Effect of Planting Patterns and NPK fertilizer on Growth and Yield of Millet and Mung Bean

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ABSTRACT

A field experiment was carried out during the spring planting season in 2017 in the fields of one of the farmers which it is located at Al- Shahabia region - Al Kifil district/ Babylon province about 28 km south of Hilla city with longitude is 44.39° east, latitude 32.30° north, and elevation from sea level is 26.6 m, in silty clay soil cultivated with Alfalfa in the previous season for studying the effect of planting patterns and compound fertilizers (NPK) on growth and yield of millet (Panicum miliaceum L.) and mung bean (Vigna radiate L.). The experiment included two factors: The Intercropping and fertilizing with compound fertilizers (NPK). The main plots included the fertilization factor on two levels of the compound fertilizer which were 200 and 400 $kg.h^{-1}$, which is symbolized by (F1) and (F2) respectively, as well as the comparison treatment (without the addition of compound fertilizer), which symbolized (F0) while the sub plots included seven patterns for the intercropping between crops of millet and mung as follows: millet is cultivated on lines alone (S1) , mung bean is cultivated on lines alone (S2) , two lines of millet + two lines of mung bean (S3), a line of mung Bean + two lines of millet (S4), three lines of millet + four lines of mung bean (S5), three lines of millet + three lines of mung bean (S6) and five lines of millet + five lines of mung bean (S7). The experimental sub-plots were separated according to the Randomized Complete Blocks Design (RCBD) according to the arrangements of split plots in three replicates. The averages were tested to the of Least Significant difference (L.S.D) under %0.05 probability level. The main results obtained were as follows:

The intercropping patterns gave a significant effect on most of the qualities of growth, yield and its components in millet as in the area of the flag leaf, the biological yield, the grain yield and the harvest index, whereas the height of the plant and the chlorophyll have not significant effect, the pattern (3 millet: 3 mung bean)gave the highest quantity of biological yield and grain are 3.57 and 1.21 $ton.h^{-1}$respectivly. The results showed a significant effect for the addition of compound fertilizer (NPK) in most of the qualities of growth and yield and it's components in millet.

As for mung bean, the intercropping patterns gave a significant effect on most of the qualities of growth, yield, and it components in (plant length, leaf area, seed yield, biological yield and harvest index), while the chlorophyll had no significant effect, as the pattern (3 millet: 3 mung bean) gave the highest quantity of seeds yield was 0.66 $ton.h^{-1}$ and the highest yield obtained from the agricultural pattern (2 millet: 1 mung bean) reached 3.48 $ton.h^{-1}$. The results showed a significant effect for the addition of NPK fertilizer in plant length, biological yield and harvest index.

The pattern of agriculture (3 millet: 3 mung bean) gave the highest average yield of the total Land Equivalent Ratio to millet and mung bean (LER) reached 1.11.

*** Research from the thesis of Master for the first Author**

تأثير انماط الزراعة والسماد المركب في نمو وحاصل الدخن والماش.

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المستخلص:

نفذت تجربة حقلية خلال الموسم الزراعي الربيعي في العام 2017 في حقول احد المزارعين الواقع في منطقة الشهابية التابعة لناحية الكفل/ محافظة بابل على بعد 28 كم جنوب مدينة الحلة بخطوط الطول ˚44.39 شرقاً والعرض˚32.30 شمالاً والارتفاع عن مستوى سطح البحر 26.6 م في تربة ذات نسجه طينية غرينيه والمزروعة بمحصول الجت في الموسم السابق لغرض دراسة تأثير انماط الزراعة والسماد المركب (NPK) في نمو وحاصل الدخن (*Panicum miliaceum* L.) والماش (*Vigna radiate* L.) وتضمنت التجربة

