
# PHENOLOGICAL DEVELOPMENT AND GROWTH STAGE DURATION OF SPRING SOFT WHEAT (TRITICUM AESTIVUM L.) AS INFLUENCED BY SOWING DATES AND NITROGEN APPLICATION RATES

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**ABSTRACT**

*A field experiment was conducted in 2025 to evaluate the effects of different sowing dates (late March vs. early April) and mineral fertilizer application rates (ranging from N_0 P_90 K_60 to N_210 P_90 K_60) on the phenological development and duration of vegetation phases in spring soft wheat (Triticum aestivum L.) cultivars 'Janub Gavhari' and 'Parvoz'. The findings demonstrated that optimal sowing in the third decade of March combined with nitrogen application at N_180 P_90 K_60 significantly extended the overall vegetation period by delaying reproductive transitions and maturity, thereby providing an extended window for dry matter accumulation. Over-fertilization (N_210 P_90 K_60) did not further prolong phenological phases, indicating a physiological saturation threshold at 180" kg N/ha" . Cultivar 'Parvoz' exhibited earlier phenological transition across all treatments compared to 'Janub Gavhari', confirming its genetic earliness.*

**Introduction.** Spring wheat (*Triticum aestivum* L.) is a vital cereal crop whose growth dynamics and productivity are strongly governed by environmental conditions and agronomic management practices (Slafer et al., 2015). Among environmental and agronomic drivers, sowing date and nitrogen supply are critical factors determining the rate of organogenesis, duration of phenological phases, and final grain yield (Langer et al., 2018; Fischer, 2020).

Optimizing the sowing date allows the crop to avoid high-temperature stress during critical developmental stages such as anthesis and grain filling (Porter & Gawith, 1999). Meanwhile, nitrogen availability dictates vegetative biomass accumulation and photosynthetic activity, directly influencing the timing and transition between developmental stages (Hay & Porter, 2006). This study investigates the combined interaction of sowing dates and escalating mineral fertilizer regimes on the phenological phases of two spring wheat cultivars ('Janub Gavhari' and 'Parvoz') under regional climatic conditions.

**Materials and methods**

Two varieties grown in the conditions of Karakalpakstan, Janubiy Gavhar and Mars-1, were selected as the objects of the study. Field experiments were conducted on the experimental plot of the "Don va Sholi" (Grain and Rice) Scientific and Production Association. The experimental field has meadow-alluvial, saline soil with a medium mechanical composition, and the groundwater level is at a depth of 1.5–2.0 m. In the experiment, the spring wheat varieties "Janubiy Gavhari" (Southern Pearl) and "Maris" were sown. The soils were noted to have light, medium, and heavy loamy compositions based on their mechanical structure. In the autumn, on a field cleared of the previous crop (the predecessor crop was potato), plowing was carried out to a depth of 28–30 cm. Before plowing, phosphorus and potassium fertilizers were applied to the soil. The preparation for sowing spring wheat involved the following activities: pre-sowing cultivation, harrowing, fertilization, control of weeds, diseases, and pests, and irrigation in irrigated areas (Масленко М.И., 2007; Торениязов Е.Ш., Утепбергенов А.Р., Ешмуратов Э.Ғ., 2013). In early spring, as soon as the soil is ready, the field is harrowed, chiseled, or cultivated to prepare it for sowing. In our experiment, the full dose of phosphorus-potassium fertilizers ($P_{75}K_{60}$) was applied to the soil before plowing.

The field experiment was carried out in 2025. The experimental setup evaluated two factors: **Sowing Dates:**Third decade of March (March 27–28), first decade of April (April 7–8).

**Cultivars:** 'Janub Gavhari' and 'Parvoz'

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

Phenological observation was recorded according to standard cereal growth stage scales (Zadoks et al., 1974), tracking the following stages: Germination/Emergence, Tillering, Jointing (Stem Elongation), Heading, Flowering, Milk Maturity, Dough/Wax Maturity, and Complete/Ripening Maturity.

**Results and discussion**

Increasing nitrogen supply from control ( $N_0$ ) to $N_{180}$ kg/ha consistently delayed the occurrence of reproductive stages and extended the complete vegetation period. For 'Janub Gavhari' sown in late March, full maturity was reached on June 24 under control conditions ($N_0$), whereas the application of $N_{180}P_{90}K_{60}$ extended full maturity to July 10, resulting in a 16-day prolongation of the crop cycle. Physiologically, nitrogen promotes vegetative organ development, maintains green leaf area (delaying senescence), and enhances chlorophyll biosynthesis (Lawlor, 2002). This sustained metabolic activity prolongs the reproductive phase, particularly the grain filling period (milk and dough maturity stages).

However, increasing the nitrogen rate further to $N_{210}P_{90}K_{60}$ did not lead to a further delay in maturity. In both cultivars and across both sowing dates, the phenological timeline under $N_{210}$ reverted back to levels comparable to $N_{150}P_{90}K_{60}$ (reaching complete maturity on July 5 for 'Janub Gavhari' sown in March). This response indicates a physiological threshold where excessive nitrogen application ceases to extend vegetative development and may induce physiological imbalance or nitrogen saturation (Cakmak, 2002).

**Impact of Sowing Dates.** Sowing in early April shortened the interval between early developmental stages due to rapidly increasing spring temperatures. However, early April sowing led to thermal stress during the late reproductive stages (heading to maturity).

Although germination and tillering progressed quickly, later growth stages were forced into rapid progression, leading to premature senescence and shorter overall vegetative growth compared to late-March sowing.

