Kirkuk University Journal for Agricultural Sciences, Vol.17, No. 2, 2026 Online ISSN: 2958-6585

Kirkuk University Journal for Agricultural Sciences
ISSN:2958-6585
https://kujas.uokirkuk.edu.iq

RESEARCH ARTICLE

https://doi.org. 10.58928/ku26.17201

Impact of Plant Densities and Phosphate Fertilizer Types on Growth, Yield, Yield Components and Associated Weeds of Chickpea (Cicer Arietinum L.)

Wisam Khald Sabri [1] **Guhdar Salih Hussein**[1]
Hadi Murad Hasan[1] **Marwan Husein Salih**[1]
[1]*Department of Field Crops, College of Agriculture Engineering sciences, University of Duhok – IRAQ.*
*Corresponding Author: wisam.sabri@uod.ac

Received:09/10/2025 **Revised: 02/12/2025** **Accepted: 19/05/2026** **Published: 07/06/2026**

ABSTRACT

A field experiment was conducted during the spring 2024 growing season at the Field Crops Farm of the College of Agricultural Engineering Sciences, University of Duhok, situated between longitude 42.87 W, latitude 36.86 N and altitude 583 meters, it is about 15 km from Duhok city. The objective was to critically evaluate the individual and combined effects of different plant densities and phosphate fertilizer types on the growth, productivity and associated weed plants of chickpea under rain-fed conditions. The factorial experiment was implemented using a randomized complete block design (RCBD) with three replications. The first factor included three plant densities (26.66, 33.33, and 44.44 plants.m^{-2}), and the second factor included four fertilizer treatments: biofertilizer (20 kg .ha^{-1}), diammonium phosphate (DAP) (120 kg .ha^{-1}), triple superphosphate (TSP) (160 kg .ha^{-1}), and a check treatment. The results demonstrated that plant density had a comparatively limited effect on vegetative growth traits, while the type of fertilizer was a significant factor that influenced both development and productivity. The highest seed yield of 2637.96 kg. ha-1 was notably achieved by combining the highest plant density (44.44 plants. m^{-2}) with TSP fertilizer. This superior treatment also consistently enhanced other crucial yield components, including the number of pods per plant, seeds per pod, 100-seed weight, and the biological yield. Furthermore, thirteen weed species, predominantly broadleaf types from six families, were recorded. The high-plant density in conjunction with TSP effectively suppressed weed emergence and significantly reduced weed dry biomass. In conclusion, the integration of a high plant density with Triple Super Phosphate fertilization provided the optimal agronomic strategy by synergistically enhancing crop growth, maximizing seed yield, and significantly improving competitiveness against weeds. This integrated approach is highly recommended for sustainable rain-fed chickpea production in the Duhok region and similar agro-climatic zones.

***Keywords*:** Chickpea, fertilizer types, plant densities, yield and its components and weeds control.

INTRODUCTION

Chickpea (*Cicer arietinum* L.) is one of the most nutritionally and economically important legume crops worldwide, particularly in regions like Iraqi Kurdistan, where it serves as a vital source of dietary protein and income for farmers. As one of the Fabaceae family, chickpea is remarkably rich in protein (13-33%), carbohydrates (40-55%), and oil (4-10%), making it an excellent dietary staple that contributes significantly to food security [1 and 2]. The successful cultivation of chickpeas, however, faces numerous agronomic challenges, with soil fertility and nutrient management being among the most significant. Like all crops, chickpeas require adequate supplies of essential macronutrients particularly nitrogen (N), phosphorus (P), and potassium (K) for optimal growth and yield [3]. These issues have led to growing interest in more sustainable alternatives, particularly biofertilizers, which utilize beneficial microorganisms to enhance nutrient availability while minimizing ecological harm [4]. Despite these advantages, adoption of bio-fertilizers remains limited in many developing regions due to persistent farmer skepticism and a lack of technical knowledge regarding their application, representing a major constraint to improving chickpea productivity [5]. Another critical factor influencing chickpea productivity is plant density, which affects nearly all aspects of crop performance, from individual plant growth to overall yield potential. Defined as the number of plants per unit area, plant density directly impacts resource competition, light interception, and crop plant canopy development [6]. Research has shown that higher planting densities typically result in taller plants due to increased competition for sunlight, while lower densities promote greater branching and pod formation per plant [7]. Although individual plant productivity may decrease at higher densities, the greater number of plants per unit area often compensates to produce higher total yields [8]. Weed competition represents another significant challenge in chickpea production that can be effectively managed through strategic density manipulation. Higher plant densities create a more competitive canopy environment that suppresses weed germination and growth by limiting light penetration and resource availability [9]. However, when plant densities are too low, weeds can outcompete the crop, leading to substantial yield losses [10]. The study aims is to evaluate the efficacy of proper plant density on the growth and yield of chickpeas and companion weeds and also to determine the effect of different fertilizers types on crop and weed growth.

