Journal of Pharmacognosy and Phytochemistry

Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
www.phytojournal.com
JPP 2021; 10(1): 2490-2493
Received: 27-11-2020
Accepted: 04-01-2020

Amit Kumar
Ph.D. Research Scholar, Department of Agricultural Meteorology, ANDUAT, Kumarganj, Ayodhya, Uttar Pradesh, India

AK Singh
Associate Professor, Department of Argicultural Meteorology, ANDUAT, Kumarganj, Ayodhya, Uttar Pradesh, India

Avinash Kumar Singh
Ph.D. Research Scholar, Department of Agronomy, ANDUAT, Kumarganj, Ayodhya, Uttar Pradesh, India

RK Aryan
Ph.D. Research Scholar, Department of Agricultural Meteorology, ANDUAT, Kumarganj, Ayodhya, Uttar Pradesh, India

Ajeet Kumar
Ph.D. Research Scholar, Department of Agricultural Meteorology, ANDUAT, Kumarganj, Ayodhya, Uttar Pradesh, India

Corresponding Author:
Amit Kumar
Ph.D. Research Scholar, Department of Agricultural Meteorology, ANDUAT, Kumarganj, Ayodhya, Uttar Pradesh, India

Study of thermal unit and thermal use efficiency of mustard under different growing environment

Amit Kumar, AK Singh, Avinash Kumar Singh, RK Aryan and Ajeet Kumar

Abstract
The present investigation entitled **"**Study of thermal unit and thermal use efficiency of mustard under different growing environment**"** was conducted at Instructional Farm of Narendra Deva University of Agriculture and Technology Kumarganj, Ayodhya (U.P.) during rabi season of 2016-2017 and 2017-18. The experimental site falls under sub-tropical region in Indo Gangatic plains with hot summer and cold winter. Meteorological conditions such as distribution of rainfall, maximum and minimum temperature, relative humidity and evaporation recorded during the crop season. The experiment constituted of nine treatment combinations was laid out in Randomized Block Design (RBD). Narendra Rye-8501 variety used in this experiment. Mustard seeds were sown in line at the distance as per treatments with the help of kudal. Maximum, Minimum temperature, relative humidity bright sunshine hours, Evaporation, Soil temperature and rainfall were collected from the weather observatory situated in the same farm during crop period as daily basis. Maximum Thermal unit/G.D.D/heat Unit requirement from sowing to maturity 1685.5^0 days during 2016-17 and 1686.0 ^{0}C days during 2017-18 were obtained in 5 Oct date of sowing, while minimum thermal unit were obtained in 5 Nov date of sowing (1433.8 ^{0}C days during 2016-17 and.1435.2 ^{0}Cdays in 2017-18) from sowing to maturity of Indian mustard. Maximum thermal use efficiency (0.53 during 206-17 and 0.54 during 2017-18) requirement from sowing to maturity were obtained in 5 Nov date of sowing. The maximum heat Unit/ thermal unit (GDD) requirement from sowing to maturity 1891.0 ^{0}C days in 2016-17 and1891.4 ^{0}C days in 2017-18 days were recorded in planting geometry (45×25cm.The thermal use efficiency (g/m^{-2}/days) requirement from sowing to maturity 0.67 were recorded in planting geometry 0.53 during 2016-17 and 0.55 during 2017-18 at planting geometry (45×20cm.).

Keywords: temperature, relative humidity, evaporation, weather observation, thermal unit and thermal use efficiency

