Effect of Tillage systems and NPK Fertilizer on Growth and Yield of Chickpea (Cicer arietnum) under Sulaimani Conditions

Shara J. Hama 1 **Fawzy F. Khurshid2** **Shno O. Sofy**

Assist.Professor **Lecturer** **Assist. Lecturer**

Department of Crops Sciences, College of Agricultural Sciences, University of Sulaimani, Iraq.

E-mail:shara.hama@univsul.edu.iq1 ; Fawzy.Khurshid@univsul.edu.iq2 ; Shno.sofy@univsul.edu.iq3.

ABSTRACT

This study was conducted during 2017 season at Bakrajo Agriculture Research Station, College of Agricultural sciences, University of Sulaimani, using split plot design the main plots conducted in Randomized Completely Block Design (RCBD) with three replicates to study the effect of three tillage systems using (Mould board plow followed by Cultivator one pass, Disk plow followed by Cultivator one pass and Cultivating one pass) and NPK fertilizer levels on growth, yield and yield components of chickpea. The three tillage systems were implemented in the main plots, three NPK fertilizer levels (0, 40 and 80) kg NPK/ha from NPK complex (15-15-15) source, were implemented in the subplot. Comparisons between means were carried out by the least significant difference (L.S.D) at 1 % and 5 % level of significance.

The results of this investigation confirm that plowing with mould board followed by Cultivator recorded the maximum values for all of the studied characters which indicate the effectiveness of this system compared to disc plow followed by Cultivator and Cultivator one pass.The application 80 Kg NPK/ha was found to be the best level for this crop .

Key words: Chickpea, Tillage systems, NPK fertilization, Growth, yield and yield components

تاثير نظم الحراثة والتسميد (NPK) على نمو وحاصل الحمص (Cicer arietnum) تحت ظروف منطقة السليمانية

شارا جلال حمه1، فوزي فيض الله خورشيد2 و شنو عثمان صوفي 3

1 دكتوراه في المحاصيل الصناعية، 2 ماجستير في المكننة الزراعية و 3 ماجستير في الانتاج المحاصيل الحقلية

قسم العلوم المحاصيل الحقلية، كلية العلوم الزراعية، جامعة السليمانية/ العراق

((E-mail: shara. hama@univsul.edu.iq

الخلاصة

اجريت هذه الدراسة خلال الموسم الزراعي الربيعي 2017 في محطة الابحاث الزراعية في بكرجو, كلية العلوم الزراعية، جامعة السليمانية، باستخدام تصميم الالواح المنشقة بوضع القطاعات الرئيسية تحت نظام تصميم القطاعات العشوائية الكاملة (RCBD) وبثلاث مكررات لدراسة تاثير ثلاثة انظمة للحراثة باستخدام (المحراث المطرحي القلاب يتبعها العازقة الحقلية مرور واحد، المحراث القرصي القلاب يتبعها العازقة الحقلية بمرور واحد و العازقة الحقلية بمرور واحد) ومستويات التسميد (NPK) على نمو، الحاصل ومكونات الحاصل لمحصول الحمص. انظمة الحراثة الثلاثة وضعت في الالواح الرئيسية، ثلاثة مستويات للتسميد (0، 40 و80) كغم (NPK)/ هكتارمن سماد (NPK) المركب (15-

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15-15) حيث وضعت في القطاعات المنشقة وبعد تحلّيل النتائج تم مقارنة المتوسطات باختبار اقل فرق معنوي L.S.D عند مستوى معنوية (0.1) و (0.05).

اثبتت نتائج هذه التجربة ان معاملة الحراثة بالمحراث المطرحي القلاب المتبوع بالعازقة الحقلية قد سجلت اعلى القيم ولجميع الصفات المدروسة والذي يبين فاعلية هذا النظام مقارنة بمعاملة المحراث القرصي القلاب المتبوع بالعازقة الحقلية وكذلك معاملة العازقة الحقلية مرور واحد. معاملة التسميد 80كغم (NPK)/هكتار وجدت كافضل مستوى للتسميد لهذا المحصول.

