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Interactive effects of transplanting dates and crop cover durations on growth and flowering attributes of chilli (*Capsicum annuum* L.) under kharif conditions

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ABSTRACT

During the 2023-2024, a field experiment was carried out at the Instructional Farm of the Department of Vegetable Science, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola. The study's purpose was to investigate how different transplanting dates and the durations of crop cover affect chilli plants' growth and flowering characteristics during the kharif season. The experiment utilized a Factorial Randomized Block Design, featuring twenty treatment combinations, each repeated three times. The treatments included five transplanting dates: D_1 (1st June), D_2 (1st July), D_3 (1st August), D_4 (1st September), and D_5 (1st October), alongside three crop cover durations: C_1 (up to first flower initiation), C_2 (up to 50% flower initiation), and C_3 (up to the first harvest), with an additional control C_4 (without cover). A crop cover of 17 gsm was used. The treatment combination D_2C_2 , which involved transplanting on 1st July with crop cover maintained until 50% flower initiation, proved to be superior by significantly improving growth metrics like plant height, branch count, and plant spread. The D_2C_3 treatment, involving transplanting on 1st July with crop cover until the first harvest, achieved the greatest stem girth in chilli plants. However, the leaf area, days to the first flower initiation, and days to 50% flower initiation did not exhibit notable differences due to the interaction of transplanting dates and crop cover durations.

Keywords: Chilli, Crop cover, Plant height, Stem girth, Flowering

Introduction

Chilli, also known as hot pepper (*Capsicum annuum* var. *annuum* L.), is becoming an economically significant and widely favored vegetable crop. It is cultivated for its green fruits, which are consumed as vegetables, and its red dried fruits, which are used as spices. Additionally, chillies are utilized in various processing industries to produce items like pepper sauce, pickled pepper, ground pepper, and dried pepper. This plant is part of the Solanaceae family and has its origins in the Latin American regions of New Mexico, Guatemala, and Bulgaria. The Portuguese introduced it to India from Brazil towards the end of the 15th century, and by the 17th century, its cultivation had gained popularity. Green chilli fruits are rich in phytonutrients, ascorbic acid, carotenoids, and rutin, which are important for pharmaceutical purposes (Deshpande, 2001) [1]. Chillies are known for their two key characteristics: piquancy and pungency, as well as their appealing red color, which is due to capsaicin and capsanthin, respectively (Surh et al., 1995) [2]. India stands as the largest producer and exporter of chillies, with Madhya Pradesh leading in green chilli production. Gujarat follows in second place, producing 719.60 thousand tonnes and holding a 12.55 per cent share, while Maharashtra ranks third with 640.35 thousand tonnes and an 11.17 per cent share of India's total green chilli production (Anonymous, 2025).

Determining the optimal time for planting is essential in agriculture, as it sets the stage for the environmental conditions a crop will encounter throughout its growth cycle (Madhumathi and Sadarunnisa, 2013). The timing of planting plays a significant role in how well crop phenological stages coincide with climatic factors such as temperature, solar radiation, rainfall, and relative humidity (Kumar et al., 2015) [3]. The interaction between a crop's genetic makeup and its environment influences growth and development, meaning even slight adjustments in planting time can impact the duration and speed of developmental stages, resource efficiency, and overall yield. By selecting the right planting window, crops can benefit from favorable environmental conditions during key phases like establishment and vegetative growth (Singhal et al., 2009) [4]. Crop covers, also known as agrotexile, non-woven fabric covers, and row fleece, are synonymous with non-woven crop covers. These covers are widely employed in agriculture. Depending on their thickness and colour, different crop covers are applied to various crops. They embody a novel agro-technological approach that integrates physical protection with selective solar radiation filtration (Licciardi et al., 2007) [5]. From the early stages of plant growth, these covers shield crops from sucking pests such as thrips, mites, and whiteflies, which can deform plants and spread diseases. Due to their versatility and cost-effectiveness, crop

covers hold significant global importance. Non-woven crop covers are innovative products with distinct structural characteristics designed for agricultural use. They serve purposes like weed control, wind protection, and frost cover, helping to moderate weather conditions against sudden temperature shifts and seasonal changes. These covers can modify various microclimatic factors, including temperature, relative humidity, and the amount and quality of solar radiation (Nissim-Levi *et al.*, 2008) [6] that reaches the crop canopy. Such modifications can impact physiological processes, particularly photosynthesis and CO₂ assimilation (Ogden *et al.*, 2009) [7], thereby affecting plant growth and development (Kittas *et al.*, 2009) [8].