Introduction
Mustard (*Brassica juncea* L. Czern & Coss) is an important rabi season oilseed crop which belongs to family crucifereae (Brassicaceae) and genus Brassica. Indian mustard or brown mustard is natural amphidiploids having chromosome no. (2n=36) with its origin place is China. It is self- pollinated crop but certain amount (2-15%) of cross pollination occurs due to insects and other factors. Its seeds are known by different names in different places e.g. sarson, rai or raya, toria or lahi. White sarson and toria are termed as rape seed, rai or raya or laha is termed as mustard. The major mustard growing states in India are Rajasthan, Uttar Pradesh, Madhya Pradesh, Haryana, Gujarat, West Bengal, Assam, Bihar, Punjab and Jammu & Kashmir. Mustard is cool season crop, which requires temperature range from 6 to 27°C, mustard follows C3 pathway for carbon assimilation and at this temperature the plant achieve maximum CO2 assimilation range. Mustard is generally grown under rainfed conditions and moderately tolerant to soil acidity. It requires well drained soil having pH near to neutral. Mustard has a low water requirement (240–400 mm) which fits well in the rainfed cropping system. Nearly 20% area of mustard is under rainfed condition. Rapeseed mustard (Brassica) contributes 32% of the total oilseed production in India and it is the second largest indigenous oilseed crop. The total production of this crop in India is 4.4 m tones with a productivity of 907 kg/ha. It covers approximately 5.0 m ha land, 50% of which is arid and saline, with uncertain rainfall. Further, the crop is grown on marginal lands in India, which is a major cause for not exploiting the full potential of the crop. In Rajasthan, rapeseed and mustard occupies prime place amongst all the oilseed crops grown in the state, occupying 6.5 m. hectares area, with production of 7.8 m tones and 1208 kg/ha average yield (Anonymous 2013-2014). Rajasthan ranks first both in area and production of rapeseed and mustard in the country. In Uttar Pradesh, it is grown over an area of 1.67 million hectare with total production of about 0.77 million tonnes and productivity 11.62 qtl/ha. Rajasthan and Uttar Pradesh are the

major mustard producing state in the country. Rajasthan is the largest mustard producer in the country with a contribution of (54%) to the country's total mustard production followed by Punjab and Haryana which simultaneously contributes (14%) in India, (D.E.S, New Delhi, 2014).

Methods and Material

The present investigation entitled "Study of thermal unit and thermal use efficiency of mustard under different growing environment" was conducted at Instructional Farm of Narendra Deva University of Agriculture and Technology Kumarganj, Ayodhya (U.P.) during rabi season of 2016-2017 and 2017-18. The farm is located 42 Km away from Faizabad city on Faizabad-Raebareily road at 26˚47 N latitude and 82˚12 E longitude and about 113 meters above the mean sea level.

Climate and Weather

The experimental site falls under sub-tropical region in Indo-Gangatic plains with hot summer and cold winter. Nearly 85percent of the total rainfall is received during monsoon season from June to September with a few showers in winter season. The region receives a mean annual precipitation of about 1001 mm. Westerly hot winds start from the month of April and continued till the onset of the monsoon.

Meteorological conditions during crop season

Meteorological conditions such as distribution of rainfall, maximum and minimum temperature, relative humidity and evaporation recorded during the crop season.

Detail of the experiment

The experiment constituted of nine treatment combinations was laid out in Randomized Block Design (RBD).

Date of sowing (Three)

D_1: 5 Oct.
D_2: 20 Oct.
D_3: 5 Nov.

Planting geometry (Four)

P_1: 45x10 (cm.)
P_2: 45x15 (cm.)
P_3: 45x20 (cm.)
P_4: 45x25 (cm.)

Treatment combination: 3 × 4 = 12

Table 1: Treatment combination

S. No.	Treatment	Symbols used
Date of sowing		
1.	5 Oct.	D_1
2.	20 Oct.	D_2
3.	5 Nov.	D_3
Planting geometry (cm.)		
1.	45 × 10	P_1
2.	45 × 15	P_2
3.	45 × 20	P_3
4.	45 × 25	P_4

Technical programme

1. Design: Randomized Block Design
2. Replication: 4
3. Number of treatment combinations: 12
4. Total number of plots: 48
5. Gross plot size: 5.0m × 4.0m = 20m^2
6. Net plot size: 4.0m × 3.0m = 12m^2
7. Variety: NDR-8501

