Arab Universities Journal of Agricultural Sciences
(2024) 32 (1) 141-149
Website: http://ajs.journals.ekb.eg

Impact of Organic, NPK and Biofertilization on Yield of Cowpea Cultivars Under Arid Land Conditions

CrossMark

Dalia Abd El-Atty Soliaman
Plant Production Dept, Fac of Environmental Agricultural Sci, Arish Univ, Arish, Egypt

*Corresponding author: demodaila@yahoo.com

https://doi.org/10.21608/AJS.2024.353948

Received 10 November 2023; Accepted 11 May 2024

Keywords:

Biofertilization,
Cowpea,
Farmyard manure,
Chicken manure,
Organic fertilization,
NPK fertilization

Abstract: This study was conducted to investigate the effects of organic, NPK and biofertilizers on the yield of two cowpea varieties grown under arid land conditions. Two cultivars of cowpea (Karim-7 and Dokki-331) were evaluated using different fertilizer types. The fertilizers examined were organic (farmyard manure (FYM) and chicken manure (CHM)) and biofertilizers (effective microorganisms (EM1) and technology of smart fertilizer (TS)) in addition to NPK treatments (NPK (50 kg/fed), NPK (100 kg/fed), EM1 (15 $m^3.fed^{-1}$) + NPK (50 kg/fed), TS (15 $m^3.fed^{-1}$) + NPK (50 kg/fed). A randomized complete block design (RCBD) with 16 treatments and three replications was used to set up the experiment. The measured yield parameters were seed number/plant, pod length, seed number/pod, pod number/plant, dry yield/plant, dry yield/m^2, bio yield, pod weight, 100-seed weight, and grain yield. The results cleared that the cultivar dokki-331 under EM1 biofertilizer + NPK (50 kg/fed) combination treatment was the superior practice for increasing all studied traits.

1 Introduction

Cowpea (*Vigna unguiculata* (L) Walp) is an essential tropical, annual herbaceous seed legume that belongs to the family Papilionaceae (*Fabaceae*), order *Leguminosae*, and genus *vigna*. The genus Vigna is made up of more than one hundred various species that are widely distributed within the tropics and sub-tropics with great morphological and ecological diversity (Oyewale and Bamaiyi 2013). Cowpea has the ability to withstand high temperatures and can thrive in a variety of soil textures with rapid and luxuriant vegetative growth making it an excellent choice for a cover crop and enhancing soil fertility (Giridhar et al 2020, Hall 2012). Furthermore, it can fix 40–80 kg of atmospheric nitrogen per hectare into the soil (Mafakheri et al 2017).

Proper management of NPK is one of the most important factors in increasing the cowpea yield. Nitrogen (N) is one of the main elements of organic fertilizers, that are utilized by plants for the synthesis of amino acids, proteins, and nucleic acids. Its deficiency delays reproductive stages and phonological development in growth (Fathi and Zeidali 2021). Phosphorus (P) is involved in energy conversion and is necessary for photosynthesis, reproduction and many biological processes in plants. Phosphorus fertilizers originated from global phosphate rock reserves which is a nonrenewable resource that could be depleted in 50–100 years (Marschner 2012). Potassium (K) is considered the foremost imperative basic plant supplement due to its roles in plant physiology and biological chemistry (Zia-ul-hassan et al 2011). Nevertheless, the excessive usage of chemical fertilizers causes the accumulation of nitrate in vegetable products, leading to a decline in food safety and quality. The negative impacts of excessive use of chemical fertilizers can be minimized by reducing the use of chemical fertilizers and combining them with organic fertilizers which generally have better nutritional properties (Luthria et al 2010, Vallverdú-Queralt et al 2012, Oliveira et al 2013).

Organic manure increases the amount of organic carbon in soil and soil productivity by boosting the activity of beneficial microorganisms in the soil (Hepperly et al 2009). Chicken manure contains a wide range of mineral elements and organic substances (Sushkova et al 2021). It is an excellent soil amendment because of its high contents of nitrogen and phosphorous (Han et al 2017, Espindola et al 2021).

Biofertilizers are defined as all the additives with bio-sources, such as microbial inoculants, that provide plants with their nutrient needs. The sources of these fertilizers are more available and cost-effective in comparison with chemical fertilizers. The production concept of biofertilizers relies on the fact that soil is abundant with beneficial microbes that help decompose complex materials and provide the plant with reliable and absorbable elements. Soil microbes play a significant role in maintaining the biological balance of the soil. They produce the essential CO_2 to compensate for the resulting shortage in plant photosynthesis and help maintain the gases in the atmosphere at equilibrium.

Effective microorganism (EM1) is a natural source that consists of a combination of useful microorganisms, in addition to its effective role in enhancing soil fertility. It does not contain any herbicides or harmful chemical substances.

Many researchers have recently reported advantages of adding organic or biofertilizers to soils that include improving nutrient availability, nutrient uptake, boosting crop yield and cutting down chemical fertilizer usage (Pathak et al 2017). Balanced fertilization and the combined application of manures and NPK fertilization are beneficial for the sustainable development of plant production (Wang et al 2021, Zhao et al 2016).

