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Role of Phosphorus Application and Cutting Management on Physiological Morphological Traits and Yield of Triticale (X Triticosecale wittmack L.)

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I. Abstract :

At the University of Basra/Karma Ali Agricultural Research Station/College of Agriculture, an experiment was carried out in the field (latitude 30°57' and longitude 47°80') on a silty loam soil during the winter planting season 2024–2025 in order to determine the impact of adding phosphorus and Cutting and non-cutting on the triticale growth characteristics, yield, and components. phosphate fertilizer in four levels (P0=0, P1=40, P2=80, and P3=120 kg P ha^{-1}) were used in the study. The randomized complete block design with three replicates was used to carry out the experiment in accordance with the factorial experiment technique. On October 20, 2024, the Farah variety's seeds were sown. Studies have indicated that growth characteristics, yield, and each of its components increased as phosphate fertilizer levels increased. The highest average plant height, No. of tillers, spike length, No. of spikes, No. were achieved at the level of 120 kg N ha-1, which was 102.26 cm and 580.3 tillers m^{-2}, 13.431 cm and 527.1 spikes m^{-2}. The highest average plant grains per spike, and grain yield were achieved at the level of 80 kg N ha^{-1} which was 52.08 grains per $spike^{-1}$ and 3.68 tons ha^{-1}.

The cutting treatment exhibited statistical superiority, yielding the highest mean values for the No. of tillers, No. of spikes, No.of grains per spike, and overall grain yield Cutting which was

538.5 tillers m^{-2} and 502 spikes m^{-2}. whereas non-cutting produced the highest average plant height 100.36 cm and 49.04 grains per $spike^{-1}$ and 3.13 tons ha^{-1}. While the combination P2C0 produced the highest grain yield, reaching 4.25 tons ha^{-1}, and it was superior in the majority of the attributes under study.

Keyword: triticale Triticosecale wittmack, Phosphorus, Cutting, Non- Cutting.

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II. INTRODUCTION :

Triticale (*X Triticosecale wittmack* L.) is considered an important crop due to its flexibility and adaptability to different environmental conditions, as well as its dual use as animal feed and grain for human consumption. Triticale cultivation has been observed to increase compared to other dual-use cereal crops (feed + grain) in areas with limited production factors, particularly wheat, barley, and rye, due to its ability to withstand harsh environmental conditions and limited environmental resources (Giunta et al., 2015), This crop is distinguished by combining the characteristics of both wheat and rye. It resembles wheat in appearance but is distinguished by its high lysine content, which is one of the essential amino acids in protein. It is also characterized by strong vegetative growth in terms of plant height, lateral tendrils, and leaf area. Achieving the best yield from this crop requires knowing the factors that affect its growth and productivity, such as phosphorus and cutting treatments, these nutrients play a significant role in determining morphological and physiological characteristics and influencing crop productivity. Phosphorus is an essential macronutrient for plant growth and development it is necessary for energy transfer, protein synthesis, and sugar conversion, and contributes significantly to complex metabolic processes within the plant cell (Swailam et al., 2021). Furthermore, phosphorus directly affects shoot and root growth, dry matter accumulation, and consequently, the final yield and its qualitative characteristics (Yassin et al., 2023). Conversely its deficiency hinders plant growth and reduces crop productivity. On the other hand, cutting practices are an effective agricultural practice in dual-use crop systems such as triticale, and aim to obtain green fodder, as removing the vegetative parts can lead to a temporary halt in root growth until the vegetative system recovers (Han et al., 2024), Since cutting processes affect the distribution of dry matter between different parts of the plant and its primary physiological performance, plants that have been cut require higher nutrient inputs to restore the lost leaf area (Koch et al., 2017). Tillering in triticale wheat is a key yield-determining trait. Breaking apical dominance at the beginning of growth, by removing the growing tip, stimulates the growth and number of lateral tillers, which in turn increases the number of spikes and improves the overall crop yield. The research aims to determine the response of triticale wheat to different levels of phosphorus under the effects of cutting and no-cutting treatments, thus providing future prospects that contribute to improving crop management and increasing its productivity.

