.33	20.90	16.43	1.35
	N_4	8.09	0.91	1.04	46.23	36.95	20.69	16.26	1.39
	N_5	8.05	1.00	1.14	46.46	37.29	20.86	16.43	1.35
	N_6	8.00	1.14	1.22	48.40	37.47	20.95	16.52	1.32
LSD @ 5%	Irrigation (A)	0.025	0.035	0.05	0.92	0.37	0.23	0.56	0.01
	Fertilization(B)	0.065	0.40	0.08	0.96	0.58	0.31	0.69	0.02
	Interaction (AB)	0.09	0.05	0.11	1.36	0.82	0.44	0.98	0.30

I1=100% of field capacity, I2= 80 % of field capacity, N0: control, N1: 100% recommended dose of N as urea, N2: 50% from recommended dose of N as urea+50% N from compost, N3: 50% N from urea + 50% N from chicken manure,N4:100% recommended dose of N as ammonium nitrate, N5: 50% N from ammonium nitrate + 50% N from compost, N6: 50% N from ammonium nitrate + 50% N from chicken manure.

Table 4: Effect of the experimental treatments on some vegetative growth parameters of faba bean plants grown in clayey soil.

Treatments		Plant height (cm)	No of branches plant^{-1}	Fresh weight (g pot^{-1})	Dry weight (g pot^{-1})	Chlorophyll values (SPAD)
Irrigation water levels	Fertilization					
I_1	N_0	40.25	3.42	273.45	55.21	43.96
	N_1	45.63	3.66	314.00	66.45	49.57
	N_2	48.60	4.67	363.67	72.33	54.70
	N_3	48.80	5.22	389.67	76.67	57.85
	N_4	45.15	3.56	306.33	66.00	48.20
	N_5	47.80	4.44	357.00	71.67	54.03
	N_6	48.73	4.89	373.00	74.50	55.90
	Mean	46.42	4.27	339.59	68.96	52.03
I_2	N_0	40.01	3.36	256.83	51.89	41.67
	N_1	44.43	3.55	303.33	64.33	46.93
	N_2	46.23	3.89	330.00	69.67	50.17
	N_3	47.33	4.33	348.33	71.33	53.13
	N_4	44.03	3.55	284.33	64.00	45.27
	N_5	45.73	3.67	322.33	66.67	50.10
	N_6	47.17	4.11	345.67	69.67	53.03
	Mean	44.99	3.78	312.98	65.37	48.61
Mean of nitrogen treatments	N_0	40.13	3.39	265.14	53.55	42.82
	N_1	45.03	3.61	308.67	65.23	48.25
	N_2	47.42	4.28	346.83	71.00	52.43
	N_3	48.07	4.78	369.00	74.00	55.49
	N_4	44.59	3.56	295.33	65.17	46.73
	N_5	46.77	4.06	339.67	69.17	52.07
	N_6	47.95	4.50	359.33	72.08	54.47
LSD @ 5%	Irrigation (A)	1.916	0.416	5.195	2.399	2.751
	Fertilization(B)	4.087	0.632	14.142	4.122	4.226
	Interaction (AB)	5.78	0.89	20.0	5.83	5.98

[1] Co (without supplementation),

[2]SEM: standard error of the mean.

[a,b] : Means of the same raw have the different superscript were significantly different *($P \leq 0.05$)*.

Table 5: Effect of the experimental treatments on NPK content (%), uptake (mg kg-1), WUE (kg m-3) and NUE (%) by faba bean plants grown in clayey soil