Calendar of cultural operation

Table 2: Calendar of cultural operation

S. No.	Operation	2016-17	2017-18
1.	Preparatory tillage		
(a)	Ploughing (tractor)	02.10.2016	01.10.2017
(b)	Disking and harrowing	03.10.2016	02.10.2017
2.	Layout	04.10.2016	04.10.2017
3.	Sowing		
D1		05.10.2016	05.10.2017
D2		20.10.2016	20.10.2017
D3		05.11.2016	05.11.2017
4.	Thining		
a)	Fist thining	20 days after sowing	
b)	Second thining	45 days after sowing	
5.	Fertilizer application		
a)	Basal application of N.P.K	at a time of sowing	
b)	1st Top dressing of N	30 Days after sowing	
c)	2nd Top dressing of N	60 Days after sowing	
6.	Interculture		
a)	First weeding + thinning	20 days after sowing	
b)	2nd weeding followed by hoeing	45 days after sowing	
7.	Irrigation		
a)	First irrigation	25 days after sowing	
b)	Second irrigation	55 days after sowing	
8.	Plant protection		
a)	One spraying of dimecron	12.01.2017	15.01.2018
9.	Harvesting and bundling	10.03.2017	15.03.2018

Variety used

Narendra Rye-8501

This variety was identified in 1990 from ND university of Agriculture & technology, Kumarganj, Ayodhya, Uttar Pradesh. The material was obtained from Atwa, Uttar Pradesh. It is developed by the method of selection and suitable for cultivation in irrigated and salt- affected areas of Madhya Pradesh and Uttar Pradesh. It has plant hight-160-175 cm, maturity-125 days, oil content-39%, seed size-4.9g, potential yield-2500 $kgha^{-1}$and average yield- 1100-1333 $kgha^{-1}$.

Agronomic practices

The operations like cultural, manurial and plant protection etc. practiced in raising mustard crop under the experiment are as under:

Sowing

Mustard seeds were sown in line at the distance as per treatments with the help of kudal. The seed rate was used 6 kg ha^{-1}.

Observations recorded

Dry matter accumulation (g/m^2)

Four plants were cut down randomly from each plot and chopped in to small pieces and put for sun drying for two days and then in the oven at a temperature of 65 ^{0}C till the constant weight. The average value was calculated and reported as dry matter in g/m^2.

Meteorological and micrometeorological parameters

Maximum, Minimum temperature, relative humidity bright sunshine hours, Evaporation, Soil temperature and rainfall were collected from the weather observatory situated in the same farm during crop period as daily basis.

Growing degree days/thermal unit (Heat unit)

Growing degree days (GDD) at different phenological stages were calculated using following formula:

$$GDD = \sum_{i=1}^{n} \text{heat unit(HU)}$$

Where, = 1, 2, 3…… n is number of days

$$\text{Heat unit} = \frac{\text{Max. Temp.} + \text{Min. Temp.} - \text{Base temp.}}{2}$$

Base temperature for mustard (Rabi) crop 5 ^{0}C

Thermal use efficiency ($g/m^2/^\circ$days)

Heat use efficiency (HUE) is the dry matter production per unit of heat unit by the crop heat efficiency (HUE) may be calculated from heat unit obtained above as following –

$$HUE = \frac{\text{Total dry matter } (g/m^2)}{\text{Heat unit } (^\circ \text{ days})}$$

Result and Discussion

Table 3 revealed that different date of sowing had marked influence on the Thermal unit/Heat unit/growing degree days of Indian mustard at all the phenophases. Accumulation GDD ranged from 1434.8^0 days to 1685.5 ^{0}C days in 2016-17 and 1435.2^0 days to1686.0 ^{0}C days in 2017-18 irrespective of different date of sowing. Maximum Thermal unit/G.D.D/heat Unit requirement from sowing to maturity 1685.5^0 days during 2016-17 and 1686.0 ^{0}C days during 2017-18 were obtained in 5 Oct date of sowing, while minimum thermal unit were obtained in 5 Nov date of sowing (1433.8 ^{0}C days during 2016-17 and.1435.2 ^{0}C days in 2017-18) from sowing to maturity of Indian mustard.