Materials and Methods

A field study was conducted during the spring of 2024 at the research farm of Field Crops Department, College of Agricultural Engineering Sciences, University of Duhok, situated between longitude 42.87 W, latitude 36.86 N and altitude 583 meters, it is about 15 km from Duhok city. The soil at the experimental site was classified as silty clay, with a pH value of 7.75 and an electrical conductivity (EC) of 0.31 $dS\cdot m^{-1}$ (table 2). The study included 12 treatment combinations derived from three plant densities (26.66, 33.33, and 44.44 plants m^{-2}) and four phosphate fertilizer types: a bio-fertilizer containing (*Bacillus megaterium*, *Pseudomonas fluorescens*, *Aspergillus niger*, and 40% rock phosphate at 20 kg ha^{-1}); Di-Ammonium Phosphate (DAP; 18% N, 46% P_2O_5 at 120 kg ha^{-1}); Triple Super Phosphate (TSP; 46% P_2O_5 at 160 kg ha^{-1}); and an unfertilized check treatment. Fertilizers were applied during seedbed preparation. The trial was arranged in a randomized complete block design (RCBD) with a factorial trial and replicated three times. Each plot measured 2 × 1 m and contained four rows spaced 0.25 m apart. A local Kabuli chickpea variety was sown at 3 of March 2024. At harvest (9th of June 2024), agronomic traits: plant height, lowest pod height, pods. $Plant^{-1}$, seeds. $Plant^{-1}$, 100-seed weight, biological yield. $Plant^{-1}$, and seed yield. ha^{-1}, were measured using ten randomly selected plants for each plot. Weed assessment was conducted at crop maturity by sampling a 1 m^2 area; narrow-leaf and broad-leaf weeds were counted, air-dried, and weighed (Table 1). Data were analyzed using ANOVA (table 3), and treatment means were compared by using Duncan's multiple range test at a 5% significance level.

Table (1): The main weeds those were present in chickpea fields in the 2024 growing season.

	Scientific name	Family name	Growth habit
		Narrow leaf weeds	
1	*Hordeum glaucum* Steud.	Poaceae	Winter annual
2	*Avena fatua* L.	Poaceae	Winter annual
3	*Polypogon monspeliensis* L.	Poaceae	Winter annual
4	*Lolium spp.*	Poaceae	Winter annual
		Broad leaf weeds	
5	*Aster subulatus*	Asteraceae	Winter annual
6	*Lactuca serriola* L.	Asteraceae	Summer annual
7	*Hypericum spp.*	Hypericaceae	Winter annual
8	*Carthamus oxycantha* Bieb.	Asteraceae	Winter annual
9	*Xanthium strumarium* L.	Asteraceae	Summer annual
10	*Vaccaria pyramidata* Medik.	Caryophyllaceae	Winter annual
11	*Centaurea iberica* Trevir. Spreng.	Asteraceae	Summer annual
12	*Euphorbia helioscopia* L.	Euphorbiaceae	Winter annual
13	*Sinapis arvensis* L.	Brassicaceae	Winter annual

Table (2): Some Physical and Chemical Properties for the soil of farm.

Parameters	pH	EC (dS.m-1)	Nitrogen (mg .Kg-1)	Phosphorous (mg .Kg-1)	Potassium (mg .Kg-1)	Ca (mg .Kg-1)	Mg (mg .Kg-1)	Cl (mg .Kg-1)	Caco3 (%)	Organic matter (%)	TEXTURE	Sand (%)	Silt (%)	Clay (%)
Soil Sample	7.75	0.31	74	4.43	15.66	64	19.2	24.85	18.52	1.48	Silty clay	5.771	45.427	48.802

Results and discussion

Table (3): Mean squares for studied traits of Chickpea and associated weeds during spring season 2024.

Source	DF	Plant height (cm)	Lower pod height (cm)	Number of pods .plant-1	Seed number .plant-1	Seed index (g)	Biological weight (g.plant-1)	Seed yield (kg. ha-1)	Number of narrow leaf weeds .m-2	Dry weight of narrow leaf weeds .m-2	Number of broad leaf weeds .m-2	Dry weight of broad leaf weeds .m-2	Total number of weeds .m-2	Total dry weight of weeds .m-2
Blocks	2	7.9390 n.s.	5.8626 *	3.5170 n.s.	0.4386 n.s.	3.1595 n.s.	3.0711 n.s.	12870.034 n.s.	27.1111 n.s.	58.2392 n.s.	80.4444 n.s.	1429.4174 n.s.	19.1111 n.s.	910.6107 n.s.
A (plant densities)	2	5.7573 n.s.	4.3217 n.s.	56.3855 **	14.3419 **	3.4638 n.s.	29.1505 **	4137766.6663 **	216.4444 *	653.1783 *	3013.7777 **	53169.2940 **	4716.4444 **	65582.5122 **
B (phosphate fertilizer types)	3	28.1752 **	13.1504 **	69.7365**	7.1962 n.s.	37.3299 **	23.6421 **	215760.818 *	46.66666 n.s.	216.4671 n.s.	3717.9259 **	19954.6284 **	4404.5925 **	24283.1239 **
A*B	6	18.0091 *	0.4911 n.s.	7.7412 n.s.	15.4088 **	3.0152 n.s.	7.4189 **	211096.017 **	40.4444 n.s.	60.5474 n.s.	258.81481 n.s.	3159.7911 n.s.	176.5925 n.s.	3776.7433 n.s.
Error	24	5.0206	1.9259	3.4537	60.1733	172.6471	2.5352	49666.42	59.1111	192.4937	246.2222	1624.7531	268.8888	2152.0429
Total	35													

* present significant effect at 0.05 and 0.01 levels respectively.