Material and methods

In the kharif season of 2023-2024, a study was carried out at the Instructional Farm of the Department of Vegetable Science, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola. The aim was to examine how transplanting dates and crop cover durations affect the growth and flowering of chilli plants. The research employed a Factorial Randomized Block Design (FRBD) with twenty treatment combinations, each replicated thrice. The treatments included five transplanting dates: D₁ (1st June), D₂ (1st July), D₃ (1st August), D₄ (1st September), and D₅ (1st October), alongside three crop cover durations: C₁ (up to first flower initiation), C₂ (up to 50% flower initiation), and C₃ (up to the first harvest), with a control C₄ (no cover). Thirty-day-old seedlings were transplanted on the designated dates, with a spacing of 120 × 60 cm. After transplanting, 10-gauge galvanized iron wires were placed at 2.5-foot intervals along the beds' length. These wires were fastened to sticks using ropes at both ends, and a 17 gsm crop cover was draped over them. The covers were secured at the ends and the sides were buried with soil. Removal of covers was done as per the treatment plan. Plant protection strategies were applied based on pest and disease presence. Green chilli fruits were picked at marketable maturity at regular intervals. The study documented growth metrics such as plant height, branch count, plant spread, stem thickness, days to first flower initiation, and days to 50% flower initiation.

Results and discussion

The growth and flowering of chilli were significantly influenced by the timing of transplanting and the duration of crop cover, as shown in Table 1.

Plant height (cm)

At 60 DAT, plant height data showed no significant effect from the interaction between varying transplanting dates and crop cover durations. However, by 90 DAT, a notably greater plant height of 61.40 cm was recorded with the 1st July transplanting and crop cover maintained until 50% flower initiation (D₂C₂), outperforming most other treatment combinations. At 120 DAT, the tallest plants, measuring 73.23 cm, were achieved with the 1st July transplanting and crop cover up to 50% flower initiation (D₂C₂), which was statistically comparable to the 1st July transplanting with crop cover until the 1st flower initiation (D₂C₁) at 72.20 cm. The early July transplanting likely resulted in taller plants due to more favourable conditions such as temperature, soil moisture, and solar radiation, which enhanced rapid establishment, cell division, cell elongation, and assimilate accumulation. According to Kaur *et al.* (2018) [9], transplanting chili earlier in the season can lead to increased plant height by taking advantage of a longer growing period with favourable environmental conditions, assuming soil temperature and moisture are sufficient to prevent stress. Plants grown in low light conditions exhibited more apical dominance compared to those in high light environments, as increased auxin transport led to cell elongation below the apical meristem zone, resulting in taller plants under cover (Rao *et al.* 2023) [10]. Furthermore, the cover may have reduced the adverse effects of wind and fluctuations in temperature and moisture, promoting better establishment and continuous vegetative growth.

Number of branches

At 60 DAT, the interaction between transplanting dates and crop cover durations did not significantly affect the number of branches. The 1st July transplanting with crop cover until 50 per cent flower initiation (D₂C₂) resulted in the highest branch count of 10.38, which was notably better than most other treatments at 90 DAT. By 120 DAT, the maximum branch count of 17.55 was again observed for the 1st July transplanting with crop cover up to 50 per cent flower initiation (D₂C₂), outperforming most other treatment combinations. Transplanting in July likely promotes increased branching due to favourable weather during the active vegetative phase, which may have supported vigorous growth and lateral shoot development. According to Patel *et al.* (2025) [11], earlier planting takes advantage of optimal weather for improved crop growth and development. The use of polypropylene fabric as a crop cover does not change the light spectrum but enhances light scattering, which has been shown to increase branching numbers (Nissim-Levi *et al.*, 2008) [6]. The greatest number of branches was achieved with crop cover up to 50% flowering. In low-light environments, plants showed more apical dominance than those in high-light conditions.