عاملين: هما الزراعة المتداخلة والتسميد بالسماد المركب (NPK) حيث كانت الالواح الرئيسة تشتمل عامل التسميد على مستويين من السماد المركب وهما 200 و 400 كغم.ه$^{-1}$ والتي رمز لها(F_1) و(F_2) بالتتابع فضلا عن معاملة المقارنة (بدون اضافة سماد مركب) والتي رمز لها (F_0) اما الالواح الثانوية فقد تضمنت سبعة انماط للزراعة المتداخلة بين محصولي الدخن والماش وكما يأتي: دخن لوحده مزروع على سطور (S_1) وماش لوحده مزروع على سطور (S_2) وسطرين دخن+ سطرين ماش (S_3) وسطر ماش+ سطرين دخن (S_4) وثلاثة سطور دخن+ اربع سطور ماش (S_5) وثلاثة سطور دخن+ ثلاثة سطور ماش (S_6) وخمسة سطور دخن+ خمسة سطور ماش (S_7) وفصلت الالواح التجريبية الثانوية على وفق تصميم القطاعات المعشاة بالكامل (RCBD) بترتيب الالواح المنشقة وبثلاث مكررات. واختبرت المتوسطات بحسب أقل فرق معنوي عند مستوى احتمال 0.05 وتتلخص أهم النتائج التي تم الحصول عليها بما يأتي :

اعطت أنماط الزراعة المتداخلة تأثيراً معنوياً في معظم صفات النمو والحاصل ومكوناته في الدخن كما في مساحة ورقة العلم والحاصل البايولوجي وحاصل الحبوب ودليل الحصاد في حين لم يكن لارتفاع النبات والكلوروفيل اي تأثير معنوي اذ اعطى النمط (3 دخن : 3 ماش) اعلى كمية للحاصل البايولوجي وحاصل الحبوب بلغا 3.57 و 1.21 طن.ه$^{-1}$. بينت النتائج وجود تأثير معنوي لإضافة السماد المركب NPK في معظم صفات النمو والحاصل ومكوناته في الدخن

اما الماش فقد اعطت أنماط الزراعة المتداخلة تأثيراً معنوياً في معظم صفات النمو والحاصل ومكوناته في الماش (طول النبات, المساحة الورقية وحاصل البذور والحاصل البايولوجي ودليل الحصاد) بينما لم يكن للكلوروفيل تأثير معنوي اذ اعطى النمط (3 دخن : 3 ماش) اعلى كمية لحاصل البذور بلغ 0.66 طن.ه$^{-1}$ و اعلى حاصل بايولوجي تم الحصول عليه من النمط الزراعي (2 دخن: 1 ماش) بلغ 3.48 طن.ه$^{-1}$. بينت النتائج وجود تأثير معنوي لإضافة السماد المركب NPK في طول النبات والحاصل البايولوجي ودليل الحصاد.

اعطى نمط الزراعة (3 دخن: 3 ماش) اعلى متوسط لنسبة عائد الارض الكلي لمحصولي الدخن والماش (LER) بلغ 1.11 .

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1. INTRODUCTION

There are many types of field systems patterns for cultivating crops in different regions of the world, in order to achieve the various advantages of these types. The most important of these advantages is the sustainability of natural resources and preservation through the careful use of these resources as well as the sustainability for obtaining best of quantities and types from crop production. Among these are intercropping system patterns which is a practical application to the principles of environmental diversification of crops existing in nature, which is defined as the cultivation and growth of two crops or more in a specific piece of land in a single growing season, where the two crops or overlapping crops overlap for a certain period of the season or perhaps for the whole season, and then, the competition occurs between interacted species on the elements of natural growth (light-water-nutrient). Therefore, the process of regulating distribution of the interacted species on the land area requires knowledge of the characteristics of these species in terms of their requirements for the growth factors and the Geometric shape of the plant and the ability of each species to compete [12]. The intercropping system achieves several advantages such biodiversity and what it achieves at the sustainability level of the environmental diversification, as well as the diversification of production in terms of qualitative and economic integration, and increases the efficiency of the use entrances of natural production and Factors added by human (such: soil and crop service practices, especially the addition of chemical fertilizers and pesticides) [7]. The millet crops(Panicum miliaceum L.) and mung bean (Vigna radiate L.), are from food and fodder crops which cultivated for a long time and are crops with a short growth season which adapted to Iraqi conditions, from their advantages are the relative endurance of drought and salinity and their ability to compete with the weeds, both of them do not require complex agricultural technologies, as well as ease to manage by farmers, so there is a possibility of introducing both of them into an intercropping system to provide the standards for these systems in both of them. There are several studies in Iraq that used crops such as zea mays, sorghum bicolor, mung bean, Alfalfa, Vigna, barley, and Vicia faba. But millet and mung bean cultivation by intercropping system has not been applied or practiced not at the level of research and studies or farmers' practices, despite the characteristics mentioned previously and which fit this system. The need of each crop to nutrients or fertilizer elements varies according to the crop type, the field system cultivated in which, the methods of agriculture, irrigation, etc. Therefore, the cultivation of crops with intercropping system may change the need of these crops to the quantities and types of fertilizer added compared to their cultivation of a single cultivating system for each crop and hence the importance of this study to find out the possibility of introducing the two crops of millet and mung bean with intercropping system and the effect of this in their growth and yield compared to cultivating them individually and their response to add from of compound fertilizer (NPK) under the intercropping system and compared to the single cultivating system. This study also aimed to find out the effect of the intercropping of these two crops on soil content of N, P and K elements after harvest.