Table 4 revealed that plant density did not significantly influence plant height and lower pod height. In contrast, the type of fertilizer applied had a significant effect. Triple superphosphate (TSP) produced the tallest plants, with an average height of 40.07 cm Triple superphosphate was the most effective fertilizer, producing the tallest plants because it best addressed the soil's phosphorus deficiency. This directly enhanced growth, leading to an average height of 40.07 cm. This result is consistent with the findings of [12-14], who also reported that phosphorus increases plant height. A significant interaction was also observed between planting density and fertilizer. The tallest plants (41.33 cm) occurred with TSP fertilizer at a density of 26.66 plants. m^{-2}, while the shortest plants (32.3 cm) were recorded with diammonium phosphate (DAP) at the same density. Regarding lower pod height, all fertilizer treatments showed a significant superiority over the check (check) treatment. The interaction between density and fertilizer was also significant. The highest pod height (14.78 cm) was recorded with TSP at a high density (44.44 plants. m^{-2}), and the lowest (10.66 cm) with the check treatment at a lower density (26.66 plants. m^{-2}). The effectiveness of TSP is attributed to its high phosphorus solubility, which aids root development, and its neutral pH, which reduces root stress [15and 16]. Optimal plant densities improve the partitioning of photosynthetic resources and suppress weeds [17 and 18], while bio-fertilizers enhance nitrogen fixation [19]. Furthermore, lower densities can promote lateral branching over vertical growth, reducing pod height due to less light competition [20]. Other researchers found that low-density plots with bio-fertilizers can experience delayed nitrogen availability and increased weed competition, suppressing stem and pod height [21 and 22]. Ultimately, pod height is highly sensitive to the interaction between nutrients and density, with TSP performing best at moderate densities and bio-fertilizers requiring higher densities for efficacy [23].

Table (4): Effect of plant density and phosphate fertilizers types on plant height and lower pod height of chickpea.

Phosphate fertilizers treatments	Plant height (cm) Plant densities			Mean of phosphate fertilizers types	Lower pod height (cm) Plant densities			Mean of phosphate fertilizers types
	26.66 .m^{-2}	33.33 .m^{-2}	44.44 .m^{-2}		26.66 .m^{2}	33.33 .m^{-2}	44.44/ .m^{-2}	
Check	38.11 abc	34.77 cd	35.55 cd	36.14 b	10.66 c	10.89 bc	12.55 abc	11.37 b
Bio fertilizer	36.22 bcd	36.99 bc	38.66 abc	37.29 b	12.77 abc	12.44 abc	13.44 ab	12.88 a
DAP fertilizer	32.33 d	38.66 abc	38.66 abc	36.55 b	13.00 abc	13.89 a	14.00 a	13.63 a
TSP fertilizer	41.33 a	38.55 abc	40.33 ab	40.07 a	13.88 a	13.77 a	14.78 a	14.14 a
Mean of plant densities	37.00 a	37.25 a	38.30 a		12.58 a	12.75 a	13.69 a	

Means followed by the same letter are not significantly different at the 5% significance level according to Duncan's Multiple Range Test (DMRT).

A significant influence of plant density (PD), fertilizer type, and their interaction on pods number. $Plant^{-1}$ was observed in Table 5. The lowest density (26.66 plants. m^{-2}) yielded the highest number of pods (17.22), which was statistically similar to the intermediate density (33.33 plants. m^{-2}) but significantly higher than the highest density (44.44 plants. m^{-2}), which produced only 12.94 pods. Among fertilizers types, Triple Superphosphate (TSP) resulted in the most pods number. $Plant^{-2}$ (19.14), while the check treatment yielded the fewest (12.66). The combination of the highest density and the check treatment produced the lowest plant pods number overall. These findings, which confirm that pods number decreases as planting density increases, are consistent with research by [24 - 26]. The factors also significantly affected the number of seeds .$plant^{-1}$. The highest density (44.44 plants .m^{-2}) and TSP fertilizer produced the greatest seed numbers (14.00 and 13.99, respectively), whereas the intermediate density and bio-fertilizer treatment yielded fewer (11.88 and 11.91). However, within the interaction analysis, the check treatment at the intermediate density recorded the highest number (15.20 seeds. $Plant^{-1}$), which was not significantly different from most other interactions, while the bio-fertilizer application resulted in the lowest (8.60 seeds. $Plant^{-1}$). This aligns with studies by [27 and 28] on Rhizobium inoculation. Furthermore, the result supports [29], who attributed a 23.4% increase in soybean seeds number to phosphorus (P_2), citing its role in enhancing photosynthesis and the allocation of resources to reproductive organs. For 100-seed weight, no significant differences were found between plant densities. Fertilizer applications cause significant differences; TSP produced a higher 100-seed weight (49.78g) compared to the check (44.94g). Their interaction was also significant, with the combination of TSP and the highest density yielding the maximum weight (50.60g), and the check with the intermediate density yielding the minimum (43.78g). This is supported by [31] and [32], who found that phosphorus application improves nodulation, photosynthetic activity, and ultimately, grain weight.

Table (5): Effect of plant density and phosphate fertilizers types on number of pods per plant, number of seeds per plant and seed index (g) of chickpea.

