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The effect of cutting and foliar application of nano-super fertilizer on some growth traits and green and dry forage yield of triticale (Triticosecale wittmack X)

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I. Abstract

A field experiment was conducted during the 2024–2025 winter season at the agricultural field of the Faculty of Agriculture, Karmat Ali, Basra Governorate, to estimate the impact of cutting and foliar application of nano- fertilizer on some growth traits and green and dry forage yield of triticale (Triticosecale wittmack X). The study included two factors: the first factor consisted of four genotypes (Mohannad, Liron-5, Amal-7, and Farah), labeled as G1, G2, G3, and G4, respectively. The second factor three concentrations of foliar nano-super fertilizer (0, 4, and 6 g L^{-1}), labeled as N1, N2, and N3. The experiment was conducted by using a factorial experiment under Randomized complete block design (RCBD) with three replications. Growth parameters and forage productivity, including green, dry, and total green forage yield, were evaluate. The findings indicated that increasing nano-super fertilizer levels led to significant enhancements in growth characteristics and forage yield. Fertilizer level N3 (6 g L^{-1}) produced the highest plant height, number of tillers, leaf- stem ratio, green forage yield, dry forage yield, and total green forage yield (90.42 and 98.58 cm; 467.83 and 481.83 tillers m^{-2}; 76.30% and 75.45%; 20.72 and 21.97 $Mg.ha^{-1}$; 7.395 and 8.102 $Mg.ha^{-1}$) for the first and second cuttings, respectively. Genotype G2 recorded the highest mean values for plant height, number of tillers, and green and dry forage yield. Significant interactions were observed between fertilizer levels and genotypes across all measured traits.

Keywords : *Triticale, Nano-super fertilizer, Forage productivity, Genotype.*

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II. Introduction

Triticale (*Triticosecale Wittmack* X) is a hybrid crop made by crossing wheat with rye, with the aim of combining the grain quality of wheat with the vigor and environmental resilience of rye. This crop is characterized by a high capacity to adapt to poor soil conditions and climatic stresses, in addition to producing high grain and biomass yields which makes it a dual-purpose crop for forage and grain production (Glamoclija et al., 2018).

Recent studies show that triticale possesses good nutritional value in terms of protein content and balanced amino acid composition, making it suitable for both human and animal consumption. Though the application of triticale as a good quality forage crop is well known, the rate at which farmers cultivate it is very low in Iraq as the farmers are not aware of the economic and physiological significance of this crop. Thus, there is need to widen the cultivation of triticale especially in terms of increasing the yield by applying contemporary methods, such as implementation of new high yielding cultivars. The genetic structure and their adaptation to the conditions in various regions are some of the primary aspects that currently shape the modern agriculture due to their direct dependency on the conditions of the surrounding areas and reflected in the growth characteristics, the resulting yield, and quality, which, in turn, depend on the extent to which they are adapted to the environmental conditions (Al-Aboudi, 2019).

Among the latest methods of plant nutrition and enhancement of agricultural productivity, nano-super fertilizer should be mentioned. It combines the concepts of nanoscience and the latest technologies of manufacturing fertilizers with the aim to be the most efficient in the process of plant nutrient provision. These fertilizers are founded on the transformation of macro- and micronutrients into the nanoparticles with large surface area that enhances the speed of biological uptake via roots and leaves and diminishes losses following leaching or fixation in the ground (Reena et al., 2018). The next significant thing is that these fertilizers are a potential successful alternative to chemical fertilizers that contaminate the environment of agriculture and lower the levels of nitrates in the soil (Ali and Al-Jawthari, 2019). The use of nanotechnologies in fertilization practices is one of the steps in the sustainability of agriculture based on the effective use of resources and helps to increase food security in the framework of growing climatic and economic issues. Accordingly, this study aims to evaluate the response of different genotypes to varying nano-spray fertilizer concentrations, in order to determine the optimal green and dry forage yield across two cuttings.

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III. Materials and Methods

A field experiment conducted at the winter growing season of 2024–2025 at the agricultural field of the Faculty of Agriculture, Karmat Ali site, Basra Governorate, on soil with a clay loam texture. The experiment aimed to detect the impacting of cutting and foliar application of nano- fertilizer on certain growth traits and on green and dry forage yield of triticale cultivars. The study included two factors. The first factor consisted of four Genotypes (Mohannad, Liron-5, Amal-7, and Farah), which were coded as G1, G2, G3, and G4, respectively. The second factor included three concentrations of nano-super fertilizer applied as foliar spray (0, 4, and 6 g L^{-1}), labeled as N1, N2, and N3, respectively.