2. MATERIALS AND METHODS

A field experiment was carried out in the fields of one of the farmers which it is located at Al- Shahabia region - Al Kifil district/ Babylon province about 28 km south of Hilla city with longitude is 44.39° east, latitude 32.30° north, and elevation from sea level is 26.6 m, in silty clay soil. The aim of this study was to find out the efficiency of the intercropping system of millet (Panicum miliaceum L.) and mung bean (Vigna radiate L) between the winter and summer seasons. The compound fertilizer (20-20-20 + TE) was added, TE mean the rare elements and manufactured by a German company according to the experiment treatments and by one batch when agriculture. It was mixed with the soil, and surface irrigation was used in the irrigation of the experimental plots and re-irrigation according to the moisture content of the soil, which is determined by sensor manner. The sensor devices were adopted to approximate soil moisture content and re-irrigation [12]. Five irrigations have required to the field throughout the growing season except the irrigation of germination, as for the weeds, which were the largest proportion of it are narrow leafed weeds, which was treated by the use of manual weeding and for twice, as for a broad leafed weeds, which their percentage was a small, and which were treated by the use of manual weeding for once, Was then mixed, grinding and analyzed in the Field Crops Laboratory of the College of Agriculture - Al Qasim Green University as shown in the table below

Table 1: Experimental qualities of experimental field soil and irrigation water prior to cultivating.

The physical properties of soil	
Clay	420 g.kg
silt	460 g.kg
sand	120 g.kg
Soil Texture	Silty Clay Soil
The chemical properties of soil	
Nitrogen	ppm60
Phosphorus	37 ppm
Potassium	105 ppm
pH	7.9
Electrical conduction EC	0.77 ds/m
The chemical properties of irrigation water	
pH	7.6
Electrical conduction EC	1.4 ds/m

The experiment land was divided into squares according to Randomized Complete Blocks Design (RCBD) in the order of split plots and in three replicates. The experimental unit area was 4 × 4 m. The experiment included two factors intercropping and fertilizing by compound fertilizer (NPK). The main plots included of two levels of compound fertilizer 200 and 400 kg.h-1, which is symbolized by (F1) and (F2) respectively, as well as the comparison treatment (without the addition of composite fertilizer) and its symbol (F0). As for the secondary plates, they included seven types of intercropping patterns between the two crops millet and mung bean, as follows: millet is cultivated on lines alone (S1) , mung bean is cultivated on lines alone (S2) , two lines of millet + two lines of mung bean (S3), a line of mung Bean + two lines of millet (S4), three lines of millet + four lines of mung bean (S5), three lines of millet + three lines of mung bean (S6) and five lines of millet + five lines of mung bean (S7). The experimental sub-plots were separated by furrows with 1.5 m in width to prevent fertilizer leakage.

a. **Cultivation of the two crops:**

The two crops were cultivated according to the standards of the experiment on the twentieth of March for the season 2017 and as following:

1. **Cultivation of Millet Alone:**

Millet plots were planted alone in lines using a local species of 40 cm in length and a seed quantity of 96 g for each experimental plot on the basis of 60 $kg.h^{-1}$ distributed on ten lines included in each plot.

2. **Cultivation of the mung bean alone:**

The mung bean plots were Cultivated separately in a lines using a local variety of 40 cm in length and 40 g seed in each experimental plot on 24 kg. h^{-1} which was distributed on ten lines included in each plot.