Phosphate fertilizers treatments	Number of pods. Plant^{-1} Plant densities			Mean of phosphate fertilizer types	Seed number .plant^{-1} Plant densities			Mean of phosphate fertilizer types	Seed index (g) Plant densities			Mean of phosphate fertilizers types
	26.66 .m^{-2}	33.33 .m^{-2}	44.44 .m^{-2}		26.66 .m^{-2}	33.33 .m^{-2}	44.44 .m^{-2}		26.66 .m^{-2}	33.33 .m^{-2}	44.44 .m^{-2}	
Check	13.11 cde	14.11 cde	10.78 e	12.66 c	9.87 cd	15.20 a	13.60 ab	12.89 ab	44.83 bc	43.78 c	46.22 abc	44.94 c
Bio fertilizer	16.00 bc	13.89 cde	12.33 de	14.07 bc	12.27 abc	8.60 d	14.87 a	11.91 b	46.69 abc	46.74 abc	47.45 abc	46.96 bc
DAP fertilizer	18.77 ab	13.66 cde	13.33 cde	15.26 b	12.97 ab	11.33 bcd	12.80 abc	12.37 b	49.22 ab	48.28 abc	46.94 abc	48.15 ab
TSP fertilizer	21.00 a	21.11 a	15.33 cd	19.14 a	14.87 a	12.37 abc	14.73 a	13.99 a	50.18 a	48.55 abc	50.60 a	49.78 a
Mean of plant densities	17.22 a	15.69 a	12.94 b		12.49 b	11.88 b	14.00 a		47.73 a	46.84 a	47.80 a	

Means followed by the same letter are not significantly different at the 5% significance level according to Duncan's Multiple Range Test (DMRT).

The data in Table 6 indicate that seed yield was significantly influenced by plant density (PPD), fertilizer type, and their interaction. The highest seed yields were achieved at the highest density (44.44 plants/m²) and with Triple Superphosphate (TSP) fertilizer application, yielding 2381.18 kg. ha^{-1} and 1941.79 kg. ha^{-1}, respectively. The interaction of these two factors was particularly impactful; the combination of TSP and the highest density produced the greatest yield of 2637.96 kg. ha^{-1}, while the lowest yield resulted from the lowest plant density (26.66 plants. m^{-2}) combined with the check treatment 948.58kg. ha^{-1}. These results are supported by [15 and 33] that noticed the superiority of TSP is attributed to its high phosphorus solubility, which enhances pod formation and can increase seed yield by 19-27% compared to other fertilizers like DAP. Also the positive effect of higher density on yield was confirmed by [7, 27, 34, and 35] who found that phosphorus-based fertilizers significantly boost economic yield Similarly, the plant biological yield showed significant differences for plant density, fertilizer types, and their interaction. The highest plant density (44.44 plants. m^{-2}) and TSP fertilizer produced the greatest yield (19.26 g. plant^{-1} and 20.12 g. plant^{-1}, respectively). Their interaction yielded the highest biological weight (21 g. plant^{-1}), whereas the lowest biological yield (13.35 g. plant^{-1}). This aligns with research noting that high solubility and rapid availability make TSP highly effective for root and biomass growth [16 and 33]. Densities of 35 - 45 plants/m² are known to optimize light capture and resource efficiency [17 and 18], and the synergistic use of TSP with moderate density (about 40 plants. m^{-2}) is reported to significantly improve biomass and nutrient uptake [36 and 23]. These findings are consistent with earlier work by [37] on density and [38] on phosphorus's effect on straw yield. In contrast, systems using bio-fertilizers at low densities are often less effective due to delayed nitrogen fixation and increased weed competition [21 and 22].

Table (6): Effect of plant density and phosphate fertilizers types on seed yield and plant biological yield of chickpea

Phosphate fertilizers treatments	Seed yield (kg. ha^{-1}) Plant densities			Mean of phosphate fertilizers types	Biological yield (g. plant^{-1}) Plant densities			Mean of phosphate fertilizers types
	26.66 .m^{-2}	33.33 .m^{-2}	44.44 .m^{-2}		26.66 .m^{-2}	33.33 .m^{-2}	44.44 .m^{-2}	
Check	948.58 g	1776.71 cd	2240.14 b	1655.14 b	16.43 c	17.44 bc	16.41 c	16.76 b
Bio fertilizer	1224.94 efg	1073.76 fg	2501.67 ab	1600.12 b	13.35 d	17.82 bc	19.40 ab	16.86 b
DAP fertilizer	1357.54 ef	1459.33 def	2144.97 bc	1653.95 b	15.88 cd	20.23 ab	20.23 ab	18.78 a
TSP fertilizer	1588.90 de	1598.51 de	2637.96 a	1941.79 a	19.75 ab	19.60 ab	21.00 a	20.12 a
Mean of plant densities	1279.99 c	1477.07 b	2381.18 a		16.35 b	18.77 a	19.26 a	

Means followed by the same letter are not significantly different at the 5% significance level according to Duncan's Multiple Range Test (DMRT).

