



International Journal of Research in Agronomy

E-ISSN: 2618-0618
P-ISSN: 2618-060X
© Agronomy
NAAS Rating (2026): 5.20
www.agronomyjournals.com
2026; 9(5): 969-973
Received: 21-03-2026
Accepted: 25-04-2026

Dhanendra Markam
Research Scholar, Department of
Agricultural Meteorology, College
of Agriculture, Indira Gandhi
Krishi Vishwavidyalaya, Raipur,
Chhattisgarh, India

HV Puranik
Scientist, Department of
Agricultural Meteorology, College
of Agriculture, Indira Gandhi
Krishi Vishwavidyalaya, Raipur,
Chhattisgarh, India

JL Chaudhary
Senior Scientist, Department of
Agricultural Meteorology, College
of Agriculture, Indira Gandhi
Krishi Vishwavidyalaya, Raipur,
Chhattisgarh, India

Anish Lakra
Research Scholar, Department of
Agricultural Meteorology, College
of Agriculture, Indira Gandhi
Krishi Vishwavidyalaya, Raipur,
Chhattisgarh, India

Nickey Agrawal
Ph.D. Research Scholar,
Department of Agricultural
Meteorology, College of
Agriculture, Indira Gandhi Krishi
Vishwavidyalaya, Raipur,
Chhattisgarh, India

Prem Sahu
Ph.D. Research Scholar,
Department of Agricultural
Meteorology, College of
Agriculture, Indira Gandhi Krishi
Vishwavidyalaya, Raipur,
Chhattisgarh, India

Corresponding Author:
Dhanendra Markam
Research Scholar, Department of
Agricultural Meteorology, College
of Agriculture, Indira Gandhi
Krishi Vishwavidyalaya, Raipur,
Chhattisgarh, India

Heat unit requirements for growth and development of safflower (*Carthamus tinctorius* L.) varieties under different growing environments

Dhanendra Markam, HV Puranik, JL Chaudhary, Anish Lakra, Nickey Agrawal and Prem Sahu

DOI: <https://www.doi.org/10.33545/2618060X.2026.v9.i5m.5647>

Abstract

A field experiment was conducted during *rabi* season 2024–25 at the Research and Instructional Farm of Indira Gandhi Krishi Vishwavidyalaya (IGKV), Raipur, Chhattisgarh, to studies on response of safflower cultivars under different growing environments. The experiment comprised three dates of sowing viz., D1(3rd Dec), D2(13th Dec) and D3(23rd Dec) and three safflower varieties namely CG Kusum-1, IGKV Kusum, and CG Kusum-2. Accumulated Growing Degree Days (AGDD), Accumulated Photo Thermal Units (APTU) and Accumulated Helio Thermal Units (AHTU) increased progressively from emergence to physiological maturity in all treatments. Maximum heat accumulation °C occurred under D₁ (3 Dec), followed by D₂ (13 Dec) and D₃ (23 Dec). At physiological maturity, AGDD ranged from 2871.5 to 2964.7°C days in D₁, 2694.8 to 2780.3°C days in D₂ and 2535.6 to 2616.7°C days in D₃. Among varieties, IGKV Kusum accumulated the highest thermal units followed by CG Kusum-1 and CG Kusum-2. Heat Use Efficiency (HUE) and Radiation Use Efficiency (RUE) were highest under D₃, indicating more efficient utilization of available heat and radiation at delayed planting. CG Kusum-1 exhibited the highest HUE (0.80 g m⁻² °C Day⁻¹) and RUE (1.47 g m⁻² MJ⁻¹).