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III. Material and methods:

At the Agricultural Research and Experiment Station, College of Agriculture, University of Basra, Iraq (30.57 N, longitude 47.8), A field study was conducted during the 2024–2025 winter. The aim was to determine the role of P and cut and non-cut Utilization on some growth traits components of yield and yield in triticale (X *Triticosecale wittmack* L.). There had to be two factors to the experiment. phosphate fertilizer in four levels (0 , 40, 80 , and 120 kg P ha $^{-1}$) and cut and non-cut were included in the first and second factors, that is. The experiment was conducted using a randomized complete block design (RCBD), and the treatments were distributed in a split-plot arrangement. Using three replicates, the total number of experimental units was 24 (3 × 4 × 2), with an area of 2 × 2 m². the seeds (Farah var.) were sown on October 20, 2024, at a Rate of seeding of 160 kg ha^{-1}, Hassooni (2026), with a distance of 15 cm between rows Noaema et al(2020). In clayey loam soils, as shown in (Table 1)

Table 1. chemical and physical properties of the experimental soil.

Character	pH	E.C	O.M .	Available			clay	silt	sand	Soil
				N	P	K				
unit	-	ds m^{-1}	g Kg soil	Mg Kg^{-1} soil			gm Kg^{-1} soil			Structure
Value	7.24	5.10	4.34	6.14	1.32	10.16	360	510	130	Silty loam

Before planting, phosphate fertilizer was applied in one batch as triple superphosphate fertilizer (P2O5 45%) according to the 1nd factor levels As for the nitrogen fertilizer, it was added at a rate of (140 kg N ha^{-1}) Rashid (2023) in two installments, the first after 20 days from planting and the second after cutting (it was added to both treatments, cutting and not cutting, at the same time). The cutting process was carried out after the plant reached 40 cm (in the elongation stage). The following traits were studied: -height of the plant (cm), No. of tillers (tiller m^{-2}), spike length (cm), No. of spikes (pike m^{-2}), No. of grains perspspike (ed spike^{-1}), grain yield (tons/ ha^{-1}). Following data collection, organization, and tabulation in accordance with the R.C.B.D. design, the data was analyzed using statistical analysis software (GENSTAT-Ver. 12) and compared using LSD at the P≤0.05 probability level, Al-Rawi and Khalaf Allah(2000)

IV. Results and discussion:

Plant height

The results showed a significant effect of phosphate fertilizer treatment and pruning (both cutting and non-cutting), as well as an interaction between the study factors, on plant height, as shown in Table (2). The phosphate fertilization level (120 kg P ha^{-1}) resulted in the highest average plant height of 102.26 cm, while the control treatment recorded the lowest average for this trait at 91.24 cm, This can be attributed to the fact that adding phosphate fertilizer leads to increased root branching and depth, and an increased ability to absorb nutrients and water efficiently, which in turn increases the availability of essential elements for the plant to carry out vital processes. These results are consistent with the results of(Luikham et al.,2015). The non-cutting treatment achieved the highest average plant height of 100.36 cm, whereas the cutting treatment produced the lowest average of 95.25 cm. These results agree with (Harba et al.,2021) and Al-Kinani(2019) and Al-Jiyashi(2020) . This can be attributed to the removal of the apical meristems in the clipped plants these growing points contain gibberellins, which are responsible for stimulating cell elongation and promoting overall plant height increases. The interaction between phosphate fertilizer and cutting treatments had a significant effect on this trait, as 120 kgP ha^{-1} without cutting gave the highest plant height of (105.35 cm), while the control treatment with cutting recorded the lowest plant height of 93.28 cm.

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Table (1) The role of phosphate fertilization, cutting and not cutting and the interaction between them in the average trait of plant height (cm)

Mean cutting	Phosphorus fertilization (kg P ha^{-1})				Cutting and non-cutting
	120	80	40	0	
100.36	105.35	103.03	99.76	93.28	non-cutting
95.25	99.17	96.25	96.37	89.20	Cutting
	102.26	99.64	98.07	91.24	Average fertilizer
Interaction	P levels		Cutting		L S D 0.05
4.113	2.651		4.697		