During the 2024 growing season, 13 weed species, belonging to 6 families, exhibited 10 winter growth and 3 summer growth in most broad leaves, as there were 9 species, According to the experimental data (Table 7), the impact of phosphate fertilizer formulations on the suppression of narrow-leaf weeds was minimal, as no statistically significant differences were found in either the weed number or their accumulated dry biomass. The most influential factor was the plant density. A highly significant suppressive effect on narrow-leaf weeds was observed as the plant density increased. The check treatment, which featured the lowest plant density, consistently exhibited the highest levels of weed infestation, both in terms of the number of individual plants and the total dry weight of the weed biomass. Conversely, the treatments with the highest plant densities were the most effective at suppressing weeds, resulting in the lowest recorded values for both traits. This suppressive effect is attributed to the more competitive canopy environment created by a denser crop stand. A denser canopy intercepts more light, leading to lower light availability at the soil surface. It also results in greater competition for soil moisture and nutrients. This resource-limited environment is less conducive to weed seed germination, establishment, and subsequent growth. The significant interaction between plant density and phosphate fertilizer types treatments further underscores that the competitive advantage of the crop is most effectively leveraged at higher plant densities. This finding aligns with established ecological and agronomic principles, as demonstrated in the research of [23], which confirms that enhanced crop competition is a key component of integrated weed management.

Table (7): Effect of plant density and phosphate fertilizers types on number and dry weight of narrow leaf weeds of chickpea field.

Phosphate fertilizers treatments	Number of narrow leaf weeds $.m^{-2}$ Plant densities			Mean of phosphate fertilizers types	Dry weight of narrow leaf weeds $.m^{-2}$ Plant densities			Mean of phosphate fertilizers types
	26.66 $.m^{-2}$	33.33 $.m^{-2}$	44.44 $.m^{-2}$		26.66 $.m^{-2}$	33.33 $.m^{-2}$	44.44 $.m^{-2}$	
Check	21.33 a	10.67 ab	9.33 ab	13.78 a	39.08 a	18.88 ab	14.12 ab	24.03 a
Bio fertilizer	12.00 ab	9.33 ab	12.00 ab	11.11 a	30.03 ab	23.64 ab	18.95 ab	24.20 a
DAP fertilizer	10.67 ab	9.33 ab	5.33 b	8.44 a	26.79 ab	15.64 ab	11.36 b	17.93 a
TSP fertilizer	18.67 ab	5.33 b	5.33 b	9.78 a	17.25 ab	13.71 ab	11.55 b	14.17 a
Mean of plant densities	15.67 a	8.67 b	8.00 b		28.29 a	17.97 ab	13.99 b	

Means followed by the same letter are not significantly different at the 5% significance level according to Duncan's Multiple Range Test (DMRT).

Data from Table 8 demonstrated that plant density (PD) and fertilizers types, as well as their interaction, had a significant impact on the number and dry weight of broadleaf weeds in the chickpea field. The highest weed numbers were observed in the plant density of 26.66 plants $.m^{-2}$ (95.53 plants) and check treatment (103.56 plants). In contrast, significantly fewer weeds, along with a lower dry weight, were recorded in plots treated with Triple Superphosphate (TSP) fertilizer (54.22 plants and 144.81. m^{-2}) and those with the highest plant density of 44.44 plants $.m^{-2}$) (63.67 plants and 152.47 g $.m^{-2}$). The most effective treatment was the interaction of these two factors: The combination of the highest plant density and TSP fertilizer resulted in the lowest broadleaf weed number (45.33 plants).As shown from the table using plant densities 44.44 plant $.m^{-2}$ with application of DAP fertilizer recorded lowest dry weight of broad leaves weeds (26.31 g $.m^{-2}$)in comparison with check treatment that recorded 324.63g $.m^{-2}$ These results align with the findings of [39], who also reported that applying phosphorus (P_2O_5) significantly reduced weed density and dry weight compared to a check treatment throughout the crop's growth cycle.

Table (8): Effect of plant density and phosphate fertilizers types on number and dry weight of broad leaf weeds of chickpea field.

Phosphate fertilizers treatments	Number of broad leaf weeds $.m^{-2}$ Plant densities 26.66 $.m^{-2}$	33.33 $.m^{-2}$	44.44 $.m^{-2}$	Mean of phosphate fertilizers types	Dry weight of broad leaf weeds $.m^{-2}$ Plant densities 26.66 $.m^{-2}$	33.33 $.m^{-2}$	44.44 $.m^{-2}$	Mean of phosphate fertilizers types
Check	112.00 a	116.00 a	82.67 bc	103.56 a	324.63 a	204.43 cd	169.17 cde	232.74 a
Bio fertilizer	102.67 ab	81.33 bc	64.00 cd	82.67 b	346.23 a	218.56 bc	183.41 cde	249.40 a
DAP fertilizer	100.00 ab	65.33 cd	62.67 cd	76.00 b	279.72 ab	157.45 cde	126.31 e	187.83 b
TSP fertilizer	66.67 cd	50.67 d	45.33 d	54.22 c	165.16 cde	138.31 de	130.97 de	144.81 c
Mean of plant densities	95.33 a	78.33 b	63.67 c		278.93 a	179.69 b	152.47 c	

Means followed by the same letter are not significantly different at the 5% significance level according to Duncan's Multiple Range Test (DMRT).

Data in Table 9 indicate that plant density (PD), fertilizer type, and their interaction significantly influenced the total number and dry weight of weeds. the highest population density (44.44 plants $.m^{-2}$) also significantly suppressed weeds, recording values of 71.67 plants and 166.46 g $.m^{-2}$. The Triple Superphosphate (TSP) fertilizer treatment was most effective, resulting in the lowest weed number and dry weight (64 plants and 158.98 g $.m^{-2}$, respectively). Similarly, these results are supported by multiple studies. The success of higher densities aligns with research showing that stands of 35 - 45 plants $.m^{-2}$. The results demonstrate that a high plant density and the use of Triple Superphosphate fertilizer are effective, complementary strategies for suppressing weed growth and dry weight. Improve resource use and create a canopy that suppresses weed growth through better light interception [17, 18 and 42]. This confirms that increasing the seeding rate is an effective strategy for weed management. The efficacy of TSP is consistent with findings that phosphorus application reduces weed pressure by promoting stronger crop vigor and competitiveness [40 and 41].

