

RESEARCH PAPER

Response of two Chickpea genotypes to different fertilizers composition and different application forms

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ABSTRACT:

A field study was conducted at Grdarashe experimental field (Latitude: 36° 4' N and Longitude: 44° 2' E- elevation 415 m above Sea level), college of Agricultural engineering sciences, Salahaddin University, Erbil Iraqi Kurdistan Region, to investigate the effect of different fertilizers on growth and yield component of two Kabuli Chickpea (*Cicer arietinum* L.) genotypes, Sham and Mexican; the fertilizers composed of five treatments Bio- fertilizer, Foliar applied fertilizer, Urea as a source of nitrogen, di-ammonium phosphate (DAP), and No fertilizer as a control. The experiment designed in completely randomized block. The results showed a significant increase in plant height when treated with foliar fertilizer compared to the control treatment. Di-ammonium phosphate (DAP) treatment was recorded the largest number of primary and secondary branches per plant compared to control treatment. The Number of pods, seed.plant⁻¹ and pods.plant⁻¹, seeds weight (g.plant⁻¹), 100 seeds weight (g) ,biological and economical yield(ton.ha⁻¹),harvest index, protein and fiber ratio increased with Bio-fertilizer treatment, which recorded the highest value compared to the others treatments.

KEY WORDS: Chickpea, Bio fertilizers, productivity parameters

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INTRODUCTION:

Chickpea (*Cicer arietinum* L.) from fabaceae family is one of the most important edible seed crop in Iraqi Kurdistan and throughout the world because of its high protein (Singh et al., 2018). (Ali, 2017) indicates that chickpea contains 13 to 33% protein, 40 to 55% carbohydrates, and 4 to 10% oil. While different compounds secreted from leaves, stems and pods such content as Malic and oxalic acids have medicinal purposes for bronchitis, catarrh, constipation, diarrhea, catamenia, cholera, digestive conditions and snake bite. These acids are known to lower blood cholesterol level. In Kurdistan region cultivated area of chickpea ranged from 8000 to 9000 hectare in 2017 and 2018, while yield per hectare range from 1 to 0.9 ton (MOAWR, 2019).

Nutritional imbalance and poor nodulation appears to be the main obstacle in a single crop season (Tagore et al., 2013). Farmers distort that chickpea as a legume crop, does not need any fertilizers and usually they grow it without applying any fertilizer, this seems to be the main reason of its low yield in many countries. (Patel and Patel, 1991) observed that some progressive farmers apply a little amount of nitrogenous and phosphorus fertilizer as a starter dose (Ali et al., 2004) . An adequate supply of chemical fertilizers is closely associated with growth and development of plant as the most important inputs in crop production (Kumar et al., 2014) . (Erman et al., 2011) reported that macronutrients such as nitrogen (N), phosphorus (P) and potassium (K) are essential and important for plant growth and yield. While excessive use of chemical fertilizers can pose environmental problems which can cause potential risk for sustainability of agricultural systems (Vance, 1997).

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Nitrogen is a vital basic of chlorophyll, protoplasm, protein and nucleic acid. It is related with high photosynthetic activity, the green colour of stem and leaves, branching, leaf generation and size enlargement, vigorous growth. It improves the quality of foods and protein contents of nourishment grains (Ali et al., 2010).

The use of phosphorus in leguminous crops significantly improves the yield of seeds (Hussain et al., 1981). Meanwhile, with Rhizobium and phosphorus combined applications, the yield of chickpea was significantly increased (Raut and Kohire, 1991).

(Muhammad et al., 2010a) Stated that phosphorus is important for healthy crop growth with an efficient root system and an abundance of nodules. K is essential for nitrogen and carbohydrate metabolism, activation of various enzymes and adjustment of stomata apparatus and water relations (Boyer and Stout, 1959).