Plant spread (cm)

The timing of transplanting and the duration of crop cover did not have a notable impact on plant spread at 60 DAT. The widest plant spread, measuring 60.93 cm, was recorded with transplanting on 1st July and crop cover maintained until 50 per cent flower initiation (D₂C₂), outperforming most other treatment combinations at 90 DAT. At 120 DAT, the greatest plant spread of 72.60 cm was achieved with the 1st June transplanting and crop cover up to 50 per cent flower initiation (D₁C₂), which was significantly better than most other treatments. Early transplanting allowed sufficient time and warmer conditions for crop growth and development, consistently resulting in a robust stand and advanced vegetative growth stage (Sharma *et al.* 2003). The cover likely elevated temperature and relative humidity (Gogo *et al.*, 2014) [12]. The combination of increased temperatures and decreased light intensity might have promoted the elongation of internodes and lateral shoots as plants adjusted to the changed light conditions (Gimenez *et al.*, 2002) [13]. This lateral branch elongation led to a wider horizontal canopy, resulting in maximum plant spread under crop cover until 50 per cent flower initiation. Conversely, when the crop cover was removed at the first harvest, despite providing longer protection, it led to reduced plant spread. Extended exposure to the low-light and high-humidity environment under the cover may have caused etiolation and excessive internodal elongation, resulting in weaker plants with less effective expansion (Wanda, 2016) [14].

Stem girth (cm)

The effect of transplanting dates combined with the duration of crop cover on stem girth at 60 DAT was not statistically significant. However, at 90 DAT, the greatest stem girth of 4.65 cm was recorded with the 1st July transplanting when the crop cover was extended until the first harvest (D₂C₃). This result was statistically comparable to the 1st July transplanting with crop cover maintained until 50 per cent flower initiation (D₂C₂), which resulted in a stem girth of 4.62 cm. At 120 DAT, the maximum stem girth of 7.44 cm was achieved with the 1st July transplanting and crop cover maintained until the first harvest (D₂C₃), which was statistically similar to the 1st July transplanting with crop cover up to 50 per cent flower initiation (D₂C₂), producing a stem girth of 7.40 cm. Chilli plants transplanted on 1st July showed the thickest stems. Solar radiation plays a crucial role in stem growth by enhancing photosynthetic assimilate production, while adequate water supply supports cell expansion and maintains stem rigidity (Singhal *et al.*, 2009) [4]. Extending the cover period likely helped maintain optimal temperature and relative humidity, aligning the crop with its ideal photosynthetic conditions (Licciardi *et al.* 2008). Enhanced photosynthetic activity would have increased the production of photosynthates, thereby boosting the availability of assimilates

for structural growth (Rao *et al.* 2023) [10]. These assimilates were likely directed towards stem development.

Leaf area (cm²)

The effect of the interaction between transplanting dates and durations of crop cover on the leaf area of chilli was not significant. In contrast, crop covers in cucurbits (Franczuk *et al.*, 2017) [15] have a notable impact on leaf area, but the findings of this study differ, possibly due to the weather conditions experienced during the research period.

Days to flowering

The study found that the interaction between the dates of transplanting and durations of crop cover did not significantly affect the number of days to the first flower initiation and 50% flower initiation.

Conclusion

The dates of transplanting and crop cover durations significantly affected the plant growth parameters. The 1st July transplanting date with crop cover up to 50 per cent flower initiation performed best for desirable growth characters.

Table 1. Combined effect of transplanting dates and crop cover durations on various growth parameters and flowering.