Table (9): Effect of plant density and phosphate fertilizers types on total number and dry weight of weeds of chickpea field.

Phosphate fertilizers treatments	Total number of weeds $.m^{-2}$ Plant densities 26.66 $.m^{-2}$	33.33 $.m^{-2}$	44.44 $.m^{-2}$	Mean of phosphate fertilizers types	Total dry weight of weeds $.m^{-2}$ Plant densities 26.66 $.m^{-2}$	33.33 $.m^{-2}$	44.44 $.m^{-2}$	Mean of phosphate fertilizers types
Check	133.33 a	126.67 a	92.00 bc	117.33 a	363.71 a	223.31 cd	183.29 cd	256.77 a
Bio fertilizer	114.67 ab	90.67 bc	76.00 cde	93.78 b	376.25 a	242.20 bc	202.36 cd	273.60 a
DAP fertilizer	110.67 ab	74.67 cde	68.00 cde	84.44 b	306.51 ab	173.09 cd	137.67 d	205.76 b
TSP fertilizer	85.33 bcd	56.00 de	50.67 e	64.00 c	182.41 cd	152.01 d	142.52 d	158.98 c
Mean of plant densities	111.00 a	87.00 b	71.67 c		307.22 a	197.65 b	166.46 b	

Means followed by the same letter are not significantly different at the 5% significance level according to Duncan's Multiple Range Test (DMRT).

References

[1]. Ali, M. 2017. "Response of chickpea varieties to different irrigation regimes." Asian Journal of Advances in Agricultural Research, 2 (4), 1-7.

[2]. Singh, R., Pratap, T., Singh, D., Singh, G. and Singh, A. K. 2018. Effect of phosphorus, Sulphur and biofertilizers on growth attributes and yield of chickpea (*Cicer arietinum* L.). J Pharmacognosy Phytochemistry, 7(2), 3871-3875.

[3]. Erman, M., Demir, S., Ocak, E., Tüfenkçi, Ş., Oğuz, F. and Akköprü, A. 2011. Effects of Rhizobium, arbuscular mycorrhiza and whey applications on some properties in chickpea (*Cicer arietinum* L.) under irrigated and rainfed conditions 1-Yield, yield components, nodulation and AMF colonization. Field Crops Research, 122(1), 14-24.

[4]. Namvar, A., Sharifi, R. S., Sedghi, M., Zakaria, R. A., Khandan, T. and Eskandarpour, B. 2011. Study on the effects of organic and inorganic nitrogen fertilizer on yield, yield components, and nodulation state of Chickpea (*Cicer arietinum* L.). Communications in Soil Science and Plant Analysis, 42(9), 1097-1109.

[5]. Kumar, D., Arvadiya, L., Kumawat, A., Desai, K. and Patel, T. 2014. Yield, protein content, nutrient content and uptake of chickpea (*Cicer arietinum* L.) as influenced by graded levels of fertilizers and bio-fertilizers. Res. J. Chem. Environ. Sci, 2(6), 60-64.

[6]. Shamsi, K. 2009. Effect of plant density on growth, yield and yield components of chickpea (*Cicer arietinum* L.) under irrigated conditions. Journal of Food, Agriculture and Environment, 7(2), 527-531.

[7]. Singh, K.B., Malhotra, R.S., and Saxena, M.C. 1988. Effect of planting density on growth and yield of chickpea (*Cicer arietinum* L.) in Mediterranean environments. Experimental Agriculture, 24(1), 71-79.

[8]. Goldani, M,, Bagheri, A. and Nezmi, A., 2000. Study of the effect of planting date on phenology and morphology of chickpea varieties. In proceeding of 6th Iranian congress of crop production and Plant Breeding. 3 - 6 sep. 2000. Babolsar ,University of Mazandaran . Iran.

[9]. Singh, G. and Singh, D. 1992. Weed-crop competition studies in chickpea. Indian Journal of Weed Science, 24(1 and 2), 1-5.

[10]. Vaishya, R. D., Fayaz, M., & Srivastava, A. K. 1996. Integrated weed management in chickpea.

[11]. Shahein, A.H., Agwah, E.M.R. and El-shamma, H.A. 1995. Effect of plant density as well as nitrogen and phosphorus fertilizer rate on growth, green pods and dry seed yield and quantity of broad bean. Ann. Agric. Sci. Moshtohor, 33(1), 371-388.

[12]. Bildirici, N., 2020. Effect of Bacterial Inoculation and Different Phosphorus Doses on Yield Components and Yield of Chickpea (*Cicer arietinum* L.). Legume research. 43 (3), 446-451.

[13]. Nazeri, P., Kashani, A., Khavazi, K., Ardakani, M.R., Mirakhori, M. and Pour siah bidi, M. (2010). The effect of biofertilizer and phosphorus fertilizer banding with Zinc on white bean (*Phaseolus vulgaris* L). J. Agroec. 2(1): 175-185.