3. **Intercropping**:

The same seed quantities were used for each line used for each two crop (millet and mung bean), however, the number of lines of each crop varied from one treatment to another and according to the patterns used in the treatment of the experiment described in paragraphs (1 and 2).

b. **The studied qualities for millet and mung bean**

1. **Plant height (cm):** The height of the plant was measured from the surface of the soil to the flowering nodes at the end of the plant for ten main stems taken randomly from each experimental unit. The length of the plant for mung bean was calculated by measuring the length of ten plants for each secondary experimental unit and intermediate lines randomly and extracted the average.
2. **The content of the leaves of chlorophyll (SPAD):** Determination of chlorophyll content of the leaves the millet and mung bean using the chlorophyll measuring device after the completion of the emergence of Panical by taking the average of three readings per leaf and ten flag leaves randomly selected from each secondary experimental unit and extracted the average ten leaves.
3. **The area of the flag leaf (cm^2):** it was calculated as an average of 10 plants randomly taken from the intermediate lines and each secondary experimental unit according to following equation [8] is $A = L \times W \times K$, where A = the leaf area, L = the length of the leaf, W = the maximum width of the leaf and K = constant (0.7554). The leaf area in the mung bean was calculated as an average of 10 plants taken randomly from the middle lines and for each secondary experimental unit using the scanner.
4. **The biological yield ($Tn.h^{-1}$):** It was calculated from the weight of the plants harvested from the length meter for each experimental unit where the weight of the plants (stems, leaves, and flowers) was converted to a $ton.h^{-1}$.
5. **Grain yield ($ton.h^{-1}$):** The grain yield was calculated from the harvest of a length meter from one of the intermediate lines taken randomly from each secondary experimental unit and then studied the Panical to extract the grains, cleaned well and weighed, and turned it into ton. As for the mung bean, the grain yield of the harvested plants was calculated randomly from each secondary experimental unit. The Mung Bean were then removed to extract the grains, cleaned well, weighed the grains and turned into ton.
6. **Harvest index (%):** It was calculated by dividing the grain yield on the

biological yield and according to the following equation [14]:

$$\text{Harvest index} = \frac{\text{grain yield}}{\text{biological yield}} \times 100\%.$$

3. RESULTS:

Table (2) shows significant differences in the types of intercropping patterns in the area of the flag leaf in the millet, the grain yield, the biological yield and the harvest index, while the intercropping patterns did not affect plant height as these results were agreement with what mentioned [9] and chlorophyll content. As for the compound fertilizer (NPK), there were significant differences in plant height, grain yield, biological yield and harvest index, whereas chlorophyll, and area of flag leaf, were showed no significant differences. As for the pattern of millet alone gave the highest area of flag leaf was 17.26 cm^2 while the cultivation pattern (5 millet: 5 mung bean) less leaf area of 12.32 cm^2 and these results did not agreement with the study of [1]. The pattern (3 millet: 3 mung bean) gave the highest grain yield and biological yield and harvest index reached 1.21 $ton.h^{-1}$, 3.57 $ton.h^{-1}$ and 33.57 respectively, while the cultivation pattern (2 millet: 2 mung bean) gave less grain yield and harvest index 0.82 $ton.h^{-1}$ and 27.07 respectively, the cultivation pattern of millet alone gave a biological yield of 2.88 $ton.h^{-1}$. These results did not match with what (5) in terms of the biological yield, but they matched to the grain yield. For compound fertilizer (NPK), Table (2) shows that the addition of 400 $kg.h^{-1}$ compound fertilizer gave the highest plant height of 55.07 cm and the highest biological yield of 3.63 $ton.h^{-1}$ compared with that without addition, which gave the lowest plant height and a biological yield of 41.83 cm and 2.58 $ton.h^{-1}$ respectively, as this treatment agrees with what is mentioned by [3]. The addition of 200 $kg.h^{-1}$ compound fertilizers gave the highest grain yield of 1.07 $ton.h^{-1}$, which did not differ significantly from the addition of 400 $kg.h^{-1}$ compound fertilizer compared to that without addition, which gave less grain yield of 0.83 ton. As for the harvest index, the treatment of without addition gave the highest harvest index of 33.10 and the lowest harvest index of 28.31 at the addition of 400 kg.