Keywords: Safflower, Growing degree days (GDD), Photo-thermal units (PTU), Helio-thermal units (HTU), Heat use efficiency (HUE), Radiation use efficiency (RUE)

1. Introduction

Safflower (*Carthamus tinctorius* L.) Commonly known as Kardi (Marathi), Kusube (Kannada), Kusum (Hindi) and Kusuma (Telugu) is a cool (*rabi*) season oilseed crop, It belongs to Asteraceae family and well branched, tistle like winter annual plant, typically with numerous long sharp spine on the leaves and has been under cultivation in India for its brilliantly coloured florets and the orange red dye (carthamin) extracted from them and traditionally grown for its seeds. Its use as a less costly saffron is indicated by the names false saffron, bastard saffron, thistle saffron and dyer's saffron (Weiss,1983) ^[11] Safflower contains 24-36% oil which is flavorless, colorless and nutritionally similar to sunflower oil and 11-24% protein and provides three principal products: oil, meal and birdseed. Safflower oil consists of two types: those high in monounsaturated fatty acid (oleic) and those high in polyunsaturated fatty acid (linoleic) which is useful in desirable frying characteristics of stability and a blend flavour (Yeilaghi *et al.*, 2012) ^[12] and reducing blood cholesterol. Additionally, safflower is used in traditional medicine for its anti-inflammatory and antioxidant properties. Safflower is grown as a vegetable crop, cut flower, fodder crop, medicinal plant, a dye crop for the textile industry, and safflower oil is also used in the manufacture of high-quality paint. (Emongor, 2015) ^[3]. Safflower oil meal is mainly used as animal feed. Safflower cake has the potential to be used as a human food if the bitter principles are removed (Nagaraj,1995) ^[6]. Safflower cake in combination with all-purpose flour 1:3 proportion was found to be highly suitable for manufacturing of protein enriched biscuits with 22% protein in them (Singh and Abidi, 2005) ^[9]. Safflower leaves are rich in carotene, riboflavin, and vitamin C, and hence young seedlings and pruning are used as a green leafy vegetable in safflower- growing areas in India. Another important and interesting use of

safflower seed has recently emerged by mean of its genetic modification to produce high value protein as pharmaceuticals and industrial enzymes.

2. Materials and Methods

Study Area Description

Study was carried out the Department of Agriculture meteorology, College of Agriculture, Raipur during season 2024-25, Raipur district is situated between 21.23° and 22.26° north latitudes and 81.34° and 83.40° east longitudes, in the central part of the Chhattisgarh. The experiment was laid out in a factorial randomized bl °Ck design with three replications. Treatments consisted of three dates of sowing dates: D₁(3rd Dec), D₂ (13th Dec) and D₃ (23rd Dec) and three safflower varieties: CG-Kusum1, IGKV Kusum and CG-Kusum2. Recommended agronomic practices were followed throughout the crop season. The daily weather data viz. maximum, minimum temperature range were collected from Agrometeorological observatory Raipur. GDD, PTU and HTU were computed for different phenological stages by following formula. Heat use efficiency and Radiation use efficiency were calculated using dry matter accumulation and intercepted radiation

Accumulated Growing Degree Days (AGDD)

ΣAGDD = [(Tx + Tn)/2- Base temperature]

Where, Tx = Daily maximum temperature
Tn = Daily minimum temperature
The base temperature which is considered 5 °C for Rabi crops

Accumulated Photothermal Unit (APTU)

PTU is calculated by multiplying GDD with maximum possible sunshine hours (N) PTU=GDD x N
Where, N= maximum possible sunshine hours.

Accumulated Helio Thermal Unit (AHTU)

HTU is calculated by multiplying GDD with actual sunshine hours (n)

HTU= GDD x n

Where, n = actual sunshine hour

Heat Use Efficiency (HUE)

Heat use efficiency (HUE) for total dry matter was obtained as under

HUE (gm⁻² /°C) = Biomass (g /m²) / AGDD

Radiation Use Efficiency (RUE)

RUE = Biomass (g/m²) / IPAR (MJ/m²/day)

Where,
IPAR is cumulative intercepted photo synthetically active radiation.