Treatments	Plant height (cm)			Number of branches			Plant spread (cm)			Stem girth (cm)			Leaf Area (cm ²)	Days to 1 st flower initiation	Days to 50% flower initiation
	60 DAT	90 DAT	120 DAT	60 DAT	90 DAT	120 DAT	60 DAT	90 DAT	120 DAT	60 DAT	90 DAT	120 DAT			
D ₁ C ₁	45.63	55.77	63.37	4.77	8.01	15.05	43.23	54.57	67.03	2.34	4.06	5.68	21.73	35.67	48.33
D ₁ C ₂	47.60	57.50	66.10	5.70	9.10	16.80	41.07	58.57	72.60	2.57	4.27	7.11	21.97	34.67	46.00
D ₁ C ₃	45.53	54.23	67.03	5.25	8.42	15.35	36.43	55.77	70.73	3.12	4.62	6.46	21.47	34.67	47.67
D ₁ C ₄	43.47	51.97	63.30	4.73	7.05	14.00	33.10	50.83	63.51	2.18	3.90	5.32	20.97	38.33	51.67
D ₂ C ₁	49.20	59.10	72.20	5.33	8.41	16.50	41.62	57.63	68.40	3.25	4.37	7.18	21.80	33.33	47.33
D ₂ C ₂	50.77	61.40	73.23	6.15	10.38	17.55	45.83	60.93	70.37	3.44	6.62	7.40	22.70	33.33	45.33
D ₂ C ₃	48.13	57.73	71.27	6.05	9.28	16.73	43.93	59.17	69.33	3.57	4.65	7.44	22.81	34.00	46.33
D ₂ C ₄	46.33	53.50	65.67	4.33	7.07	12.10	36.41	52.53	62.37	3.21	4.07	5.49	19.96	36.67	52.33
D ₃ C ₁	46.70	56.77	69.93	5.07	7.62	12.40	34.80	51.83	60.53	2.93	4.09	6.49	19.83	33.67	48.00
D ₃ C ₂	48.43	58.60	71.63	5.93	8.84	14.94	36.60	55.80	67.13	3.17	4.29	6.67	20.69	34.33	48.33
D ₃ C ₃	46.40	55.00	69.03	4.55	7.65	12.95	37.60	57.20	64.07	3.33	4.31	6.55	20.67	35.67	46.33
D ₃ C ₄	43.93	52.53	62.83	4.08	7.04	11.95	33.17	51.94	61.27	2.58	4.02	6.67	17.30	38.33	53.00
D ₄ C ₁	46.50	54.97	68.20	4.17	8.30	13.35	36.23	53.17	62.47	3.06	4.07	5.65	18.47	35.33	50.67
D ₄ C ₂	48.43	56.03	70.90	4.90	8.45	14.60	37.07	55.53	61.40	2.29	4.38	6.27	19.10	35.67	49.00
D ₄ C ₃	47.03	53.53	68.93	4.53	8.30	14.38	38.13	57.13	65.11	3.41	4.61	7.37	19.87	36.33	50.33
D ₄ C ₄	44.83	50.67	63.47	3.13	7.11	12.93	33.60	50.07	52.97	3.27	3.81	5.95	17.83	40.00	54.00
D ₅ C ₁	44.80	53.00	64.27	4.20	7.30	12.90	32.77	52.50	63.60	2.85	3.95	6.70	17.43	36.67	51.00
D ₅ C ₂	45.27	54.17	65.77	4.60	7.78	12.92	33.13	54.87	63.97	3.08	4.27	6.15	18.00	36.67	48.67
D ₅ C ₃	47.20	54.80	67.00	4.40	8.80	13.75	35.83	55.63	65.07	3.22	4.32	7.17	18.63	37.00	48.00
D ₅ C ₄	43.37	50.93	57.50	3.13	7.02	12.80	32.40	48.11	52.20	2.34	3.72	5.41	16.87	44.00	54.67
F test	NS	Sig	Sig	NS	Sig	Sig	NS	Sig	Sig	NS	Sig	Sig	NS	NS	NS
SE (m)±	0.57	0.40	0.44	0.26	0.33	0.21	1.26	0.12	0.30	0.04	0.05	0.08	0.81	1.03	0.61
CD @ 5%	-	1.14	1.29	-	0.97	0.61	-	0.34	0.87	-	0.16	0.24	-	-	-

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