Available online at http://bjas.bajas.edu.iq
https://doi.org/10.37077/25200860.2025.38.sp.25
College of Agriculture, University of Basrah

Basrah Journal of Agricultural Sciences

ISSN 1814 – 5868 Basrah J. Agric. Sci., 38(Special Issue), 281-288,2025 E-ISSN: 2520-0860

The Effect of Fertilizers Combination on Growth and Yield of Cowpea

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Received 13th September 2024; Accepted 18th February 2025; Available online 24th August 2025

Abstract: The field experiment was conducted during the spring season of 2021 at the experimental fields of the College of Agriculture, Al-Qasim Green University, to evaluate the effect of biological and organic fertilization technologies on the seed yield and related traits of two cowpea (Vigna unguiculata L.) cultivars. The experiment used a factorial arrangement in a randomized complete block design (RCBD). The first factor involved two cowpea cultivars C1: Farmer's Bayader and C2: Hitech Seed, the second factor consisted of different fertilizers combination : F0: chemo-fertilization, F1: organo-fertilization + 1/2 chemo-fertilization, F2: organo-fertilization + chemo-fertilization, F3: bio-fertilization + 1/2 chemical fertilizer, F4: bio-fertilization + chemo-fertilization, F5: bio-fertilization + organo-fertilization + 1/2 chemo-fertilization, F6: bio-fertilization + organo-fertilization + chemo-fertilization, The results showed that C1 performed better in all traits except protein percentage, The F3 excelled in all characteristics. Moreover, the fertilization combination found in treatment (C3 × F3) demonstrated excellence in all study traits.

Keywords: Biological fertilizers, Chemical fertilizers, Non-polluting fertilizers, Organic fertilizers, Utilizer.

Introduction

Cowpea (*Vigna unguiculata* L. (Walp)) is a field crop with a high yield. The plant has rapid vegetative growth and a continuous economic yield (Jabbar & Sbti, 2022). It is considered one of the legumes, and most of its seeds are a source of protein (Jabbar, 2019). Chemical fertilizers play an important role in providing nutrients to the soil that the plant needs primarily for biosynthesis, and which the soil loses during the plant's growing season (AL-Furtosi *et al.,* 2019), but the desire to use Non-polluting fertilizers and the high cost of chemical fertilizers that reduce profits are prompting studies on safe and effective alternatives in increasing productivity. Therefore, using Non-polluting fertilizers completely or reducing the amount of added chemical fertilizers is an important factor in reducing environmental pollution rates in addition to the economic cost.

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Extracts of herbs, algae, bacteria, fungi and their mixtures have played a role in increasing the availability of elements such as phosphorus, potassium and some minor elements, adding some elements from their decomposition and providing basic nutrition for plant growth, in addition to their role in stimulating the plant to secrete plant growth regulators and manufacture organic and amino acids inside the plant, play a role in many physiological processes in plant parts and their involvement in stress tolerance mechanisms (Vessey, 2003). Adding bio-fertilizer (spraying or adding it to the soil) plays a role in the availability of elements, correcting agricultural soil and increasing the soil's readiness for water, thus facilitating the work of the roots (Amal & El-Guad ,2020).

Bio fertilization is added as supplementary fertilizers, and algae are used in some areas as a soil by fixing the mobile elements within the soil content. Therefore, bio-fertilization has played a major role in reducing the use of chemical fertilizers and their direct impact on plant growth and thus on the economic yield (Kurniawati *et al.*, 2023).

Adding bio-fertilization affects the yield and its components. Jayshree & Umesha (2021) found that adding bio-fertilizations as supplements with basic fertilizers significantly increased the economic yield by increasing the number of branches and fruit buds. So, the decrease of chemo-fertilization and compensation a from bio-fertilization appear to Increase in the yield 2.06 Mega ha^{-1} of the treatment 45kg chemo+ bio-fertilization While 55kg chemo-fertilizer which gave a seed yield 1.84 Mega ha^{-1}. Moosavi *et al.* (2020) found that the plant yield increased by adding bio-fertilization with increased in plant yield about 249-266 g m^{-2}, while the control gave 194.46 g m^{-2}, while Kalegore *et al.* (2018) explained the effective of bio-fertilization played an important role in increasing plant yield 7.51 gm $plant^{-1}$ and an economical yield (1.581 Mega ha^{-1}) compared to control treatment 6.33 gm $plant^{-1}$ and an economical yield 1.305 Mega ha^{-1}. Nadeem *et al.* (2017) confirmed that adding bio fertilization positively affected obtaining an economical seed yield 25%, hence the fertilization treatment appeared superiority in protein yield 0.323 Mega ha^{-1} compared to the control treatment 0.277 Mega ha^{-1}.

