



Impact of Varied Sowing Dates on Seed Quality Parameters in Wheat

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

The impact of varying sowing dates on the seed quality parameters of wheat is a subject of critical importance in agricultural research. Diverse sowing dates lead to distinct developmental trajectories and maturation patterns in wheat. These variations, in turn, significantly influence critical seed quality parameters. The current research study employed a split-plot design with three replications during the rabi season of 2016-17 at the Wheat Research Unit, Dr. P.D.K.V., Akola (M.S.). The experimental design featured various treatments, encompassing three distinct sowing dates: 15th November, 26th November and 13th December, representing timely sowing, late sowing and extreme late sowing, respectively. The investigation incorporated seven distinct wheat genotypes as variables. Of the parameters studied, including germination percentage, shoot length and seed vigor index, those seeds sown in a timely period exhibited superior performance. In contrast, root length reached its peak in the context of late sown period. This divergence in results underscores the influence of sowing date on specific aspects of wheat growth and development.

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1. INTRODUCTION

Wheat (*Triticum aestivum* L.) holds a prominent position within India as a significant food grain crop, recognized for its vital role [1]. Ranked second only to rice among cereal crops [2], it serves as a staple dietary element for both humans and animals [3]. Impressively, it caters to approximately 20% of the total caloric requirements for human sustenance [4]. This crop's historical impact includes ushering in the green revolution in India, a pivotal step towards achieving food security [5]. Notably, it stands as an exceptional source of proteins, minerals and vitamins in the realm of cereals [6,7]. Its contribution, comprising about 60% of daily protein needs and a significant portion of global dietary calories, remains unparalleled among food crops [8].

Wheat's growth and metabolic processes are intricately linked to photothermal dependencies [9]. Evaluating wheat cultivation in India, Singh et al. [10] aptly described it as a "gamble with temperature," emphasizing the critical role temperature plays. The progression of wheat, however, is substantially hindered by environmental stressors like elevated higher temperatures, soil moisture deficiencies, and reduced light intensity [10]. Particularly, temperature stress holds a detrimental sway over wheat cultivation, significantly compromising its potential [11]. Heat stress, in particular, adversely affects the reproductive stages of wheat [12], trickling down to influence crucial facets such as seed germination, root emergence, and seed quality [13].

The timing of sowing, notably, plays a pivotal role in the entire process [14,15,16]. Late sowing often creates a suboptimal growth environment for wheat [17]. As a result, the quality attributes of wheat seeds become intricately linked with the timing of sowing [18]. Considering the global significance of wheat for ensuring food security, it becomes paramount to address whether delays in sowing have a discernible impact on seed quality?

2. MATERIALS AND METHODS

The experiment was conducted at the farm of the Wheat Research Unit, located within the Mission School Block of Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola (M.S.), during the Rabi season of 2016-17. Akola finds itself positioned

within the subtropical zone, situated at a latitude of 20° 42' North and a longitude of 77° 02' East. Notably, the elevation of this location stands at 307.41 meters above mean sea level.

The topography of the experimental field exhibited a remarkable degree of uniformity and levelness. Employing a split-plot design, the research experiment was organized into three replications. Here, the primary plots were allocated to the different sowing dates, while the subplots were dedicated to the distinct wheat genotypes. The sowing times encompassed three specific dates, namely S1 (timely sowing on 15th November), S2 (late sowing on 26th November) and S3 (very late sowing on 13th December). The study incorporated a total of seven diverse wheat genotypes, each bringing a unique genetic profile to the investigation. These genotypes were identified as follows: G1 (AKAW-4627), G2 (AKDW-4021), G3 (AKAW-3722), G4 (AKW-1071), G5 (NIDW-295), G6 (AKAW-3997) and G7 (AKAW-4210-6). Thus, the entirety of the experiment encompassed ten samples of 21 distinct treatments. To ensure consistency, a planting arrangement featuring a spacing of 20 cm between adjacent rows and 2 cm between individual plants was meticulously maintained throughout the study.

Data on various seed quality parameters was recorded under laboratory condition. The technique followed for recording each of the observations is outlined below.

i. Germination percentage (%)

Three replications of hundred seed were kept for germination in laboratory. After 7-8 days germinated seed were counted and non-germinated seed also counted and germination percentage was drawn using following formula.

$$\text{Germination\%} = \frac{\text{No.of germinated seeds}}{\text{Total seeds}} \times 100$$

ii. Shoot Length (cm)

After the emergence of seedling the shoot length of seedling of each genotype were recorded at 7th Day.

iii. Root Length (cm)

After the emergence of seedling the shoot length of seedling of each genotype were recorded at 7th Day.

iv. Seed vigor Index=Germination% X Seedling length

After calculating germination percentage and seedling length seed vigour index were calculated by using above formula at 7th Day.