Using environmentally safe fertilizers is one of the main components of sustainable agriculture methods. Bio-fertilizers are substances that contain living microorganisms and promotes growth by increasing the availability of primary nutrients, reduces environmental contamination and maximizes crop growth also they are the most

Table (1): Some physical and chemical properties of the soil used in the Grdarashe field experiment

Soil properties	Average Value
Clay	397.60 g.kg ⁻¹
Silt	546.20 g.kg ⁻¹
Sand	56.20 g.kg ⁻¹
Soil texture	SICL (silty clay loam)
Total (N)	1000 mg.kg ⁻¹
Available (P)	4.10 mg.kg ⁻¹
Available (K)	13.65 mg.kg ⁻¹
pH	7.71
EC	0.517 dSm ⁻¹
CEC	22.79 Cmolc.kg ⁻¹
Calcium carbonate	340 g.kg ⁻¹
Organic matter (Walkly and Black method)	9.6 g.kg ⁻¹

* The Soil properties were analyzed in Agriculture Research Centre - Ainkawa /Erbil.

needed techniques in crop yield that increases plant growth and yield (Namvar et al., 2011). although the chemical fertilizers application increased in developing countries, the farmers still believe that there is no need for fertilizers in chickpea fields and this is the main constrain the chickpea production.

This study was conducted to evaluate and compare the use of different fertilizer types and application forms on growth, yield and yield component of two of chickpea genotypes (Sham and Mexican).

2. MATERIALS &METHODS

2.1 Study Site: The experiment was conducted in Grdarashe field (Latitude: 36° 4' N and Longitude: 44° 2' E- elevation 415 m above Sea level) of Agriculture engineering sciences college, Salahaddin University, Erbil Kurdistan Region, during 2019 agriculture season. Some soil physiochemical properties -clay, silt, sand, soil texture (hydrometer method), total nitrogen (kjeldahl method), available phosphor (spectrophotometer), available potassium (flame photometer method), PH (PH meter), EC (electrical conductivity), CEC, calcium carbonate, organic matter, are indicated in table (1).

2.2. Meteorological data was recorded by the automated meteorological station in the field of table (2) (MOAWR, 2019).

2.3. Experimental design: The study involved three fertilization forms soil application of Urea $\text{CO}(\text{NH}_2)_2$ (N 46%) ; DAP $(\text{NH}_4)_2\text{HPO}_4$ (18:46:0) ,seed treatment with bio-fertilizer (Corabac G ,TRM) and foliar application of (Volijob), with no

fertilizer applied treatment which was considered as control . The tested plants were two chickpea genotypes (Sham and Mexican) (table 3), plots were laid out in a (Randomize Complete block design) with three replication and plot size was (1.5*2.1 m) each consisting of 6 rows (each row consisted 15 plants keeping 30 cm apart between rows and 15 cm within plants).

Table (2): Meteorological data for season 2018-2019

Months	Maximum Temp. °C	Minimum. Temp. °C	Average. Temp. °C	Average RH%	Rain precipitation mm
October	38.70	11.35	25.31	35.34	22.61
November	28.24	6.30	15.62	65.83	113.55
December	21.69	13.81	17.70	35.19	18.29
January	19.22	-2.91	8.15	72.88	96.27
February	18.43	-0.02	9.21	71.92	42.42
March	21.54	0.48	11.01	72.25	215.91
April	26.62	3.51	15.06	69.57	125.74
May	39.33	9.25	24.29	41.03	5.84
Jun	44.33	16.67	32.53	19.63	0.00
Total					640.63

* Ministry of Agriculture and Water resources (M.O.AWR 2019)

Table (3): Fertilizer types and their nutrient at percentage components

No.	Fertilizer types	Components	percentage%
1	Corabac (Bio) Microorganism	(Azotobacter, Bacillus megaterium) Gardened cultured Riolete granules	1.0 2.0 97.0
2	Voligop (foliar)	Nitrogen (carbamide) phosphor (Phosphate) potassium (hydroxide) molybdenum (molbidade) Boron (borate)	17.2 4.9 6.3 0.046 0.036
3	Urea	Nitrogen	46
4	Di-Ammonium phosphate (DAP)	Nitrogen, phosphate	18:46:0
5	control	No Fertilizers	—