Number of Tillers

The results in Table (3) show that there is a significant effect on the number of tillers due to the influence of phosphate fertilizer, cutting, non-cutting, and the interaction between them. The fertilizer level (120 kg P ha^{-1}) resulted in the highest average number of tillers, amounting to 305.45 tillers m^{-2}, While the comparison level gave the lowest average for this trait, amounting to 206.06 till m^{-2} that also agreed with Al-Jayashi (2020),this can be attributed to the active role of phosphate fertilizer in strengthening crop roots, accelerating early growth, and stimulating lateral buds through its role in energy formation. The cutting treatment recorded the highest average for this characteristic, reaching 266.58 till m^{-2}, While the treatment without cutting gave the lowest average for this trait, which was (256.07) tillers m^{-2} ,These results are consistent with(Al-Furaih et al.,2015) and (Anum et al.,2020), Cutting contributes to remove apical dominance and encourage the growth of lateral buds. The interaction between the levels of phosphate fertilizer and the cutting and non-cutting treatment showed a significant effect on this trait, as the highest average number of tillers was (313.89) tillers/m^{-2} in the P3C1 combination, The lowest mean for this class in the P0C1 combination was (188.89) till m-2. This differed significantly from the other interference coefficients

Table (2) The role of phosphate fertilization, cutting and not cutting and the interaction between them in the average trait of the number of tillers (till m^{-2})

Mean cutting	Phosphorus fertilization (kg P ha^{-1})				Cutting and non-cutting
	120	80	40	0	
522.08	566.78	548.52	516.25	456.77	non-cutting
538.79	584.06	563.66	538.95	468.49	Cutting
	575.42	556.09	527.60	462.63	Average fertilizer
Interaction	P levels		Cutting		L S D 0.05
23.031	16.285		11.515		

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spike length

The results of the statistical analysis showed a significant effect of phosphate fertilizer, the cutting and non-cutting treatment, and their interaction in the spike length characteristic, as shown in Table (4) The effect of phosphate fertilizer on the spike length characteristic, as it gave the highest average length of (13.431) cm at the level (120 kgP ha^{-1}), while the comparison treatment level gave the lowest average length of the spike, which was (11.383) cm These results are consistent with those of (Noonari et al.,2016) and (Ali et al.,2020),This can be attributed to the active role of phosphorus in the formation of energy compounds ATP and ADP, thus supporting cell division and growth processes in young tissues, including spike length. Cutting and not cutting had no significant effect on spike length. The highest average spike length was achieved with the C0P3 combination (13.697) cm, while the C1P0 combination gave the lowest average spike length of (11.124) cm.

Table (3) The role of phosphate fertilization, cutting and not cutting and the interaction between them in the average spike length characteristic (cm)

Mean cutting	Phosphorus fertilization (kg P ha^{-1})				Cutting and non-cutting
	120	80	40	0	
12.700	13.697	13.145	12.314	11.642	non-cutting
12.319	13.166	12.653	12.334	11.124	Cutting
	13.431	12.899	12.324	11.383	Average fertilizer
Interaction	P levels		Cutting		L S D 0.05
0.6642	0.5045		N.S		

number of spikes

The level (120 kgP ha^{-1}) gave the highest average number of spikes, reaching 575.42 spikes m^2 (Table 6), while the control treatment recorded the lowest number of spikes, reaching 462.36 spikes m^2 these results are consistent with those of (lslam et al. 2017) and (Hamada et al.,2017).This can be attributed to the active role of phosphorus in increasing the number of tillers and reducing competition between plants, which contributes to increasing the number of tillers that which survive remain and turn into spikes, The results showed a significant difference between the cutting and non-cutting treatments. The cutting treatment resulted in the highest average number of spikes (538.79 spikes m^2), whereas the non-cutting treatment resulted in the lowest mean for this trait (522.08 spikes m^2) these results are in agreement with the findings of Mansoor and Jeber (2020). This result can be attributed to the role of pruning in stimulating the production of tillers, which subsequently developed into spikes. Furthermore, the interaction between phosphorus fertilization and pruning treatments significantly affected the number of spikes The C1P3 combination gave the highest average yield of (584.06spikes m^2), and the lowest average yield of the trait was given by the C0P0 combination of (462.63 spikes m^2).