Table 2: Effect of planting patterns and NPK fertilizer (20:20:20+TE) in some the qualities of growth and product in millet planted sole or intercrop with mung bean in season of 2017

Factors	Treatments	Plant height (cm)	Chlorophyll (SPAD)	Area of flag leaf (cm^2)	Grain yield $ton.h^{-1}$	Biological yield $ton.h^{-1}$	Harvest index HI
planting patterns	S_1	51.21	28.40	17.26	0.94	2.88	32.63
	S_3	48.18	29.09	13.90	0.82	3.08	27.07
	S_4	49.18	26.98	14.46	1.02	3.25	30.23
	S_5	45.91	30.33	13.12	0.87	3.04	28.30
	S_6	48.70	30.06	12.84	1.21	3.57	33.57
	S_7	53.08	29.26	12.32	1.01	3.09	35.52
NPK fertilizer	F_0	41.83	30.17	13.87	0.83	2.58	33.10
	F_1	51.37	27.82	14.60	1.07	3.24	32.26
	F_2	55.07	29.07	13.44	1.04	3.63	28.31
L.S.D0.05							
planting patterns		N.S	N.S	1.31	0.09	0.33	1.97
NPK fertilizer		9.68	N.S	N.S	0.03	0.23	2.47

Table (3) shows that there were significant differences in the types of intercropping patterns in the length of the leaf plant, the leaf area, the seed yield, the biological yield and the harvest index, while the cultivation patterns did not affect the chlorophyll content in the mung bean leaves. The compound fertilizer (NPK) also showed significant differences in plant length, while the chlorophyll content, leaf area and grain yield had no significant effect, the cultivation patterns (2 millet: 1 mung bean) gave the highest length of plant was 41.08 cm and the length of the plant was 31.98 cm when the cultivation of mung bean alone and these results did not match with what is mentioned by [9]. The highest leaf area was 48.71 cm^2 when cultivated in the pattern (3 millet: 3 mung bean) and the least leaf area was 41.55 cm^2 when cultivating the pattern (5 millet: 5 mung bean). While the pattern (3 millet: 3 mung bean) gave the highest yield of grains and biological yield and harvest index reached 0.66 $ton.h^{-1}$ and 3.21 $tons.h^{-1}$ and 20.61 respectively, while the pattern (2 millet: 2 mung bean) gave less grain yield was 0.53 $ton.h^{-1}$ and the pattern in which the mung bean were planted alone has a biological yield of 2.91 $ton.h^{-1}$ and the lowest harvest index was 16.43 when cultivating with the pattern (2 millet: 1 mung bean). These results did not match what was mentioned by [5]. For compound fertilizer (NPK), Table (3) shows that the addition of 400 $kg.h^{-1}$ of compound fertilizer gave the highest length of the plant of mung bean of 44.18 cm and the highest biological yield of 3.32 $ton.h^{-1}$ compared with that of without addition, which gave the lowest plant length and biological yield 31.86 cm 2.88 $ton.h^{-1}$ respectively. As for the harvest index, the treatment of without addition was given the highest harvest index of 21.34 which did not differ significantly from the addition of 200 $kg.h^{-1}$ compound fertilizer and the least harvesting index was 15.72 when adding 400 kg.

Table 3: Effect of planting patterns and NPK fertilizer (20:20:20+TE) in some the qualities of growth and product in mung bean planted sole or intercrop with millet in season of 2017.

Factors	Treatments	Plant height (cm)	Chlorophyll (SPAD)	Leaf area (cm^2)	Grain yield ton.h-1	Biological yield $ton.h^{-1}$	Harvest index HI
planting patterns	S_2	31.98	43.14	45.43	0.59	2.91	20.34
	S_3	38.74	41.63	47.73	0.53	3.08	18.12
	S_4	41.08	42.35	47.36	0.57	3.48	16.43
	S_5	36.70	45.83	42.51	0.54	2.95	18.80
	S_6	38.27	45.42	48.71	0.66	3.21	20.61
	S_7	38.74	43.09	41.55	0.54	2.75	19.96
NPK fertilizer	F_0	31.86	41.45	43.24	0.60	2.88	21.34
	F_1	36.72	44.28	45.65	0.59	2.98	20.07
	F_2	44.18	45.00	47.75	0.52	3.32	15.72
LSD0.05							
planting patterns		1.21	N.S	4.42	0.03	0.12	1.12
NPK fertilizer		1.44	N.S	N.S	N.S	0.09	1.49

As for Land Equivalent Ratio (LER), Table (4) shows that presence of significant differences for Land Equivalent Ratio to millet alone and mung bean alone and the overlap between them, while the pattern S6 (3 millet: 3 mung bean) gave the highest rate of Partial Land Equivalent Ratio of millet overlapped with mung bean, 0.66 compared to millet alone, which was given a value of 1. The same pattern gave the highest Partial Land Equivalent Ratio of the overlapped mung bean with millet of 0.46 compared to the cultivation of mung bean alone, which was given a value of 1. The Total Land Equivalent Ratio of millet and mung bean gave the cultivation pattern of (3 millet: 3 mung bean) the highest ratio of 1.11 and the lowest value of 0.89 (3 millet: 4 mung bean), and these results are consistent with what [5] and [11].