A factorial experiment was carried out under a randomized complete block design (RCBD) with three replicates . The factorial treatments of the Genotypes were randomly distributed within each block. The land was divided into plots, with each experimental unit measuring 1.5 m × 2 m. Each plot contained 10 rows, with a row length of 1.5 m and a spacing of 20 cm between rows. Sowing was carried out on 1 November 2024 for all experimental units. Irrigation was applied immediately after sowing, while subsequent irrigations were provided as required. The nano-fertilizer concentrations were sprayed early in the morning in two applications: the first was at the vegetative growth phase and the second after the first cutting. Liquid detergent solution was employed as a surfactant to increase absorption efficiency by reducing the surface tension of water, whereas the control treatment was sprayed with distilled water only. Urea (46% N) was used as the nitrogen source and applied in two split applications: the first at a rate of 120 kg N ha^{-1}, 15 days after sowing, and the second at the stem elongation stage (Al-Abdullah, 2015). Phosphorus fertilizer was also applied at a rate of 100 kg P_2O_5 ha^{-1} in the form of triple superphosphate (20% P), as a single dose before sowing (Al-Morshedy, 2023).

All data were analyzed statistically using ANOVA for each studied trait, and the means of treatments were compared by the least significant difference (LSD) test at a 5% probability level, Al-Rawi and Khalaf Allah (1980). The measured traits include

1. Plant height (cm)
2. Number of tillers m^{-2}
3. Leaf to stem ratio (%)
4. Yield of green forage ($Mg.ha^{-1}$)
5. Dry forage yield ($Mg.ha^{-1}$)
6. Total green forage yield ($Mg.ha^{-1}$)

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IV. Results and Discussion

1. Plant height (cm)

Table 1 illustrates the superiority of plants treated with the N3 fertilizer concentration, which achieved the highest plant height, 90.42 cm and 98.58 cm for the first and second cuttings, respectively. , in comparison to the control treatment N1, which showed the lowest plant height, 77.50 and 86.75 cm for the first and second cuttings, respectively. his increase can be attributed to the sufficient nutrients provided by the nano-fertilizer, which likely enhanced gibberellin production within plant tissues. Consequently, cell division and elongation were promoted, positively influencing plant height. These results are consistent with previous findings of Al-Hassani (2021).

The results in Table 1 also indicated the superiority of genotype G2, which recorded the highest average plant height of 93.00 cm and 102.22 cm for the first and second cuttings, respectively, compared to genotypeG1, which showed the lowest plant heights 73.00 cm and 82.89 cm for the first and second cuttings, respectively. This variation can be attributed to the genetic variation amongst the genotype. These findings are consistent with the findings by Al-Shammari (2021). Regarding the interaction effect between fertilizer concentrations and genotypes, a significant difference was observed for this trait in both cuttings. The combination of genotype G2 and fertilizer concentration N3 resulted in the highest mean plant height, reaching 106.33 and 113.67 cm for the first and second cuttings, respectively. In contrast, the interaction between genotype G1 and fertilizer concentration N2 produced the lowest plant height (70.67 cm) at the first cutting, while at the second cutting, the interaction between genotype G1 and fertilizer concentration N3 resulted in the lowest plant height (81.33 cm), with no significant difference compared to some other interactions.

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Table (1): Effect of Genotypes, nano-super fertilizer concentrations, and their interaction on plant height (cm) at the first and second cuttings.