3. Results and Discussion

3.1 Accumulated Growing Degree Days (AGDD) °C days

AGDD values ranges between 431 °C to 467.8 °C for emergence, 526.1 °C to 540.6 °C for rosette stage, 1249.2 °C to 1284 °C for branching stage, 1546.3 °C to 1591.5 °C for flower initiation stage, 1671.8 °C to 1733.8° C for 50% flowering stage, 1927.7 °C to 2005 °C for 100% flowering stage and 2871.5 °C to 2964.7 °C for physiological maturity stage under D₁ (3rd Dec). In D₂ (13th Dec), AGDD values varies between 257.1 °C to 308.1 °C for emergence, 376.8 °C to 411.3 °C for rosette stage, 1077.4 °C to 1136.7 °C for branching stage, 1367.1 °C to 1429.1 °C for flower initiation stage, 1568.8 °C to 1613.3 °C for 50% flowering stage, 1776.6 °C to 1851.2 °C for 100% flowering stage and 2694.8 °C to 2780.3 °C for physiological maturity stage. AGDD values varies between 152.6 °C to 180.2 °C for emergence, 243.8 °C to 270.6 °C for rosette stage, 898.3 °C to 950.8 °C for branching stage, 1192 °C to 1266.2 °C for flower initiation stage, 1467 °C to 1505 °C for 50% flowering stage, 1712.3 °C to 1755.1 °C for 100% flowering stage and 2535.6 °C to 2616.7 °C for physiological maturity stage under D₃ (23rd Dec). In varieties, values ranges between 152.6 °C to 431 °C for emergence of CG Kusum-1 variety, 243.8 °C to 526.1 °C for rosette stage, 898.3 °C to 1249.2° C for branching stage, 1192 °C to 1546.3 °C for flower initiation stage, 1467 °C to 1733.8 °C for 50% flowering stage, 1733.8 °C to 1927.7 °C for 100% flowering stage and 2590.2 ° C to 2902 ° C for physiological maturity of CG Kusum-1 variety. In IGKV Kusum variety AGDD values varies between 180.2 °C to 467.8 °C for emergence, 270.6 ° C to 540.6 °C for rosette stage, 950.8 °C to 1284 °C for branching stage, 1266.2 °C to 1591.5 °C for flower initiation stage, 1505 ° C to 1691 °C for 50% flowering stage, 1712.3 °C to 2005 °C for 100% flowering stage and 2616.7 °C to 2964.7 °C for physiological maturity stage. AGDD value ranges between 166.4 °C to 450.5 °C for emergence stage, 257.1 °C to 512.1 °C for rosette stage, 931.5 °C to 1266.2 °C for branching stage, 1232.9 °C to 1568.8 °C for flower initiation stage, 1486.7 °C to 1671.8 °C for 50% flowering stage, 1755.1 °C to 1978.3 °C for 100% flowering stage and 2535.6 °C to 2871.5 °C at physiological maturity.

Table 1: Accumulated Growing degree days (AGDD)°C days values at different phenological stages of different varieties of safflower under different growing environments

Treatments	Emergence	Rosette	Branching	Flowering Initiation	50% Flowering	100% Flowering	Physiological Maturity
				D1(3/12/24)			
V1-CG Kusum 1	431.0	526.1	1249.2	1546.3	1733.8	1927.7	2902.0
V2-IGKV Kusum	467.8	540.6	1284.0	1591.5	1691.0	2005.0	2964.7
V3-CG Kusum 2	450.5	512.1	1266.2	1568.8	1671.8	1978.3	2871.5
				D2(13/12/24)			
V1-CG Kusum 1	257.1	393.4	1077.4	1367.1	1591.5	1776.6	2722.7
V2-IGKV Kusum	308.1	411.3	1136.7	1429.1	1568.8	1851.2	2780.3
V3-CG Kusum 2	270.6	376.8	1118.9	1388.8	1613.3	1801.4	2694.8
				D3(23/12/24)			
V1-CG Kusum 1	152.6	243.8	898.3	1192.0	1467.0	1733.8	2590.2
V2-IGKV Kusum	180.2	270.6	950.8	1266.2	1505.0	1712.3	2616.7
V3-CG Kusum 2	166.4	257.1	931.5	1232.9	1486.7	1755.1	2535.6