Table 4: Land Equivalent Ratio for sole agriculture and intercropping for millet and mung bean in season of 2017.

planting patterns	Land Equivalent Ratio (LER)		
	Millet	**Mung Bean**	**Millet+ Mung bean**
S1	1	-	1
S2	-	1	1
S3	0.53	0.38	0.91
S4	0.63	0.35	0.98
S5	0.55	0.33	0.89
S6	0.66	0.46	1.11
S7	0.55	0.44	1.01
L.S.D 0.05	0.06	0.03	0.07

4. DISCUSSION

The cultivation of the lines of mung bean adjacent to the millet lines have a positive impact in terms of soil coverage and reduce evaporation, which helps to retain moisture [10]. Also curb the weeds accompanying the millet as a result of the coverage caused by the associated crop, which reduces its competition [4]. As well as increasing ratio of air humidity in the area surrounding by millet plants due to the process of transpiration in the leaves of mung bean, which reduces the impact of harsh temperatures and works to sustain the process of photosynthesis [7] [12]. The increase in millet was not associated with the low plant height and the leaf area of the flag leaf as shown in Table (2). This means that the plant maintained its equilibrium in terms of total vegetative, which helped in the transfer of photosynthetic products during the emergence of Panical and their number increase. As well as an increase in the number of grain sites, which is reflected in the increase in the number of cereals, as this increase is reflected in the increase in biological yield as shown in Table (2). The results confirmed that the highest yield of millet grain was obtained when cultivating with mung bean in pattern of S6 (3: 3), which amounted to 1.21 $ton.h^{-1}$ as shown in Table (2). This increase was due to the increase in the components of the yield in the unit area [5]. The grain yield is a product of the biological yield and the harvest index as shown in Table (2). Increased biological yield means more accumulation of dry matter, which is distributed between the area of the flag leaf and chlorophyll content as shown in Table (2). The cultivation pattern treatment of (S6) (3: 3) gave the highest seed yield of 0.66 $ton.h^{-1}$ as shown in Table (3). The cultivating by pattern (3 millet: 3 mung bean) leads to reduces the competition for neighboring plants and weeds. Two lines of the mung bean lines are adjacent to two lines of millet lines, which makes the competition for growth requirements less as they belong to two different types (one of them are Legume and the other is Poaceae family), The growth rate of the crop obtained from this treatment (S6), was reflected in the increase in the yield, leaf area, and chlorophyll content as shown in Table (3), which achieved a high rate of the biological yield as shown in Table (3). The increase in plant height when adding compound chemical fertilizers (NPK) is due to increased nutrient availability necessary for plant growth and soil fertility because the rapid melting of chemical fertilizers leads to increased nutrient readiness and absorption by the plant [13]. The increase of fertilizer from 200 to 400 $kg.h^{-1}$ did not significantly affect the grain yield under the intercropping system, which confirms that the need to add fertilizer under this system is less compared to individual agriculture. The response to the S6 treatment may be due to increased growth and accumulation of dry matter, biological yield and grain yield, which require more nutrients, Although the fertilization has an effect on the yield of mung bean, but the intercropping of patterns with fertilization had a significant effect in the increase of mung bean, the pattern (S6) (3: 3) gave the highest grain yield as shown in Table (3). Increased growth and biological yield require more elements, so it looks like adding 400 $Kg.h^{-1}$, which had a clear response to the properties of growth and yield and its components. For the purpose of evaluating the efficiency of the Intercropping system versus single cultivation, the concept of Land Equivalent Ratio (LER) was used, It expresses the value of the yield resulting from Intercropping using land [2][15]. The results of Table (4) shows that the Land Equivalent Ratio has increased in comparison with single cultivation and the reason for the increase in LER in the case of Intercropping may be due to mutual benefit between crops with each other and this is what is called mutual cooperation [6][15]

4. REFERENCES

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