2.4. Agronomical practices: Experimental plots were prepared by two dry ploughing, land levelling by rotavator, then rows were established by chisel plough after that it was hand seeded with two chickpea genotypes (Sham and Mexican) on 24th of January 2019 with the rate of (60 kg.ha⁻¹) keeping 30 cm (between rows) and 15 cm within plants ,fertilizers were used as Bio (Corabac G) with (20 kg.ha⁻¹), Urea fertilizer with the rate (40 kg.ha⁻¹), DAP (Di-ammonium phosphate) with (60 kg.ha⁻¹) which were soil applied with the sowing process, while foliar fertilizer (VOLIGOP NPK,17.2:4.9:6.3) with rate 50 ml /10 L water (20L/ha) was sprayed after 45 days from sowing.

$$\text{Biological yield} = \text{pod's weight} + \text{seed's wt.} + \text{dry shoot's wt.} \text{ --- (1)}$$

$$\text{Economical yield(t/ha)} = \frac{\text{seed's weight (g/plant)} * 2500}{\text{area plant(m}^2\text{)} * 10000} * 4 \text{ --- (2)}$$

$$\% \text{Harvest index} = \frac{\text{economical yield}}{\text{biological yield}} * 100 \text{ (Dobermann, 2007)----- (3)}$$

2.5.3. Chemical characteristics:

The chickpea seed contents (Nitrogen, Phosphorus, Potassium, Protein, carbohydrate, Oil content, Fibre and Starch) were determined in laboratories of Salahaddin and Duhok universities.

Dried seeds or shoot plant were grinded separately by an electrical blender; crushed

***Total nitrogen:**

Was determined from digested samples by kjeldahl method (Sáez-Plaza et al., 2013)

$$\% \text{ N} = \frac{(T - B) * N * 1.401}{G} \text{ --- (4)}$$

T= ml of sample titrated.

B= ml of Blank titrated.

N= acid normality (0.01N).

G= weight of powder.

***Total phosphor:**

the total phosphorous was estimated from digested samples by spectrophotometer at 410 nm as described by (Schuffelen et al., 1961).

*** Total potassium:**

Flame photometer was used for determination of potassium from plant extract according to (Allen et al., 1974).

*** Total protein:**

It was calculated by multiplying the values of total nitrogen content by 6.25 by following equation according to (Khanizadeh et al., 1995).

$$\% \text{ protein} = \% \text{ Nitrogen} * 6.25 \text{ --- (5)}$$

*** Soluble carbohydrate:**

$$\% \text{ Soluble carbohydrate} = \frac{C(\text{mg}) * \text{extract volume}(\text{ml})}{10 * \text{aliquot}(\text{ml}) * \text{sample wt}(\text{g})} \text{ --- (6)}$$

C=mg glucose obtained from the using graph

2.5. Recorded Data - parameters which have been recorded in this study were:

2.5.1. Growth characteristics

Plant height (cm), number of primary and secondary branches, pods per plant, Grains per plant, Nodules per plant, weights of 100-grains that were recorded after harvesting experimental units.

2.5.2. Yield and yield components

The data that were recorded under this category were biological yield, economical yield and harvest index (HI) according to these equations:

samples were kept in closed plastic tubes, using (0.5 g) powdered of seed and shoot mixed with (10 ml H₂SO₄) sulpheric acid and (2 ml) HClO₄ then Heating them till the color changes from black to white, make Filtration and Complete the Volume to 100 ml by distilled water as described by (Horwitz, 2010) to determine the following:

*** Oil * Fibre * Starch content (Cunniff and Washington, 1997).**

2.6. Statistical analysis: The recorded data means were compared using Duncan multiple range test with a probability of 0.05 using SPSS version 22 and computer analysis (Bah, 2001)

3. RESULTS & DISCUSSION

3.1. The effect of genotypes on some growth and yield characteristics of two chickpea genotypes

3.1.1. Vegetative parameters

As shown in the table (4) the vegetative parameters affected significantly at $P \leq 0.05$ by genotypes. The plant height (cm), number of pods per plant, number of seeds per plant, pods weight (g .per plant), seeds weight (g. per plant), and 100 seed weight (g), were (50.73, 15.00, 13.48, 7.16, 5.99 and 51.85) respectively recorded higher in

