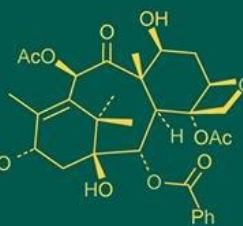
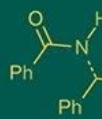


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Impact of transplanting dates and irrigation on phenology and yield of chilli (*Capsicum annuum* L.) under organic management system

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Abstract

Climate change-induced temperature rise and erratic rainfall have significantly affected vegetable production, particularly in water-sensitive crops like chilli. Optimizing transplanting time and irrigation scheduling is crucial for sustaining productivity under organic farming systems. The present investigation was conducted during Kharif 2021 at the organic experimental block of the Division of Vegetable Science, SKUAST-Kashmir, to evaluate the effect of different transplanting dates and irrigation schedules on phenology, growth, yield, quality, agrometeorological indices and economics of chilli (*Capsicum annuum* L.). The experiment was laid out in a split-plot design with four irrigation schedules as main plot treatments and three transplanting dates as sub-plot treatments, replicated thrice. Irrigation schedules consisted of irrigation at vegetative+ 50% flowering+ 50% turning phase (I₁), irrigation at vegetative + 50% flowering phase (I₂), irrigation at 50% flowering phase (I₃) and rainfed condition (I₄). Transplanting dates include 14th, 18th and 22nd Standard Meteorological Weeks. Results revealed that irrigation at critical growth stages combined with early transplanting significantly improved plant growth, earliness, yield attributes, quality parameters and water use efficiency. The treatment combination I₁D₁ recorded maximum fruit yield (186.44 q/ha), higher water use efficiency, superior quality traits and the highest net returns (₹3,68,053/ha) with a benefit-cost ratio of 2.29. The study concludes that early transplanting coupled with irrigation at vegetative, flowering and turning stages is optimal for enhancing productivity and profitability of organic chilli under temperate conditions.

Keywords: Chilli, irrigation scheduling, transplanting dates, organic farming, yield, water use efficiency

Introduction

Chilli (*Capsicum annuum* L.) is one of the most important vegetable-cum-spice crops cultivated worldwide for its culinary, nutritional, medicinal and industrial value. Chilli fruits are rich sources of vitamin A and C and contain capsaicin, the bioactive compound responsible for pungency, along with capsanthin, the principal red pigment contributing to color quality. India is the largest producer and exporter of chilli, contributing significantly to the global spice trade.

In Jammu and Kashmir, chilli is an important cash crop, particularly valued for its bright red color and moderate pungency. However, productivity in the region remains lower than the national average, primarily due to sub-optimal agronomic practices, improper transplanting time and inefficient water management. Climate change has further aggravated the problem by altering temperature regimes and rainfall patterns, leading to moisture stress during critical crop growth stages.

Irrigation plays a decisive role in influencing growth, flowering, fruit set, yield and quality of chilli. Water stress during flowering and fruit development can lead to flower drop, reduced fruit set and poor accumulation of capsaicin and capsanthin. Similarly, transplanting time determines the crop's exposure to prevailing weather conditions, thereby affecting phenological development and yield performance.

Organic farming being environmentally sustainable, avoids synthetic inputs but demands precise management of water and cultural practices to achieve optimum yield.

Therefore, identification of suitable transplanting dates and irrigation schedules under organic management is essential for improving chilli productivity in temperate regions. Keeping these aspects in view, the present study was undertaken to evaluate the combined influence of transplanting dates and irrigation schedules on phenology, yield, quality and economics of chilli under organic farming conditions

Materials and Methods

The experiment was conducted during kharif 2021 at the organic experimental field of the Division of Vegetable Science, SKUAST-Kashmir, Shalimar, Srinagar (34°08' N latitude and 74°83' E longitude) at an altitude of 1587 m above mean sea level. The region experiences a temperate climate with cool nights and moderate summer temperatures.

The soil of the experimental field was silty clay loam in texture with neutral pH, medium organic carbon and available N, P and K status. The chilli variety 'Kashmiri Long-1' was used for the study.

The experiment was laid out in a split-plot design with three replications. Four irrigation schedules were assigned to main plots and three transplanting dates to sub-plots, resulting in twelve treatment combinations. Organic nutrient management was followed using well-decomposed farmyard manure as per recommended organic practices. Irrigation was applied as per treatment schedules using surface irrigation.

Observations were recorded on growth parameters, phenology, yield attributes, fruit yield, quality parameters, water use efficiency and economics. Vitamin C was estimated following AOAC methods, while capsaicin and capsanthin content were estimated using standard analytical procedures. Data were subjected to analysis of variance (ANOVA) and treatment means were compared at the 5% level of significance.

