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Response Growth Characteristics of two Sorghum Cultivars to the Application Timing of Nitrogen

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Abstract

An experiment in field was carried out during the fall season of 2021 at the Agricultural Research Station of the College of Agriculture - Al-Muthanna University in the Al-Bandar area, which is 2 km from the center of the city of Samawah, in order to know the effect of application timing of nitrogen according to the different growth stages on growth characteristics of two sorghum cultivars .The experiment was applied according to the randomized complete block design (R.C.B.D.) with split plot arrangement and three replications, as two cultivars of the sorghum crop (Rabeh and Local) occupied the main panels, while the sub plots occupied application timing of nitrogen that included (half the quantity at sowing + half after 45 days of sowing, half at the stage of 4 leaves + half at the beginning of the boot stage, half at the stage of 4 leaves + half at the stage of 50 % flowering, and one third at the stage of 4 leaves + one third at the stage of boot + one third at the stage 50 % flowering) and its symbol (N1, N2, N3, N4) respectively. The results have showed that the application timing of nitrogen N4 with one third at the stage of 4 leaves + one

third at the stage of boot + one third at the stage 50 % flowering was significantly superior, as it gave the least number of days from sowing until the 50% flowering stage (66.50 days) and it gave the highest rates in the leaves content of nitrogen, growth crop rate (CGR), plant height and leaf area ,with averages (2.56% , 5.12 gm $m^{-2}day^{-1}$, 131.58 cm and 4087cm^2 , respectively). The cultivars differed asignificantly in the most qualities of growth traits of the cultivar (Rabeh)) gave the highest average of leaves content of nitrogen, growth crop rate (CGR) and plant height,with averages (2.53% , 5.06 gm $m^{-2}day^{-1}$ and 129.41 cm, respectively . The interaction effect between the study factors was significant only in the trait of number of days from sowing until the 50% flowering .

Keywords: timing of nitrogen , cultivars, growth traits, sorghum.

1.Introduction

The sorghum crop (*Sorghum bicolor* L. Moench) is one of the most important cereal and fodder crops globally. It is grown for the production of grains that are used for human and animal nutrition and it is one of the most important fodder grain crops that is important in Iraq and the world. This crop ranks fifth in the world in terms of importance and grain production after rice, wheat, maize, and barley. Agriculture is carried out in Iraq for various purposes, including grain production and increasing green fodder and its importance increases as a result of the increasing demand for its grains in the local markets to feed poultry and prepare rations for fattening cattle by 50%, as well as the use of its stems and vegetative group as green fodder and in the hay and silage industry. One of the advantages of this crop is its high tolerance, high salinity and drought , and the number of beetles increases when temperatures rise in the summer[1- 2].

Despite the importance of this crop in Iraq and the availability of the appropriate environment of climate, water and soil, its productivity is still declining compared to global production , which invites us to think seriously about the search for means and techniques that increase production and maintain a clean environment, including paying attention to added chemical fertilizers and reaching a balance between the added quantities that are appropriate for the appropriate crop growth stages to achieve the highest utilization of mineral elements by the plant and improve its growth and productivity, as the use of nitrogen fertilizers is the highest in the world compared to other fertilizers in the agricultural field. Loss of many added nitrogen fertilizers occurs through volatilization processes, especially under conditions of calcareous Iraqi soils, reverse nitrification and washing . To control the liberation of nitrogen and reduce its loss, nitrification inhibitors, urease inhibitors, and low water soluble compounds were used [3].

The Iraqi soils in the south of Iraq suffer from a deterioration in the fertility content as a result of mismanagement of the crop in its various stages of growth and intensive cultivation and the failure to add nutrients in a timely manner, which caused a

decrease in productivity and an increase in environmental problems. Therefore, this study aims for knowing the response of sorghum to the dates of nitrogen addition, its components and quality, and determining the best combination of study factors and reducing the volume of environmental pollution by reducing the amount of nitrogen fertilizer by reducing its loss through different application times.

2.Materials and Methods

Random samples were taken from different places of the soil of the field before planting and at a depth of (0-30) cm. After that, all samples were mixed, and a comprehensive sample was extracted from it, which was air-dried and passed through a sieve with a diameter of 2 mm. Some of the chemical and physical properties of the soil were obtained as shown in the (Table 1).