INTRODUCTION

Chickpea (Cicer arietnum)is usually grown of marginal areas of the world. It is the nineteenth most important crop on the basis of cultivated area globally and is grown in thirty-four countries of the world. India, Pakistan, Bangladesh, and Nepal grow 90% of the world hectare age. It is also an important crop in northern Africa and in parts of North and South America (17) .It is an edible legume of the family Leguminous; high in protein and one of the earliest cultivated vegetables (34). Chickpeas are a helpful source of zinc, folate and protein. They are also very high in dietary fiber and hence a healthy source of carbohydrates for persons with insulin sensitivity or diabetes (13). In the semi-arid tropics, chickpea seeds contain on average 23% protein, 64% total carbohydrates (47% starch, 6% soluble sugar), 5% fat, 6% crude fiber, phosphorus (340 mg/100 g), calcium magnesium (140 mg/100 g), iron (7 mg/100 g) and zinc (3 mg/100 g) (13). Chickpea is the most important pulse as well as a vegetable crop in Kurdistan region. Average chickpea yields are very low as compared to the other chickpea production countries. The major factors responsible for low crop productivity of chickpea in Kurdistan are; low organic matter in soil, poor soil structure, and deficiency of macro and micro nutrients and improper use of tillage practices. Reported that the strongest determinant of seed yield for chickpea and lentil under rain fed conditions is rainfall and its distribution. Tillage is mechanical manipulation of the soil to provide the necessary conditions favorable to the growth of crops (16). The suitability of a tillage method depends on factors such as soil physical characteristics, rainfall availability and distribution, availability of tillage equipments and cropping history of the land. Tillage is considered the most effective farm activity for the purpose of developing a desired soil structure. It improves the physical conditions of soil and favors the rooting characteristics of plants, which lead to an enhanced nutrient uptake and better yield of crops. For hard-setting soils reduced tillage and stubble retention systems are more beneficial financially (3). Deep tillage or sub-soiling can be used to enhance axial root growth of chickpea by reducing soil strength (6). The effects of tillage practice may vary, depending on the stage of growth of chickpea (10). A little information is available in Iraq- Kurdistan region about the soil and crop (especial chickpea) response to a tillage systems and their management.

Fertilizers play a pivotal role in increasing yield and improving the quality of crops (5).It is one of the soil and crop management practices, which exert a great influence on soil quality. Therefore NPK fertilizers are important in this area. They usually grow it without supplying any fertilizer, where as it is evident from the literature that application of NPK have beneficial effect on gram yield (18, 32). But the question that how much NPK should be applied to which cultivar still remains unquenchable. (26) This depends upon the final grain yield (30) and its contributing components (18) whether it is profitable combination or not (33). Among

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various factors that are responsible for better yield and quality, the proper use of fertilizers is of prime importance (29). Determination of optimum levels of NPK fertilizers is essential for obtaining maximum economic returns. According to (8) best rate of fertilizer application is that which gives maximum economic returns at least cost. Among various essential plant nutrients, the macro nutrients NPK are crucial for determining the yield and quality. (25) Examined combined application of 50, 100 and 150% of the recommended rates of inorganic nitrogen, phosphorus and potassium; and found improved results as compared to straight fertilizers. Nitrogen is required by plants in the processes of photosynthesis and involved in the energy reactions in the form of ATP; a key component of chlorophyll, proteins and enzymes; and assists the plants in the synthesis and use of carbohydrates (21, 30). Phosphorus plays a crucial role in the root proliferation, consistent grain filling, and higher grain yield and quality (9). Potassium is essential for the maintenance of electrical potential across cellular membranes and cellular turgor enhancing the cell expansion and enlargement, opening and closing of stomata, and pollen tube development. It is also involved in activation of many enzymes, translocation of nitrate and sucrose (11) .