First Cutting				
Genotypes	**Nano-super fertilizer concentrations**			**Mean of Genotypes**
	N1	N2	N3	
G1	75.67	70.67	72.60	73.00
G2	83.33	89.33	106.33	93.00
G3	71.33	72.67	85.33	76.44
G4	79.67	81.00	97.33	86.00
Mean of nano-super fertilizer	77.50	78.42	90.42	
LSD (0.05)	Genotypes	Nano-super fertilizer	Genotypes × nano-super fertilizer	
	3.110	2.693	5.386	
Second Cutting				
Genotypes	**Nano-super fertilizer concentrations**			**Mean of Genotypes**
	N1	N2	N3	
G1	85.00	82.33	81.33	82.89
G2	93.00	100.00	113.67	102.22
G3	80.33	83.33	93.67	85.78
G4	88.67	92.33	105.67	95.56
Mean of nano-super fertilizer	86.75	89.50	98.58	
LSD (0.05)	Genotypes	Nano-super fertilizer	Genotypes × nano-super fertilizer	
	3.070	**2.659**	**5.317**	

2. Number of tillers (tillers m⁻²)

The findings in Table 2 show that nano-fertilizer concentration levels had a significant effect on this trait . The highest number of tillers was recorded on plants treated using fertilizer concentration N3, with the first and second cuttings having a value of 467.83 and 481.83 tillers m $^{-2}$, respectively. The control N1, on the other hand, gave the lowest number of tillers with 429.00 and 457.08 tillers m^{-2} of the first and second cutting respectively. This growth can be attributed to the fact that nano-fertilizers have unique characteristics of being more efficient and viable in providing nutrients to plants than the traditional mineral fertilizers. This prompts more nutrient content in the plant, more growth and division in the meristematic cells and greater metabolic activity that leads to very vigor growth in vegetation and more efficient root system that has the ability to absorb nutrients. As a result, plant potential in terms of tiller development is enhanced. These results are in agreement with the findings of Burhan (2018).

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Table 2 also reveals that there are significant differences in the genotype regarding this trait. The highest mean tiller numbers were observed in genotype G2, reaching 474.67 and 497.89 tillers m^{-2} at the first and second cuttings, respectively, compared with genotype G1, which recorded the lowest means 415.44 and 438.44 tillers m^{-2}at the first and second cutting respectively. This variation is likely due to genetic differences, which influence the cultivar's capacity to produce tillers. These findings are in agreement with those reported by Al-Jabri (2020) and Sajit (2022).

Concerning the interaction between fertilizer concentrations and cultivars across the two cuttings, the combination of cultivar G2 with the N3 fertilizer produced the highest number of tillers, averaging 502.00 and 516.00 tillers m^{-2} for the first and second cuttings, respectively. In contrast, the combination of cultivar G1 with the N1 control treatment recorded the lowest tiller numbers, with averages of 390.67 and 419.67 tillers m^{-2}. This difference is likely due to the inherent genetic potential of the cultivars to produce tillers.

Table (2): Genotypes, nano-super fertilizer concentration, and its interaction with the Genotypes and their effect on the number of tillers (tillers m $^{-2}$) during the first and second cuttings...

First Cutting				
Genotypes	**Nano-super fertilizer concentrations**			**Mean of Genotypes**
	N1	N2	N3	
G1	390.67	418.33	437.33	415.44
G2	463.00	459.00	502.00	474.67
G3	423.33	409.33	450.67	427.78
G4	439.00	440.33	481.33	453.56
Mean of nano-super fertilizer	429.00	431.75	467.83	
LSD (0.05)	Genotypes	Nano-super fertilizer	Genotypes × nano-super fertilizer	
	1.846	1.599	3.197	
Second Cutting				
Genotypes	**Nano-super fertilizer concentrations**			**Mean of Genotypes**
	N1	N2	N3	
G1	419.67	444.33	451.33	438.44
G2	492.67	485.00	516.00	497.89
G3	446.33	435.33	464.67	448.78
G4	469.67	466.33	495.33	477.11
Mean of nano-super fertilizer	457.08	457.75	481.83	
LSD (0.05)	Genotypes	Nano-super fertilizer	Genotypes × nano-super fertilizer	
	3.708	3.211	6.422	

3. Leaf-to-stem ratio (%)

As shown in Table 3, the results indicate that the application of fertilizer N3 concentration N3 gave the highest ratio of the leaf to stem of 76.30% and 75.45% in first and second cuttings respectively. On the other hand, the least values of at fertilizer concentration N1 57.58 % and 57.78 % in the first and second cuttings respectively. This could be associated with the decrease in the height of the plants and the presence of more tillers with repeated cutting, which have the positive impact on the leaf-to-stem ratio of the crop. Also, the beneficial effect of nano-fertilizer on cell division causes an increase in the leaf number and size , as a result, both leaf size and number were increased, consistent with the findings reported by Nasser and Al-Shweily (2014).