Table (4): Effect of genotypes on chickpea vegetative parameters

Genotypes	Plant. Height (cm)	No. primary branch	No. Secondary branch	No. pods (plant ⁻¹)	No. seeds (plant ⁻¹)	pods weight (g. plant ⁻¹)	No. nodules (plant ⁻¹)	seeds weight (g. plant ⁻¹)	100 seed weight (g)
Sham	46.75 b	7.89 a	46.71 a	12.63 b	10.58 b	6.39 b	23.21 a	5.14 b	42.80 b
Mexican	50.73 a	7.20 a	46.04 a	15.00 a	13.48 a	7.16 a	22.50 a	5.99 a	51.85 a

3.1.2. The effect of genotypes on yield and yield components

The results in table (5) refers that the yield parameters affected significantly by genotypes, the higher values (6.82, 1.71 and 24.86) of biological, economical yield (t.ha⁻¹) and Harvest index respectively were recorded by Mexican in comparing with Sham genotype This means that

Table (5): Effects of genotypes on chickpea yield parameters

Genotypes	biological yield (t. ha ⁻¹)	Economical yield (t. ha ⁻¹)	Harvest index%
Sham	6.04 b	1.47 b	23.78 b
Mexican	6.82 a	1.71 a	24.86 a

3.1.3. The effect of genotypes on chemical characteristics

Table (6) clarified that the chemical contents of seeds seed significantly was affected by chickpea genotypes. The percentage of Fibre, nitrogen, and protein were (6.73, 3.07 and 19.20) respectively

Mexican than sham genotype, with exception of numbers of primary and secondary branches per plant in both genotypes there were no differences that may be due to genetic variation. Moreover, no significant variances were noticed between the means of genotypes in number of nodules per plant nodules coexist. Nitrogen and Phosphorus have basic role in plant body, nitrogen being an important part of nucleic acids and proteins which are very essential in promoting the growth. Similarly at early stage phosphorus helped on encouraging root growth and better crop establishment (Dalal and Nandkar, 2010).

the highest yielding genotype (Mexican) had higher ability of producing and transporting primary metabolites that created from the vegetative organs to developing seeds than that in (sham) genotype. Which maybe refer to genetic variability between the two studied chickpea genotypes (Aliu et al., 2016) and (Alam et al., 2017).

recorded by the Sham compared to the Mexican (6.06, 2.88 and 18.01) respectively. These variations may be due to metabolites translocation or dry matter accumulation ,according to (Xu et al., 2013) and (Sharma et al., 2013).

Table (6): Chemical components of genotypes chickpea seeds

Genotype	Starch %	Carbohydrate %	Fibre %	Oil %	N %	P %	K %	Protein %
Sham	51.66 a	58.33 a	6.73 a	5.66 a	3.07 a	1.81 a	0.88 b	19.20 a
Mexican	52.17 a	58.17 a	6.06 b	5.93 a	2.88 b	1.85 a	0.97 a	18.01 b

3.2. The effect of fertilizers type on some growth and yield characteristics of two chickpea genotypes

3.2.1. The effect of fertilizers type on vegetative parameters

According to table (7) the highest plant value (52.24 cm) was recorded in treatments that received foliar applied fertilizer compared to control treatment which was (44.07 cm). Significant effect was observed on secondary branches per plant, the maximum numbers were (58.14) in chickpea plots that treated with Di-ammonium phosphate comparing with control treatment (42.57). These results are agreed with (Ahmed et al., 2010). The greatest number of pods per plant was recorded in plots that treated with Bio-fertilizer 42.17% higher pods per plant than non- treated or control plot, similar results reported by (Togay et al., 2008) and (Kumar et al., 2015). Number of grains per plant (15.18)

significantly increased when treated with Bio-fertilizer about 65.18% grains per plant higher than the control (non-fertilized) plots, as it was referred by (Alam and Seth, 2014). Pods weight g/plant, Grains weight g/plant, 100 seed weight were significantly influenced in Bio-fertilizer plots, they recorded greatest magnitude (8.58, 7.47 and 48.58g) respectively while the lowest were (5.03g) with foliar fertilizer and (4.17 and 45.15g) with control respectively, the impacts of fertilizer were significant on the number of nodules, the greatest numbers (30.19) was recorded with Bio-fertilizer which increased by 65.97% while the chemical added 20.73% more number of nodules per plant compared with control, these data explained the increase of nitrogen percentage in the above situations which lead to stronger plant growth, the results are in accordance with the finding of (Kumar et al., 2015) and (Dutta and Bandyopadhyay, 2009).