The objects of this study was to determine the effects of different tillage systems (mould board plow followed by Cultivator, disk plow followed by Cultivator and Cultivating without plowing) and NPK fertilizer levels (0, 40 and 80) kg NPK/ha on yield and yield components of chickpea.

MATERIALS AND METHODS

This investigation were carried out during the spring seasons of 2017, to study the effect of different tillage systems and NPK fertilizer levels on yield and yield components of chickpea in Experimental Farm of the faculty of Agriculture, University of Sulaimani at Bakrajo. The study area is located in the southwest of Sulaimani city (Latitude: 35º 33' N; Longitude 45º 27' E at altitude of approximately 830 m .(

A brief account of some physical and chemical properties of the experimental soil is given in Table (1). Moreover, the temperature and monthly rainfall precipitation at Bakrajo is shown in Table (2). One variety of Chickpea was selected for cultivation, which has been provided by the Slaimani Agricultural Research Center, names; Flip 82 – 150.The experiment was arranged as split- plot layout. The Tillage manners (Mold board plow to depth of (25 cm) followed by Cultivator one pass(10 cm) (T1), Disk plow to depth of (25 cm) followed by Cultivator one pass(10 cm) (T2) and Cultivator one pass(T3) were implemented in the main plots and conducted with Randomized Complete Block Design(RCBD) , different levels of NPK fertilizer levels (0,40 and 80 kg ha-1) from NPK fertilizer complex (15-15-15) were implemented in the subplots. Each main plot was consisted of three subplots with 4 rows, each subplot consist of 6 rows (0.30 m between rows and 0.20 m between plants) ; thus, the plant population was 200,0000 plant ha-1. Planting date was on March 1, 2017. Whole of NPK fertilizer complex was applied at sowing time. All other agronomic practices and weed control were accomplished according to normal field practices .

The LSD test was done to find the significant differences between treatments means at 5% and 1% probability level (7). The mature plants were harvested on 25 June 2017 to estimate biological yield, seed yield and yield components.

Studied Characteristics :

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The studied characters were :

- Plant height (cm): At maturity, the mean height of the plant from ground level to the tip of five plants were recorded .

- Number of tillers per plant: At maturity, the mean tillers of the five plants were recorded .

- Deep of roots per plant: At Maturity, the mean length of roots of the five plants was recorded.

- Number of bacteria nods per plant: At Maturity, the mean number of bacteria nods per plant of the five plants was recorded.

- Number of pods per plant: At Maturity, the mean number of pods per plant of the five plants was counted and recorded.

- Number of seeds per plant: At Maturity, the mean number of seeds per plant of five plants was counted and recorded.

- 100seed weight (g): At maturity, 100 seeds were counted and weighted.

- Dry matter (g/plant): At 50% flowering, the mean weight of five plants sample were dried in oven for 48 hours in 65 Co then weighted and recorded.

- Pod weight (g/plant): At Maturity, the mean weight of pods per plant of the five plants was recorded.

- Average pod weight (g): At Maturity, the weight of pods of five plants was averaged and recorded.

- Harvest Index: Measured at Maturity by divided Seed yield (t/ha) {the mean of seeds weight of the five plant samples was recorded in each plot (g/plant) and converted to (t/ha)}to Biological yield (t/ha) {the mean of weight of the five plant samples without the roots was recorded in each plot (g/plant) and converted to (t/ha)} according to the following equation:

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- Protein percent (%): protein content in the seeds was determined by using Kildahl method as recommended by (1).

Protein% in seeds = total nitrogen% in seeds * 6.25

- Biological yield (g/ton): At Maturity, the mean of weight of the five plant samples without the roots was recorded in each plot (g/plant) and converted to (t/ha).

- Seed yield (kg /ha): At Maturity, the mean of seeds weight of the five plants samples was recorded in each plot (g/plant) and converted to (t/ha).

