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Effect of sowing windows on growth and yield of foxtail millet

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Abstract
A field experiment was conducted during *summer* 2025 at the Agricultural Meteorology Farm, College of Agriculture, Pune to study the effect of sowing windows on the growth and yield of foxtail millet (*Setaria italica* L.). The experiment was laid out in a split-plot design with three sowing windows (01 MW: 01–07 January, 03 MW: 15–21 January and 05 MW: 29 January–04 February) as subplots and five genotypes as main plots. Results revealed that early sowing in the 1st meteorological week significantly enhanced plant height (130.54 cm), tiller number (16.62 m^{-1}) and extended crop duration leading to the highest grain yield (21.35 q ha^{-1}). Delayed sowing reduced growth duration and yield potential. Among genotypes KOPFX2107 recorded the maximum yield (23.26 q ha^{-1}) while BFTM-82 produced the lowest (18.39 q ha^{-1}). Interaction effects were non-significant but early sowing with KOPFX2107 consistently performed other combinations. The study highlights the timely sowing during early January of KOPFX2107 genotypes showed maximizing foxtail millet productivity under Pune conditions.

Keywords: Sowing window, split-plot design, genotype, Meteorological weeks (MW), grain yield

Introduction
Foxtail millet (*Setaria italica* L.) is a short-duration C_4 cereal valued for drought tolerance, low input needs and nutrient density if remains important across semi-arid tracts of India including Maharashtra, Karnataka, Telangana, Andhra Pradesh, Rajasthan and Tamil Nadu. Recent national initiatives (e.g. International Year of Millets 2023) have renewed interest in small millets for climate-resilient nutrition-sensitive farming.
Within the production ecology of peninsular India, time of sowing is a primary driver of foxtail millet performance. because it aligns germination, tillering and grain filling with southwest monsoon dynamics and temperature regimes. In Maharashtra rainfed systems ICAR–IIMR recommends *Kharif* sowing in the 2nd–3rd week of July, coinciding with the established monsoon to secure uniform stands and reduce early insect pressure. The crop typically matures in 80–90 days and performs best where seasonal rainfall is ~500–700 mm with well-drained soils.
Empirical evidence from Maharashtra underscores the sensitivity of growth and yield to sowing windows. A field study at Pune (*summer* 2025) testing three sowing dates (meteorological weeks, MW 01, 03, 05) and five cultivars reported superior vegetative growth and the highest grain and straw yields when sown in 01–03 MW (late January to mid-February), particularly with ‘KOPFX2107’, while delays depressed yield attributes.
Given rising intra-seasonal rainfall variability, identifying an optimal sowing window for different agro-climatic zones of Maharashtra is critical to stabilize productivity. This study therefore evaluates the effect of staggered sowing windows on foxtail millet growth and yield, generating location-specific guidance for farmers under monsoon-dependent conditions in India.

Materials and Methods
A field experiment was conducted at the Farm of Department of Agricultural Meteorology, College of Agriculture, Pune during the *summer* season of 2025 (18°32′ N, 73°51′ E; 557.7 m MSL). The region receives an average annual rainfall of 675 mm, with mean seasonal temperatures ranging from 29.3 to 40.5 °C (maximum) and 11.1 to 23.5 °C (minimum).
The trial was laid out in a split-plot design with three replications. The subplot treatments

consisted of three sowing windows (1 MW, 3 MW, and 5 MW) while the main plots comprised five foxtail millet genotypes. Standard agronomic practices were followed uniformly across treatments.
Observations were recorded on plant population, plant height, tillers per plant, number of functional leaves, dry matter accumulation and phenological stages (50% flowering and maturity). Growth indices such as Absolute Growth Rate (AGR), Crop Growth Rate (CGR), and Relative Growth Rate (RGR) were computed using standard formulas. Post-harvest observations included number of panicles plant^{-1}, grain yield and straw yield.
Daily weather data (temperature, rainfall, relative humidity and sunshine hours) were collected from the observatory located near the experimental site. Data were analyzed statistically using ANOVA for a split-plot design and treatment means were compared at the 5% level of significance.

Results and Discussion

Growth attributes

The effect of sowing windows on growth parameters of foxtail millet was found to be significant. Plant height was maximum (130.54 cm) under S_1 (1 MW) sowing which was statistically superior to S_2 (127.98 cm) and S_3 (127.32 cm). Early sowing allowed the crop to utilize favorable temperature and sunshine conditions during the vegetative phase resulting in better elongation. Similar trends were reported by Mubeena *et al.* (2019) [5], Nandini and Sridhara *et al.* (2019) [6] who observed taller plants in early-sown foxtail millet under semi-arid conditions.

