INFLUENCE OF SOWING DATES AND MINERAL FERTILIZER RATES ON TILLERING DYNAMICS AND PRODUCTIVE TILLER NUMBER IN SPRING SOFT WHEAT (TRITICUM AESTIVUM L.)

Sabirova Shakhnoza Pamirovna
Researcher at the Karakalpakstan Institute
of Agriculture and Agrotechnologies
email;sahnozasabirova6@gmail.com
ORCID ID;
0009-0004-7163-7153

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ABSTRACT

Productive tiller count per plant is a primary yield-determining component in spring soft wheat (Triticum aestivum L.). A three-year field experiment (2023–2025) was conducted to evaluate the interactive effects of two sowing dates (the third decade of March vs. the first decade of April) and six mineral fertilizer application rates (ranging from N_0 P_90 K_60 to N_210 P_90 K_60) on the productive tillering performance of two spring wheat cultivars ('Janub Gavhari' and 'Parvoz'). The results revealed that sowing in the third decade of March combined with nitrogen application at N_180 P_90 K_60 " kg/ha" generated the highest number of productive tillers per plant (1.46 tillers/plant in 'Janub Gavhari' and 1.48 tillers/plant in 'Parvoz'). Delaying sowing to early April led to a significant decline in productive tillering across all fertilizer regimes. Furthermore, increasing nitrogen application beyond 180" kg N/ha" to 210" kg N/ha" induced a clear vegetative depression, reducing productive tiller counts. Overall, cultivar 'Parvoz' demonstrated superior tillering capacity and response to mineral nutrition compared to 'Janub Gavhari'.

Introduction.

Spring soft wheat (*Triticum aestivum* L.) plays a crucial role in global food security due to its short growth cycle and high grain quality. Wheat grain yield is determined by three main structural components: the number of productive spikes (tillers) per unit area, the number of grains per spike, and individual grain weight (Slafer et al., 2015). Among these, the formation of productive tillers per plant serves as the foundational agronomic metric establishing crop canopy density and potential sink strength (Fischer, 2020).

Tillering dynamics are regulated by genetic traits and influenced by environmental drivers and agronomic management practices (Hay & Porter, 2006). Sowing date is a vital determinant of thermal and moisture regimes during early vegetative phases; timely sowing enables plants to utilize early spring soil moisture and establish secondary tillers prior to high-temperature stress (Porter & Gawith, 1999). Simultaneously, nitrogen (N) availability plays an essential role in hormone signaling and carbon allocation during tiller bud initiation and survival (Lawlor, 2002).

Despite widespread research on winter wheat, optimizing agro-technical parameters (sowing timing and mineral fertilization) for spring wheat varieties under semi-arid conditions requires detailed multi-year investigation. This study evaluates the effect of sowing dates and escalating mineral fertilizer rates on the productive tiller number of two prominent spring soft wheat cultivars over a three-year period (2023–2025).

Materials and methods

Experimental Design and Treatments

The field experiment was conducted over three consecutive growing seasons (2023, 2024, and 2025). The trial utilized a split-split-plot experimental design with three replicates:

Sowing Dates:

Third decade of March (March 27–28)

First decade of April (April 7–8)

Cultivars: 'Janub Gavhari', 'Parvoz'

Mineral Fertilizer Regimes (kg/ha):): Control($N_0P_{90}K_{60}$), $N_{90}P_{90}K_{60}$, $N_{120}P_{90}K_{60}$, $N_{150}P_{90}K_{60}$, $N_{180}P_{90}K_{60}$, $N_{210}P_{90}K_{60}$

Phosphorus (P_{90}) and potassium (K_{60}) were applied prior to primary tillage, while nitrogen split applications were performed during basal dressing and early growth stages according to standard agro-technical guidelines. At full maturity (harvest stage), random destructive plant sampling was conducted from representative inner rows of each plot. The number of fertile, spike-bearing (productive) tillers was counted for individual plants, and average values were calculated as tillers per plant (tillers/plant).

Results and discussion

The three-year average data (2023–2025) demonstrated a clear parabolic response of productive tiller formation to increasing nitrogen rates.

Sowing in Late March: In cultivar 'Janub Gavhari', the control treatment ($N_0P_{90}K_{60}$) produced an average of 1.07 tillers/plant. Increasing nitrogen to $N_{180}P_{90}K_{60}$ significantly increased productive tillers to 1.46 tillers/plant (a 36.4% increase over control). Similarly, cultivar 'Parvoz' responded to $N_{180}P_{90}K_{60}$ by increasing productive tillers from 1.09 tillers/plant (control) to 1.48 tillers/plant (a 35.8% increase).