Treatments		Macronutrient content (%)			Macronutrient uptake (mg kg^{-1})			WUE	NUE
Irrigation water levels	Fertilization	N	P	K	N	P	K	(kg m^{-3})	(%)
I_1	N_0	1.31	0.14	1.66	723.25	76.74	916.49	3.10	--
	N_1	1.94	0.17	1.93	1289.13	110.97	1282.49	3.78	18.31
	N_2	2.24	0.21	2.01	1620.19	152.62	1453.83	4.88	33.62
	N_3	2.36	0.26	2.08	1809.41	201.64	1594.74	4.98	38.47
	N_4	1.78	0.16	1.87	1174.80	104.94	1234.20	3.70	22.26
	N_5	2.04	0.20	1.97	1462.07	141.91	1411.90	4.57	38.71
	N_6	2.33	0.21	2.06	1735.85	159.43	1534.70	4.97	39.96
	Mean	2.00	0.19	1.94	1402.10	135.46	1346.91	4.28	27.33
I_2	N_0	1.26	0.13	1.58	653.81	68.49	819.86	3.60	--
	N_1	1.87	0.16	1.88	1202.97	105.50	1209.40	4.47	19.64
	N_2	2.21	0.20	1.92	1539.71	138.64	1337.66	5.85	36.22
	N_3	2.34	0.25	2.01	1669.12	176.90	1433.73	5.90	39.64
	N_4	1.69	0.15	1.78	1081.60	97.92	1139.20	4.37	17.69
	N_5	2.00	0.19	1.95	1333.40	124.67	1300.07	5.42	31.86
	N_6	2.27	0.21	1.97	1581.51	144.91	1372.50	5.87	40.23
	Mean	1.95	0.18	1.87	1294.59	122.43	1230.35	5.07	22.11
Mean of nitrogen treatments	N_0	1.29	0.14	1.62	688.53	72.62	868.18	3.35	--
	N_1	1.91	0.17	1.91	1246.05	108.24	1245.95	4.13	18.98
	N_2	2.23	0.21	1.97	1579.95	145.63	1395.75	5.37	34.92
	N_3	2.35	0.26	2.05	1739.27	189.27	1514.24	5.44	39.06
	N_4	1.74	0.16	1.83	1128.20	101.43	1186.70	4.04	19.98
	N_5	2.02	0.19	1.96	1397.74	133.29	1355.99	4.99	35.29
	N_6	2.30	0.21	2.02	1658.68	152.17	1453.60	5.42	40.10
LSD @ 5%	Irrigation (A)	0.150	0.02	0.17	236.06	34.06	307.39	0.212	5.65
	Fertilization(B)	0.05	0.002	0.02	122.64	8.02	63.83	0.387	6.31
	Interaction (AB)	0.07	0.002	0.03	173.44	11.34	90.26	0.547	8.92

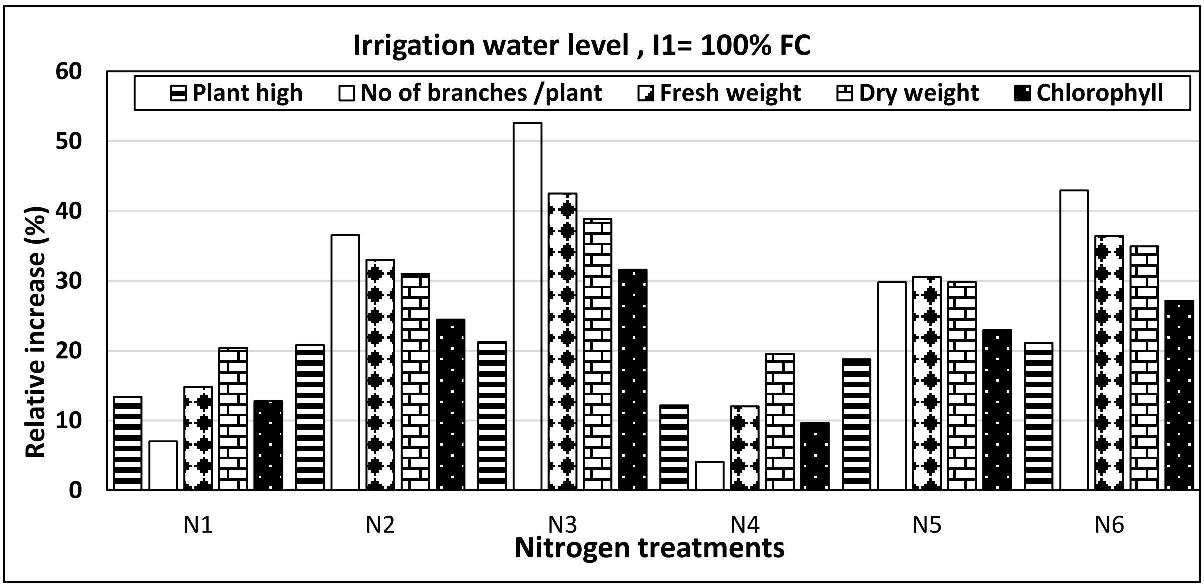

Figure 1: The relative increase (%) in faba bean growth parameters under nitrogen fertilization (N1-N6) and irrigation (I1)