Table 1: Mean growth and yield parameters of foxtail millet genotypes under different sowing windows in *summer* season

Treatments	Plant height (cm)	No. of tillers/m (60 DAS)	AGR (at harvest)	CGR (at harvest)	RGR (at harvest)	Days to 50% flowering	Days to maturity	Grain yield (q/ha)
Genotypes								
KIFXG-22-09(V_1)	124.47	16.22	1.3780	0.4278	0.0235	42	80	20.73
KIFXG-22-02(V_2)	135.60	17.08	1.3593	0.4543	0.0267	44	82	21.59
KOPFX2107(V_3)	140.27	18.58	1.5913	0.5883	0.0198	45	83	23.26
BFTM-82(C) (V_4)	119.30	14.23	1.3300	0.4969	0.0399	43	80	18.39
DHFT-109-3(C) (V_5)	123.43	15.47	1.3443	0.4376	0.0263	41	79	20.12
Mean			-	-	-			
S.E.(m)±	1.43	0.25	-	-	-	0.38	0.27	0.13
C.D. @5%	4.69	0.83	-	-	-	1.26	0.91	0.44
Sowing window								
S_1- 01 MW (01 January -07 January)	130.54	16.62	1.4340	0.4994	0.0264	45	82	21.35
S_2-03 MW (15 January -21January)	127.98	15.98	1.3833	0.4716	0.0253	43	81	20.73
S_3- 05 MW (29 January -04 February)	127.32	16.35	1.3840	0.4722	0.0260	42	81	20.38
S.E.(m)±	0.71	0.09	-	-	-	0.17	0.19	0.08
C.D. @5%	2.11	0.29	-	-	-	0.52	0.56	0.24
Interaction								
Mean	128.61	16.32	1.4005	0.4810	0.0267	43	81	20.82
S.E.(m)±	1.94	0.31	-	-	-	0.50	0.44	0.20
C.D. @5%	NS	0.98	-	-	-	NS	NS	0.63

The number of tillers/m row length followed a similar trend, with S_1 recording the highest (16.62**)** followed by S_3 (16.35) and S_2 (15.98). Timely sowing ensured better tiller initiation and survival due to favorable soil moisture and temperature synchronization with crop growth stages.
Growth rate parameters (AGR, CGR, RGR) varied marginally across sowing windows and were statistically non-significant. However, numerically higher values of crop growth rate (0.4994 g m^{-2} day^{-1}) and relative growth rate (0.0264 g g^{-1} day^{-1}) were recorded under S_1 sowing, suggesting better biomass accumulation under early sown conditions.

Phenology

Sowing windows had a marked influence on crop phenology. Days to 50% flowering (45 days) and maturity (82 days) were highest in S_1, followed by S_2 and S_3. Early sowing extended the crop growth duration by 2–3 days, which might have supported better partitioning of assimilates towards reproductive structures. Delayed sowing (S_3) shortened the vegetative phase, leading to faster attainment of flowering and maturity, which agrees with the findings of Gochar *et al.* (2022) [2]. on foxtail millet under late sowing.

Yield and yield attributes

Grain yield was significantly influenced by sowing windows. The highest grain yield (21.35 q ha^{-1}) was recorded in S_1, followed by S_2 (20.73 q ha^{-1}), while the lowest yield was obtained under S_3 (20.38 q ha^{-1}). Yield reduction under delayed sowing was mainly due to reduced plant height, lower tiller numbers, and shorter crop duration, which collectively constrained assimilate accumulation and partitioning.
Across genotypes, KOPFX2107 (V_3) produced the highest grain yield (23.26 q ha^{-1}), whereas the check variety BFTM-82 (V_4) recorded the lowest (18.39 q ha^{-1}). This indicates the importance of genetic potential in addition to sowing time for realizing higher productivity.
Interaction effects between sowing window and genotype were non-significant for most traits except tiller number and yield. However numerically KOPFX2107 (V_3) sown in S_1 consistently outperformed other treatment combinations suggesting that early sowing coupled with a high-yielding genotype optimizes crop performance.
Overall, the results highlight that timely sowing during the 1 MW (early January) ensures better growth, prolonged duration and higher grain yield of foxtail millet under Pune conditions. Delayed sowing beyond the 3 MW–5 MW reduces growth duration and yield potential.

Conclusion

The present investigation clearly indicated that sowing window exerted a significant influence on the growth, phenology and yield of foxtail millet under Pune conditions during *summer*

2025. Early sowing in the 1 meteorological week) resulted in taller plants, higher tiller number, extended crop duration and ultimately the highest grain yield (21.35 q ha^{-1}). Delayed sowing beyond mid-January led to reduced growth duration and yield potential. Among the genotypes, KOPFX2107 (V_3) consistently outperformed others, recording the highest yield (23.26 q ha^{-1}).
Thus it can be concluded that timely sowing during the 1 MW coupled with the use of high-yielding genotypes like KOPFX2107 is most suitable for maximizing foxtail millet productivity in the agro-climatic conditions of Pune.

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