There is not much research done on the interactions between NPK, organic and biofertilizers in crop production. Doklega and Abd El-Hady (2017) found that fertilization of broccoli plants with compost (4 tons/fed.), 75% NPK of recommended dose and inoculation with EM (10 ml/plant) improve productivity and quality of broccoli plants. The ses ame crop (Soliaman 2023) gave also the highest values of leaf number, stem diameter and leaf area in two seasons when plants were fertilized with chicken manure and EM1 biofertilizer, while the highest values of plant height were obtained when plants were fertilized with chicken manure and TS biofertilizer.

Consequently, the present study aimed to determine the best combination of chemical, organic and biofertilizers that can be used with the two varieties of cowpea grown in the summer season in an arid land as well as their effects on pod length (cm), seed number per pod, bio-yield (ton/fed), pod weight (g), 100-seed weight (g), seed number/plant, dry yield/plant (g), dry yield/m^2 (kg.), pod number/plant, and grain yield (kg/fed).

2 Materials and Methods

2.1 Plant materials

Two cultivars of cowpea (Karim-7 and Dokki-331 CV.) were obtained from the Forage Research Department, Field Crops Research Institute (FCRI), Agricultural Research Center (ARC), Giza, Egypt.

2.2 Experimental location and growing seasons

This study was conducted during two successive summer seasons 2020 and 2021 at the Experimental Farm of the Faculty of Environmental Agricultural Sciences, Arish University, Egypt.

2.3 Experimental design and its management

The field experiments were performed as a split-split plot based on a randomized complete block design (RCBD) with three replications. The main plot size was 160 m^2; the subplot size was 80 m^2 and the sub-subplot size was 10 m^2. The sowing distances were 40 cm between rows and 15 cm within each row. For both seasons, seeds were sown on April 8. Plants were thinned to four plants per hill after one month of planting; after 45 days, they singled to one plant. Every cultural practice related to the production of cowpeas was implemented as advised at the appropriate time.

2.4 Soil mechanical and chemical analyses

The soil mechanical and chemical analyses were performed during the two seasons at the Soil and Water Department (SWD) and are presented in **Tables 1 and 2**.

Table 1. Soil mechanical analysis (Average of the two season means)

Soil Depth (cm)	Fine Sand (%)	Coarse Sand (%)	Silt (%)	Clay (%)	Soil Texture
0-45	19.7	66.3	2.9	11.1	Sandy loam

Table 2. Soil chemical analysis (Average of the two season means)

Soil Depth (cm)	pH	EC (dS m^{-1})	$CaCO_3$ (%)	Organic carbon g.kg-1	Organic matter g.kg-1
0-45	8.619	1.8	3.91	1.08	2.07
Soluble Cations (meq L^{-1})				**Soluble Anions (meq L^{-1})**	
K^+	Na^+	Mg^{++}	Cl^-	Ca^{++}	HCO_3^-
0.46	2.63	2.17	1.277	2.5	2.405

2.4.2 Organic fertilization

During land preparation, two organic manure sources (farmyard manure and chicken manure) were added at a rate of 15 $m^3.fed^{-1}$. **Table 3** displays the results of the organic manure analysis. The American Public Health Association was consulted to determine total nitrogen, organic carbon, and available phosphorus (APHA 1992).

2.4.3 Biofertilizers

The biofertilizers EM1 (effective microorganisms) and TS (technology of smart fertilizer) were added in two equal portions at a rate of 5 ml/m^2. The first part was added after the second thinning of the EM1 solution (injected through the drip irrigation system in the sandy lands) while the second part was added at the onset of the floral siliqua emergence at the studied rates. The components of the used Biofertilizers are displayed in **Table 4**.

2.4.4 NPK fertilization

NPK (20N:20P:20K) was added at a rate of 100 kg/fed. Experimental treatments were designated as follows:

- Tr1: Dokki 331 + farmyard manure (15 $m^3.fed^{-1}$) + NPK (50 kg/fed).
- Tr2: Dokki 331 + farmyard manure (15 $m^3.fed^{-1}$) + NPK (100 kg/fed).
- Tr3: Dokki 331+ farmyard manure (15 $m^3.fed^{-1}$) + EM1+ NPK (50 kg/fed).
- Tr4: Dokki 331+ farmyard manure (15 $m^3.fed^{-1}$) + TS+ NPK (50 kg/fed).
- Tr5: Dokki 331+ chicken manure (15 $m^3.fed^{-1}$) + NPK (50 kg/fed).
- Tr6: Dokki 331+ chicken manure (15 $m^3.fed^{-1}$) + NPK (100 kg/fed).
- Tr7: Dokki 331+ chicken manure (15 $m^3.fed^{-1}$) + EM1+ (NPK (50 kg/fed).
- Tr8: Dokki331 + chicken manure (15 $m^3.fed^{-1}$) + TS+ NPK (50 kg/fed).
- Tr9: Karim 7+ farmyard manure (15 $m^3.fed^{-1}$) + NPK (50 kg/fed).
- Tr10: Karim 7+ farmyard manure (15 $m^3.fed^{-1}$) + NPK (100 kg/fed).
- Tr11: Karim 7+ farmyard manure (15 $m^3.fed^{-1}$) + EM1+ NPK (50 kg/fed).
- Tr12: Karim 7+ farmyard manure15 $m^3.fed^{-1}$ +TS+ NPK (50 kg/fed).
- Tr13: Karim 7+ chicken manure (15 $m^3.fed^{-1}$) + NPK (50 kg/fed).
- Tr14: Karim 7+ chicken manure (15 $m^3.fed^{-1}$) + NPK (100 kg/fed).
- Tr15: Karim 7+ chicken manure (15 $m^3.fed^{-1}$) + EM1+ NPK (50 kg/fed).
- Tr16: Karim 7+ chicken manure (15 $m^3.fed^{-1}$) + TS+ NPK (50 kg/fed).