3.2 Accumulated Photo Thermal Units (PTU) °C days hour

Accumulated photo thermal unit (APTU) values, varies between 4697.9 °C to 5099 °C for emergence, 5584.1 °C to 5897.6 °C for rosette stage, 13831.5 °C to 14231.2 °C for branching stage, 17258.5 °C to 17801.5 °C for flower initiation stage, 18765.1 °C to 19508.5 °C for 50% flowering stage, 21835.9 °C to 22762.9 °C for 100% flowering stage and 33534.5 °C to 34708.8 °C for physiological maturity stage under D₁ (3rd Dec). In D₂ (13th Dec), APTU values ranges between 2802.4 °C to 3357.7 °C for emergence, 4107.1 °C to 4482.1 °C for rosette stage, 11855.8 °C to 12537.8 °C for branching stage, 15186.8 °C to 15899.8 °C for flower initiation stage, 17528.5 °C to 18062.5 °C for 50% flowering stage, 20022.7 °C to 20917.3 °C for 100% flowering stage and 31308.1 °C to 32384.7 °C for physiological maturity stage. APTU values varies between 1662.8 °C to 1963.6 °C for emergence, 2657.4 °C to 2949 °C for rosette stage, 9832.8 °C to 10409.8 °C for branching stage, 13173.2 °C to 14027 °C for flower initiation stage, 16335.7 °C to 16772.7 °C for 50% flowering stage, 19250.5 °C to 19764.7 °C for 100% flowering stage and 29301.5 °C to 30324.4 °C for physiological maturity stage under D₃ (23rd Dec). Highest APTU value was found

33921.3 °C in D₁ and lowest value was found 29301.5 °C in D₃ (23rd Dec). In varieties, APTU values ranges between 1662.8 °C to 4697.9 °C for emergence, 2657.4 °C to 5738.1 °C for rosette stage, 9832.8 °C to 13831.5 °C for branching stage, 13173.2 °C to 17258.5 °C for flower initiation stage, 16335.7 °C to 19508.5 °C for 50% flowering stage, 19508.5 °C to 21835.9 °C for 100% flowering stage and 29989.5 °C to 33921.3 °C for physiological maturity of CG Kusum-1 variety. In IGKV Kusum variety, APTU values ranges between 1963.6 °C to 5099 °C for emergence, 2949 °C to 5897 °C for rosette stage, 10409.8 °C to 14231.2 °C for branching stage, 14027 °C to 17801.5 °C for flower initiation stage, 16772.7 °C to 18995.5 °C for 50% flowering stage, 19250.5 °C to 22762.9 °C for 100% flowering stage and 30324.5 °C to 34708.8 °C for physiological maturity stage. APTU values ranges between 1813.8 °C to 4910.5 °C for emergence, 2802.4 °C to 5584.1 °C for rosette stage, 10198 °C to 14027 °C for branching stage, 13644.1 °C to 17528.5 °C for flower initiation stage, 16562.2 °C to 18765.1 °C for 50% flowering stage, 19764.7 °C to 22442.5 °C for 100% flowering stage and 29301.5 °C to 33534.5 °C for physiological maturity of CG Kusum-2 variety.

Table 2: Accumulated Photo Thermal Units (APTU)°C days hour values at different phenological stages of different varieties of safflower under different growing environments

Treatments	Emergence	Rosette	Branching	Flowering Initiation	50% Flowering	100% Flowering	Physiological Maturity
				D1(3/12/24)			
V1-CG Kusum 1	4697.9	5738.1	13831.5	17258.5	19508.5	21835.9	33921.3
V2-IGKV Kusum	5099.0	5897.6	14231.2	17801.5	18995.5	22762.9	34708.8
V3-CG Kusum 2	4910.5	5584.1	14027.0	17528.5	18765.1	22442.5	33534.5
				D2(13/12/24)			
V1-CG Kusum 1	2802.4	4288.1	11855.8	15186.8	17801.5	20022.7	31659.6
V2-IGKV Kusum	3357.7	4482.1	12537.8	15899.8	17528.5	20917.3	32384.7
V3-CG Kusum 2	2949.0	4107.1	12333.1	15436.4	18062.5	20319.7	31308.1
				D3(23/12/24)			
V1-CG Kusum 1	1662.8	2657.4	9832.8	13173.2	16335.7	19508.5	29989.5
V2-IGKV Kusum	1963.6	2949.0	10409.8	14027.0	16772.7	19250.5	30323.4
V3-CG Kusum 2	1813.8	2802.4	10198.0	13644.1	16562.2	19764.7	29301.5