Data pertaining to accumulated Heat Unit requirement of Indian mustard at different Phenophases as affected by date of sowing and planting geometry have been presented in Table 3. Table revealed that the maximum heat Unit (GDD) requirement from sowing to maturity were recorded 1891.0 ^{0}C days in 2016-17 and1891.4 ^{0}C days in 2017-18 at planting geometry (45×25cm.) while minimum accumulated growing degree days from sowing to maturity1433.8 ^{0}C days in 2016-17 and 1434.1 ^{0}C days in 2017-18 were observed under planting geometry (45×10cm) Wider planting geometry recorded minimum GDD requirement at all the stages, During the both years.

Table 3 revealed that different date of sowing had marked influence on the thermal use efficiency of Indian mustard at all the phenophases. Thermal use efficiency ranged from 0.44 to 0.53 during 216-17 and 0.46 to 0.56 during 2017-18 irrespective of different date of sowing. Maximum thermal use efficiency (0.53 during 206-17 and 0.54 during 2017-18,) requirement from sowing to maturity were obtained in 5 Nov date of sowing while minimum thermal use efficiency was obtained in 5 Oct date of sowing (0.44 during 2016-17 and 0.46 during 2017-18) from sowing to maturity of Indian mustard.

Data pertaining to Thermal use efficiency requirement of Indian mustard at different Phenophases as affected by date of sowing and planting geometry have been presented in Table 3. Table 3 revealed that the maximum Thermal use efficiency requirement from sowing to maturity were recorded 0.53 during 2016-17 and 0.55 during 2017-18 at planting geometry (45×20cm.) while minimum Thermal use efficiency from sowing to maturity 0.37 during 2016-17 and 0.38 during 2017-18 were observed under planting geometry (45×25cm.). Wider planting geometry recorded minimum thermal use efficiency requirement at all the stages during the both year.

Table 3: Thermal unit at different phenophases (^{0}C days) of mustard as affected by date of sowing and planting geometry

Treatments	Emergence		Four leaf stage		Flower initiation		Siliquae initiation		Pod development		Maturity	
	2016-17	2017-18	2016-17	2017-18	2016-17	2017-18	2016-17	2017-18	2016-17	2017-18	2016-17	2017-18
Date of sowing												
5 Oct.	92.7	92.9	394.4	394.9	577.9	578.4	894.7	895.2	1264.9	1265.3	1685.5	1686.0
20 Oct.	91.5	91.6	381.2	381.7	577.7	577.9	886.6	886.9	1247.3	1247.7	1659.9	1660.1
5Nov.	90.4	90.6	376.8	377.0	567.0	567.5	886.3	886.8	1239.6	1240.1	1434.8	1435.2
Planting geometry												
45X10 cm	89.6	89.9	375.9	376.2	566.5	567.1	885.9	886.2	1238.4	1238.8	1433.8	1434.1
45X15cm	89.8	89.9	373.3	374.5	573.9	574.2	888.7	888.9	1232.5	1232.7	1436.2	1436.5

45X20 cm	91.2	91.4	385.5	385.7	574.9	574.7	888.1	888.3	1255.1	1255.3	1452.1	1452.5
45X25 cm	93.6	93.8	392.8	393.0	575.1	575.3	889.3	889.5	1263.3	1263.7	1891.0	1891.4

Table 4: Thermal use efficiency of mustard affected by date of sowing and planting geometry

Treatments	Thermal use efficiency ($g/m^{-2}/^0$ days)													
	30 DAS		45 DAS		60 DAS		75 DAS		90 DAS		105 DAS		At harvest	
	16-17	17-18	16-17	17-18	16-17	17-18	16-17	17-18	16-17	17-18	16-17	17-18	16-17	17-18
Date of sowing														
5 Oct.	0.42	0.43	0.20	0.21	0.22	0.23	0.31	0.32	0.34	0.35	0.37	0.38	0.44	0.46
20 Oct.	0.53	0.53	0.26	0.26	0.27	0.28	0.39	0.40	0.43	0.44	0.46	0.47	0.48	0.49
5Nov.	0.50	0.53	0.24	0.26	0.26	0.28	0.37	0.40	0.40	0.44	0.50	0.51	0.53	0.54
Planting geometry														
45X10 cm	0.46	0.48	0.23	0.24	0.24	0.25	0.34	0.35	0.37	0.39	0.46	0.48	0.50	0.52
45X15cm	0.55	0.58	0.27	0.29	0.29	0.30	0.40	0.43	0.45	0.47	0.55	0.58	0.46	0.47
45X20 cm	0.50	0.52	0.24	0.25	0.26	0.27	0.37	0.39	0.40	0.42	0.50	0.52	0.53	0.55
45X25 cm	0.41	0.43	0.20	0.21	0.22	0.23	0.32	0.33	0.34	0.36	0.33	0.34	0.37	0.38