Table (7): Effects of fertilizer types on chickpea vegetative parameters

Fertilizers	Plant Height (cm)	No. primary branch	No. Secondary branch	No. pods (plant ⁻¹)	No. seeds (plant ⁻¹)	Pods weight (g. plant ⁻¹)	No. nodules (plant ⁻¹)	Seeds weight (plant ⁻¹)	100 seed weight(g)
Bio	47.82 b	7.88 a b	51.61 a b	17.80 a	15.18 a	8.58 a	30.19 a	7.47 a	48.58 a
Foliar	52.24 a	7.17 a b	43.61 a b	11.97 b	10.60 b	5.03 c	21.44 b c	4.45 b	48.10 ab
Urea	48.55 b	6.91 b	35.93 b	13.04 b	10.67 b	6.54 b	20.92 c	5.17 b	47.07 ab
DAP	51.01 a	9.00 a	58.14 a	13.75 b	14.50 a	7.53 a b	23.53 b	6.56 a	47.73 ab
Control	44.07 c	6.79 b	42.57 a b	12.52 b	9.19 b	6.22 b c	18.19 d	4.17 b	45.15 b

3.2.2. The effect of fertilizers type on yield and yield components

Table (8) indicated the significant effect of fertilizers on Biological yield, Economical yield and Harvest index, the highest value (7.53, 2.13 t.ha⁻¹ and 28.31) respectively by Bio-fertilizer comparing with the non-fertilizer which recorded the lowest value (5.61, 1.19 ton per hectare and

21.08) respectively, The bio fertilizers increase the yield components percentage (34.22%, 79% and 34.30%) for (Biological, Economical yield and Harvest index) over the control. The obvious progress in these treatments may be due to the application of bio-fertilizer and its content of useful bacteria, nitrogen fixing bacteria NFB, phosphate solubilizing bacteria PSB and

Potassium mobilizing bacteria KMB as well as some beneficial fungus, i.e., yeast and Trichoderma. Such bacteria affected plant growth and productivity through their ability to release some supporter's plant growth regulators such as indole acetic acid, ethylene, gibberellins acid and cytokinins as well as increase essential nutrients

supply nitrogen, phosphorus and potassium for plant growth (Dutta and Bandyopadhyay, 2009).

Table (8): Effects of fertilizers on yield parameters

Fertilizers	biological Yield (t. ha ⁻¹)	economical yield (t. ha ⁻¹)	Harvest index%
Bio	7.53 a	2.13 a	28.31 a
Foliar	5.79 b	1.27 b	21.67 b c
Urea	5.99 b	1.48 b	24.70 a b c
DAP	7.24 a	1.87 a	25.86 a b
Control	5.61 b	1.19 b	21.08 b c

3.2.3. The effect of fertilizers type on chemical characteristics

The fertilizers application significantly influenced nutrients and chemical contents of chickpea seeds except on the phosphor and potassium content (table9).The maximum percentage values (7.89, 6.31, 3.25, 0.98 and 20.31) were recorded by the (Fibre, Oil, Nitrogen, Potassium and Protein) in response to the application of bio-fertilizer comparing with the other treatments. Significant effects of bio-fertilizer on the percentage of N,P,K content of chickpea seeds was mentioned by (Kumar et al., 2014) .The protein is the main goal in chickpea which increased by (8.73% and 21.70%) compared to chemical and non-fertilization

treatments respectively. (Mohammadi et al., 2010) indicated that chickpea with bio-fertilizers have significantly higher protein grain, this is also clarified by(Seleiman and Abdelaal, 2018).The starch and carbohydrate recorded highest percentage (54.04 and 59.66)with no fertilizers applied and the lowest(48.62 and 56.52) recorded by bio-fertilizer usage respectively (table 9), these results are in agreement with those obtained by (Jutur and Reddy, 2007).The application of macronutrients (N, P and K) and Bio-fertilizer to chickpea plants illustrated the increase of essential yield components. Macro elements as well as bio and organic fertilizers may cause increase mineral uptake by plant and seed content (Goud et al., 2014).