The experiment was applied according to the randomized complete block design RCBD with split plot arrangement and three replications, as two cultivars of the sorghum crop (Rabeh and Local) occupied the main panels, while the sub plots occupied application timing of nitrogen that included (half the quantity at sowing + half after 45 days of sowing, half at the stage of 4 leaves + half at the beginning of the boot stage, half at the stage of 4 leaves + half at the stage of 50 % flowering, and one third at the stage of 4 leaves + one third at the stage of boot + one third at the stage 50 % flowering) and its symbol (N1, N2, N3, N4) respectively.The experimental land was plowed with two orthogonal plows, and then smoothing and leveling operations were carried out and the field was divided according to the design used into 72 experimental units, at the rate of 24 experimental units for each replicate, then the seeds of the Rabeh and Local cultivar were sown to achieve a plant density of 80,000 plants h-1 by planting in experimental units of dimensions (2 × 2.5). m^2, with an area of 5.0 m2, each experimental unit contains 5 lines, a length of 2 m for each line, a distance of 50 cm between one line and another, and the distance between pockets is 25 cm. The experiment was fertilized with mono super phosphate fertilizer (P2O5 22%) when planting at a rate of 200 kg per hectare of element P.

Nitrogen fertilizer was added in the form of urea fertilizer at a rate of 400 kg h^{-1} [4]. This fertilizer was divided according to the times of nitrogen addition used in the experiment.

The granular diazinon pesticide (10% effective substance) was used at a rate of 6 kg per hectare for the preventive control of the corn stalk borer (*Sesamia criteco*) as it was added as a feeding by placing granules of the pesticide at the growing apex of the plant in two batches, the first was three weeks after planting and the second batch two weeks after the first control.

Table 1 : Some chemical and physical properties of the experiment soil before planting.

Properties		**Unit**	**Value**
Electrical conductivity (Ec)		ds m-1	5.9
pH of soil		-	7.3
Organic mater		(%)	1.6
Available nitrogen		Ppm	17.64
Available phosphorus		Ppm	11.46
Available potassium		Ppm	130.24
Soil properties	Sand	(%)	624
	Silt	(%)	211
	Clay	(%)	165
Soil texture		Sandy Loam	

3.Studied Traits

3.1. Number of days from sowing until the 50% flowering stage(days)

It was calculated on the basis of the number of days from sowing until the 50% flowering stage for the plants of the lines middle for each experimental unit.

3.2. leaves content of nitrogen (N%)

The leaves content of nitrogen was calculated at the 50% flowering stage as an average of ten plants taken randomly from the midlines of each experimental unit.

3.3. Growth Crop Rate(CGR) (gm $m^{-2}day^{-1}$)

CGR = (1 / A) × {(W2-W1) / (T2-T1)}

3.4. plant height (cm)

The height of ten plants from the soil surface to the node below the inflorescence was randomly measured from the midlines of each experimental unit after flowering was completed, and then an average was taken.

3.5. leaf area (cm^2)

Leaf area was calculated by measuring leaf length x maximum width x 0.75, and for all plant leaves as the mean of the ten plants from the midlines of each experimental unit after flowering was completed .

4.Results and Discussion

4.1.Number of Days from Sowing until the 50% Flowering Stage

It is noted from the results of Table 2 that the application timing of nitrogen N4 with one third at the stage of 4 leaves + one third at the stage of boot + one third at the stage 50 % flowering was significantly superior, as it gave the least number of days from sowing until the 50% flowering stage (66.50 days). It seems that the addition of nitrogen increasing the efficiency of photosynthesis, which accelerated the growth of the plant and its transition to the reproductive growth stage, and thus reduced the time required to reach the flowering stage), agreed with [5].

The results of Table 2 indicates the superiority of Rabeh cultivar in giving the highest average of days from sowing until the 50% flowering stage (70.33 days), while Local cultivar gave the lowest average (65.17days), agreed with [6].

The interaction between the two factors of study was significant in the average number of days from sowing until the 50% flowering stage (Table 2), as Local cultivar with nitrogen timing application N4 with one third at the stage of 4 leaves + one third at the stage of boot + one third at the stage 50 % flowering achieved the least value of the interaction, which amounted to 64.67days, while Rabeh cultivar with nitrogen timing application N3 with half at the stage of 4 leaves + half at the stage of 50 % flowering had the highest value of interaction, which was 72.67days.

Table 2. Effect of application timing of nitrogen on the number of days from sowing until the 50% flowering (day)

	Nitrogen timing application				
cultivars	**N1**	**N2**	**N3**	**N4**	**Average**
Rabeh	70.00	70.33	72.67	68.33	70.33
Local	65.67	65.00	65.33	64.67	65.17
LSD 0.05			1.06		1.29
Average	67.83	67.67	69.00	66.50	
LSD 0.05			0.64		

4.2. leaves content of nitrogen (N%)

Table 3 showed that asignificant increase of leaves content of nitrogen by application timing of nitrogen at N4 one third at the stage of 4 leaves + one third at the stage of boot + one third at the stage 50 % flowering, gave the highest average (2.56%), while the addition treatment N1 at the half the quantity at sowing + half after 45 days of sowing gave the lowest average (2.30%). The reason may be attributed to this treatment had the shortest number of days from sowing until the 50% flowering stage (Table 2) and increased efficiency of the nitrogen when adding at this stage, thus positively reflected in increasing of the leaves content of nitrogen.