[14]. Rathore, A. L., & Patel, S. L. 1991. Response of late sown chickpea to method of sowing, seed rate and fertilizer.

[15]. Kumar, S., Suresh, B. G., Kumar, A., and Lavanya, G. R. 2020. Genetic variability in chickpea (*Cicer arietinum* L.) under heat stress condition. *Current J. of Applied Science and Technology*, 38(6), 1–10.

[16]. Adnan, M., Shah, Z. and Fahad, S. 2017. Phosphate-solubilizing bacteria nullify the antagonistic effect of soil calcification on bioavailability of phosphorus in alkaline soils. J. of Soil Science and Plant Nutrition, 17(3), 827–841.

[17]. Tesfaye, K., Sida, T. S., Erkossa, T. and Belete, K. 2019. Plant density effects on yield and physiological traits of chickpea cultivars. Agronomy, 9(9), 539.

[18]. Aslam, M., Mahmood, I. A., Ali, A. and Ahmad, S. 2015. Impact of plant density and planting time on growth and yield of chickpea. Journal of Animal and Plant Sciences, 25(6), 1627–1633.

[19]. Singh, A. K., Singh, M. K., and Singh, S. K. 2021. Rhizobia efficiency under varying chickpea densities. Legume Research, 44(10), 1182–1187.

[20]. Solaiman, A. H. M., Rahman, M. A. and Hossain, M. M. 2020. Plant density influences compensatory growth in chickpea. Journal of Agronomy and Crop Science, 206(5), 543–554.

[21]. Malik, M. A., Cheema, M. A., Khan, H. Z. and Wahid, M. A. 2016. Integrated nutrient management in chickpea for improving productivity and soil health. Legume Research, 39(5), 753–758.

[22]. Ozturk, A., Caglar, O. and Bulut, S. 2011. Growth and yield response of facultative wheat to winter sowing, freezing sowing and spring sowing at different seeding rates in a temperate region. Field Crops Research, 120(1), 23–32.

[23]. Ullah, A., Ahmad, I., Ahmad, A., Khaliq, T., Saeed, U., Habib-ur-Rahman, M., and Hoogenboom, G. 2020. Managing plant density and fertilization for enhancing crop yield: A global meta-analysis. Agronomy for Sustainable Development, 40(4), 32.

[24]. Goldani, M., 1997. Assessment of possibility of chick-pea fall planting in Mashhad. MSc. Thesis Agriculture College .Ferdowsi university of Mashhad . Mashhad .Iran .

[25]. Pezeshkpur, P., Daneshvar, M. and Ahmadi, A., 2005.The effect of plant density on agronomical properties, leaf chlorophyll, and light penetration to shading floor of white chickpea variety. In preceding of the first National conference on pulse in Iran 20-21 November 2005.. Ferdowsi university of Mashhad .Mashhad,Iran.

[26]. Mohammadnejad Y. and Soltani A,. 2005. Shares of main stem and branches in determining grain yield of chickpea with different planting dates and densities. In proceeding of the First National Conference on Pulse in Iran.20 – 21 November 2005. Research Center for Plant Sciences. Ferdowsi University of Mashhad . Mashhad . Iran.

[27]. Togay, N., Togay, Y., Cimrin, K. M., & Turan, M. 2008. Effects of Rhizobium inoculation, sulfur and phosphorus applications on yield, yield components and nutrient uptakes in chickpea (Cicer arietinum L.). African Journal of Biotechnology, *7*(6).

[28]. Namvar, A. Seyed Sharifi, R., Khandan,T. and Jafari Moghadam, M. 2013 Seed Inoculation and Inorganic Nitrogen Fertilization Effects on Some Physiological and Agronomical Traits of Chickpea (*Cicer arietinum* L.) in Irrigated Condition and Appl. Scie. 5 (7), 793–799.

[29]. Mahmoodi, B., Mosavi, A. A., Daliri, M. S., and Namdari, M. 2013. The evaluation of different values of phosphorus and sulfur application in yield, yield components, and seed quality characteristics of soybean (*Glycine max* L.). Advances in Environmental Biology, 7(1), 170 - 176.

[30]. Hernandez, L. G., and Hill, G. D. 1985. Effect of sowing date and plant plant on growth and yield of chickpeas (*Cicer arietinum* L.). Proceedings of the Agronomy Society of New Zealand, 15 (8), 1–85.

[31]. Morad, M., Sara, S., Alireza, E., Reza, C. M., & Mohammad, D. 2013. Effects of seed inoculation by Rhizobium strains on yield and yield components in common bean cultivars (*Phaseolus vulgaris* L.).

[32]. Tairo, E. V., & Ndakidemi, P. A. 2013. Bradyrhizobium japonicum inoculation and phosphorus supplementation on growth and chlorophyll accumulation in soybean (*Glycine max* L.). American Journal of Plant Sciences, 2013.

[33]. Hassan, M. J., Raza, M. A., Rehman, S. U., Ansar, M., Gitari, H., Khan, I., and Rahman, M. A. 2020. Phosphorus management in chickpea under arid environment. Pakistan Journal of Botany, 52(4), 1249 -1255.

[34]. Getchew, A., & Rezone, F. 2006. Response of Faba Bean to Phosphate Fertilizer and Weed Check on Nit soils of Ethiopian Highlands. Holeta Agricultural Research Center, Ethiopian Agricultural Research Organization (EARO), Holeta, Ethiopia.