Table (9): Effect of different fertilizers types on chickpea seed component

Fertilizers	Starch %	Carbohydrate %	Fibre %	Oil %	N %	P %	K %	Protein %
Bio	48.62 b	56.52 b	7.89 a	6.31 a	3.25 a	1.82 a	0.98 a	20.31 a
Foliar	51.54 ab	57.66 ab	6.12 bc	5.80 bc	2.84 c	1.84 a	0.87 a	17.75 c
Urea	52.80 a	58.95 a	6.24 b	5.50 c	3.02 b	1.86 a	0.90 a	18.87 b
DAP	52.59 a	58.45 ab	6.10 bc	6.00 ab	3.10 ab	1.78 a	0.90 a	19.41 ab
control	54.04 a	59.66 a	5.63 c	5.35 c	2.67 c	1.85a	0.95 a	16.69 c

3.3. Combination effect of genotypes and fertilization on some growth and yield parameters of chickpea

3.3.1. Combination effect of genotypes and fertilization on vegetative parameters

Table (10) clarified that interaction of chickpea genotypes and fertilizers application affected significantly on all vegetative parameters, whereas

the highest plant value was (56.57cm) observed by Mexican genotype treated with foliar fertilization compared to control treatment which recorded lowest value (43.19 cm). The greatest numbers of primary and secondary branches per plant were (10.61 and 64.51) respectively recorded by Sham genotype that received Di-ammonium phosphate fertilizer. The highest number of pods per plant (20.92) was obtained with Mexican chickpea using Bio-fertilizer, it increased by (63.82%) compared with control treatment (12.77). Number of grains per plant was (17.09) for Mexican chickpea when treated by Di-ammonium phosphate. The results in the table

(10) shows that Bio-fertilizer application on Mexican genotype obtained maximum Pods and Grains weight per plant (9.66 and 7.70 g) and increased by (60.73% and 66.67%) than control which were (6.01 and 4.62g) respectively, number of nodules per plant was (33.55) recorded the maximum value with Bio-fertilizer application which increased by (83.53%) nodules per plant compared to control treatment (18.28) nodules per plant. The maximum 100 seed weight was (53.37 g) recorded by Mexican types with foliar fertilization impacts comparing to non-fertilized treatment (48.57).

Table (10): Combination effects of genotypes and type of fertilizers on vegetative parameters of chickpea

Genotype	Fertilizer	Height (cm)	primary branch	Secondary branch	no. pods (plants ⁻¹)	no. seeds (plant ⁻¹)	pods wt. (g. plant ⁻¹)	No. nodules (plant ⁻¹)	seeds weight (plant ⁻¹)	100 seed weight (g)
SHAM	Bio	45.81 cd	7.38 b	48.71 abc	14.68 b	14.02 a b	7.49 b	33.55 a	7.24 a b	44.27 b c
	Foliar	47.91 b c	7.71 b	45.16 abc	10.17 b	8.95 cd	4.49 c	21.00 cde	3.60 e	42.83 c
	Urea	47.33 bcd	6.91 b	30.52 c	12.00 b	9.95 cd	5.80 b c	19.67 d e	5.09 c d e	42.83 c
	DAP	47.73 b c	10.61a	64.51 a	14.03 b	11.90 b c	7.76 a b	23.55 c	6.05 abcd	42.33 c
	Control	44.95 de	6.86 b	44.62 a bc	12.27 b	8.05 d	6.42 b c	18.28 e	3.71 e	41.73 c
MEXICAN	Bio	49.83 b	8.38 ab	54.51 a b	20.92 a	16.33 a	9.66 a	26.83 b	7.70 a	52.90 a
	Foliar	56.57 a	6.62 b	42.05 a bc	13.76 bc	12.24 b c	5.56 b c	21.89 c d	5.30 bcde	53.37 a
	Urea	49.76 b	6.92 b	41.33 abc	14.07 b	11.38 b cd	7.28 b	22.17 c d	5.24 c de	51.30 a
	DAP	54.29 a	7.38 b	51.76 a bc	13.47 b	17.09 a	7.31 b	23.50 c	7.06 a bc	53.13 a
	Control	43.19 de	6.71 b	40.52 b c	12.77 b	10.33 cd	6.01 b c	18.11 e	4.62 d e	48.57 a b