2.5 Data recorded

At harvesting on 17 July, during the first and second seasons, 10 plants of cowpea were pulled up from each sub-sub plots and then plant and yield attributes were recorded i.e. pod length (cm), seed number per pod, bio-yield (ton/fed), pod weight (g), 100-seed weight (g), seed number/plant, dry yield/ plant (g), dry yield/m^2 (kg.), pod number/plant, and grain yield (kg/fed).

Table 3. Chemical analyses of the used organic manure

Parameters \ Organic	CM)	(FYM)	(CM)	(FYM)
	2020		2021	
Total nitrogen (g.kg^{-1})	45.3	36.7	52.22	39.6
Total phosphorus (g.kg^{-1})	0.53	0.46	0.58	0.49
Total potassium (g.kg^{-1})	27.9	21.7	30.99	22.16
Organic carbon (g.kg^{-1})	520	440	529	452
Organic matter (g.kg^{-1})	865	752	899	769
C/N Ratio	15.6	14	15.9	15

Table 4. Bio-fertilization composition

Bio fertilizers types	Lactic acid bacteria	Photosynthetic bacteria	Fungi	Yeast
EM1	*Lactobacillus plantarum, L.casei, Streptococcus lactis*	*Rhodopseudomonas plustris, Rhodobacter sphacerodes*	*Apergillus, Penicilium*	*Saccharamyces cereresiae*
TS	*Bacillus polmyxa* *Bacillus circulance* *Bacillus megatherium*			

2.6 Statistical analysis

The statistical analysis was performed using M-Satat computer software program (Snedecor and Cochran 1989). The analysis of variance was used to examine the data (ANOVA) by one way test. Mean values were compared at P≤ 0.05 using the multiple range test (Duncan 1955).

3 Results and Discussion

3.1 Effect of different organic sources, bio-fertilizers and NPK

Regarding the cultivar type, cowpea cultivars, Dokki-331CV., produced higher values of most studied traits, as shown by the data in **Tables 5 and 6**. Concerning the effect of organic fertilizers, results indicated that the application of chicken manure (compared to farm yard manure) significantly increased the percentage of traits, *viz*. seeds number/plant up to (13.37 and 14.84 %), pod length up to (12.36 and 10.14 %), seeds number/pod up to (5.2 and 7.93 %), pods number/plant up to (19.91 and 20.05%), dry yield/plant up to (19.21and 14.55 %), dry yield/m^2 up to (16.66 and13.73%), bio yield up to (16.12 and14.92 %), pod weight up to (26.19 and 25.38 %), 100-seed weight up to (3.87 and 2.93 %), and grain yield up to (15.91 and 14.84%) in seasons one and two respectively. It is known that organic manure fertilization enhances soil structure and plant growth as well as providing gradual nutrient release. The superior application of chicken manure with inorganic fertilization, where it is richer in nutrients than other manures. Foliar spray of poultry litter extract may be used as an alternative environment-friendly means and can increase the growth and yield of plants with maximum profit (Islam et al 2013). Chemical analyses of the used organic manure presented in **Table 3** show that the chicken manure contains a large amount of all components, *viz*. total nitrogen, total phosphorus, total potassium, organic carbon, organic matter, and C/N, which caused the superiority of chicken manure.

These results are in agreement with the results obtained by Doklega and Abd El-Hady (2017), Kumar et al (2017) and Soliaman (2023).