3.3 Accumulated Helio Thermal Units (HTU) °C days hour

Accumulated helio thermal unit (AHTU) value, ranges between 1916.6 °C to 2044.8 °C for emergence, 2342.9 °C to 2583.3 °C for rosette stage, 5463 °C to 5813.9 °C for branching stage, 8164.9 °C to 8508.5 °C for flower initiation stage, 9188.7 °C to 9727.9 °C for 50% flowering stage, 11142.1 °C to 11651.6 °C for 100% flowering stage and 18476 °C to 19396 °C for physiological maturity stage under D₁ (3rd Dec). In D₂ (13th Dec), AHTU values varies between 1226.3 °C to 1478.7 °C for emergence, 1718.1 °C to 1776.4 °C for rosette stage, 4940.2 °C to 5022 °C for branching stage, 6517.7° C to 7060.7 °C for flower initiation stage, 8358.4 °C to 8652.1 °C for 50% flowering stage, 10064.5 °C to 10675.8° C for 100% flowering stage and 16872.9° C to 17570.7 °C for physiological maturity stage. AHTU values ranges between 478.5 °C to 662 °C for emergence, 1130.5 °C to 1319 °C for rosette stage, 4453.7 °C to 4708 °C for branching stage, 5316.9 °C to 5634.6 °C for flower initiation stage, 7426° C to 7786° C for 50% flowering stage, 9562.3° C to 9873.1 °C for 100% flowering stage and 15479 °C to 16175.9 °C for physiological maturity stage under D₃ (23rd Dec). Highest 19396° C AHTU value was found in D₁ and

lowest value 15934.8° C was found in D₃. In varieties, AHTU values ranges between 478.5° C to 1916.6 °C for emergence, 1130.5 °C to 2456.3 °C for rosette stage, 4453.7 °C to 5463 °C for branching stage, 5316.9 °C to 8164.9 °C for flower initiation stage, 7426 °C to 9727.9 °C for 50% flowering stage, 9727.9 °C to 11142.1 °C for 100% flowering stage and 15934.8 °C to 18777.8 °C for physiological maturity of CG Kusum-1 variety. In IGKV Kusum variety, AHTU values ranges between 662 °C to 2044.8 °C for emergence, 1319 °C to 2583.3 °C for rosette stage, 4708 °C to 5813.9 °C for branching stage, 5634.6 °C to 8508.5 °C for flower initiation stage, 7786 °C to 9371.1 °C for 50% flowering stage, 9562.3 °C to 11651.6° C for 100% flowering stage and 16175.9 °C to 19396 °C for physiological maturity stage. AHTU values ranges between 565.7 °C to 1979 °C for emergence, 1226.2 °C to 2342.9 °C for rosette stage, 4646.4 °C to 5634.7 °C for branching stage, 5334.1 °C to 8358.4 °C for flower initiation stage, 7599.3 °C to 9188.7 °C for 50% flowering stage, 9873.1 °C to 11472.7 °C for 100% flowering stage and 15479 °C to 18476 °C for physiological maturity stage of CG Kusum-2 variety.

Table 3: Accumulated Helio Thermal Units (AHTU) °C days hour values at different phenological stages of different varieties of safflower under different growing environments

Treatments	Emergence	Rosette	Branching	Flowering Initiation	50% Flowering	100% Flowering	Physiological Maturity
				D1(3/12/24)			
V1-CG Kusum 1	1916.6	2456.3	5463.0	8164.9	9727.9	11142.1	18777.8
V2-IGKV Kusum	2044.8	2583.3	5813.9	8508.5	9371.1	11651.6	19396.0
V3-CG Kusum 2	1979.0	2342.9	5634.7	8358.4	9188.7	11472.7	18476.0
				D2(13/12/24)			
V1-CG Kusum 1	1226.3	1726.4	4940.2	6517.7	8508.5	10064.5	17101.7
V2-IGKV Kusum	1478.7	1776.4	5022.0	7060.7	8358.4	10675.8	17570.7
V3-CG Kusum 2	1319.1	1718.1	5013.1	6695.6	8652.1	10282.3	16872.9
				D3(23/12/24)			
V1-CG Kusum 1	478.5	1130.5	4453.7	5316.9	7426.0	9727.9	15934.8
V2-IGKV Kusum	662.0	1319.0	4708.0	5634.6	7786.0	9562.3	16175.9
V3-CG Kusum 2	565.7	1226.2	4646.4	5334.1	7599.3	9873.1	15479.0

