**Short Research Article**

**Optimizing the sowing windows and irrigation schedules for enhanced growth and productivity for potato crop**

**Abstract**

Potato is world’s fourth most important staple food crop with significant role in global food and nutritional security. The present field investigation conducted to evaluate the effect of various sowing windows (10th December, 2020; 30th December, 2020; and 10th January, 2021) and irrigation schedules (2, 3, 4 and 5 irrigations) on potato growth and productivity. The study was conducted in a randomized block design with factorial arrangement, 12 treatments and 3 replications. The results of the investigation revealed that higher plant height, number of leaves, shoots, tubers per plant, average tuber weight and tuber yield were recorded for the 10th December sown crop whereas irrigation schedule consisting of 5 irrigations resulted in the higher plant height, number of leaves, shoots, tubers per plant, average tuber weight and tuber yield for potato crop. However, 10th January sown crop and 2 or 3 irrigation-based schedules resulted in the lowest plant height, number of leaves, shoots, tubers per plant, average tuber weight and tuber yield for the potato crop.

**Introduction**

Potato (*Solanum Tuberosum* L.) has been a highly valuable and prominent crop for food and nutritional security across the globe (Rana *et al.,* 2004). Potato has been advocated primarily for carbohydrate supply, mineral and vitamin source. Potato is cultivated widely across various countries of the globe with 16.8 million hectares cultivation area, production and productivity of around 383 million tonnes and 22 ton per hectare, respectively (FAOSTAT, 2025). Potato also occupies a significant place in food value chain of Indian population. Potato is cultivated over an area of 2.3 million hectare with production and productivity of around 60.1 million tonnes and 25.8 ton per hectare, respectively (FAOSTAT, 2025).

Crop production systems are facing a significant issue of climate change in the 20th century. Rising temperatures and fluctuating rainfall regimes under the scenario of climate change has influenced magnitude of water resources, crop water availability and demand (Rana *et al.,* 2013; Rana *et al.,* 2018; Pareek *et al.,* 2021). Among cultivated crops, C3 crops like potato are highly vulnerable to the issue of climate change. Several scientific investigations have advocated malign effects of temperatures and rainfall regime son crop productivity. Optimum growing conditions for potato includes temperature regimes of 14-18 0C wherein rising temperatures above 28 0C leading to substantial reduction in potato productivity (Kirina *et* *al.,* 2025; Rana *et al.,* 2025; Sharma *et al.,* 2025). Rising temperatures may have several effects on photosynthesis, respiration, sprouting and tuber formation in potato crop (Rai and Dong, 2025). Apart from rising temperatures, fluctuating rainfall regimes may highlight vulnerability of potato crop to drought and waterlogging conditions severely due to shallow rooting system of the crop (Rana et *al.,* 2021; Naik *et al.,* 2024; Sharma *et al.,* 2024). Therefore, water application based on prevailing climatic conditions *i.e.,* evapotranspiration-based irrigation scheduling can play a significant role in optimizing crop productivity levels (Kumar *et al.,* 2024). Several field investigations have reported significant effects of evapotranspiration-based irrigation scheduling on potato growth and productivity. Apart from climatic condition-based irrigation scheduling, optimizing sowing windows may play a substantial role in improving crop productivity levels (Pathania *et al.,* 2018; Pathania *et al.,* 2019; Chandel *et al.,* 2022).

Altering the sowing window of potato crops can significantly influence their exposure to variable climatic conditions, subsequently impacting biomass accumulation.  Altering sowing windows can change the exposure of potato crop to variable climatic conditions affecting biomass accumulation significantly (Pareek *et al.,* 2023; Kumar *et al.,* 2024). Early sowing or planting of potato has been reported due to exposure of potato crop to higher temperatures especially at reproductive or flowering stages leading to reduced tuber yield levels. Similarly, late planting of potato crop may lead to reduced biomass accumulation and subsequently lower tuber yield. Similarly, optimizing sowing windows of wheat crop significant improved wheat yield levels considerably with the highest grain yield levels for wheat crop sown on 15th October under conditions of North-western Himalayas of Himachal Pradesh (Salaria *et al.,* 2024; Choudhary *et al.,* 2024).

Therefore, keeping in consideration the potential of sowing windows and irrigation schedules in influencing potato yield levels, the field investigation was conducted to evaluate the effect of various sowing dates and irrigation schedules on potato growth and productivity.