Regarding the genotypes, G3 showed the highest leaf-to-stem ratio, with mean values of 68.90% and 68.68% for the first and second cuttings, respectively. The differences observed can be explained by the difference in the response of triticale genotypes due to genetic variability of triticale genotypes. It was also observed that the successive cuttings reduced the height of the plant which resulted in an increment of the leaf-to-stem ratio by repeated cutting. These results are consistent with those of the study conducted by Al-Qaisi (2001) and Al-Qaisi (2005) who concluded that there were strong differences between genotypes of this trait. As to the relationship between fertilizer concentration and genotypes, the highest mean values were obtained with fertilizer concentration N3 and genotype G3 that produced 88.95% and 88.075% in the first and second cuttings, respectively. On the other hand, the interaction of G4 genotype with N1 fertilizer gave the least mean values, which were 55.43 % and 55.63 % in the first and second cuttings, respectively.

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Table (3): The impact of Genotypes, concentrations of nano-super fertilizer and their interaction with leaf-to-stem ratio (%) at the first and second cuttings..

First Cutting				
Genotypes	Nano-super fertilizer concentrations			Mean of Genotypes
	N1	N2	N3	
G1	59.08	66.05	73.92	66.35
G2	60.60	50.28	81.76	64.21
G3	55.22	62.51	88.95	68.90
G4	55.43	61.48	60.55	59.16
Mean of nano-super fertilizer	57.58	60.08	76.30	
LSD (0.05)	Genotypes	Nano-super fertilizer	Genotypes × nano-super fertilizer	
	3.022	2.617	5.234	
Second Cutting				
Genotypes	**Nano-super fertilizer concentrations**			**Mean of Genotypes**
	N1	N2	N3	
G1	58.26	65.05	73.04	65.45
G2	60.80	49.31	81.06	63.73
G3	56.42	61.56	88.07	68.68
G4	55.63	60.89	59.62	58.71
Mean of nano-super fertilizer	57.78	59.20	75.45	
LSD (0.05)	Genotypes	Nano-super fertilizer	Genotypes × nano-super fertilizer	
	3.034	2.628	5.256	

4. Green forage yield (Mg.ha^{-1})

The results presented in Table 4 show that the N3 fertilizer concentration produced the highest average green forage yield, 20.72 and 21.97 Mg.ha^{-1} for the first and second cuttings, respectively. This represents an increase of 42.11% and 23.35% compared to the control treatment N1, which recorded the lowest averages of 14.58 and 17.81 Mg.ha^{-1} for the first and second cuttings, respectively. This growth might be due to the fact that enough nutrients were provided by the nano-fertilizer thus contributing to the growth of the plant in height, leaf to stem ratio and the number of tillers (Tables 1, 2 and 3). The overall development of the components led to increased green forage yield. The results agree with the ones of (Buhedma et al.,2016 and Hassanein et al.,2018).

Table 4 also reveals that genotype G2 recorded the highest mean green forage yield at both cuttings 19.21 and 21.77 Mg.ha^{-1} respectively. This is a huge increment of 27.0% and 17.04 compared to the genotype G3 which had the lowest mean values of 15.13 and 18.60 Mg.ha $^{-1}$ on the first and the second cuttings respectively. Nonetheless, when genotype G3 was cut the second time, it was not significantly different than genotype G1. The difference in the genotypes in terms of green forage yields can be explained by the differences in height of plants,

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the ratio of leaves and stems, and in the tillering potential (Tables 1, 2, and 3). The results are in line with Al-Salmi (2021) and Al-Dulaimi (2022), who found that the differences between genotypes were significant. Considering the interaction effect a considerable effect was detected on this trait. Genotype G3 combined with concentration of fertilizer N3 gave the greatest mean forage yield in green which was 22.62 and 23.50 $Mg.ha^{-1}$ during the first and second cuttings respectively. Conversely, when the genotype G3 was combined with control treatment N1 it the least green forage yield of 10.93 and 15.27 $Mg.ha^{-1}$ was obtained in the first and second cuttings, respectively .This effect can be attributed to the influence of the individual factors

Table (4): The impact of Genotypes, nano-super fertilizer concentrations, and their interaction on the yield of green forage ($Mg.ha^{-1}$) in the first and second cuttings..