Organo fertilization is important in agricultural production because it improves the soil, provides nutrients and increases plant readiness (Vasileva & Kostov, 2020). Ayoola & Makinde (2007) found that the use of organo-fertilization had a significant impact on increasing the economic yield 0.37 Mega ha^{-1} compared to non-addition treatment 0.26 Mega ha^{-1}, while Amoah *et.al.* (2012) appeared to increase in yield with treatment organo-chemo fertilizers 179.7 g $plant^{-1}$, while the treatment of organo-fertilization had a yield 169.9 g $plant^{-1}$ and chemo-fertilization treatment gave 164.5 g $plant^{-1}$. The results of Sakpal *et al.* (2021) found that the treatment of organo-fertilization had a protein percentage of 20.83 % and a protein yield of 0.368 Mega ha^{-1} compared to the control treatment which gave 16.57% and 0.236 Mga ha^{-1} respectively.

The productivity of the cowpea crop varies according to a cultivar. Improved cultivars with deep root system definitely give higher productivity (Odedina *et al.*,2014). The productivity values also vary according to the nature of the cultivar's growth, whether upright or climbing (ELNaim *et al.* ,2010) .

Ibrahim *et al.* (2010) found a clear variation among some cowpea varieties in their productivity of pods and green leaves

depending on the planting distance. Babaji *et al.* (2011) evaluated four cowpea varieties at different fertilizer levels in another study. The study results showed that there is a clear variation among the studied cowpea varieties in terms of the number of leaves per plant, the number of branches, and the productivity of green pods. In Nigeria, Agbogidi & Egho (2012) found a variation in vegetative growth characteristics and productivity in a study to evaluate 8 cowpea cultivars, they found a variation among the studied cultivars in the weight of 100 dry seeds as it was the highest with values reaching 23.3 g, and the cultivars also varied among themselves in the number of pods per plant. The highest was in a 134 IT06K cultivar about 17 pods per plant, and it was superior with 27 pods per plant .

Therefore, this study was conducted to determine the role of environmentally friendly fertilizers in increasing agricultural production, especially in improving the productivity of two cultivars of cowpea crops.

Materials & Methods

Experience site

In the spring of 2021, this study was conducted in the field units of the Faculty of Agriculture - Al-Qassim Green Universty to assess the use of bio-organo-fertilization on the yield in two cultivars of cowpea (Farmer's Bayader - Hitech Seed). The soil was analyzed before planting from several different areas of experimental filed in the lab. of faculty of Agriculture, the physical and chemical properties were shown in table (1).

The distribution of treatments

The factorial experiments arrangement was used under RCBD Design:

(1) 1*st factor: cultivars (C1: Farmer's Bayader, C2: Hitech Seed) - table 1.

(2) 2*nd factor :

a) F0: chemo-fertilization
b) F1: organo-fertilization + 1/2 chemo-fertilization
c) F2: organo-fertilization + total chemo-fertilization
d) F3: biofertilization + 1/2 chemo-fertilization
e) F4: biofertilization + total chemo-fertilization
f) F5: biofertilization + organo-fertilization + 1/2 chemo-fertilization
g) F6: biofertilization + organo-fertilization + total chemo-fertilization.

Preparing the experiment for planting

The field units were prepared in advance by carrying out all the agricultural operations before planting. The experimental units included three rawS (raw distance was 5 m), the distance between plants were 25 cm, the units had three replications, and divided to fourteen units. Each replication had two cultivars of cowpea, seven fertilization levels according to factors. The seed was planted in a grooved shape (AL-Maliki *et al.,* 2020). The field was irrigated according to need.

The date of the seedling was 15teen April 2021. Each cultivar gave full germination percentage, and the units were added fertilizers according to Table 2 .

The study traits were: leaf area, Chlorophyll Content, and no. Pods per plant, Plant seed yield, Protein percentage, Protein yield.

Table (1): The Chemical and physical properties of soil

Soil components		Val.	Ind.	Val.	Ind.
Val.	Ind.	282 mg kg^{-1}	K	7.15	pH
255	Sand				
336	Clay	1.37%	Organic	3.83 M. S m^{-1}	Ec
409	alluvial			24.3 mg kg^{-1}	N
Mixed clay	Soil texture			27.6 mg kg^{-1}	P