**Material and Methods**

The field study was carried out at research farm of Department of Agronomy, CSK HPKV, Palampur wherein the experimental field was located at an elevation of 1290.8 m above mean sea level. The experimental field was located at 32°6' N latitude and 76°3' E longitude. The experimental site was characterized agro-climatically for its mild summers, severe winters and high rainfall. During the cropping season of the field investigation, the average mean weekly maximum and minimum temperature ranged between 0.83 to 16.57°C and 15.93 to 26.79 °C, respectively. Total rainfall, cumulative pan evaporation, mean relative humidity, monthly ET and bright sunshine hours during the cropping season were 355.40 mm, 489.30 mm, 48.57 to 80.14 percent, 48.5-129.5 mm and 2.79 to 9.29 hours, respectively. Similarly, site of experimental field was analyzed before sowing and was found to be silty clay loam in texture with acidic pH of 5.4, organic carbon of 0.67 percent, available nitrogen, phosphorus and potassium to be 257, 17.9 and 183.2 kg/ha, respectively.

The field experiment was conducted in a randomized block design with factorial arrangement, involving 12 treatments with 3 replications involving three dates of sowing 10th December, 2020; 30th December, 2020 and 10th January, 2021 and four irrigation schedules irrigations were 2, 3, 4 and 5 irrigations. The *Kufri Jyoti* variety was sown with spacing of 50 and 20cm for row to plant, respectively. The gross plot size was 16.56 m2 and net plot size was 12.60 m2, respectively.

Growth, yield attributes and yield data were recorded using standard protocols. The recorded data was subjected to analysis of variance using standard protocols for randomized block design as per Gomez and Gomez, 1984.

**Results and Discussion**

Sowing windows and irrigation schedules exerted significant influence over plant height of potato crop. Substantially higher plant height, number of leaves and shoots per plant were recorded for the 10th December sown crop (Table 1). However, number of leaves and leaf area index were found to be significantly higher for 10th January sown crop (Table 1 and Table 2). The lowest, plant height, number of leaves and shoots per plant were recorded for the 10th January sown crop whereas significant lower number of leaves per plant and leaf area index were found for the 10th December sown crop. Similarly, substantially higher number of tubers per plant, average tuber weight and tuber yield was recorded for the 10th December sown crop followed by 30th December and 10th January sown crop (Table 3). The lowest number of tubers per plant, average tuber weight and tuber yield was recorded for the 10th January sown crop. Optimizing the sowing windows may have resulted in aligning the crop development stages with favorable environmental conditions resulting in increased biomass accumulation and productivity (Devi *et al.,* 2024; Salaria *et al.,* 2024a). Sowing crops under favorable environmental regimes resulted in adequate soil moisture supply, optimal temperature regimes, longer photoperiods and improved growth.

Among irrigation schedules, 5 irrigation-based scheduling resulted in the highest plant height, number of leaves, shoots and tubers per plant, average tuber weight and tuber yield which performed statistically at par with irrigation scheduling based on 4 water applications. Optimizing irrigation scheduling for potato is significantly critical owing to shallow root system, sensitivity to water stress particularly at critical stages such as tuber initiation and bulking stages (Rai and Dong 2025). Maintaining optimized consistent supply may have improved soil moisture regime, photosynthetic efficiency, nutrient uptake, utilization and assimilation resulted in enhanced potato productivity (Badr *et al.,* 2022). The lowest plant height, number of leaves, shoots and tubers per plant, average tuber weight and tuber yield was recorded for the limited irrigation schedule based on 2 irrigations.

**Conclusion**

Sowing windows and irrigation schedules significantly influenced potato growth and yield. Sowing of the crop by 10th December resulted in highest plant height, number of leaves, shoots, tubers per plant, average tuber weight and tuber yield. Delayed sowing by 10th January lead to considerable reduction in growth attributes such as plant height, number of leaves, shoots per plant as well as for tubers per plant, average tuber weight and potato tuber yield. Similarly, irrigation schedule consisting of 5 irrigations can considerably enhance potato growth attributes such as plant height, number of leaves, shoots per plant and tubers per plant, average tuber weight and potato tuber yield. However, limited irrigation regimes lead to substantial reduction in growth attributes such as plant height, number of leaves, shoots per plant as well as for tubers per plant, average tuber weight and potato tuber yield.

COMPETING INTERESTS DISCLAIMER:

Authors have declared that they have no known competing financial interests OR non-financial interests OR personal relationships that could have appeared to influence the work reported in this paper.