Physiological Depressional Threshold ($N_{210}P_{90}K_{60}$): Increasing the nitrogen rate further to 210 kg N/ha resulted in a reduction in productive tiller count across all treatments. For late March sowing, productive tillers dropped to 1.40 tillers/plant in 'Janub Gavhari' and 1.42 tillers/plant in 'Parvoz'

Physiological Mechanism: Excessive nitrogen fertilization during early vegetative stages induces over-tillering with non-productive secondary stems. These excessive sinks create intra-plant competition for light, water, and carbohydrate reserves, leading to higher tiller mortality before spike differentiation (Cakmak, 2002).

Effect of Sowing Dates; Under the optimal $N_{180}P_{90}K_{60}$ regime, delayed sowing reduced productive tillers in 'Janub Gavhari' from 1.46 to 1.37 tillers/plant (a 6.2% decrease). For 'Parvoz', the count dropped from 1.48 to 1.39 tillers/plant (a 6.1% decrease. This decline under late sowing is attributed to rapidly rising air temperatures during late spring, which shortens the duration of the tillering phase (Zadoks GS 20–29) and accelerates stem elongation (jointing) before lower-order tillers can develop fertile spikes (Porter & Gawith, 1999).

Genotypic Variation: Across all treatments and trial years, 'Parvoz' consistently maintained a slightly higher productive tiller count (+0.01 to +0.03 tillers/plant) compared to 'Janub Gavhari'. This indicates greater genetic stability and higher physiological efficiency in secondary tiller development under variable mineral supply.

Inter-Annual Variability: The highest productive tillering values were recorded during the 2024 season (e.g., reaching 1.52 tillers/plant in 'Parvoz' under March N_{180}), whereas 2025 exhibited slightly lower values (1.43 tillers/plant) due to seasonal variations in precipitation and temperature profiles during early vegetative development.

1-table

Influence of sowing dates and mineral fertilizer rates on the number of productive stems of spring soft wheat varieties, units/plant 2023-2025 y.

№	Sowing period	Varieties	Fertilizer rates	2023	2024	2025	Medium
1	March III decade	Janub gavhari	Nazorat	1,06	1,08	1,06	1,07
2			$N_{90}P_{90}K_{60}$	1,18	1,20	1,14	1,17
3			$N_{120}P_{90}K_{60}$	1,24	1,26	1,20	1,23
4			$N_{150}P_{90}K_{60}$	1,32	1,34	1,26	1,31
5			$N_{180}P_{90}K_{60}$	1,48	1,50	1,41	1,46
6			$N_{210}P_{90}K_{60}$	1,42	1,45	1,33	1,40
7		Parvov	Nazorat	1,08	1,10	1,08	1,09
8			$N_{90}P_{90}K_{60}$	1,20	1,22	1,16	1,19
9			$N_{120}P_{90}K_{60}$	1,26	1,28	1,22	1,25
10			$N_{150}P_{90}K_{60}$	1,35	1,36	1,28	1,33
11			$N_{180}P_{90}K_{60}$	1,49	1,52	1,43	1,48
12			$N_{210}P_{90}K_{60}$	1,43	1,47	1,36	1,42
13	April I decade	Janub gavhari	Nazorat	1,03	1,05	1,04	1,04
14			$N_{90}P_{90}K_{60}$	1,11	1,14	1,10	1,12
15			$N_{120}P_{90}K_{60}$	1,17	1,20	1,16	1,18
16			$N_{150}P_{90}K_{60}$	1,23	1,26	1,22	1,24
17			$N_{180}P_{90}K_{60}$	1,37	1,40	1,35	1,37
18			$N_{210}P_{90}K_{60}$	1,32	1,34	1,28	1,31
19		Parvoz	Nazorat	1,04	1,06	1,05	1,05

20			$N_{90}P_{90}K_{60}$	1,13	1,16	1,12	1,14
21			$N_{120}P_{90}K_{60}$	1,19	1,22	1,18	1,20
22			$N_{150}P_{90}K_{60}$	1,25	1,28	1,24	1,26
23			$N_{180}P_{90}K_{60}$	1,39	1,42	1,36	1,39
2			$N_{210}P_{90}K_{60}$	1,34	1,36	1,31	1,34

Conclusion

Optimal Sowing Date: Sowing spring soft wheat in the **third decade of March** provides the most favorable thermal conditions for maximize productive tiller survival and canopy architecture.

Cultivar Selection: Cultivar **'Parvoz'** exhibits superior tillering energy and yield structure performance compared to 'Janub Gavhari' under spring cultivation conditions.

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