**Cultivar Responses.** A clear genetic variation was observed between the two cultivars. Cultivar 'Parvoz' consistently completed all growth stages 5 to 7 days earlier than 'Janub Gavhari' across all fertilizer treatments and sowing dates. For instance, under late-March sowing with $N_{180}P_{90}K_{60}$ , 'Parvoz' reached complete maturity on July 3, whereas 'Janub Gavhari' matured on July 10. This highlights 'Parvoz' as an early-maturing genotype suitable for regions prone to early summer heat stress

1.table

Influence of sowing dates and mineral fertilizer rates on the duration of the growing season of spring soft wheat varieties, 2025.

| № | Sowing period | Varieties | Fertilizer rates | Germination | Accumulation | Intubation | Heading | Flowering | ripening | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | Milk Boiling | Diaper rash | Cook until done |
| 1 | March III decade | Janub gavhari | Nazorat | 28/III | 09/IV | 24/IV | 10/V | 15/V | 27/V | 10/VI | 24/VI |
| 2 | | | $N_{90}P_{90}K_{60}$ | 28/III | 09/IV | 25/IV | 12/V | 17/V | 30/V | 14/VI | 28/VI |
| 3 | | | $N_{120}P_{90}K_{60}$ | 28/III | 08/IV | 26/IV | 14/V | 19/V | 01/VI | 17/VI | 01/VII |
| 4 | | | $N_{150}P_{90}K_{60}$ | 28/III | 09/IV | 27/IV | 16/V | 21/V | 04/VI | 21/VI | 05/VII |
| 5 | | | $N_{180}P_{90}K_{60}$ | 28/III | 08/IV | 29/IV | 19/V | 24/V | 08/VI | 26/VI | 10/VII |
| 6 | | | $N_{210}P_{90}K_{60}$ | 28/III | 09/IV | 27/IV | 16/V | 21/V | 04/VI | 21/VI | 05/VII |
| 7 | | Parvoz | Nazorat | 27/III | 08/IV | 22/IV | 07/V | 12/V | 23/V | 05/VI | 18/VI |
| 8 | | | $N_{90}P_{90}K_{60}$ | 27/III | 08/IV | 23/IV | 09/V | 14/V | 26/V | 09/VI | 22/VI |
| 9 | | | $N_{120}P_{90}K_{60}$ | 27/III | 07/IV | 24/IV | 10/V | 15/V | 28/V | 11/VI | 25/VI |
| 10 | | | $N_{150}P_{90}K_{60}$ | 27/III | 08/IV | 25/IV | 12/V | 17/V | 31/V | 15/VI | 29/VI |
| 11 | | | $N_{180}P_{90}K_{60}$ | 27/III | 07/IV | 27/IV | 15/V | 20/V | 04/VI | 20/VI | 03/VII |
| 12 | | | $N_{210}P_{90}K_{60}$ | 27/III | 08/IV | 25/IV | 12/V | 17/V | 31/V | 15/VI | 29/VI |
| 13 | April I decade | Janub gavhari | Nazorat | 08/IV | 20/IV | 04/V | 19/V | 24/V | 04/VI | 17/VI | 29/VI |
| 14 | | | $N_{90}P_{90}K_{60}$ | 08/IV | 20/IV | 05/V | 21/V | 26/V | 07/VI | 21/VI | 03/VII |
| 15 | | | $N_{120}P_{90}K_{60}$ | 08/IV | 19/IV | 05/V | 22/V | 27/V | 09/VI | 24/VI | 06/VII |
| 16 | | | $N_{150}P_{90}K_{60}$ | 08/IV | 0/IV | 07/V | 25/V | 30/V | 13/VI | 28/VI | 10/VII |
| 17 | | | $N_{180}P_{90}K_{60}$ | 08/IV | 19/IV | 08/V | 27/V | 02/VI | 16/VI | 01/VII | 13/VII |
| 18 | | | $N_{210}P_{90}K_{60}$ | 08/IV | 20/IV | 07/V | 25/V | 30/V | 13/VI | 28/VI | 10/VII |
| 19 | | Parvoz | Nazorat | 07/IV | 19/IV | 01/V | 15/V | 20/V | 30/V | 11/VI | 22/VI |
| 20 | | | $N_{90}P_{90}K_{60}$ | 07/IV | 19/IV | 02/V | 17/V | 22/V | 02/VI | 14/VI | 25/VI |
| 21 | | | $N_{120}P_{90}K_{60}$ | 07/IV | 18/IV | 02/V | 18/V | 23/V | 04/VI | 17/VI | 28/VI |
| 22 | | | $N_{150}P_{90}K_{60}$ | 07/IV | 19/IV | 04/V | 21/V | 26/V | 07/VI | 21/VI | 02/VII |
| 23 | | | $N_{180}P_{90}K_{60}$ | 07/IV | 18/IV | 05/V | 23/V | 28/V | 10/VI | 25/VI | 06/VII |
| 24 | | | $N_{210}P_{90}K_{60}$ | 07/IV | 19/IV | 04/V | 21/V | 26/V | 07/VI | 21/VI | 02/VII |

**Conclusion**

The experimental results demonstrate that sowing spring wheat during the third decade of March provides optimal conditions for phenological progression. Applying $N_{180}P_{90}K_{60}$ kg/ha maximizes the duration of the reproductive and grain-filling phases, providing a longer period for photosynthate translocation. Exceeding this rate to $N_{210}$ kg/ha confers no additional phenological delay. Cultivar 'Parvoz' represents an earlier-maturing ideotype compared to 'Janub Gavhari', offering flexibility in cropping systems requiring early harvest.

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