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**Table 1. Effect of different sowing dates and irrigation scheduling on plant height and number of leaves per plant**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Treatments** | **Plant height (cm)** | | | | | **Number of leaves per plant** | |  |
|  | **60 DAP** | **90 DAP** | **120 DAP** | **At harvest** | **60 DAP** | **90 DAP** | **120 DAP** | **At harvest** |
| **Date of sowing** | | | | | | | | |
| 10th December | 25.04 | 29.46 | 41.50 | 44.67 | 6.08 | 11.53 | 16.21 | 12.47 |
| 30th December | 23.60 | 28.12 | 39.56 | 40.75 | 5.68 | 10.84 | 15.42 | 13.12 |
| 10th January | 22.34 | 27.09 | 38.24 | 38.67 | 5.31 | 10.57 | 14.58 | 13.52 |
| SEm± | 0.36 | 0.41 | 0.66 | 0.92 | 0.10 | 0.17 | 0.26 | 0.20 |
| CD (P=0.05) | 1.06 | 1.20 | 1.94 | 2.70 | 0.29 | 0.50 | 0.78 | 0.59 |
| **Irrigation scheduling based on ET Method** | | | | | | | | |
| 2 irrigations | 20.72 | 24.41 | 35.52 | 37.94 | 4.83 | 10.18 | 14.27 | 12.29 |
| 3 irrigations | 21.24 | 24.89 | 37.12 | 39.88 | 5.39 | 10.43 | 14.60 | 12.30 |
| 4 irrigations | 24.32 | 29.74 | 41.63 | 42.60 | 6.02 | 11.07 | 16.06 | 13.34 |
| 5 irrigations | 28.36 | 33.84 | 44.79 | 45.02 | 6.52 | 11.51 | 16.69 | 14.21 |
| SEm± | 0.42 | 0.47 | 0.76 | 1.06 | 0.12 | 0.20 | 0.31 | 0.23 |
| CD (P=0.05) | 1.22 | 1.38 | 2.24 | 3.11 | 0.34 | 0.58 | 0.90 | 0.68 |

**Table 2. Effect of different sowing dates and irrigation scheduling on leaf area index of the crop**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Treatment** | **Leaf Area Index** | | | |
| 60 DAP | 90 DAP | 120DAP | At harvest |
| **Date of sowing** | | | | |
| 10th December | 2.42 | 3.23 | 3.13 | 2.54 |
| 30th December | 2.18 | 2.99 | 2.88 | 2.68 |
| 10th January | 1.93 | 2.81 | 2.62 | 2.88 |
| SE(m)± | 0.04 | 0.05 | 0.04 | 0.04 |
| LSD (P=0.05) | 0.12 | 0.15 | 0.13 | 0.11 |
| **Irrigation scheduling based on ET Method** | | | | |
| 2 Irrigations | 1.91 | 2.72 | 2.63 | 2.44 |
| 3 Irrigations | 2.01 | 2.92 | 2.77 | 2.53 |
| 4 Irrigations | 2.27 | 3.14 | 2.99 | 2.86 |
| 5 Irrigations | 2.51 | 3.26 | 3.13 | 2.98 |
| SE(m)± | 0.05 | 0.06 | 0.05 | 0.05 |
| LSD (P=0.05) | 0.14 | 0.18 | 0.15 | 0.13 |

**Table 3. Effect of different sowing dates and irrigation scheduling on yield attributes and yield of potato crop**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Treatments** | **No. of shoots/plant** | **Average number of tubers/plant** | **Average tuber weight (g)** | **Tuber yield (q/ha)** |
| **Date of sowing** | | | | |
| 10th December | 3.09 | 7.67 | 74.91 | 272.9 |
| 30th December | 2.76 | 7.29 | 71.15 | 244.6 |
| 10th January | 2.44 | 7.17 | 69.69 | 228.6 |
| SE(m)± | 0.05 | 0.14 | 1.10 | 5.54 |
| LSD (P=0.05) | 0.16 | 0.42 | 3.23 | 16.26 |
| **Irrigation scheduling based on ET Method** | | | | |
| 2 Irrigations | 1.57 | 6.80 | 65.61 | 209.9 |
| 3 Irrigations | 2.41 | 7.02 | 68.24 | 233.4 |
| 4 Irrigations | 3.37 | 7.77 | 75.15 | 268.4 |
| 5 Irrigations | 3.71 | 7.91 | 78.65 | 282.4 |
| SE(m)± | 0.06 | 0.14 | 1.27 | 6.40 |
| LSD (P=0.05) | 0.18 | 0.42 | 3.73 | 18.78 |