2.1 Statistical Analysis

The data on various parameters was subjected to statistical analysis by employing standard statistical methods for Split Plot Design as proposed by Panse and Sukhatme [19].

3. RESULTS AND DISCUSSION

3.1 Germination Percentage (%)

The data presented in Fig. 1 indicates a noteworthy trend in germination percentages for different wheat sowing timings. Timely sowing of wheat exhibited a significantly higher germination percentage (96.38%) in comparison to both late sowing (95.14%) and extreme late sowing (92.86%). This outcome aligns with the findings of Tripathi et al. (2003). Among the various genotypes, AKAW-4627 showed the highest germination percentage (95.55%), closely trailed by NIDW-295 (95.11%) and AKAW-3722 (95.11%). On the other end of the spectrum, the genotype AKDW-4021 displayed the lowest germination percentage (93.89%), followed by genotype AKAW-3997 (94.11%).

The germination count was conducted within controlled laboratory conditions, ensuring uniformity in germination percentages across all genotypes. Under timely sown conditions, AKAW-4627 genotype exhibited the highest germination percentage (98.33%), followed by AKAW-4210-6 (97.67%), AKDW-4021 (97.00%), AKAW-3997 (96.33%) and NIDW295 (96.00%). In the context of late sown conditions, AKAW-4210-6 demonstrated a significantly elevated germination percentage (96.33%), whereas AKAW-3722 displayed a comparatively lower germination rate (94.33%). During extreme late sown conditions, AKAW-3722 recorded the highest germination percentage (96.67%) among all genotypes, surpassing the others. These findings are consistent with prior research as reported by Tripathi et al. (2003). Moreover, drawing from two years of field experiments, Mumtaz et al. [20] concluded that wheat sown on the 11th of November (timely sown) exhibited superior performance with respect to germination count over late sowing. Also, Ali et al., [21] revealed that the germination percentage of wheat was maximum (86.5 8%) in early

sowing (15th Nov.) whereas it was minimum (83.68 %) in mid late sowing (30th Nov.)

3.2 Root Length (cm)

The data shown in Fig. 2 indicated that, root length (cm) was found higher in case of extreme late sowing of wheat (16.46 cm) as compared with late sowing (13.60 cm) and timely sowing (13.36 cm). Similar results were reported by Tripathi et al., [22]. Among the genotypes AKAW-4210-6 (15.35 cm) recorded the higher root length which was non significantly differed with genotypes AKAW-3722 (15.18 cm), AKAW-3997(14.61 cm), AKW-1071 (14.55 cm) and AKAW-4627(14.51 cm). And lower root length was recorded in genotype NIDW-295 (13.25 cm). A comparable outcome was noted by Ali et al. [21], demonstrating that the root length of wheat when sown early (November 15th) was smaller, measuring 11.26 cm, in contrast to the relatively greater length of 12.05 cm observed with mid to late sowing (November 30th). Interaction effect between sowing dates and genotypes was found statistically non-significant for root length.

3.3 Shoot Length (cm)

The data presented in Fig. 3 highlights notable trends. Specifically, shoot length exhibited a significant increase with timely sowing (14.71 cm) in comparison to very late sowing (13.34 cm). Among the various genotypes, AKAW-3722 demonstrated the most impressive shoot length (14.48 cm), while NIDW-295 exhibited the shortest shoot length (13.61 cm). Notably, the interaction between sowing dates and genotypes did not yield statistically significant differences in the seedling shoot length. This finding aligns with the work of Tripathi et al. [22], who noted higher shoot lengths in normally sown wheat compared to late sowing. Moreover, Ali et al. [21] revealed that early sowing (November 15th) resulted in the maximum shoot length (12.67 cm) for wheat, surpassing the shoot length of mid-late sowing (November 30th), which measured 12.34 cm. Interaction effect between sowing dates and genotypes was found statistically non-significant for shoot length of seedling

3.4 Seed Vigour Index

The data presented in Fig. 4 demonstrates that seed vigor index exhibited a significant increase in cases of timely sowing (3005), in contrast to late sowing (2643.79) and very late sowing

(2480.40). Among the genotypes studied, AKAW-3722 (2818.80) displayed the highest seed vigor index, indicating its superiority, while NIDW-295 (2557.26) exhibited the lowest seed vigor index compared to the other genotypes. The interaction between sowing dates and genotypes was found to have a statistically significant impact on seed vigor index. In the context of timely sowing, AKAW-4210-6 recorded the highest seed vigor index (3095.06), followed closely by AKDW-4021 (3084.49), AKAW-3722 (3052.52) and genotype AKAW-3997 (3012.83). On the other hand, the lowest seed vigor index was observed in the NIDW-295 genotype (2839.26).