Table (2): specification of Fertilizations and Cultivars

Adding date	The content	Recommendation	Manufacture Company	Fertilizer name	Type fertilizer
20-04-2020	Balanced P:12 Balanced N:12 High K:36	150-200 kg ha-1	Haya Agricultural - Libya	Farms Fertilize	Chemical
20-04-2020	Ascophyllum Nodosum: %45, Alginic Acid: %17.9, N: % 2.3, P205: % 3.8, K20: %18.2	100 g. 100 L water foliar application and 1600 g ha-1 with Irrigation	Already company	Seaweed Power	Organic
20-04-2020	Fungi Trichoderma harzianum15% Bacteria Bacillus subtilis10% Algae 55% Humic acid15% Seaweed extract 5%	4-5 kg ha-1	Humintech company – Germany	Bio Health WSG	Biology
The cultivars limited according to Sabti , 2022					
C2: Hitech Seed A semi-erect cultivar characterized by high seed productivity - origin: south america - grown in arid and semi-arid regions			C1: Farmer's Bayade A semi-erect cultivar characterized by its dense vegetative growth, so strains of it are grown as green fodder crops - origin: USA - grown in semi-arid and temperate regions		

Results & Discussion

In Table 3, the results appeared excel C1 treatment in all studies traits as leaf area 227.2 cm2, chlorophyll content 34.8 spad, number of pods per plant 120.44 pods $plant^{-1}$, plant yield 91.6 g $plant^{-1}$ and protein yield 24.6 g $plant^{-1}$ in comparison C2 treatment gave a low in the leaf area of 200.8 cm^2, chlorophyll content of 31.9 spad , several pods per plant 114.7 pod $plant^{-1}$, plant seed yield of 78.8 g $plant^{-1}$ and protein yield of 19.6 g plant-1. The cultivars differ in benefit degree from growth factors, so their ability to adapt to environmental conditions through changes in physiological processes and control of gene expression leads the plant to increase the formation of chlorophyll in the leaves, which affects the process of photosynthesis (Wade *et.al.,* 2014), Moreover it increases the concentration of plant hormones that affect the increase in vegetative growth and reflected in the buds and the number of pods (Nwofia *et al.*, 2014), and reflected in the plant seed yield (Sousa *et al.,* 2015, Kamara *et al*., 2017).

The results in Table 3 showed variations among the addition of fertilizers , the treatment F0 gave low values in leaf area 164.1 cm^2 , chlorophyll content 26.4 spad , number of pods per plant 108.4 pods $plant^{-1}$, the seed yield plant 61.3g $plant^{-1}$, the percentage of protein was 22.3% and protein yield 13.7 g $plant^{-1}$, while F3 appeared to have high values in leaf

area 225.6 cm^2, chlorophyll content 37.7 spad , number of pods per plant 125.9 pods $plant^{-1}$, seed yield plant 100.6 g $plant^{-1}$, percentage of protein 29.6% and protein yield 29.8 g $plant^{-1}$. The superiority in the number of pods comes from interaction among the Bio health components by regulating the vital activities related to growth and cell division, to give the best vegetative growth. And causes an increase growth efficiency in leaf area and chlorophyll content, and reflected on the yield and its components (Vikram & Hamzehzarghani, 2008, Khan *et al.,* 2017) who found that bio-fertilization an important complement to chemo-fertilization, it is possible to reduce the amount of chemo-fertilization and replace with biological additives. At the sometime, Asokan *et al.*, (2000) found an increase in yield when bio-fertilization was with half of the chemo-fertilization. In another study, the addition of bio-fertilization had increased in the accumulation of dry matter in the plant and increased the seed weight, and its role in increasing of the flowering rate, which increased of the number of pods. (Nadeem *et al.*, 2017). Bio-fertilization also play an important role in manufacturing and assembling compounds in the plant by increasing the protein content in the seeds (Amal & El-Guad ,2020).

Table (3): The cultivars and fertilizers addition

Protein yield (g $plant^{-1}$)	Protein percentage **(%)**	Plant seed yield (g $plant^{-1}$)	No. pods per plant	Chlorophyll Content (SPAD)	Leaf area (cm^2)	Traits / Treatments
Cultivars						
26.9	24.6	91.6	120.44	34.8	227.2	C1
24.9	19.6	78.8	114.7	31.9	200.8	C2
N.S	4	6.4	3.51	2.2	18.8	L.S.D0.05
Fertilizers						
22.3	13.7	61.3	108.4	26.4	164.1	F0
23.7	22.6	95.4	120.4	36.8	234.2	F1
24.5	20.11	82.1	114.7	32.8	204	F2
29.6	29.8	100.6	125.9	37.7	255.6	F3
26.9	22.3	83.1	115.8	33	206.1	F4
25.5	23.3	91.3	121.6	35.9	231.5	F5
26.5	21.9	82.6	116.4	31.1	202.7	F6
3.01	3.01	4.8	2.59	2.03	11.3	L.S.D0.05
Interaction						
14.8	22.4	65.9	111.03	27.9	176.1	C1F0
24.7	24.8	99.8	123.72	38.3	245.1	C1F1
22.4	25.1	89.3	117.14	34.3	218.1	C1F2
32.4	30.4	106.7	128.56	39.3	268.9	C1F3
25.1	27.7	90.7	118.38	34.6	219.2	C1F4
26.2	26.6	98.7	124.77	37.2	243	C1F5
24.3	26.9	90.2	119.5	32.1	220.2	C1F6
12.6	22.2	56.6	105.73	24.9	152	C2F0
20.6	22.6	91	117.04	35.4	223.3	C2F1
17.8	23.8	74.9	112.23	31.3	189.9	C2F2
27.2	28.8	94.4	123.2	36	242.3	C2F3
19.7	26	75.7	113.24	31.4	193	C2F4
20.5	24.4	83.9	118.43	34.5	220	C2F5
19.8	26.5	74.9	113.24	30.1	185.2	C2F6
5.5	5.11	7.5	4.73	2.51	21.3	L.S.D 0.05

