EFFECT OF SEEDING RATES AND CUTTING DATES ON THE GROWTH TRAITS, SEED YIELD AND SEED YIELD COMPONENTS OF THE FENUGREEK *Trigonella foenum-graecum L.*

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ABSTRACT

A field experiment was conducted at the experimental farm of the field crops sciences department/ College of Agriculture/ University of Diyala during season (2016-2017) to study the effect of seeding rates (24, 36, 48 kg.h^{-1}) and cutting dates (90, 105, 120) days after cultivating on growth traits , seed yield and seed yield components of fenugreek local cultivar. The experiment was conducted with the Randomized Complete Blocks Design (RCBD) in the split plot arrangement with three replicates. The seeding rates were the main plots, while the cutting dates were assigned as a sub plots. The study showed the following results: The seeds and dates had a significant effect on all the studied traits except number of branches that were not significant in both factors. The seeding rate was 24 kg.h^{-1} and the cutting date 90 days after cultivating gave a higher seed yield 0.590 and 0.548 ton, respectively. There was a significant effect of the interaction between seed rates and mowing cutting in all studied traits.

Keywords: *Trigonella foenum-graecum*, Seeding Rates, Cutting Dates, Seed Yield.

تأثير كميات البذار و مواعيد الحش في صفات النمو و حاصل البذور ومكوناته للحلبة *Trigonella foenum-graecum* L.

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المستخلص

أجريت تجربة حقلية في الحقول العائدة لقسم المحاصيل الحقلية / كلية الزراعة – جامعة ديالى للموسم (2016-2017) لدراسة تأثير كميات البذار (24 و 36 و 48 كغم.هـ$^{-1}$) ومواعيد الحش (90 و 105 و 120) يوم بعد الزراعة في صفات النمو وحاصل البذور و مكوناته للحلبة صنف محلي، نفذت التجربة بتصميم القطاعات الكاملة المعشاة R.C.B.D بترتيب الالواح المنشقة إذ احتلت كميات البذار العامل الرئيسي ,في حين احتلت مواعيد الحش العامل الثانوي و بثلاث مكررات. أظهرت الدراسة النتائج الآتية: كانت لكميات البذار و مواعيد الحش تأثيراً معنوياً في جميع الصفات المدروسة بأستثناء صفة عدد التفرعات التي لم تكن معنوية في كلا العاملين، حققت كمية البذار 24 كغم. هـ$^{-1}$ و موعد الحش 90 يوم بعد الزراعة اعلى حاصل بذور بلغ 0.590 و 0.548 طن.هـ$^{-1}$ بالتتابع. كان هناك تأثيراً معنوياً للتداخل بين كميات البذار و مواعيد الحش في جميع الصفات المدروسة.

الكلمات المفتاحية : حلبة , كميات البذار , مواعيد حش , عدد البذور, حاصل البذور .

1. INTRODUCTION

The *Trigonella foenum-graecum* is an annual winter plant. Its green plants used as animal feed for its high content of proteins, carbohydrates and minerals such as iron, calcium and vitamins A, B and C. Its seeds are used to treat many diseases such as gout, asthma, back pain and rheumatism. As well as its role in improving soil properties and fertility by adding atmospheric nitrogen by the bacterial nodes growing at its roots as a plant of the Fabaceae. Seeding rates are one of the factors influencing the seed yield and its components, because they have a great role in determining the ideal number of plants in the area unit and therefore the lack of competition