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Table 1: Physical and chemical properties of the studied soil:

Soil properties	***Values***
Soil texture (P.S.D)	Silty Clay
Sand ($g.kg^{-1}$)	48.5
Silt ($g.kg^{-1}$)	449.8
Clay ($g.kg^{-1}$)	501.7
E.C. ($dS.m^{-1}$)	0.33
pH	7.44
O.M. ($g.kg^{-1}$)	21.02
CaCO3 ($g.kg^{-1}$)	337.6
Total N (ppm)	19.93
K+ ($g.kg^{-1}$)	2.67
Na+ (ppm)	27.66
Ca++ ($Meq.l^{-1}$)	2.66
Mg++ ($Meq.l^{-1}$)	1.98

Table 2: Average air temperature and rainfall during the growing seasons of 2016-2017 at Bakrajo Location

Months	***Average Air Temperature (°C)***		***Rainfall (mm)***
	Max.	***Min.***	
November	21.3	7.6	44.5
December	11.1	3.0	158.0
January	11.10	1.46	59.2
February	13.02	0.26	96.5
March	17.73	7.45	111.5
April	23.89	10.97	54.5
May	31.63	13.48	27.7
Total			551.9

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RESULTS AND DISCUSSION

Data in Table (3) and appendix (1) confirm that the differences among tillage systems were highly significant for the studied characters plant height, number pods per plant, protein percent, biological yield and seed yield, while it was significant for the characters number of tiller per plant, number of seeds per plant, dry matter g per plant, pod weight and harvest index. It was observed that the plowing with Mold board was recorded maximum values for the character's plant height (cm), number of tiller / plant, number pods /plant, number of seeds / plant, dry matter g / plant, pod weight (g), protein percent (%), biological yield t/ha and seed yield t/ha With 47.089 cm, 3.444, 36.556, 41.333, 8.843 g, 11.411g/plant, 22.881 %, 3.704 t/ha and 1.733 t/ha respectively, while plowing with Disc plow produced minimum values for almost all of the characters excepted harvest index, recording 43.033 cm, 3.056, 27.333, 34.778, 6.224 g, 9.177 g, 19.197 %, 2.498 t/ha and 1.263 t/ha for the characters plant height(cm), number of tiller / plant, number pods / plant, number of seeds / plant, dry matter g / plant, pod weight g / plant, protein percent(%), biological yield t/ha and seed yield t/ha respectively. These results indicate the effect of compacting of the disc plow on the soil as well as reduce the required nutrient, water and air around the root of the plant, while mold board plow was more effective system in cultivating chickpea in bakrajo soil condition because it improves the size of the soil clods and give the roots good ventilation. The root system is crucial factor for optimum crop yields when soil is in good condition. Similar result was obtained in an investigation on the effect of tillage system on studied characters and root length (4). (19) Also reported better root development increase grain yield in silty loam and silty clay soil. Tillage methods affect the sustainable resources through its influence on soil properties, crop growth and the use of excessive and un-necessary tillage operations is often harmful to soil (22). The better root development associate with breaking of compact layer below the plow layer is the major contribution to increase crop yield (24). This is similar to that of (20) who recorded a significantly lower grain yield and dry matter yields on no-till treatment plots compared with conventionally tilled plots on loamy soils in Islamabad, Pakistan. Results of (27) showed that intensive tillage methods like CT are needed in systems where wheat is grown in monoculture. Similar results have been narrated by (12, 14.(