The results also showed that cultivars affected this trait , as the Rabeh cultivar gave the highest average (2.53%), while the Local cultivar gave the lowest average (2.34%). The reason is due to the genetic differences between the two cultivar , agreed with[7].

The results of Table 3 indicate the interaction between the two factors was not significant differences in this trait.

Table 3. Effect of application timing of nitrogen on the leaves content of nitrogen(N%)

	Nitrogen timing application				
cultivars	**N1**	**N2**	**N3**	**N4**	**Average**
Rabeh	2.40	2.56	2.50	2.67	2.53
Local	2.21	2.33	2.37	2.45	2.34
LSD 0.05		N.S			0.12
Average	2.30	2.45	2.44	2.56	
LSD 0.05		0.07			

4.3 Growth Crop Rate(CGR) (gm $m^{-2}day^{-1}$)

Table 4 indicates that there were significant differences in the growth crop rate, the addition treatment N4 one third at the stage of 4 leaves + one third at the stage of boot + one third at the stage 50 % flowering gave the highest average of CGR reached 5.12 gm $m^{-2}day^{-1}$. Whereas, the addition treatment N3 with half half at the stage of 4 leaves + half at the stage of 50 % flowering gave the lowest average of CGR of 4.76 gm $m^{-2}day^{-1}$. The reason for the increase in the average of CGR may be attributed to decrease the average of the leaves content of nitrogen for this treatment (Table 3) .

The results of Table 4 indicate that cultivars had significantly affected this trait with Rabeh cultivar achieved the the highest average of CGR of 5.06 gm $m^{-2}day^{-1}$ compared to Local cultivar that achieved the longest average of CGR of 4.85 gm $m^{-2}day^{-1}$ agreed with[8].

The interaction between factors of study was non - significant in the average of this trait (Table 4) .

Table 4. Effect of application timing of nitrogen on Growth Crop Rate(CGR) (gm $m^{-2}day^{-1}$)

	Nitrogen timing application				
Cultivars	**N1**	**N2**	**N3**	**N4**	**Average**
Rabeh	5.08	5.10	4.82	5.23	5.06
Local	4.80	4.91	4.69	5.01	4.85
LSD 0.05			N.S		0.13
Average	4.94	5.01	4.76	5.12	
LSD 0.05			0.08		

4.4. plant height (cm)

It appears from Table 5 that the treatment of timing application N4 with one third at the stage of 4 leaves + one third at the stage of boot + one third at the stage 50 % flowering achieved the highest average of plant height of 131.58 cm, while the treatment of timing application N3 with half at the stage of 4 leaves + half at the stage of 50 % flowering gave the lowest average of plant height of 121.25 cm .

The results of Table 4 indicate that cultivars had significantly affected this trait with Rabeh cultivar achieved average of plant height of 129.41 cm compared to Local cultivar that achieved the longest average of plant height of 123.13 cm , agreed with[9-10].

The results of Table 5 appears that non- significant differences in the interaction between the two factors in this trait.

Table 5. Effect of application timing of nitrogen on plant height (cm)

	Nitrogen timing application				
Cultivars	**N1**	**N2**	**N3**	**N4**	**Average**
Rabeh	126.53	131.00	124.57	135.53	129.41
Local	122.13	124.80	117.93	127.63	123.13
LSD 0.05			N.S		2.85
Average		127.90	121.25	131.58	
	124.33				
LSD 0.05			3.31		

4.5. leaf area (cm^2)

The results of Table 6 indicate that the treatment of timing application N4 with one third at the stage of 4 leaves + one third at the stage of boot + one third at the stage 50 % flowering achieved the highest average of leaf area of 4087 cm^2 , while the treatment of timing application N3 with half at the stage of 4 leaves + half at the stage of 50 % flowering gave the lowest average of leaf area of 3734 cm^2 . The reason may be attributed to this treatment N4 had the highest average of growth crop rate CGR and plant height (Table 4-5) and increased efficiency of the nitrogen when adding at this stage, thus positively reflected in increasing of the leaf area cm , agreed with[11].

The affected of two cultivar and the interaction between the two factors of this study were non-significant in the average of leaf area (Table 6) .

Table 6. Effect of application timing of nitrogen and on leaf area (cm^2)

Cultivars	**Nitrogen timing application**				
	N1	**N2**	**N3**	**N4**	**Average**
Rabeh	4019	4063	3861	4102	4011
Local	3877	4022	3608	4072	3894
LSD 0.05			N.S		N.S
Average	3948	4042	3734	4087	
LSD 0.05			91.9		

Conclusions

We conclude that the fractionation of the amount of nitrogen in order to reduce nitrogen from the soil and increase plant utilization of it , and adding it at the appropriate stage of growth, especially when using three stage for nitrogen timing, which led to an increase in the growth traits for sorghum.

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