for water and nutrients among plants, which positively reflects on seed yield and its components **[16]. McGraw [15]** noted increase in the yield of the seeds of the Lotus corniculatus and closely by increasing the plant densities while the density gave 19 plants m^{-2} higher yield of the seeds. **Rashidi [19]** showed significant differences in the average number of pods.m^{-2} Seed yield when cultivating Medicago sativa with the seeding rates of (2.5, 5, 7.5, 10, 12.5 kg.h^{-1}) and that the highest seed yield achieved at the average of 2.5 kg.h^{-1}. There were no significant differences in the number of seeds, pod^{-1} and the weight of 1000 seeds. **Tuncturk [22]** noted that there is a positive relationship between the Fenugreek plants cultivated with low seeding rates and the high average number of pods. $Plants^{-1}$ and the number of $seed^{-1}$ and 1000-seed weight compared to high seeding rates. Choosing the appropriate date for the cutting is the necessary field operation to obtain a high seed yield. **Clifford [8]** noted the average height of the seed yield when the red trifolium pretense was cut in 1/12 before it was leave to produce the seeds compared with the 1/10 and 1/11 cultivars. The researcher was attributed this result to an increase in the number of Inflorescences formed in the stems. **Khail [13]** noted that the cutting of Trifolium alexandrinum plants for one time and release it for seed production has achieved the highest average seed yield, which differed significantly with the treatment of the cutting for two times and three times. **Thapa [21]** studied the effect of non-cutting and one-time cutting and twice the seed yield and its constituents of the Pusa cultivar. He found increased the yield of seed yield and the weight of 1000 seeds in the non-cutting treatment compared to other cutting treatments. **Kamataka [12]** found that the early harvesting of the Fenugreek plants reduced the seed yield and quality due to lack of time to grow and the accumulation of carbohydrate and nutrients in the seeds. The plants of the Fenugreek give one cutting and then leave to produce the seeds. The aim of this study was to obtain green feed to the animals and then to know the effect of seeding rates and dates in the growth traits and seed yield and its components for the Fenugreek.

2. MATERIALS AND METHODS

This experiment was conducted at the experimental farm of the field crops sciences department/ College of Agriculture/ University of Diyala during season (2016-2017) to study the effect of seeding rates and cutting dates on growth traits, seed yield and its components for the fenugreek plant in the soil that with their physical and chemical properties as shown in Figure (1).

Table 1: Some physical and chemical properties of the field soil.

Measurements	Measuring unit	Field soil
PH	———	8.4
Ec	Desi Siemens.m^{-1}	2.74
N	Mg/Kg	34.8
P	Mg/Kg	13.7
K	Mg/Kg	509
Organic materials	g/ Kg	1.82
Sand	g/Kg	22%
Clay	g/Kg	24%
Tissue	———	Sandy clay

The experiment was designed according to Randomized Complete Blocks Design (RCBD) in the split plot arrangement with three replicates. The seeding rates were (24, 36, 48 kg.h^{-1}), which gave the symbols (S1, S2, S3) sequentially at the main plots, while the cutting dates were assigned as a sub plots, which are after 90, 105 and 120 days of cultivating, which have been symbolized with symbols (C1, C2, C3) respectively, After conducting the operations of the service of the soil such as tilling, smoothing and leveling in preparation for cultivation, it was divided into three replicates. Each of the replicate included three main plots with the area of the single plot 12 m^2 (2 m x 6 m) while the area of the single sub plots was (2 x 2) m^2. Cultivation was carried out on 18/10/2016 using

the local cultivar. Seeds were cultivated in the lines between 10 cm and 10 cm. In the above quantities, the seeds were covered with soil not more than 1-2 cm to ensure germination, after the cultivating, the experiment was fertilized with 200 kg of NPK fertilizer. Crop service operations were conducted as needed. The plants were collected after the arrival of the above mentioned cutting dates using a hand-operated machete. The cutting was 5 cm above the surface of the soil. The green feed yield resulted from cutting treatments of after 90 to 105 and 120 days of cultivation of (3.36, 5.76, 6.40 tons.h^{-1}), respectively was reached. And then left the plants for seed production.

Experimental measurements of vegetative growth at the end of the growth season were carried out on all experimental units and included the following traits:

1. Plant height (cm).
2. Number of branches. $Plant^{-1}$
3. Number of leaves. $Plant^{-1}$.
4. Number of pods. $Plant^{-1}$.
5. Number of seeds. pod^{-1}.
6. Weight of 1000 seeds gm.
7. The seed yield ton.h^{-1}.