The increase in seed yield is attributed to the efficiency of bio fertilizers through the formation of the root system, which plays a major role in increasing the efficiency of the biological fixation process, which in turn is reflected in increasing the protein synthesis within the different parts of the plant, promoting the absorption of the nutrient, and also increasing the plant growth and development , the addition of bio fertilizer also leads to an increase in the number of root nodules, Their efficiency in fixing nitrogen and the percentage of protein in the seeds. These results are consistent with what was found by (Khokhar *et al.*, 2001).

The variation in all study traits in the interaction between factors, the interaction C1*F3 gave high values in leaf area 268.9 cm^2, chlorophyll content 39.3 spad , and number of pods per plant 128.56 pods $plant^{-1}$, plant seed yield 106.7 g $plant^{-1}$, percentage of protein 30.4% and protein yield 32.4 g $plant^{-1}$ while the interaction C2*F0, recorded low values in leaf area 152 cm^2 , chlorophyll content 24.9 spad , number of pods per plant 105.73 pods $plant^{-1}$, plant seed yield 56.6 g $plant^{-1}$, percentage of protein 22.2% and protein yield 12.6 g $plant^{-1}$.

Conclusions

The Bayader farm cultivar excelled in plant seed and high protein yield, so it is recommended for its planting. The fertilization of 1/2 of the chemo-fertilization with the bio-fertilization appeared to have the best results especially in the yield. This means the replacing 1/2 of the chemo-fertilization recommendation with superior growth characteristics, yield, and quality results.

Acknowledgements

We thank the organizers of the Fifth International Conference of the College of Agriculture, University of Basra, for allowing us to consolidate this study in a way that would be presented to the agricultural community and benefit.

Contributions of authors

M. Kh. J.: Constructed the idea and wrote the manuscript.

AL. A. S.: Did the experiment, collection and analyzed the data**.**

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Conflicts of interest

The authors declare that they have no conflict of interests.

Ethical approval

There is no ethical approval in this study.

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تأثير توليفات من الأسمدة على نمو وإنتاجية اللوبيا

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[2]كلية الزراعة، جامعة القاسم الخضراء، بابل، العراق

المستخلص: في ربيع عام 2021، أجريت دراسة في الوحدات الحقلية لكلية الزراعة، جامعة القاسم الخضراء، لدراسة تأثير تقنية التسميد البيولوجي والعضوي على إنتاجية محصول البذور لصنفين من اللوبيا. استخدمت التجربة ترتيب العوامل بتصميم القطاعات الكاملة العشوائية (RCBD). العامل الأول شمل صنفين من اللوبيا C1: Farmer's Bayader و C2: Hitech Seed، العامل الثاني يتكون من مزيج من الأسمدة المختلفة: F0: التسميد الكيميائي، F1: التسميد العضوي + 2/1 التسميد الكيميائي، F2: التسميد العضوي + التسميد الكيميائي، F3: التسميد الحيوي + 2/1 السماد الكيميائي، F4: التسميد الحيوي + التسميد الكيميائي، F5: التسميد الحيوي + التسميد العضوي + 2/1 التسميد الكيميائي، F6: التسميد الحيوي + التسميد العضوي + التسميد الكيميائي، أظهرت النتائج أن C1 كان أفضل أداء في جميع الصفات باستثناء نسبة البروتين، وتفوق F3 في جميع الصفات، كما أظهرت تركيبة التسميد الموجودة في المعاملة (C3 × F3) تفوقًا في جميع الصفات المدروسة.

الكلمات المفتاحية: الأسمدة البيولوجية، الأسمدة الكيميائية، الأسمدة غير الملوثة، الأسمدة العضوية، المستفي