During late sowing conditions, the wheat genotype AKAW-3722 (2749.67) displayed the maximum seed vigor index, followed by genotype AKW-1071 (2684.60). In contrast, the minimum seed vigor index was observed in genotype NIDW-295 (2501.00). Under extreme late sowing conditions (December 13th), genotype AKAW-4210-6 (2703.3) demonstrated the highest seed vigor index, while the lowest index was recorded for genotype AKDW-4021 (2170.37). This pattern of results aligns with the findings of Ali et al. [21], who similarly reported that wheat seed vigor index was higher under early sowing conditions (15th November, with a value of 2050.35) compared to mid-late sowing (30th November, where the vigor index was 2038.03).

High-temperature treatments have been observed to decrease both germination rates and the potential for robust growth across multiple cultivars [23,24]. The vigor potential of seeds is subject to a multitude of influences, encompassing both biotic and abiotic factors [25]. Among these, abiotic factors such as heat and drought exert adverse effects on seed vigor [26]. Grass and Burris [23] noted instances of impaired germination, coupled with a decline in seed vigor among wheat varieties. This was manifested by reductions in shoot and root dry weights, as well as heightened seed conductivity a consequence of elevated temperatures experienced during the phases of seed development and maturation. These findings align with the observations of Seshu and Dadlani [27], who emphasized the pivotal role of high germination percentages and robust vigor in assessing seed quality.

The significance of seeds with superior germination percentages and vigor indices becomes evident in their potential contributions towards achieving optimal plant populations, growth trajectories and developmental outcomes [28,29]. We believe that the rapid and uniform emergence in field conditions stands as a crucial prerequisite for fostering enhanced growth and ultimately yielding bountiful harvests. Furthermore, the earlier research outcomes underscore the variable nature of seed germination and vigor, often attributed to differences in sowing timings [30,31].

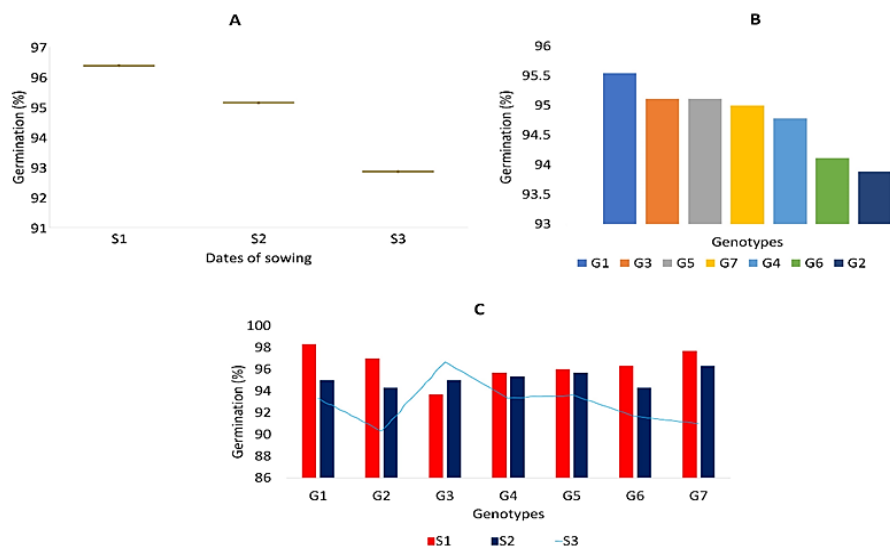


Fig. 1. Germination percentage of wheat at different dates of sowing. B. Germination percentage of different wheat genotypes. C. Interaction between sowing dates and genotypes for germination percentage