Summary and Conclusion

Maximum Thermal unit/G.D.D/heat Unit requirement from sowing to maturity 1685.5^0 days during 2016-17 and 1686.0 ^{0}C days during 2017-18 were obtained in 5 Oct date of sowing, while minimum thermal unit were obtained in 5 Nov date of sowing (1433.8 ^{0}C days during 2016-17 and.1435.2 ^{0}Cdays in 2017-18) from sowing to maturity of mustard.

Maximum thermal use efficiency (0.53 during 206-17 and 0.54 during 2017-18,) requirement from sowing to maturity were obtained in 5 Nov date of sowing while minimum thermal use efficiency was obtained in 5 Oct date of sowing (0.44 during 2016-17 and 0.46 during 2017-18) from sowing to maturity of Indian mustard. Relationship developed between Thermal unit and leaf area index of Indian mustard (20 Oct date of sowing) developed. Thermal unit and leaf area index have polynomial relationship with R^2=0.90. Relationship between Thermal unit (GDD) and dry matter of Indian mustard (20 Oct date of sowing) developed. Dry matter was linearly correlated with GDD (R^2=0.96).

The maximum heat Unit/ thermal unit (GDD) requirement from sowing to maturity 1891.0 ^{0}C days in 2016-17 and1891.4 ^{0}C days in 2017-18 days were recorded in planting geometry (45×25cm) while minimum accumulated growing degree days from sowing to maturity1433.8 ^{0}C days in 2016-17 and 1434.1 ^{0}C days in 2017-18 were observed under planting geometry (occurred on 45×10cm) during the both years. The thermal use efficiency (g/m^{-2}/days) requirement from sowing to maturity 0.67 were recorded in planting geometry 0.53 during 2016-17 and 0.55 during 2017-18 at planting geometry (45×20cm.) while minimum thermal use efficiency from sowing to maturity (0.37 g/m^{-2}/days during 2016-17 and 0.38 g/m^{-2}/days during 2017-18) was observed under planting geometry (occurred on 45×25cm).

Reference

1. Khavse Rajesh, Singh R, Manikandan N, Chaudhary JL. Influence of Temperature on Rapeseed-Mustard Yield at Selected Locations in Chhattisgarh State, Current World Environment 2014;9(3):1034-1036.
2. Khichar ML, Yadav YC, Bishnoi OP, Ram Niwas. Radiation use efficiency of mustard as influenced by sowing date, planting spacing and cultivars. Journal of Agrometeorology 2000;2(1):97-99.
3. Khobragade AM, Singh R, Agashe DR, Waghmare CR. Radiation use efficiency in the mustard (*Brassica juncea* L.) as influenced by different sowing dates, plant spacings and genotypes. J Soils and Crops 2008;18(2):73-80.
4. Khushu MK, Jamwal JS, Raina AK. Heat unit efficiency in Indian mustard (Brassica juncea). Cruciferae Newsletter 2001;(23):37-38.
5. Kumar G, Adak T, Chakravarty NVK, Chamola R, Katiyar RK, Singh HB. Effect of ambient thermal on growth and yield of *Brassica* cultivars. Brassica 2007;9(1-4):47-52.
6. Kumar Parvinder, Singh Surender, Singh Raj, Dagar CS. Evaluation of heat unit, radiation use efficiency, thermal use efficiency and yield of mustard in different growing environments, Journal of Agro meteorology 2018;20:240-244.
7. Yadav RN, Suraj Bhan, Uttam SK. Yield and moisture use efficiency of mustard in relation to sowing date, variety and spacing in rainfed lands of central Uttar Pradesh. Ind. J Soil Cons 1994;22(3):29-32.