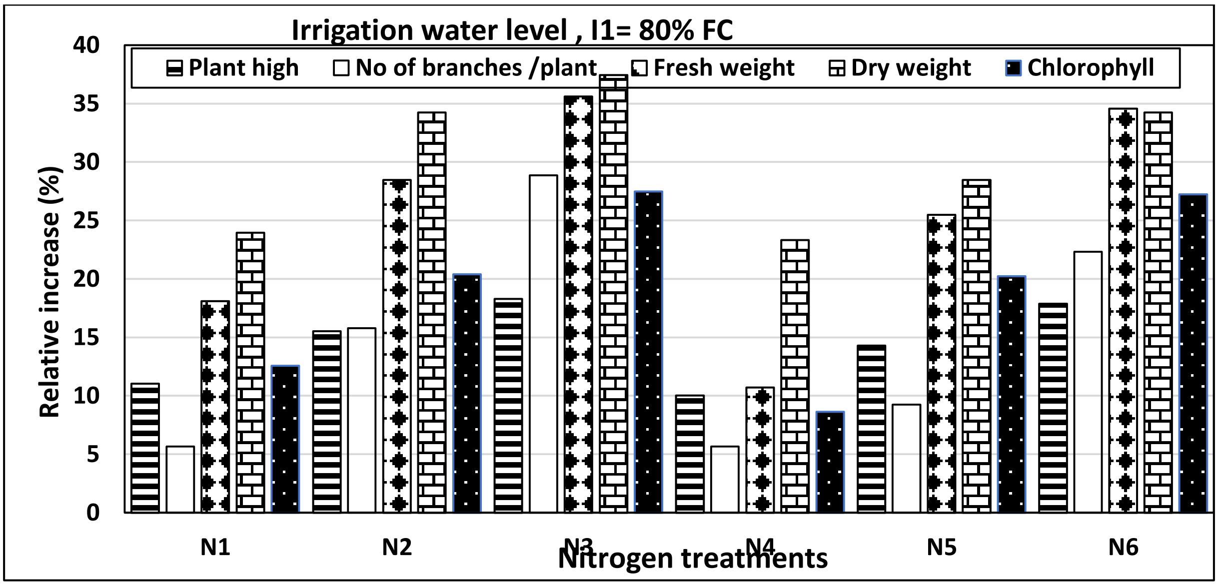

Figure 2: The relative increase (%) in faba bean growth parameters under nitrogen fertilization (N_1-N_6) and irrigation (I_2)

.