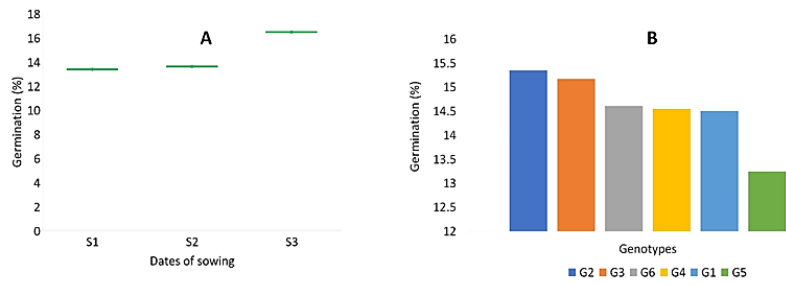


Fig. 2. Germination percentage of wheat at different dates of sowing. B. Germination percentage of different wheat genotypes

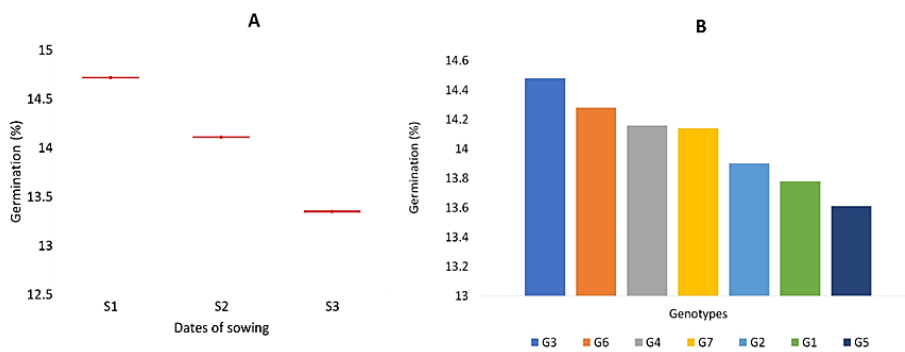


Fig. 3. Germination percentage of wheat at different dates of sowing. B. Germination percentage of different wheat genotypes

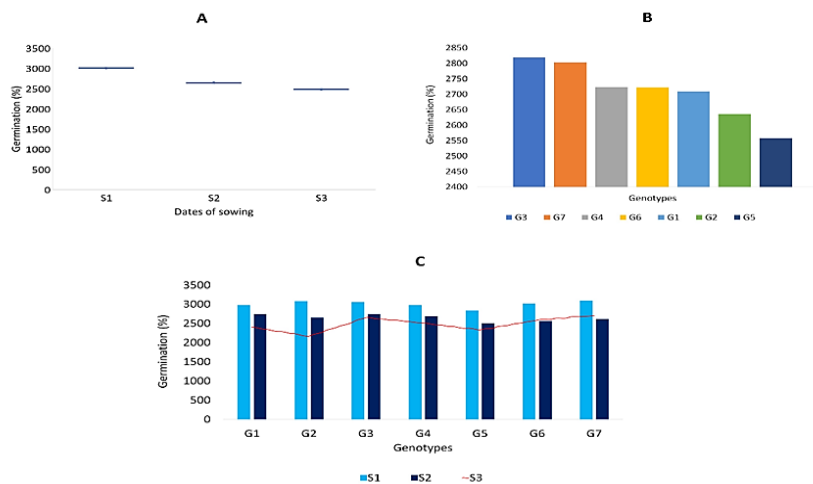


Fig. 4. Germination percentage of wheat at different dates of sowing. B. Germination percentage of different wheat genotypes. C. Interaction between sowing dates and genotypes for seed vigour index

4. CONCLUSION

Various genotypes exert a noteworthy influence on the quality parameters of seeds. Moreover, distinct sowing dates instigate variations in the developmental and maturation of wheat crop.

These variations subsequently influence the germination rate, root as well as shoot length and composition of the seeds produced. Furthermore, the interaction between sowing dates and prevailing environmental conditions, such as temperature, moisture availability and

photoperiod, can significantly shape the seed quality traits. This investigation underscores a compelling observation, germination percentage, shoot length and seed vigor index attained their higher when sown timely (15th November). Conversely, maximum root length manifested under conditions of very late sowing, presenting a notable contrast to the outcomes of both timely and moderately delayed sowing, albeit lacking a statistically significant interaction effect. The timing of sowing dates profoundly affects wheat seed quality encompassing the factors mentioned above. Understanding these relationships is crucial for optimizing seed quality and overall crop performance in wheat farming.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

We all authors hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of manuscripts.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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