First Cutting				
Genotypes	**Nano-super fertilizer concentrations**			**Mean of Genotypes**
	N1	N2	N3	
G1	16.24	12.90	19.40	16.18
G2	13.57	21.43	22.62	19.21
G3	10.93	14.61	19.83	15.13
G4	17.58	16.57	21.03	18.39
Mean of nano-super fertilizer	14.58	16.38	20.72	
LSD (0.05)	Genotypes	Nano-super fertilizer	Genotypes × nano-super fertilizer	
	0.754	0.653	1.305	
Second Cutting				
Genotypes	**Nano-super fertilizer concentrations**			**Mean of Genotypes**
	N1	N2	N3	
G1	18.52	17.17	20.88	18.85
G2	17.65	24.17	23.50	21.77
G3	15.27	18.90	21.63	18.60
G4	19.80	19.63	21.87	20.43
Mean of nano-super fertilizer	17.81	19.97	21.97	
LSD (0.05)	Genotypes	Nano-super fertilizer	Genotypes × nano-super fertilizer	
	0.690	0.598	1.195	

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5. Dry forage yield (Mg.ha^{-1})

The results presented in Table 5 indicated that plants treated with the N3 fertilizer concentration achieved the highest dry forage yield, recording 7.395 and 8.102 Mg.ha^{-1} for the first and second cuttings, respectively. In contrast, the control treatment N1 produced the lowest averages, with 5.333 and 6.276 Mg.ha^{-1}. This increase is likely due to the superior green forage yield obtained under the N3 treatment (Table 4), which positively influenced the dry forage yield. These findings are consistent with the results reported by Al-Mousawi (2020).

The data of Table 5 also proves the superiority of genotype G2, which at the first cutting obtained the highest dry forage yield of 6.712 Mg.ha^{-1}, which were not significantly different in comparison with genotype G4. In the second cutting, genotype G4 recorded the highest mean dry forage yield of 7.773 Mg.ha^{-1} that was not any different with genotype G2 but genotype G3 registered the lowest mean dry forage yield of 5.646 Mg.ha^{-1}. This is due to the fact that genotype G2 has better growth characteristics and green forage yield which in turn resulted in high yields of dry forage. These findings are consistent with the study of (Al-Jiyashi, 2020 and Al-Salmi ,2021).

Regarding the interaction between fertilizer concentration levels and cultivars, the combination of cultivar G2 with the N3 fertilizer concentration recorded the highest mean dry forage yield, reaching 8.233 Mg.ha^{-1} at the first cutting. In the second cutting, the highest mean was observed in the combination of G2 with the N2 concentration, reaching 9.233 Mg.ha^{-1}.

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Table (5): Influence of Genotypes, nano-super fertilizer concentration and their combination on dry forage yield (Mg.ha $^{-1}$).

First Cutting				
Genotypes	Nano-super fertilizer concentrations			Mean of Genotypes
	N1	N2	N3	
G1	5.950	4.227	6.950	5.709
G2	4.610	7.293	8.233	6.712
G3	4.133	5.570	7.233	5.646
G4	6.637	6.030	7.163	6.610
Mean of nano-super fertilizer	5.333	5.780	7.395	
LSD (0.05)	Genotypes	Nano-super fertilizer	Genotypes × nano-super fertilizer	
	0.5621	0.4867	0.9735	
Second Cutting				
Genotypes	**Nano-super fertilizer concentrations**			**Mean of Genotypes**
	N1	N2	N3	
G1	5.997	6.373	7.833	6.734
G2	4.977	9.233	8.730	7.647
G3	5.930	7.400	8.027	7.119
G4	8.200	7.300	7.820	7.773
Mean of nano-super fertilizer	6.276	7.577	8.102	
LSD (0.05)	Genotypes	Nano-super fertilizer	Genotypes × nano-super fertilizer	
	0.4590	0.3975	0.7950	

6. Total green forage yield (Mg.ha^{-1})

The findings of Figure 1 show that plants under the fertilizer concentration N3 were significantly better, and they had the highest total green forage yield 42.69 Mg.ha^{-1}, when compared to control treatment N1 which had the least yield of 32.39 Mg.ha^{-1}. This growth in total forage yield is explained by the increase in growth indices and constituents of forage such as higher plant height and number of tillers (Tables 1 and 2). These are the same results as Burhan (2018) reported.