Regarding the effect of bio and NPK fertilization, the recorded data in Tables 5 and 6 indicated that the treatment of EM1 biofertilizer + NPK (50 kg/fed) fertilizer significantly enhanced (compared to NPK (50 kg/fed) treatment) the yield parameters, namely, seeds number/plant up to (40.6 and 40.00 %), pod length up to (39.9 and 36.3 %), seeds number/pod up to (37.9 and 40.2 %), pods number/plant up to (54.6 and 51.35 %), dry yield/plant up to (49.2 and 47.5 % g), dry yield/m^2 up to (49.38 and 50%), bio yield up to (49.11 and 52.64 %), pod weight up to (53.80 and 52.58%), 100 seed weight up to (13.02 and 11.9%), and grain yield up to (48.61 and 47.55%) in first and second seasons,

Table 5. Effect of different organic sources, bio-fertilization types and NPK on (seed number/pod, pod length (cm), seed number/plant, pod number/plant and grain yield) of two cultivar of cowpea during two successive growing seasons 2020 and 2021

Characters / Fertilization	Seeds no./p.	Pod length	Seeds no./pod	Pods n./p.	Grain yield
First season 2020					
Dokki-331	148.29[a]	23.54[a]	12.79[a]	23.63[a]	659.05[a]
Karim-7	129.54[b]	20.63[b]	12.13[b]	18.17[b]	371.61[b]
FYM*	128.96[b]	20.79[b]	12.13[b]	18.58[b]	470.79[b]
CHM**	148.88[a]	23.38[a]	12.79[a]	23.20[a]	559.87[a]
Control(50%NPK)	104.08[d]	16.58[d]	9.42[d]	13.17[d]	353.8[d]
NPK(100%NPK)	149.58[b]	24.00[b]	13.58[b]	24.42[b]	562.4[b]
Ts+(50%NPK)	126.67[c]	20.17[c]	11.67[c]	17.00[c]	456.7[c]
Em1+(50%NPK)	175.33[a]	27.58[a]	15.17[a]	29.00[a]	688.5[a]
SD (0.05)	2.12	0.719	0.335	0.67	8.202
Second season 2021					
Dokki-331	163.26[a]	26.74[a]	17. 20[a]	26.56[a]	762.75a
Karim-7	142.63[b]	23.99[b]	15.74[b]	21.08[b]	441.64b
FYM*	142.38[b]	24.01[b]	15.79[b]	21.17[b]	553.93b
CHM**	163.51[a]	26.72[a]	17.15[a]	26.48[a]	650.46a
Control(50%NPK)	115.13[d]	19.74[d]	12.26[d]	15.85[d]	419.3[d]
NPK(100%NPK)	165.80[b]	27.43[b]	17.85[b]	26.76[b]	662.4[b]
Ts+(50%NPK)	139.12[c]	23.32[c]	15.28[c]	20.11[c]	529.5[c]
Em1+(50%NPK)	191.73[a]	30.98[a]	20.49[a]	32. 58[a]	797.6[a]
SD (0.05)	1.74	0.75	0.0434	0.668	9.161

Numbers followed by the same letter in the same columns are not significantly different at 5% DMR. FYM*: farmyard manure CHM**: chicken manure

Table 6. Effect of different organic sources, bio-fertilizers and NPK in (dry yield/plant (g), dry yield/m^2 (kg) Bio yield (ton/fed), pod weight (g) and 100-seed weight (g)) of two cultivar of cowpea during two successive growing seasons 2020 and 2021

Characters / Fertilization	Dry yield/p.	Dry yield/m^2	Bio yield	Pod weight	100seeds w.
First season 2020					
Dokki-331	38.75[a]	1.55[a]	6.51[a]	76.41[a]	26.21[a]
Karim-7	21.71[b]	0.87[b]	3.65[b]	64.58[b]	16.83[b]
FYM*	27.58[b]	1.10[b]	4.63[b]	59.88[b]	21.10[b]
CHM**	32.88[a]	1.32[a]	5.52a	81.13[a]	21.95[a]
Control(50%NPK)	20.58[d]	0.82[d]	3.46[d]	45.08[d]	20.03[d]
NPK(100%NPK)	33.00[b]	1.32[b]	5.54[b]	79.33[b]	22.03[b]
Ts+(50%NPK)	26.83[c]	1.07[c]	4.51[c]	60.00[c]	21.01[c]
Em1+(50%NPK)	40.50[a]	1.62[a]	6.80[a]	97.58[a]	23.03[a]
SD (0.05)	0.501	0.018	0.084	.1.854	0.095
Second season 2021					
Dokki-331	45.49[a]	1.80[a]	7.62[a]	78.88[a]	27.57[a]
Karim-7	26.24[b]	1.05[b]	4.41[b]	67.18[b]	18.22[b]
FYM*	33.05[b]	1.32[b]	5.53[b]	62.42[b]	22.55[b]
CHM**	38.68[a]	1.53[a]	6.50[a]	83.65[a]	23.23[a]
Control(50%NPK)	24.95[d]	1.00[d]	4.19[d]	47.52[d]	21.52[d]
NPK(100%NPK)	39.43[b]	1.58[b]	6.62[b]	81.83[b]	23.39[b]
Ts+(50%NPK)	31.53[c]	1.22[c]	5.29[c]	62.55[c]	22.23[c]
Em1+(50%NPK)	47.5[a]	2.00[a]	7.96[a]	100.22[a]	24.42[a]
SD (0.05)	0.592	0.041	0.097	1.88	0.226