3.3.2. Combination effect of genotypes and fertilization on yield and yield components

The results in the table (11) shows that chickpea genotypes interaction with fertilizer treatments had significant impacts on yield parameters, whereas the table explained that biological and economical yield (8.11 and 2.20 t.ha⁻¹) respectively due to Mexican chickpea treatment

with bio-fertilizer. Harvest index recorded highest data (29.45) in Sham genotype plots that treated with bio-fertilizer, due to microorganisms activity in fixing atmospheric nitrogen and release auxins to the root zone to promotes growth, moreover bio-fertilizer enhances bacterial response to nitrogen fixation and soil fertility ([Rees et al., 2005](#)).

Table (11) Combination effects of genotypes and fertilization on yield parameters of chickpea

Genotype	Fertilizer	Biological yield (ton. ha ⁻¹)	Economical yield (ton. ha ⁻¹)	Harvest index
SHAM	Bio	6.95 bcd	2.07 ab	29.45 a
	Foliar	5.15 e	1.03 e	20.02 c
	Urea	5.93 de	1.45 cde	24.48 abc
	DAP	7.07 be	1.73 abcd	24.42 abc
	Control	5.11 e	1.06 e	20.53 c
MAXICAN	Bio	8.11 a	2.20 a	27.16 ab
	Foliar	6.44 bcd	1.51 bcde	23.32 abc
	Urea	6.05 cde	1.50 cde	24.91 abc
	DAP	7.41 ab	2.02 abc	27.3 ab
	Control	6.1 cde	1.32 de	21.6 bc

3.3.3. Combination effect of genotypes and fertilization on chemical characteristics

Table (12) clarified that the (Fibre, Oil, Nitrogen, Protein) had significantly affected by the interaction of chickpea genotype and fertilizer application, the mentioned parameters recorded

the greatest percentage (8.56, 6.69, 3.32 and 20.75) with Sham chickpea treated by Bio-fertilizer, this may be due to the increase in the mineral uptake by plants (Mohammadi et al., 2011).

Table (12): Combination effects of genotypes and type of fertilizers on chickpea seed components

Genotype	Fertilizer	Starch %	Carbohydrate%	Fibre %	Oil %	N %	P %	K %	Protein %
SHAM	Bio	46.64 b	55.22 c	8.56 a	6.69 a	3.32 a	1.81 a	1.03 a	20.75 a
	Foliar	53.2 a	59.26 ab	6.02 cd	5.8 bc	2.88 cd	1.78 a	0.82 a	18.00 cd
	Urea	52.37 a	59.04 ab	6.67 bc	5.08 c	3.16 ab	1.86 a	0.86 a	19.75 ab
	DAP	52.72 a	58.76 ab	6.37 cd	5.38 bc	3.28 a	1.72 a	0.84 a	20.52 a
	Control	53.33 a	59.37 ab	6.05 cd	5.35 bc	2.72 cd	1.88 a	0.83 a	17.00 cd
MAXICAN	Bio	50.60 ab	57.82 abc	7.23 b	5.94 b	3.18 a b	1.84 a	0.94 a	19.87 ab
	Foliar	49.82 ab	56.06 bc	6.23 cd	5.80 bc	2.8 cd	1.91 a	0.92 a	17.50 cd
	Urea	53.24 a	58.87 ab	5.82 de	5.92 b	2.88 cd	1.87 a	0.95 a	18.00 cd
	DAP	52.47 a	58.14 abc	5.84 de	6.63 a	2.93 bc	1.85 a	0.97 a	18.31 bc
	Control	54.76 a	59.96 a	5.22 e	5.36 bc	2.62 d	1.82 a	1.07 a	16.38 d

4. CONCLUSIONS

Fertilization is important for improving chickpea production and bio-fertilizer is the most vital for increasing vegetative growth, yield and chemical characteristics of chickpea seeds, due to its environmentally safe prospective. The Mexican genotype was superior to Sham genotype in this study.

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