Statistical data were statistically analyzed using the use of the Gen Stat program and the least significant difference was used to test the different averages at a significant level of 0.05% **[20].**

3. Results and discussion

3.1 Plant height (cm)

Table (2) shows that the effect of seeding rates in plant height traits was significant, as plant height increased by decreasing seeding rates per unit area, The S1 treatment achieved the highest average of this traits reached of (51.50 cm) compared to S3, which recorded the lowest average of (42.63 cm), This may be due to the fact that the reduction in seeding rates that it has created a favorable environment for plant growth characterized by low competition for different growth requirements and increased photosynthesis, which has been positively reflected in higher plant height compared with high seeding rates, This result is consistent with what's findings **[23]** of the increase in the height of Egyptian clover plants when cultivated it with low plant densities. Table (2) shows that the effect of the cutting date in the plant height was significant, where excelled the date of (C1) by its achievement of the highest average of this traits reached of (47.98 cm) Compared to C2 which recorded the lowest average (41.87 cm). This may be due to the fact that the plants cutting in the early stages of growth allowed the plants a long period of growth to carry out the various chemical processes of cell reconstruction and their elongation and provided sufficient time to perform photosynthesis **[6],** This results is consistent with what's the findings of both **[7, 11].** As for the effect of the interaction between the seeding rates and the cutting dates on the plant height of the Fenugreek, Table (2) shows significant differences due to the difference in the relative response between the two study factors. In treatment S1 we observe the increase in the average height of the plants in the sequence of the cutting dates. While in S2 notes that these averages lowered with the cutting dates, as for the treatment S3, the average height of plants decreased at the time of C2 before re-rising again by the date of C3.

Table 2: Effect of seeding rates, cutting dates and interaction between them on plant height (cm)

Seeding rates effect	Cutting dates			Seeding rates (Kg.h^{-1})
	C_3	C_2	C_1	
51.50	57.17	50.84	46.50	S_1
40.78	37.00	38.78	46.55	S_2
42.63	41.00	36.00	50.89	S_3
	45.06	41.87	47.98	Cutting dates effect
	Interaction	Cutting dates	Seeding rates	
	5.232	3.565	2.198	$LSD_{0.05}$

3.2 Branches number. Plant^{-1}

The results of Table (3) showed no significant differences in seeding rates in the number of major branches of the plant. The results of the same table showed no significant differences in cutting dates in this trait. The results of Table (3) indicate a significant interaction between the seeding rates and the cutting dates with difference in the relative response of the two study factors, At treatment S1, we notice an increase at the cutting date C2 before it decreases again at date of C3, As for S2, we note a decrease in the average number of branches along the cutting dates, whereas was inverted at quantity S3 where there was a direct increase in the number of branches with the sequence of the cutting dates.

Table 3: Effect of seeding rates, cutting dates and interaction between them on branches number (Plant^{-1})

Seeding rates effect	Cutting dates			Seeding rates (Kg.h^{-1})
	C_3	C_2	C_1	
4.17	3.67	5.00	3.84	S_1
3.72	2.89	3.00	3.34	S_2
3.41	3.67	3.17	3.00	S_3
	3.41	3.72	3.39	Cutting dates effect
	Interaction	Cutting dates	Seeding rates	$LSD_{0.05}$
	1.211	N.S.	N.S.	

3.3 Number Leaves (Plant^{-1})

The results shown in Table (4) indicate that there are significant differences in the seeding rates and leaves number, the treatment S1 gave the highest average reached (30.15 leaf, plant^{-1}), While the S2 gave the lowest average (19.78 leaf, plant^{-1}), which did not significantly different with the quantity S3, This may be attributed to the lack of competition between plants, food and light, which allowed for increasing of effective photosynthesis, which was positively reflected in the increase in the leaves number of the plant. Table (4) shows that there are significant differences in the cutting dates of this traits, as the date C1 gave the highest average (27.08 leaf. plant^{-1}) while C3 gave the lowest average (17.96 leaf). The increase in the number of leaves in C1 is due to the length of vegetation growth, allowing for the formation of the average number of branches in the plant as shown in Table (2) and then increase the number of leaves **[17]** this is agreed with **[2, 12].**

Table (4) shows significant interaction between the two study factors. This is due to the difference in the relative response of the seeding rates to the effect of the dates in two factors. In S1 and S3, we notice the average leaves number in the plant at date of C2 before falling again at date of C3, While S2 gave a decrease in the leaves number formed by sequence of the cutting dates.