The effect of NPK fertilizer application was found to be highly significant for most studied characters except number of bacteria nod per plant, pod weight, protein percent and biological yield which were significant only (Table 4 and Appendix 1). The application of 80 Kg/ha recorded the best values for all characters except the character average pod weight, recording 47.311 cm, 3.722, 15.222 cm , 12.444, 36.667, 43.556, 23.923 g, 9.724 g/plant, 11.626 g/plant , 0.504, 22.341 %, 3.472 t/ha and 1.743 t/ha for the characters plant high, number of tiller per plant, deep of roots, number of bacteria nod per plant, number pods per plant, number of seeds per plant, 100 seed weight, dry matter weight per plant, pod weight, harvest index, protein percent, biological yield and seed yield respectively, while the control treatment recorded the maximum value for the character average pod weight with 0.339 g but gave the lowest values for the other characters with 41.478 cm, 2.667, 12.556 cm, 8.111, 27.222, 32.556, 21.817 g, 5.897 g/plant, 9.170 g/plant, 19.812 %, 2.684 t/ha and 1.321 t/ha for plant high, number of tiller per plant, deep of roots, number of bacteria nod per plant, number pods per plant, number of seeds per plant, 100 seed weight, dry matter weight per plant, pod weight, protein percent, biological yield and seed yield respectively . Similar results have been narrated by (18)

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and (28). Application of fertilizer affected significantly on plant height of chickpea, Minimum plant height was recorded in the crop grown without fertilizer application (control). These results confirmed those of the (23) and (15). The highest seed protein content was recorded, when the highest value of NPK fertilizer was applied, while the lowest seed protein content was recorded in the treatment of control. Similar trends were noted by (32) and (31). The highest biological yield and grain yield were recorded, when the highest value of NPK fertilizer was applied, while the lowest biological yield and grain yield were recorded in control. Similar trends were noted by (2).The highest1000-grain weight (237 g) was exhibited when the highest value of NPK fertilizer was applied, while the lowest 1000-grain weight (230 g) was observed in control treatment. Similar results have been narrated by (18, 28.(

Data in table (5) confirms that there were no significant interaction between genotypes and NPK fertilizer application levels on all yields and yield components characters

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Table 3: Effect of Tillage systems on the studied characters

Tillage systems	Pant height (cm)	No.of Tillers/plant	Root length(cm)	No. of bacteria nod/plant	No.of pod /plant	No.of seeds/plant	100 Seed weight (g)	Dry matter weight (g/plant)	Pod weight (g/plant)	Average pod weight (g)	HI	Protein %	Biological yield (t/ha)	Seed yield (t/ha)
T1	47.089	3.444	14.333	10.667	36.556	41.333	23.101	8.843	11.411	0.316	0.466	22.881	3.704	1.733
T2	43.033	3.056	13.667	11.000	27.333	34.778	22.650	6.224	9.177	0.336	0.499	19.197	2.498	1.263
T3	44.500	3.056	13.556	9.556	33.000	38.000	22.811	7.917	10.480	0.321	0.509	20.847	2.956	1.517
L.S.D (P≤0.05)	2.420	0.321	n.s	n.s	4.978	5.152	n.s	1.601	1.532	n.s	0.031	1.863	0.481	0.226
L.S.D (P≤0.01)	3.334	n.s	n.s	n.s	6.859	n.s	n.s	n.s	n.s	n.s	n.s	2.567	0.663	0.311

Table 4: Effect of NPK fertilizer levels on the studied characters

NPK levels (Kg/ ha)	Pant height (cm)	No.of Tillers /plant	Root length(cm)	No.of bacteria nod/plant	No.of pod /plant	No.of seeds /plant	100 Seed weight (g)	Dry matter weight (g/plant)	Pod weight (g/plant)	Average pod weight (g)	HI	Protein %	Biological yield (t/ha)	Seed yield (t/ha)
0	41.478	2.667	12.556	8.111	27.222	32.556	21.817	5.897	9.170	0.339	0.489	19.812	2.684	1.321
40	45.833	3.167	13.778	10.667	33.000	38.000	22.822	7.363	10.272	0.314	0.480	20.771	3.002	1.450
80	47.311	3.722	15.222	12.444	36.667	43.556	23.923	9.724	11.626	0.319	0.504	22.341	3.472	1.743
L.S.D (P≤0.05)	2.420	0.321	0.000	3.376	4.978	5.152	0.837	1.601	1.532	0.000	0.000	1.863	0.481	0.226
L.S.D (P≤0.01)	3.334	0.442	n.s	n.s	6.859	7.098	1.153	2.205	n.s	n.s	n.s	0.000	n.s	0.311