Results and Discussion

Growth and phenological parameters

Irrigation schedules and transplanting dates exerted a significant influence on growth and phenological traits of chilli (Table-1). Early transplanting during the 14th SMW combined with irrigation at Vegetative, flowering and turning stages resulted in significantly taller plants, greater plant spread and earlier flowering. This may be attributed to favourable temperature regimes and uninterrupted moisture availability during critical growth phases, which enhanced physiological activity and vegetative growth.

Table 1: Effect of irrigation schedules and transplanting dates on growth and phenological parameters of chilli

Treatment	Plant height (cm)	Plant spread (cm)	Days to flowering	Branches/plant
I ₁	63.33	39.63	31.00	-
I ₂	61.87	39.40	33.30	-
I ₃	42.32	38.51	33.63	-
I ₄	36.24	37.51	34.32	-
D ₁	70.05	43.89	27.46	-
D ₂	55.70	41.05	33.97	-
D ₃	27.02	31.30	37.75	-
I ₁ D ₁	87.60	45.60	25.30	-
SEm ±	0.18	0.45	0.13	0.35
CD (P = 0.05)	0.56	1.03	0.43	0.98
Interaction (I×D)	Significant	Significant	Significant	Significant

Yield attribute and fruit yield

Yield attribute and total fruit yield were significantly influenced by irrigation scheduling and transplanting dates (Table-2). Irrigation at vegetative, flowering and turning stages significantly enhanced fruit length, fruit weight and total yield. Early transplanting during the 14th SMW recorded superior yield performance, with the maximum fruit yield (186.44 q/ha) observed under the I₁D₁ treatment combination.

Table 2: Effect of irrigation schedules and transplanting dates on yield attributes and yield of chilli

Treatment	Fruit length (cm)	Fruit weight (g)	Yield (q/ha)
I ₁	8.69	4.57	172.38
I ₂	8.21	4.12	158.74
I ₃	7.45	3.68	132.50
I ₄	6.90	3.20	108.26
D ₁	8.92	4.78	176.12
D ₂	7.88	4.05	148.36
D ₃	6.54	3.41	115.90
I ₁ D ₁	9.12	4.96	186.44
SEm ±	0.11	0.08	2.10
CD (P = 0.05)	0.32	0.23	6.30
Interaction (I×D)	Significant	Significant	Significant

Quality Parameters

Quality parameters such as TSS, vitamin C, capsaicin and capsanthin were significantly influenced by irrigation schedules and transplanting dates (Table-3). Higher quality values were recorded under well-irrigated treatments combined with early transplanting, possibly due to enhanced nutrient uptake and favourable metabolic activity under optimal moisture conditions.

Table 3: Effect of treatments on quality parameters of chilli

Treatment	TSS (°Brix)	Vitamin C (mg/100 g)	Capsaicin (%)	Capsanthin (%)
I ₁	6.42	132.4	0.81	0.39
I ₂	6.18	126.8	0.74	0.36
I ₃	5.94	118.2	0.68	0.32
I ₄	5.60	110.5	0.61	0.28
I ₁ D ₁	6.58	138.6	0.85	0.42
SEm ±	0.05	0.85	0.02	0.01
CD (P = 0.05)	0.15	2.53	0.06	0.03
Interaction (I×D)	Significant	Significant	Significant	Significant

Water use efficiency and economics

Irrigation at critical growth stages resulted in higher water use efficiency and economic returns (Table-4). The treatment combination I₁D₁ recorded the highest net returns (₹3,68,053/ha) with a benefit-cost ratio of 2.29, indicating the economic viability of timely irrigation combined with early transplanting under organic farming systems.

Table 4: Water use efficiency and economics of chilli cultivation

Treatment	Net returns (₹/ha)	B:C ratio
I ₁	3,42,110	2.18
I ₂	3,01,240	1.94
I ₃	2,35,870	1.58
I ₄	1,84,210	1.29
I ₁ D ₁	3,68,053	2.29
SEm ±	4,210	0.05
CD (P = 0.05)	12,500	0.15
Interaction (I×D)	Significant	Significant

Conclusion

Early transplanting of chilli during the 14th Standard Meteorological Week combined with irrigation at vegetative, flowering and turning stages significantly improves growth, yield, quality, water use efficiency and profitability under organic management. The treatment combination I₁D₁ is therefore recommended for sustainable organic chilli production under temperate climatic conditions.

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