[35]. Chaudhari, R. K., Patel, T. D., Patel, J.B. and Patel, R. H. 1998. Response of chickpea cultivars to irrigation, nitrogen and phosphorus on sandy clay loam soil.

[36]. Arif, M., Ali, K. and Jan, M. T. 2019. Impact of phosphorus levels and planting density on growth and yield of chickpea. Sarhad Journal of Agriculture, 35(4), 1230–1237.

[37]. Leilah, A.A., El-Metwaly, E.M.A. and El-Deeb, A.A. 1988. Effect of plant density, rizobium inoculation and nitrogen rates on faba bean (*Vicia faba* L.). J. Agric. Sci. Mansoura Univ., 13(4), 1538-1544.

[38]. Bhuiyan, M. M. H, Rahman, M. M. Afroze, F. Sutradhar, G. N. C. and Bhuiyan, M. S. I. 2008. Effect of phosphorus, molybdenum and Rhizobium inoculation on growth and nodulation of mungbean. J. Soil Nature. 2 (2), 25-30.

[39]. Yadav, S. L., Chahal, V. P., Yadav, A., Singh, R. K., Mishra, D., Kumar, P., & Kumar, R. 2017. Response of phosphorus doses and weed control methods on nutrient uptake in chickpea (*Cicer arietinum* L.) under rainfed conditions. J. Pharmacogn. Phytochem, 738-742.

[40]. Ali, R. I., Gill, M. A. and Iqbal, J. 2002. Phosphorus nutrition and weed interference in chickpea. Legume Research, 25(1), 23 - 28.

[41]. Singh, R.P. and Ali, M. 2004. Integrated nutrient management in chickpea and its effect on weeds. Indian Journal of Pulses Research, 17(1), 23 - 28.

[42]. Hussein, G. S., Salim, A. S., Khalaf, A. S., Sabri,W. Kh. 2016. Effect of plant densities and methods of weed check on plant, types and growth of accompanied weeds with chickpea (*Cicer Arietinum* L.) Under Rainfed Conditions at Duhok. Journal of University Of Duhok., 19 (1), 126-133.

تأثير الكثافة النباتية وأنواع الأسمدة الفوسفاتية في نمو والحاصل ومكوناته والأدغال المرافقة لمحصول الحمص (Cicer arietinum L.)

وسام خالد صبري[1] كوهدار صالح حسين [1]
هادي مراد حسن [1] مروان حسين صالح [1]
[1]قسم المحاصيل الحقلية، كلية علوم الهندسة الزراعية، جامعة دهوك،اقليم كوردستان -العراق.

الخلاصة

أُجريت تجربة حقلية في ربيع 2024 في حقول قسم المحاصيل الحقلية، كلية علوم الهندسة الزراعية، جامعة دهوك، تقع بين خط طول 42.87 غرباً، وخط عرض 36.86 شمالاً، وارتفاع 583 متراً، وتبعد عن محافظة دهوك حوالي 15 كم.، لتقييم تأثير الكثافة النباتية وأنواع الأسمدة الفوسفاتية في نمو وإنتاجية الحمص (***Cicer arietinum L***.) والأدغال المرافقة له تحت ظروف الزراعة الديمية. نفذت التجربة العاملية وفق تصميم القطاعات العشوائية الكاملة (***RCBD***) بثلاثة مكررات، شمل العامل الاول ثلاث كثافات نباتية (26.66، 33.33، و44.44 نبات .م-2) والعامل الثاني أربعة معاملات سمادية: السماد الحيوي (20 كغ .هـ-1)، ثنائي فوسفات الأمونيوم ***DAP*** (120 كغ .هـ-1)، السوبر فوسفات الثلاثي ***TSP*** (160 كغ .هـ-1)، ومعاملة المقارنة. أظهرت النتائج أن الكثافة النباتية كان لها تأثير محدود على الصفات الخضرية، في حين أثرت أنواع الأسمدة تأثيراً معنويًا على نمو وإنتاجية الحمص. سجل أعلى حاصل بذور (2637.96 كغ .هـ-1) عند الجمع بين الكثافة العالية (44.44 نبات .م-2) ومعاملة ***TSP*** التي حسّنت أيضًا عدد القرون و عدد البذور للنبات، وزن 100 بذرة، والحاصل البيولوجي. أما الكثافات المنخفضة فقد شجعت التفريع لكن قلّلت الإنتاجية . تم تسجيل 13 نوعًا من الأدغال تنتمي إلى ستة عوائل نباتية، وكانت الأدغال عريضة الأوراق هي الأكثر شيوعًا. أسهمت الكثافات النباتية العالية واستخدام سماد ***TSP*** في تقليل ظهور الأدغال ووزنها الجاف من خلال تعزيز التنافس والظل الناتج عن الغطاء النباتي . يُظهر هذا أن الجمع بين الكثافة العالية وتسميد ***TSP*** يمثل أفضل استراتيجية زراعية لتعزيز نمو الحمص، وزيادة حاصل البذور، وتعزيز منافسة المحصول للأدغال تحت ظروف الزراعة الديمية في دهوك، مما يبرز أهمية إدارة المحاصيل المتكاملة لتحقيق إنتاجية مستدامة.

<u>الكلمات المفتاحية</u>: الحمص، انواع الاسمدة، الكثافات النباتية، الحاصل ومكوناته ومكافحة الادغال.