3.4 Heat Use Efficiency (g/m² deg day) and Radiation Use efficiency (g/m²/MJ)

Highest value 0.72 g m⁻² °C⁻¹ day⁻¹ of heat use efficiency (HUE) was observed in D₃ (23 Dec) followed by 0.68 g m⁻² °C⁻¹ day⁻¹ in D₁ (3 Dec) and 0.67 g m⁻² °C⁻¹ day⁻¹ in D₂ (13 Dec). Among the varieties, CG Kusum-1 reported highest value of HUE 0.80 g m⁻² °C⁻¹ day⁻¹ in D₃ (23 Dec) and D₂ (13 Dec), respectively and lowest value 0.74 g m⁻² °C⁻¹ day⁻¹ was observed in D₁ (3 Dec). Whereas, highest value of HUE 0.70 g m⁻² °C⁻¹ day⁻¹ was noticed in D₃ (23 Dec) followed by 0.68 g m⁻² °C⁻¹ day⁻¹ in D₁ (3 Dec) and 0.62 g m⁻² °C⁻¹ day⁻¹ in D₂ (13 Dec) of IGKV Kusum variety. Whereas, CG Kusum-2 showed high value of HUE 0.65 g m⁻² °C⁻¹ day⁻¹ in D₃ (23 Dec) followed by 0.62 g m⁻² °C⁻¹ day⁻¹ in D₁ (3

Dec) and 0.59 g m⁻² °C⁻¹ day⁻¹ in D₂ (13 Dec).

Highest value 1.40 g m⁻² MJ⁻¹ of radiation use efficiency (RUE) was observed in D₃ (23 Dec) followed by 1.35 g m⁻² MJ⁻¹ in D₁ (3 Dec) and 1.31 g m⁻² MJ⁻¹ in D₂ (13 Dec). Among the varieties, CG Kusum-1 reported highest value of RUE 1.47 g m⁻² MJ⁻¹ in D₂ (13 Dec) followed by 1.46 g m⁻² MJ⁻¹ in D₃ (23 Dec) and 1.43 g m⁻² MJ⁻¹ in D₁ (3 Dec). Whereas, highest value of RUE 1.36 g m⁻² MJ⁻¹ was noticed in D₃ (23 Dec) followed by 1.33 g m⁻² MJ⁻¹ in D₁ (3 Dec) and 1.22 g m⁻² MJ⁻¹ in D₂ (13 Dec) for IGKV Kusum variety. Whereas, CG Kusum-2 showed high RUE value 1.38 g m⁻² MJ⁻¹ in D₃ (23 Dec) followed by 1.31 g m⁻² MJ⁻¹ in D₁ (3 Dec) and 1.24 g m⁻² MJ⁻¹ in D₂ (13 Dec).

Table 4: Heat Use Efficiency (g/m² deg day) and Radiation Use Efficiency (g/m²/MJ) for different safflower varieties under different growing environments

Heat use efficiency (g/m ² deg day)					Radiation use efficiency (g/m ² /MJ)			
Varieties	D1-3/12/24	D2-13/12/24	D3-23/12/24	Mean	D1-3/12/24	D2-13/12/24	D3-23/12/24	Mean
CG Kusum 1	0.74	0.80	0.80	0.78	1.43	1.47	1.46	1.45
IGKV Kusum	0.68	0.62	0.70	0.67	1.33	1.22	1.36	1.30
CG Kusum 2	0.62	0.59	0.65	0.62	1.31	1.24	1.38	1.31
Mean	0.68	0.67	0.72	Mean	1.35	1.31	1.43	

3.5 Grain yield

Grain yield was significantly affected by growing environments and varieties. Significantly maximum grain yield 1437 kg/ha was observed in first date of sowing D₁(3 Dec) followed by 1041.1 kg/ha D₂ (13 Dec) and 752.3 kg/ha D₃ (23 Dec). In varieties, CG Kusum-1 reported non-significantly higher grain yield 1136.3 kg/ha and, non-significantly lowest grain yield was recorded 1016 kg/ha in IGKV Kusum variety.