Numbers followed by the same letter in the same columns are not significantly different at 5% DMR. FYM*: farmyard manure CHM**: chicken manure

Table 7. Effect the interaction of organic , NPK and biofertilizationin (Seeds number/pod, Pod length (cm), Seeds number/plant and Pods number/plant) of Cowpea cultivars in two successive growing seasons 2020and 2021

Characters / Treatments	Seeds n./p.	Pod length	Seeds/pod	Pods n./p.
***First season* (2020)**				
Tr$_{1}$	103.33^{j}	18.00^{fg}	9.00^{i}	12.00^{g}
Tr$_{2}$	155.00^{e}	25.00^{c}	14.00^{cd}	27.67^{c}
Tr$_{3}$	132.00^{g}	20.67^{de}	11.00^{gh}	17.00^{e}
Tr$_{4}$	174.00^{c}	27.67^{ab}	15.33^{ab}	30.67^{ab}
Tr$_{5}$	113.00^{i}	19.67^{ef}	11.00^{h}	17.67^{e}
Tr$_{6}$	165.00^{d}	25.67^{bc}	14.00^{cd}	28.67^{bc}
Tr$_{7}$	144.67^{f}	22.33^{d}	12.00^{fg}	23.00^{d}
Tr$_{8}$	199.33^{a}	29.33^{a}	16.00^{a}	32.33^{a}
Tr$_{9}$	95.00^{k}	12.33^{h}	8.00^{j}	8.67^{h}
Tr$_{10}$	122.33^{h}	20.33^{de}	13.67^{de}	18.67^{e}
Tr$_{11}$	106.00^{j}	16.67^{g}	11.00^{gh}	10.67^{g}
Tr$_{12}$	144.00^{f}	25.67^{bc}	15.00^{abc}	23.33^{d}
Tr$_{13}$	105.00^{j}	16.33^{g}	9.67^{i}	14.33^{f}
Tr$_{14}$	156.00^{e}	25.00^{c}	12.67^{ef}	22.67^{d}
Tr$_{15}$	124.00^{h}	21.00^{de}	12.67^{f}	17.33^{e}
Tr$_{16}$	184.00^{b}	27.67^{ab}	14.33^{bcd}	29.67^{bc}
***Second season* (2021)**				
Tr$_{1}$	114.00^{j}	20.64^{e}	11.59^{gh}	14.50^{h}
Tr$_{2}$	170.13^{e}	28.30^{c}	18.60^{bc}	30.27^{c}
Tr$_{3}$	147.10^{g}	23.60^{d}	14.40^{f}	19.90^{f}
Tr$_{4}$	192.57^{c}	30.97^{ab}	20.03^{b}	33.87^{b}
Tr$_{5}$	123.50^{i}	23.36^{d}	14.57^{f}	20.27^{ef}
Tr$_{6}$	187.10^{d}	29.08^{bc}	18.53^{bc}	30.90^{c}
Tr$_{7}$	155.77^{f}	25.46^{d}	15.97^{e}	25.43^{d}
Tr$_{8}$	215.93^{a}	32.51^{a}	23.90^{a}	37.37^{a}
Tr$_{9}$	106.30^{k}	15.46^{f}	10.30^{h}	11.97^{i}
Tr$_{10}$	135.23^{h}	23.83^{d}	17.77^{cd}	20.77^{ef}
Tr$_{11}$	118.60^{ij}	20.14^{e}	14.20^{f}	13.17^{hi}
Tr$_{12}$	155.07^{f}	29.13^{bc}	19.47^{b}	24.93^{d}
Tr$_{13}$	116.73^{j}	19.49^{e}	12.57^{g}	16.67^{g}
Tr$_{14}$	170.73^{e}	28.50^{c}	16.50^{de}	25.10^{d}
Tr$_{15}$	135.00^{h}	24.08^{d}	16.57^{de}	21.93^{e}
Tr$_{16}$	203.33^{b}	31.31^{ab}	18.57^{bc}	34.13^{b}

Numbers followed by the same letter in the same columns are not significantly different at 5% DMR

Table 8. Effect the interaction of organic, NPK and bio-fertilization on cowpea cultivars (Dry yield/plant (g), Dry yield/m^2 (kg) Bio yield (ton/fed), Pod weight (g), 100-seed weight (g) and grain yield) in two successive growing seasons 2020 and 2021