Another important difference revealed using the findings was between genotypes in this trait. Genotype G2 was better with the highest mean total green forage yield of 40.98 Mg.ha -1. This excellence could be credited on the robust development of G2, such as increased height of the plant, and increased tillers. On the other hand, genotype G3 had the lowest mean of 33.73 Mg.ha $^{-1}$ that could be associated with its genetic composition that affects the effectiveness of its nutrition uptake, metabolism and concentration of critical compounds like sugars and amino acids. These increase vegetative growth positively that in effect increases the total green forage yield. The findings are consistent with those of Al-Jiyashi (2020) and Al-Kafai (2018).

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Concerning the interaction effect between the genotypes and the fertilizer levels, G2 and N3 had the highest total green forage yield of 46.12 Mg.ha $^{-1}$. This value was not significantly different to the combination of the genotype G2 and concentration N2. On the other hand, G3 genotype with control treatment N1 had the lowest green forage yield 26.20 Mg.ha $^{-1}$.

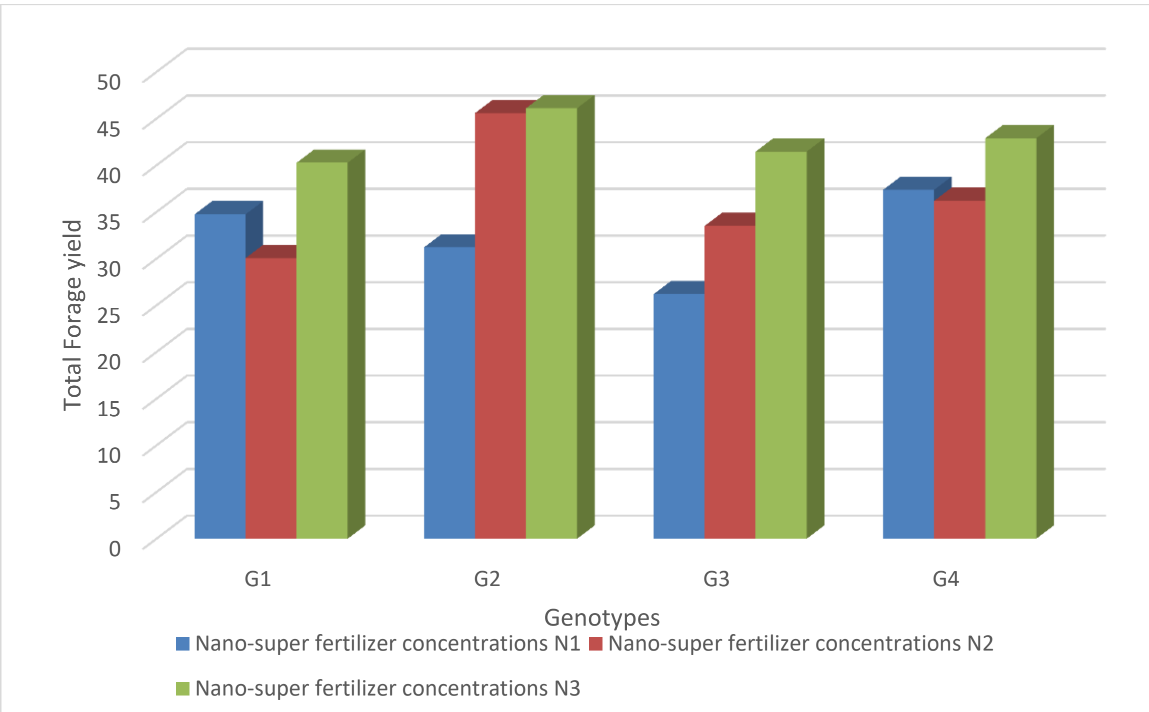

Figure (1): The effect of Genotypes, the concentration of nano-super fertilizer and its interaction on the total green forage yield (Mg.ha $^{-1}$).

V. Conclusion

It can be concluded that applying the nano-super fertilizer at a concentration of 6 g/L is the most effective for improving growth traits and increasing both green and dry forage yields. Significant differences were also observed among the genotypes, with Amal-7 achieving the highest forage productivity compared to the others.

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VI. References

Al-Abdullah, S. A. K. M. (2015). *Effect of nitrogen application on N, P, and K uptake and distribution in plant parts, growth, and yield of three wheat (Triticum aestivum L.) cultivars* (Doctoral dissertation). College of Agriculture, University of Basra.