Table4: Effect of seeding rates, cutting dates and interaction between them on leaves number (plant^{-1})

Seeding rates effect	Cutting dates			Seeding rates (Kg.h^{-1})
	C_3	C_2	C_1	
30.15	22.11	34.67	33.67	S_1
19.78	14.34	20.00	25.00	S_2
21.89	17.44	26.56	21.67	S_3
	17.96	27.08	26.78	Cutting dates effect
	Interaction	Cutting dates	Seeding rates	$LSD_{0.05}$
	8.885	5.214	6.789	

3.4 Pods number (pod^{-1})

The results shown in Table (5) indicate that there are significant differences in the seeding rates in the average number of pods in plant, the quantity S1 giving the highest average of (12.45 pod. Plant^{-1}) while the quantity S2 gave the lowest average of (7.41 pod. Plant^{-1}). The decrease in the total pods number of plant in high seeding rates may be due to the competition between plants for light, water and other essential nutrients, which reduces the size of the plant and the number of fruit branches formed and thus reduces the pods number in the plant **[4],** this is consistent with **[18].** The results of Table (5) showed that the effect of cutting dates in this trait was significant, where treatment C1 gave the highest average of (11.85 pod. plant^{-1}); While C3 gave the lowest average reached of (8.11 pod. plant^{-1}). While C3 was given the lowest average. The reason is that the cutting in the early stages of crop growth led to positive reactions to the plant, which slowed the vegetative growth of the plant and increased the number of flowers as well as the pods number **[14],** this is consistent with **[11, 12].** As for the interaction between the two study factors, it was significant in the relative response to seeding rates by the effect of cutting dates as shown in the results of Table (5), In two treatments S1 and S2, we notice a decrease in the pods number of the plant at date of C2 and then increased again at the date of C3. As for the treatment S3, we note that the average pods number decreased during the same dates.

Table 5: Effect of seeding rates, cutting dates and interaction between them on pods number. Plant^{-1}

Seeding rates effect	Cutting dates			Seeding rates (Kg.h^{-1})
	C_3	C_2	C_1	
12.45	11.67	10.34	15.34	S_1
7.41	8.00	5.56	8.67	S_2
8.63	4.67	9.67	11.55	S_3
	8.11	8.52	11.85	Cutting dates effect
	Interaction	Cutting dates	Seeding rates	$LSD_{0.05}$
	4.227	2.603	2.937	

3.5 Seeds number (pods^{-1})

The results of Table (6) showed that there were significant differences between the seeding rates of in the average seeds number for pod, The seed yield of S1 gave the highest average reached of (13.15 seed.pod^{-1}), while the quantity S3 achieved the lowest average for this trait reached of (10.03 seed.pod^{-1}),The reason for the low seeds number in treatment S3 is due to the intense competition between plants for growth requirements and therefore the low ability of the plant to provide the largest seeds number in pod **[5].** This is agreed with **[10].** The same table showed there is a significant effect of cutting dates in this trait, where the date of C1 gave the highest average of (13.35 seed.pod^{-1}); While C3 gave the lowest average of (9.97 seed.pod^{-1}). This is due to the fact that the cutting in the early stages of crop growth led to positive reactions to the plant, which slowed the vegetative growth process and increased the flowers number **[14]** this is agree with **[11, 7].** Table (6) shows that there is a significant interaction between the two study factors, and it is clear that the seeds rates are affected by the cutting dates. The reason for the interaction between the two factors is due to the difference in the relative response between the levels of the first factor by affecting the second factor, In treatment S1, we note that the average seeds number in pod decreased by date of C3, As for the S2 treatment, the results indicate that the pods number decreased in date of C2 before rising again at date of C3, As for treatment S3, we notice a decrease in the pods number of the plant in sequence of cutting dates.