Table 5: Grain yield (kg/ha) of different safflower varieties under different growing environments

Varieties	D ₁ - (03/12/24)	D ₂ - (13/12/24)	D ₃ - (23/12/24)	Mean
CG Kusum 1 (V ₁)	1484.8	1116.8	807.3	1136.3
IGKV Kusum (V ₂)	1363.6	989.1	697.0	1016.6
CG Kusum 2 (V ₃)	1464.6	1017.4	752.5	1078.2
Mean	1437.7	1041.1	752.3	
		Sem ±	CD (P=0.05)	CV (%)
				9.15
Date (D)	S	32.9	98.5	
Varieties (V)	NS	32.9	NS	
D x V	NS	56.9	NS	

Similar work done by Verma *et al.*, (2014) [10] revealed that maximum GDD (4136 °C), HTU (31397 °C) and PTU (47894 °C) were observed under the 15th Nov. was followed by 30th

Nov. and 15th Dec.

Adesh *et al.*, (2020) [1] results revealed that among three sowing dates i.e., D₁-18th December, D₂-28th December and D₃-6th January, the crop shown (6th January) showed maximum accumulation of GDD (1440.3 °C), HTU (10773.3 °C) and PTU (12.92) at maturity. The crop sown in D₁-(18th December °C) shows minimum accumulation of GDD (1072.1 °C), HTU (6790.4 °C) and PTU (10.25 °C).

References

- Adesh G, Paliwal HB, Nickey A. Different micro environment condition on growth and yield of safflower (*Carthamus tinctorius* L.) in Prayagraj. Journal of Pharmacognosy and Phyt °Chemistry. 2020;9(2):1385–1388.
- Bharadi HH, Kurubetta S. An analysis of growth rate performance of oilseed crops in Karnataka state. International Journal of Farm Sciences. 2018;8(1):110–113.
- Emongor VE, Oagile O, Kedikanetswe B. Effects of plant population and season on growth and development of safflower (*Carthamus tinctorius* L.) as an ornamental plant. Acta Horticulturae. 2015;1077:35–45.
- Ghareeb SA. Yield and yield components of safflower as affected by varieties and different sowing dates. Journal of Kirkuk University for Agricultural Sciences.

- 2024;15(2):63–67.
5. Kumari P, Wadood A, Singh RS, Kumar R. Response of wheat crop to different thermal regimes under the agr °Climatic conditions of Jharkhand. *Journal of Agrometeorology*. 2009;11(1):85–88.
 6. Nagaraj G. Nutritional characteristics of three Indian safflower cultivars. Directorate of Oilseeds Research and World Adaptability. 2009:303–305.
 7. Orange MJ, Ebadi A. Responses of phenological and physiological stages of spring safflower to complementary irrigation. *African Journal of Biotechnology*. 2011;11(10):2465–2471.
 8. Shabana R, El Mohsen AA, Gouda AH. Impact of temperature fluctuation on yield and quality traits of different safflower genotypes. *World Essays Journal*. 2013;1(3):74–87.
 9. Singh U, Das K, Roy A, Tripathy AK. Estimation of growth rate and decomposing of output components of oilseeds: A comparative study among the states of North East India. *Indian Journal of Hill Farming*. 2005;20(2):96–101.
 10. Verma AK, Devidas R, Shrivastava GK, Tripathi VK, Pandey N. Temperature and sunshine hour-based indices, seed and oil yield of safflower cultivars as influenced by sowing dates. *Journal of Agrometeorology*. 2014;16(1):131–133.
 11. Weiss EA. Castor, sesame, and safflower. New York: Barnes and Noble Inc.; 1971. p. 529–554.
 12. Yeilaghi H, Arzani A, Ghaderian M, Fotovat R, Feizi M, Pourdad SS. Effect of salinity on seed oil content and fatty acid composition of safflower genotypes. *Food Chemistry*. 2012;130(3):618–625.