Characters / Treatments	Dry yield/p.	yield/m^2	Bio yield	Pod w.	100seeds w.	Grain yield
***First season* (2020)**						
Tr$_1$	24.67^{h}	0.99^{h}	4.14^{h}	46.00^{h}	24.13^{e}	418.95^{i}
Tr$_2$	40.00^{d}	1.60^{d}	6.72^{d}	71.33^{e}	26.20^{c}	682.21^{d}
Tr$_3$	33.00^{f}	1.32^{f}	5.54^{f}	46.33^{g}	25.17^{d}	558.04^{f}
Tr$_4$	47.00^{b}	1.88^{b}	7.90^{b}	85.33^{d}	27.30^{b}	797.93^{b}
Tr$_5$	28.00^{g}	1.12^{g}	4.70^{g}	54.00^{g}	25.30^{d}	480.30^{g}
Tr$_6$	44.33^{c}	1.77^{c}	7.45^{c}	98.33^{c}	27.23^{b}	754.91^{c}
Tr$_7$	37.33^{e}	1.49^{e}	6.27^{e}	75.67^{e}	26.20^{c}	636.64^{e}
Tr$_8$	55.67^{a}	2.23^{a}	9.35^{a}	124.33^{a}	28.17^{a}	943.40^{a}
Tr$_9$	13.67^{k}	0.55^{k}	2.30^{k}	37.00^{i}	15.00^{m}	239.40^{l}
Tr$_{10}$	20.33^{i}	0.81^{i}	3.42^{i}	65.67^{f}	17.00^{i}	349.38^{j}
Tr$_{11}$	16.67^{j}	0.67^{j}	2.80^{j}	44.33^{h}	16.00^{k}	284.23^{k}
Tr$_{12}$	25.33^{h}	1.01^{h}	4.26^{h}	73.00^{e}	18.00^{g}	435.46^{hi}
Tr$_{13}$	16.00^{j}	0.64^{j}	2.69^{j}	43.33^{h}	15.67^{l}	276.44^{kl}
Tr$_{14}$	27.33^{g}	1.09^{g}	4.59^{g}	82.00^{d}	17.67^{h}	462.90^{gh}
Tr$_{15}$	20.33^{i}	0.81^{i}	3.42^{i}	63.67^{f}	16.67^{j}	347.26^{j}
Tr$_{16}$	34.00^{f}	1.36^{f}	5.71^{f}	107.67^{b}	18.67^{f}	577.13^{f}
***Second season* (2021)**						
Tr$_1$	29.13^{h}	1.16^{f}	4.88^{h}	48.25^{i}	25.53^{f}	489.00^{g}
Tr$_2$	46.87^{d}	1.87^{c}	7.85^{c}	73.66^{ef}	27.47^{c}	784.96^{c}
Tr$_3$	39.00^{f}	1.55^{d}	6.52^{f}	58.72^{h}	26.40^{e}	652.40^{e}
Tr$_4$	55.63^{b}	2.21^{b}	9.27^{b}	87.84^{d}	28.67^{b}	927.38^{b}
Tr$_5$	33.10^{g}	1.32^{e}	5.55^{g}	56.21^{h}	26.77^{de}	555.38^{f}
Tr$_6$	53.73^{c}	2.15^{b}	9.03^{b}	101.11^{c}	28.73^{b}	903.45^{b}
Tr$_7$	42.63^{e}	1.56^{d}	7.17^{d}	78.25^{e}	27.40^{cd}	717.01^{d}
Tr$_8$	63.80^{a}	2.55^{a}	10.72^{a}	127.10^{a}	29.57^{a}	1072.6^{a}
Tr$_9$	17.87^{k}	0.72^{h}	3.00^{k}	39.77^{j}	16.83^{k}	300.61^{j}
Tr$_{10}$	24.97^{i}	1.00^{g}	4.19^{i}	68.35^{fg}	18.50^{i}	420.27^{h}
Tr$_{11}$	20.70^{j}	0.83^{h}	3.48^{j}	47.01^{i}	17.50^{jk}	348.67^{i}
Tr$_{12}$	30.20^{h}	1.21^{ef}	5.04^{h}	75.72^{e}	19.50^{gh}	508.11^{fg}
Tr$_{13}$	19.70^{j}	0.80^{h}	3.31^{j}	45.85^{i}	16.94^{k}	332.23^{ij}
Tr$_{14}$	32.17^{g}	1.29^{e}	5.40^{g}	84.31^{d}	18.87^{hi}	541.15^{f}
Tr$_{15}$	23.77^{i}	0.95^{g}	3.99^{i}	66.20^{g}	17.63^{j}	399.92^{h}
Tr$_{16}$	40.57^{f}	1.62^{d}	6.82^{e}	110.23^{b}	19.97^{g}	682.14^{de}

Numbers followed by the same letter in the same columns are not significantly different at 5%

respectively. These results are in harmony with those obtained by, Doklega and Abd El-Hady (2017), Hassan et al (2017), Kumar et al (2017), Nadeem et al (2018) and Soliaman (2023).

EM contains mixed cultures of useful microorganisms such as photosynthetic bacteria (e.g. *Rhodopseudomonas palustris, Rhodobacter sphaeroides*), lactobacilli (e.g., *Lactobacillus plantarum, L. casei, and Streptococcus lactis*), yeasts (e.g., *Saccharomyces* spp.), and *Actinomycetes* (*Streptomyces* spp.) as reported by Javaid (2010). The synthesis of amino acids, nucleic acids, sugars and bioactive substances utilizes supplies from root secretions, organic matter (carbon), sunlight and geothermal heat from the soil as sources of energy. Unlike plants, microorganisms get energy from the infrared band of solar radiation (700 – 1,200 nm) to form organic matter thereby increasing the efficiency of plant growth. EM plays an important role in improving flower starter formation because of its effect on carbohydrate accumulation. It also has an enhancing effect on the biological processes of amplification, protein and DNA synthesis and chlorophyll formation.

