



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



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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 m³.fed⁻¹) + NPK (50 kg/fed), TS (15 m³.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/m², 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 phenological 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 (Ziaul-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 CO₂ 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/m² (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 m²; the subplot size was 80 m² and the sub-subplot size was 10 m². 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 m³.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/m². 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 m³.fed⁻¹) + NPK (50 kg/fed).
- Tr2: Dokki 331 + farmyard manure (15 m³.fed⁻¹) + NPK (100 kg/fed).
- Tr3: Dokki 331+ farmyard manure (15 m³.fed⁻¹) + EM1+ NPK (50 kg/fed).
- Tr4: Dokki 331+ farmyard manure (15 m³.fed⁻¹) + TS+ NPK (50 kg/fed).

- Tr5: Dokki 331+ chicken manure (15 m³.fed⁻¹) + NPK (50 kg/fed).
- Tr6: Dokki 331+ chicken manure (15 m³.fed⁻¹) + NPK (100 kg/fed).
- Tr7: Dokki 331+ chicken manure (15 m³.fed⁻¹) + EM1+ (NPK (50 kg/fed).
- Tr8: Dokki331 + chicken manure (15 m³.fed⁻¹) + TS+ NPK (50 kg/fed).
- Tr9: Karim 7+ farmyard manure (15 m³.fed⁻¹) + NPK (50 kg/fed).
- Tr10: Karim 7+ farmyard manure (15 m³.fed⁻¹) + NPK (100 kg/fed).
- Tr11: Karim 7+ farmyard manure (15 m³.fed⁻¹) + EM1+ NPK (50 kg/fed).
- Tr12: Karim 7+ farmyard manure 15 m³.fed⁻¹ +TS+ NPK (50 kg/fed).
- Tr13: Karim 7+ chicken manure (15 m³.fed⁻¹) + NPK (50 kg/fed).
- Tr14: Karim 7+ chicken manure (15 m³.fed⁻¹) + NPK (100 kg/fed).
- Tr15: Karim 7+ chicken manure (15 m³.fed⁻¹) + EM1+ NPK (50 kg/fed).
- Tr16: Karim 7+ chicken manure (15 m³.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/m² (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
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	<i>Lactobacillus plantarum</i> , <i>L.casei</i> , <i>Streptococcus lactis</i>	<i>Rhodospseudomonas plustris</i> , <i>Rhodobacter sphacerodes</i>	<i>Apergillus</i> , <i>Penicilium</i>	<i>Saccharamyces cereresiae</i>
TS	<i>Bacillus polmyxa</i> <i>Bacillus circulance</i> <i>Bacillus megatherium</i>			

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/m² 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/m² 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
<i>First season 2020</i>					
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
<i>Second season 2021</i>					
Dokki-331	163.26 ^a	26.74 ^a	17.20 ^a	26.56 ^a	762.75 ^a
Karim-7	142.63 ^b	23.99 ^b	15.74 ^b	21.08 ^b	441.64 ^b
FYM*	142.38 ^b	24.01 ^b	15.79 ^b	21.17 ^b	553.93 ^b
CHM**	163.51 ^a	26.72 ^a	17.15 ^a	26.48 ^a	650.46 ^a
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/m² (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/m²	Bio yield	Pod weight	100seeds w.
<i>First season 2020</i>					
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	5.52 ^a	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
<i>Second season 2021</i>					
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	Seeds n./p.	Pod length	Seeds/pod	Pods n./p.
Treatments				
First season (2020)				
Tr1	103.33 ^j	18.00 ^{fg}	9.00 ⁱ	12.00 ^g
Tr2	155.00 ^e	25.00 ^c	14.00 ^{cd}	27.67 ^c
Tr3	132.00 ^g	20.67 ^{de}	11.00 ^{gh}	17.00 ^e
Tr4	174.00 ^c	27.67 ^{ab}	15.33 ^{ab}	30.67 ^{ab}
Tr5	113.00 ⁱ	19.67 ^{ef}	11.00 ^h	17.67 ^e
Tr6	165.00 ^d	25.67 ^{bc}	14.00 ^{cd}	28.67 ^{bc}
Tr7	144.67 ^f	22.33 ^d	12.00 ^{fg}	23.00 ^d
Tr8	199.33 ^a	29.33 ^a	16.00 ^a	32.33 ^a
Tr9	95.00 ^k	12.33 ^h	8.00 ^j	8.67 ^h
Tr10	122.33 ^h	20.33 ^{de}	13.67 ^{de}	18.67 ^e
Tr11	106.00 ^j	16.67 ^g	11.00 ^{gh}	10.67 ^g
Tr12	144.00 ^f	25.67 ^{bc}	15.00 ^{abc}	23.33 ^d
Tr13	105.00 ^j	16.33 ^g	9.67 ⁱ	14.33 ^f
Tr14	156.00 ^e	25.00 ^c	12.67 ^{ef}	22.67 ^d
Tr15	124.00 ^h	21.00 ^{de}	12.67 ^f	17.33 ^e
Tr16	184.00 ^b	27.67 ^{ab}	14.33 ^{bcd}	29.67 ^{bc}
Second season (2021)				
Tr1	114.00 ^j	20.64 ^e	11.59 ^{gh}	14.50 ^h
Tr2	170.13 ^e	28.30 ^c	18.60 ^{bc}	30.27 ^c
Tr3	147.10 ^g	23.60 ^d	14.40 ^f	19.90 ^f
Tr4	192.57 ^c	30.97 ^{ab}	20.03 ^b	33.87 ^b
Tr5	123.50 ⁱ	23.36 ^d	14.57 ^f	20.27 ^{ef}
Tr6	187.10 ^d	29.08 ^{bc}	18.53 ^{bc}	30.90 ^c
Tr7	155.77 ^f	25.46 ^d	15.97 ^e	25.43 ^d
Tr8	215.93 ^a	32.51 ^a	23.90 ^a	37.37 ^a
Tr9	106.30 ^k	15.46 ^f	10.30 ^h	11.97 ⁱ
Tr10	135.23 ^h	23.83 ^d	17.77 ^{cd}	20.77 ^{ef}
Tr11	118.60 ^{ij}	20.14 ^e	14.20 ^f	13.17 ^{hi}
Tr12	155.07 ^f	29.13 ^{bc}	19.47 ^b	24.93 ^d
Tr13	116.73 ^j	19.49 ^e	12.57 ^g	16.67 ^g
Tr14	170.73 ^e	28.50 ^c	16.50 ^{de}	25.10 ^d
Tr15	135.00 ^h	24.08 ^d	16.57 ^{de}	21.93 ^e
Tr16	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/m² (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
<i>First season (2020)</i>						
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 ⁱ
Tr ₁₀	20.33 ⁱ	0.81 ⁱ	3.42 ⁱ	65.67 ^f	17.00 ^j	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
<i>Second season (2021)</i>						
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. *Rhodospseudomonas palustris*, *Rhodobacter sphaeroides*), lactobacilli (e.g., *Lactobacillus plantarum*, *L. casei*, and *Streptococcus lactis*), yeasts (e.g., *Saccharomyces* spp.), and *Actinomyces* (*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 infra-red 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/m², (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 Tr₉ (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/m², 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.

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