Table 6: Effect of seeding rates, cutting dates and interaction between them on Seed number.Pod^{-1}

Seeding rates effect	Cutting dates			Seeding rates (Kg.h^{-1})
	C_3	C_2	C_1	
13.15	12.50	13.47	13.47	S_1
11.53	10.67	9.46	14.47	S_2
10.03	6.73	11.27	12.1	S_3
	9.97	11.4	13.35	Cutting dates effect
	Interaction	Cutting dates	Seeding rates	$LSD_{0.05}$
	3.181	1.765	2.624	

3.6 Weight of 1000 seeds

It is cleared from Table (7) that there are significant differences between the seeding rates in the weight of 1000 seeds (g), Where the quantity S1 recorded the highest average reached of (10.06 g), While treatment S2 gave the lowest average reached of (8.05 g) this is due to the fact that the cultivation of plants in small seeding rates led to an increase in the branches number and the result of the biological yield. Thus increasing the light interception, leading to an increase in the processed materials from photosynthesis which transmitted to the seeds and thus increase the weight compared to high seeding rates **[18]** this is agree with **[1, 24].** It is also noted from the same table that there are significant differences of cutting dates in this trait, the date of C1 achieved the highest average reached of (9.28 g), While the date of C2 gave the lowest average reached of (8.27 g).This is because cutting in the early stages of crop growth reduced vegetative growth process of plant and increased flowering, pods, seed yield and weight of 1000 seed. The later pieces caused poor flower production and delayed emergence of inflorescences, which eventually resulted in a decrease in the seeds number and weight of 1000 seed **[7].** These results are agreed with **[14, 17].**The data shown in Table (7) indicate a significant interaction between the two factors. This is due to the difference in the relative response of seeding rates and cutting dates, In the two treatments S1 and S2, we note that the average weight of 1000 seed at date of C2 is low before returning to rise again at C3, In the S3 treatment, the table indicates that the average weight of 1000 seeds is higher than the date of C2 and remains unchanged at date of C3.

Table 7: Effect of seeding rates, cutting dates and interaction between them on weight of 1000 seeds (g)

Seeding rates effect	Cutting dates			Seeding rates (Kg.h^{-1})
	C_3	C_2	C_1	
10.06	9.95	8.92	11.30	S_1
8.05	8.30	7.30	8.55	S_2
8.40	8.60	8.60	8.00	S_3
	8.95	8.27	9.28	Cutting dates effect
	Interaction	Cutting dates	Seeding rates	$LSD_{0.05}$
	1.000	0.645	0.601	

3.7 Seed yield (ton. h-1)

It is cleared from Table (8) that there are significant differences between the seeding rates in this trait, where the quantity S1 achieved the highest average reached of (0.178 ton.h^{-1}), and an increase of 70%. This may be due to the recording of treatment S1 for the highest average to each of the pods number. Plant^{-1} and seeds number.pod^{-1} and the weight of 1000 seeds as shown in Table (5, 6, 7) respectively. As well as this treatment gave the highest plant height as shown in Table (2).

This is agree with **[25]** in the existence of a positive correlation between the seed yield in the plants of the fenugreek and plant height. The same table shows significant differences between the cutting dates in seed yield trait, the date C1 recorded the highest average of (0.548 ton.h^{-1}). While the date C3 achieved the lowest average of (0.144 ton.h^{-1}), an increase of 73.7%. This increase is due to the achievement of the date C1 for the highest average to each of pods number, and the seeds number and weight of 1000 seed, thus the seed yield as shown in Table (5, 6, 7). This is agreed with **[3, 12].**

Table (8) shows a significant interaction between the two factors due to the difference in the relative response to the seeding rates and the cutting dates, In the two treatments S1 and S3, we note that the average seed yield reduced by sequence of cutting dates, As for the quantity S2, the results show a decrease in the average seed yield at the date of C2 before returning to rise again at the date of C3.

Table 8: Effect of seeding rates, cutting dates and interaction between them on Seed yield (ton.h^{-1})

Seeding rates effect	Cutting dates			Seeding rates (Kg.h^{-1})
	C_3	C_2	C_1	
0.590	0.141	0.573	1.057	S_1
0.219	0.143	0.097	0.418	S_2
0.178	0.147	0.218	0.169	S_3
	0.144	0.296	0.548	Cutting dates effect
	Interaction	Cutting dates	Seeding rates	$LSD_{0.05}$
	0.259	0.136	0.259	

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