3.2 Interaction of bio, organic and NPK fertilization

Data displayed in **Tables 7 and 8** revealed that the interaction of bio, organic and NPK fertilization significantly increased the percentage of yield characters which were sored up to seeds number/plant (52.34 and 50.77%), pod length (57.96 and 52.44%), seeds number/pod (50 and 56.90%), pods number/plant (73.18 and 67.97%), dry yield/plant (75.44 and 71.99%), dry yield/m^2, (75.34 and 71.76%), bio yield (75.40 and 72.01%), pod weight (70.24 and 68.71%) and 100 seed weight (46.75 and 43.43%) in the first and second seasons respectively. These findings were obtained when the dokki-331 cultivar was fertilized with chicken manure combined with EM1 + NPK (50 kg/fed). On the other hand, treatment Tr_9 (Karim 7+ farmyard manure + NPK (50 kg/fed). gave the lowest values in both seasons. The benefit of EM1 stems from its ability to increase photosynthetic activity in plants, which in turn increases the synthesis of proteins and enzymes **(**Talaat 2019). EM1 has a faster rate of production of chlorophyll-green pigment, which is required for the processes of absorbing carbon dioxide, sunlight, and other substances and promoting plant growth development. The impact of EM1 on plant root development, followed by improved nutrient fostering, could also result in increasing leaf area which implies enhanced photosynthetic and biomass synthesis. In addition, a study conducted by Yamada and Xu (2000) claimed that EM1 contains phytohormones and other physiologically active compounds that prevent plants from going dormant and boost photosynthetic activity. These results are in harmony with those obtained by Doklega and Abd El-Hady (2017), Hassan (2017), Kumar et al (2017), Nadeem et al (2018) and Soliaman (2023).

4 Conclusions

The present study demonstrated the effects of various fertilizers on yield characters viz., (seeds number/plant, pod length, seeds number/pod, pod number/plant, dry yield/plant, dry yield/m^2, bio yield, pod weight,100seed weight, and grain yield kg/fed) where these parameters increased significantly when Dokki-331 cultivar was fertilized with chicken manure combined with EM1 + (NPK 50 kg/fed) in both seasons.

References

APHA (1992) Standard methods for the examination of wastewater and water. 18th ed, APHA, AWWA, WPCF (American Public Health Association, American Waterworks Association, Water Pollution Control Federation) Washington DC. 1105 Pp

Doklega SMA, Abd El-Hady MA (2017) Impact of organic, mineral and bio-fertilization on broccoli. *Journal of Plant Production* 8, 945-951. https://jpp.journals.ekb.eg/article_40920.html

Duncan DB (1955) Multiple range and multiple f-test. *Biometrics* 11, 1-42**.** https://psycnet.apa.org/doi/10.2307/3001478

Espindola J, Selim OM, Amano RS (2021) Co-pyrolysis of rice husk and chicken manure. *Journal of Energy Resources Technology* 143, 022101. https://doi.org/10.1115/1.4047678

Fathi A, Zeidali E (2021) Conservation tillage and nitrogen fertilizer: A review of corn growth and yield and weed management. *Central Asian Journal of Plant Science Innovation* 1, 121–142. https://doi.org/10.22034/CAJPSI.2021.03.01

Giridhar K, Raju PS, Pushpalatha G, et al (2020) Effects of plant density on yield parameters of cowpea (*Vigna unguiculata* L.). *International Journal of Chemical Studies* 8, 344-347. https://doi.org/10.22271/chemi.2020.v8.i4f.10090

Hall AE (2012) Phenotyping cowpeas for adaptation to drought. *Frontiers in Physiology* 3, 155. https://doi.org/10.3389/fphys.2012.00155

Han X, Rusconi N, Ali P, et al (2017) Nutrients extracted from chicken manure accelerate growth of microalga Scenedesmus obliquus HTB1. *Green and Sustainable Chemistry* 7, 101-113. https://doi.org/10.4236/gsc.2017.72009

Hepperly P, Lotter D, Ulsh CZ, et al (2009) Compost, manure and synthetic fertilizer influences crop yields, soil properties, nitrate leaching and crop nutrient content. *Compost Science and Utilization* 17, 117-126. https://doi.org/10.1080/1065657X.2009.10702410

Hassan MA (2017) Application of biofertilization and biological control for cowpea production. *Annals of Agricultural Science, Moshtohor* 55, 271–286. https://doi.org/10.21608/assjm.2017.56852

Islam Md, Mondal C, Hossain I, et al (2013) Compost tea and poultry litter extract: Alternative organic management approaches for stem canker of potato caused by *Rhizoctonia solani*. *Journal of Agricultural Science* 5, 261-272. https://doi.org/10.5539/jas.v5n10p261