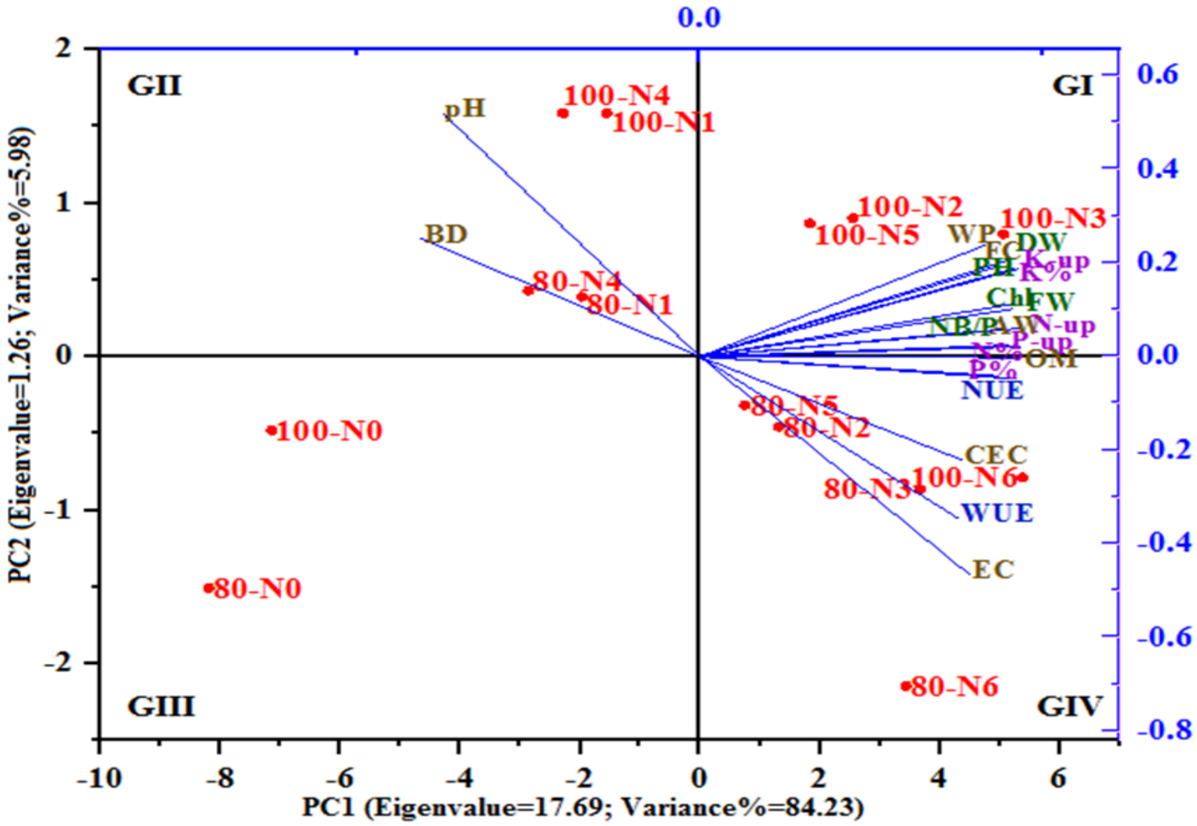

Figure 3: The biplot diagram shows similarities and dissimilarities in the association soil properties (brown color), plant growth parameters (green color), WUE, NUE (blue color) and nutritional status (purple color) of faba bean plants during organic and inorganic nitrogen fertilizers under different levels of irrigation water (red color). PH: Plant height, NB/P: no of benches plant $^{-1}$, FW: fresh weight, DW: dry weight, Chl: chlorophyll value, N%: nitrogen content, P %: phosphorus content, K %: potassium content, N-up: Nitrogen uptake, P-up: phosphorus uptake, K-up: Potassium uptake, WUE: water use efficiency, NUE: nitrogen uptake efficiency, pH: soil reaction, EC: electrical conductivity, OM: organic matter, CEC: Cation exchange capacity, FC: Field capacity; PWP: Permanent wilting point; AW: Available water; BD: Bulk density

التطبيق التكاملي للأسمدة العضوية وغير العضوية على بعض خواص التربة ونمو الفول تحت مستويات مختلفة من مياه الري

محمد مرتضى البدري*, محمد سليمان زيد, أحمد جمعة منسي, سيد عبد الرحمن عابدين

قسم الأراضي والمياه،كلية الزراعة ، جامعة الازهر، القاهرة، مصر

* البريد الإلكتروني للباحث الرئيسي:mohamedelbadry.205@azhar.edu.eg

الملخص العربي:

أجريت تجربة أصص لدراسة التأثير المشترك للتسميد (المصادر العضوية وغير العضوية) تحت مستويات الري 100٪ ، 80٪ من السعة الحقلية على خواص التربة الطينية ، مقاييس النمو ، كفاءة استخدام المياه (WUE) ، وكفاءة امتصاص النيتروجين (NUE) لنبات الفول البلدى (صنف جيزة 843). أظهرت النتائج أن التأثير المشترك لمعاملات التسميد ومستويات الري أدى إلى زيادة معنوية في المادة العضوية للتربة ، والسعة التبادلية الكاتيونية ، وإنخفاض قيم الكثافة الظاهرية للتربة مقارنةً بمعاملة الكنترول. بالإضافة إلى ذلك ، سجلت معاملة 50) N3 ٪ نيتروجين من سماد الدواجن+ 50٪ نيتروجين من سماد اليوريا) عند مستوى رى 100٪ من السعة الحقلية أعلى زيادة نسبية في ارتفاع النبات (سم) ، عدد الأفرع / نبات ، الوزن الطازج (جرام/أصيص) والوزن الجاف (جرام/أصيص) وقيم الكلوروفيل والتي كانت 21.24 ، 52.63 ، 42.50 ، 38.87 ، 31.60٪ على التوالي. علاوة على ذلك ، تم تسجيل أعلى قيم معنوية لمحتوى وامتصاص NPK تحت معاملات التسميد المتكاملة للاسمدة العضوية وغير العضوية عند معاملة N3 يليها معاملة 50) N6٪ نيتروجين من سماد الدواجن+ 50٪ نيتروجين من سماد نترات الأمونيوم) مقارنة بالاضافة المنفردة لسماد اليوريا ((N1و سماد نترات الامونيوم ((N4. أظهر تحليل المكون الرئيسي (PCA) أن معظم خصائص التربة المدروسة، ومقاييس النمو ، WUE، NUE والحالة الغذائية لنبات الفول ترتبط مع معاملات N3و N6 تحت كلا مستويي الري ، لذلك يصبح التكامل بين الأسمدة العضوية وغير العضوية في ظل الإدارة الجيدة للري أمرًا ضروريًا لتعزيز نمو النبات وتحسين خصائص التربة واستدامتها.

الكلمات الاسترشادية : الاسمدة العضوية والمعدنية، الرى ، الفول البلدى، التربة الطينية ، تحليل المكون الرئيسي.