Al-Aboudi, M. A. K. B. (2019). Analysis of genetic stability of wheat (Triticum aestivum L.) genotypes cultivated in different environments in Basra Governorate (Doctoral dissertation). College of Agriculture, University of Basra.

Al-Dulaimi, O. Z. A. M. S. (2020). Effect of seed priming with salicylic acid and humic acid addition on growth traits and yield of three triticale cultivars (Doctoral dissertation). College of Agriculture, University of Tikrit.

Al-Gabr, H. H. F. (2020). Contribution of main stem and tillers to yield and its components in soft wheat cultivars under nitrogen fertilization (Master's thesis). College of Agriculture, University of Al-Muthanna.

Al-Hassani, R. T. J. (2021). Effect of nano and mineral NPK fertilizers on growth and yield of three barley cultivars (Doctoral dissertation). College of Agriculture, University of Al-Muthanna.

Al-Jiyashi, M. T. A. (2020). Effect of cutting, sowing dates, and cultivars on growth traits and forage and grain yield of barley (Hordeum vulgare L.) (Doctoral dissertation). College of Agriculture, University of Al-Muthanna.

Al-Morshedy, H. Y. J. (2023). Comparison of foliar nano-phosphate fertilizer and soil application of triple superphosphate on growth and yield of two wheat (Triticum aestivum L.) genotypes (Master's thesis). College of Agriculture, University of Basra.

Al-Musawi, B. K. H. (2020). Effect of biofertilizers, nano-organic fertilizers, and NPK levels on some soil fertility properties and growth and yield of wheat (Triticum aestivum L.) (Doctoral dissertation). College of Agriculture, University of Al-Muthanna.

Al-Qaisi, A. L. A. R. (2001). Response of barley (Hordeum vulgare L.) genotypes to repeated cutting and grain yield (Master's thesis). College of Agriculture, University of Baghdad.

Al-Qaisi, A. M. M. (2005). Effect of sowing dates on vegetative traits of six barley cultivars. Al-Anbar Journal of Agricultural Sciences, 3(2), 47–56.

Al-Salami, O. Z. (2022). Effect of nitrogenous mineral and nano-fertilizer application on growth and yield of soft wheat cultivars (Master's thesis). College of Agriculture, University of Al-Muthanna.

Al-Salmi, A. S. Z. (2021). Response of some wheat cultivars to different levels of agricultural sulfur (Master's thesis). College of Agriculture, University of Basra.

ISSN Onlin:2708 -9347, ISSN Print: 2708 -9339 Volume 15, Issue 1 (2026)
https://iasj.rdd.edu.iq/journals/journal/issue/20226 *https://doi.org/10.54174/utjagr.v13ii 11.*

Al-Shammari, D. J. M. (2021). Effect of splitting mineral and nano-phosphate fertilizers on phosphorus availability, uptake, growth, and yield of wheat (Master's thesis). College of Agriculture, University of Al-Muthanna.

Buhedma, A. S. I., Mohamed, F. F., & Saleh, S. H. (2016). Effect of biofertilizer and mineral nitrogen levels on yield and yield components of triticale. Journal of Agricultural Research, 42(4), 480–493.

Burhan, M. J. (2018). Effect of foliar application of nano NPK fertilizer on growth, yield, and quality of bread wheat (Master's thesis). College of Agricultural Engineering Sciences, University of Baghdad.

Glamočlija, N., Starčević, M., Širić, J., Šefer, D., Glišić, M., Baltić, Ž., Marković, R., Spasić, M., & Glamočlija, Đ. (2018). The importance of triticale in animal nutrition. Veterinary Journal of the Republic of Srpska, 18(1), 73–94.

Hassanein, M. S., Ahmed, A. G., & Zaki, N. M. (2018). Effect of nitrogen fertilizer and bio-fertilizer on yield and yield components of two wheat cultivars under sandy soil. Middle East Journal of Applied Sciences, 8(1), 37–42.

Nasser, A. F., & Al-Shweily, M. H. F. (2014). Effect of nitrogen fertilization and different seed mixing ratios of barley (Hordeum vulgare L.) with Egyptian clover (Trifolium alexandrinum L.) on forage yield and quality. Basrah Journal of Agriculture.