Javaid A (2010) Beneficial Microorganisms for Sustainable Agriculture. In: Lichtfouse E (Ed), Genetic Engineering, Biofertilization, Soil Quality and Organic Farming. vol 4, Sustainable Agriculture Reviews. Springer, Dordrecht, pp. 347-369. https://doi.org/10.1007/978-90-481-8741-6_12

Kumar V, Saikia J, Barik N (2017) Influence of organic, inorganic and biofertilizers on growth, yield, quality and economics of okra [*Abelmoschus esculentus* (L) moench] under assam condition. *International Journal of Current Microbiology and Applied Sciences* 6, 2565-2569. https://doi.org/10.20546/ijcmas.2017.612.297

Luthria D, Singh A P, Wilson T, et al (2010) Influence of conventional and organic agricultural practices on the phenolic content in eggplant pulp: plant-to-plant variation. *Food Chem*istry 121, 406–411.https://doi.org/10.1016/j.foodchem.2009.12.055

Mafakheri K, Bihamta MR, Abbasi AR, et al (2017) Assessment of genetic diversity in cowpea (*Vigna unguiculata* L) germplasm using morphological and molecular characterization. *Cogent Food and Agriculture* 3, 1327092. https://doi.org/10.1080/23311932.2017.1327092

Marschner P (2012) Marschner's Mineral Nutrition of Higher plants. 3rd ed. Academic Press, San Diego, CA .3rd Ed, Academic Press, London, 651 Pp. https://library.wur.nl/WebQuery/titel/1973856

Nadeem MA, Singh V, Dubey RK, et al (2018) Influence of phosphorus and bio-fertilizers on growth and yield of cowpea [*Vigna unguiculata* (l.) Walp.] In acidic Soil of NEH Region of India. *Legume Research - An International Journal* 41, 763-766. https://doi.org/10.18805/LR-3790

Oliveira AB, Moura CF, Gomes-Filho E, et al (2013) The impact of organic farming on quality of tomatoes is associated to increased oxidative stress during fruit development. *PLoS One* 8, e56354. https://doi.org/10.1371/journal.pone.0056354

Oyewale RO, Bamaiyi LJ (2013) Management of cowpea insect pests. *Scholars Academic Journal of Biosciences* 1, 217-226. http://repository.futminna.edu.ng:8080/jspui/handle/123456789/4151

Pathak DV, Kumar M, Rani K (2017) Biofertilizer Application in Horticultural Crops. In: Panpatte DG, Jhala YK, Vyas RV, et al (Eds), Microorganisms for Green Revolution, Vol 1, Microbes for Sustainable Crop Production. Springer, Singapore. pp 215-227. https://doi.org/10.1007/978-981-10-6241-4_11

Snedecor GW, Cochran WG (1989) Statistical Methods. 8th ed., Iowa state Univ., Wiley-Blackwell Iowa, U.S.A, 524 pp.

Soliaman DA (2023) The impact of bio, organic and N, P, K fertilizers on the growth and yield of sesame. *New Valley Journal of Agricultural Science* 3, 957-967. https://doi.org/10.21608/nvjas.2023.212053.1209

Sushkova S, Minkina T, Chaplygin V, et al (2021) Subcritical water extraction of organic acids from chicken manure. *Journal of the Science of Food and Agriculture* 101, 1523-1529. https://doi.org/10.1002/jsfa.10768

Talaat NB (2019) Effective microorganisms: An innovative tool for inducing common bean (*Phaseolus vulgaris* L.) salt-tolerance by regulating photosynthetic rate and endogenous phytohormones production. *Scientia Horticulturae* 250, 254-265. https://doi.org/10.1016/j.scienta.2019.02.052

Vallverdú-Queralt A, Medina-Remón A, Casals-Ribes I , et al (2012) Is there any difference between the phenolic content of organic and conventional tomato juices?. *Food Chemistry* 130, 222–227. https://doi.org/10.1016/j.foodchem.2011.07.017

Wang JL, Liu KL, Zhao XQ, et al (2021) Balanced fertilization over four decades has sustained soil microbial communities and improved soil fertility and rice productivity in red paddy soil. *Science of The Total Environment* 793, 148664. https://doi.org/10.1016/j.scitotenv.2021.148664

Yamada K, Xu HL (2000) Properties and applications of an organic fertilizer inoculated with effective microorganisms. *Journal of Crop Production* 3, 255-268. https://doi.org/10.1300/J144v03n01_21

Zhao J, Ni T, Li J, et al (2016) Effects of organic–inorganic compound fertilizer with reduced chemical fertilizer application on crop yields, soil biological activity and bacterial community structure in a rice–wheat cropping system. *Applied Soil Ecol*ogy 99, 1–12. https://doi.org/10.1016/j.apsoil.2015.11.006

Zia-ul-hassan, Arshad M, Khalid A (2011) Evaluating potassium-use-efficient cotton gentypes using different ranking methods. *Journal of Plant Nutrition* 34, 1957-1972. https://doi.org/10.1080/01904167.2011.610483