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Table (4) The role of phosphate fertilization, cutting and not cutting and the interaction between them in the average trait of number of spikes (spikes m^{-2})

Mean cutting	Phosphorus fertilization (kg P ha^{-1})				Cutting and non-cutting
	120	80	40	0	
458.9	502.8	475.6	446.7	410.3	non-cutting
502.0	551.3	528.8	502.9	425.1	Cutting
	527.1	502.2	474.8	417.7	Average fertilizer
Interaction	P levels		Cutting		L S D 0.05
29.52	14.79		38.64		

number of grains per spike

Phosphate fertilizer levels gave the highest average number of grains per spike, reaching 52.08 grains per spike - at the level (80 kg P ha^{-1}) (Table 6), which differed significantly from the rest of the addition levels, While level (P0) recorded the lowest average number of grains per spike, which was 35.92 grains per $spike^{-1}$ these results are consistent with those of Singh and Binder(2018) and (Abas et al.,2023), this can be attributed to the active role of phosphorus in the formation of ATP energy compounds, which increases the efficiency of the pollen and improves fertilization. The non-cutting treatment was superior, giving the highest average number of grains per spike, amounting to 49.04 grains per $spike^{-1}$, while the cutting treatment recorded the lowest average for the trait, amounting to 44.73 grains per $spike^{-1}$ these results are in agreement with the findings of Mansoor and Jeber (2020), Cutting contributes to increasing the number of tillers (increasing vegetative growth), but most of these tillers are weak and do not produce ears, and if ears are formed, they have a small number of grains. In addition to the increase in spike length resulting from the C0P3 treatment, which leads to the inclusion of a larger number of grains, the P3C0 combination significantly outperformed in giving the highest average number of grains per spike, reaching 53.90 grains per $spike^{-1}$, compared to the C1P0 combination, which in turn gave the lowest average for the trait, reaching 33.71 grains per $spike^{-1}$.

Table (5) The role of phosphate fertilization, cutting and not cutting, and the interaction between them in the average number of grains per spike (grain per $spike^{-1}$)

Mean cutting	Phosphorus fertilization (kg P ha^{-1})				Cutting and non-cutting
	120	80	40	0	
49.04	53.90	53.68	50.44	38.13	non-cutting
44.73	49.96	50.48	44.75	33.71	Cutting
	51.93	52.08	47.59	35.92	Average fertilizer
Interaction	P levels		Cutting		L S D 0.05
1.864	1.382		1.587		

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grain yield

The results in Table (7) indicate a significant effect of the study factors and their interactions on grain yield, as the highest average yield was obtained at (3.19 tons ha⁻¹) at the level of 80 kg P ha^{-1}, while the control treatment recorded the lowest average yield of (2.12 tons/ ha⁻¹)these results are consistent with (shende et al.,2020) , as increasing the number of grains in the spike had a reflection on the yield, In contrast, the results of the analysis of the cutting and non-cutting coefficients indicated a significant effect, represented by the superiority of the non cutting treatment in giving the highest average yield of (3.13 tons ha⁻¹), and the lowest average yield in the cutting treatment of (2.72 tons ha⁻¹) these results are consistent with those of Mansoor and Jeber(2020) and (soudy et al.,2024),the increase in yield when using the non-cutting treatment can be attributed to the number of grains in the spike. Yielded the highest average yield at the C0P2 combination, which reached (4.25 tons ha^{-1}), and the lowest average at the C1P0 combination, which reached (1.98 tons ha^{-1}). These results are consistent with what was reached by (Shende et al., 2020), (Mansoor, 2020 and Jeber), (Soudy et al., 2024).

Table (6) The role of phosphate fertilization, cutting and not cutting and interference in the trait of average grain yield (ton ha⁻¹)

Mean cutting	Phosphorus fertilization (kg P ha⁻¹)				Cutting and non-cutting
	120	80	40	0	
3.13	3.37	4.25	2.63	2.25	non-cutting
2.72	3.02	3.11	2.78	1.98	Cutting
	3.19	3.68	2.70	2.12	Average fertilizer
Interaction	P levels		cutting		L S D 0.05
0.279	0.157		0.353		

V. Conclusion

Phosphorus and cutting management contributed to an improvement in all studied traits, including growth parameters, yield, and its components. Higher phosphorus levels achieved the highest values for the studied attributes and significantly enhanced grain yield. maximum productivity can be attained by optimizing fertilizer application levels alongside the timely implementation of the cutting process.

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