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Table 5: The interaction effects of tillage systems and NPK fertilizer levels on the studied characters

Tillage systems× NPK-fertilizer levels	Pant height (cm)	No.of Tillers/plant	Root length(cm)	No. of bacteria nod/plant	No. of pod /plant	No. of seeds/plant	100 Seed weight (g)	Dry matter weight (g/plant)	Pod weight (g/plant)	Average pod weight (g)	HI	Protein %	Biological yield (t/ha)	Seed yield (t/ha)
T1 × 0	42.933	2.833	12.333	9.667	27.667	30.000	21.690	5.933	8.613	0.313	0.487	21.160	2.835	1.381
T1× 40	48.000	3.333	13.667	9.333	38.667	42.333	22.520	7.853	11.667	0.307	0.447	23.010	3.684	1.673
T1× 80	50.333	4.167	17.000	13.000	43.333	51.667	25.093	12.743	13.953	0.327	0.463	24.473	4.593	2.147
T2 × 0	40.167	2.500	12.667	8.000	24.000	31.333	21.447	5.253	8.613	0.357	0.497	18.120	2.339	1.172
T2 × 40	44.500	3.000	14.000	11.667	27.667	35.333	23.043	5.920	8.983	0.323	0.473	19.537	2.467	1.183
T2 × 80	44.433	3.667	14.333	13.333	30.333	37.667	23.460	7.500	9.933	0.327	0.527	19.933	2.687	1.435
T3 × 0	41.333	2.667	12.667	6.667	30.000	36.333	22.313	6.503	10.283	0.347	0.483	20.157	2.877	1.410
T3 × 40	45.000	3.167	13.667	11.000	32.667	36.333	22.903	8.317	10.167	0.313	0.520	19.767	2.856	1.494
T3 × 80	47.167	3.333	14.333	11.000	36.333	41.333	23.217	8.930	10.990	0.303	0.523	22.617	3.135	1.647
L.S.D (P≤0.05)	n.s	n.s	n.s	n.s	n.s	n.s	n.s	n.s	n.s	n.s	n.s	n.s	n.s	n.s
L.S.D (P≤0.01)	n.s	n.s	n.s	n.s	n.s	n.s	n.s	n.s	n.s	n.s	n.s	n.s	n.s	n.s

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Appendix 1 : Mean square of variance analysis of the studied characters

S.O.V	d.f	Pant height (cm)	No. of Tillers/plant	Deep of roots/plant	No. of bactrianod/plant	No.of pod /plant	No.of seeds/pod	100 Seed weight (g)	Dry matter (g/plant)	Pod weight (g/plant)	Averag pod weight (g)	HI	Protein %	Biological yield (t/ha)	Seed yield (t/ha)
Blocks	2	0.507	0.259	0.926	14.370	10.815	8.0370	2.083	1.494	0.408	0.001	0.000	0.744	0.099	0.008
A	2	37.951	0.454	1.593	5.148	194.704	96.7037	0.470	15.871	11.338	0.001	0.005	30.655	3.336	0.498
B	2	82.774	2.509	16.037	42.704	204.037	272.2593	9.992	33.567	13.614	0.002	0.001	14.669	1.415	0.421
AB	4	2.370	0.120	2.870	5.370	25.370	68.9259	1.737	6.096	4.953	0.001	0.002	1.745	0.536	0.069
Exp. Error	16	5.863	0.103	4.551	11.412	24.815	26.5787	0.701	2.565	2.349	0.001	0.001	3.476	0.232	0.051

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