The Pharma Innovation Journal 2023; 12(6): 2941-2944

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2023; 12(6): 2941-2944

www.thepharmajournal.com
Received: 22-04-2023
Accepted: 25-05-2023

Rahul
Department of Agricultural Meteorology, CCS Haryana Agricultural University, Hisar, Haryana, India

ML Khichar
Department of Agricultural Meteorology, CCS Haryana Agricultural University, Hisar, Haryana, India

Ramniwas
Department of Agricultural Meteorology, CCS Haryana Agricultural University, Hisar, Haryana, India

Amit Singh
Department of Agricultural Meteorology, CCS Haryana Agricultural University, Hisar, Haryana, India

Harshana
Department of Agricultural Meteorology, CCS Haryana Agricultural University, Hisar, Haryana, India

Abhishek
Department of Agronomy, CCS Haryana Agricultural University, Hisar, Haryana, India

Corresponding Author:
Rahul
Department of Agricultural Meteorology, CCS Haryana Agricultural University, Hisar, Haryana, India

Evaluation of agromet indices on pigeonpea under different crop geometry

Rahul, ML Khichar, Ramniwas, Amit Singh, Harshana and Abhishek

Abstract
A field experiment was conducted during *kharif* season 2020 and 2021 at research farm of Department of Agricultural Meteorology, Chaudhary Charan Singh Haryana Agricultural University, Hisar to evaluate the agromet indices on pigeonpea varieties under various crop geometry. The results revealed that highest GDD, HTU and PTU were recorded in 60 × 10 cm crop geometry and Pusa 992 from seedling emergence to physiological maturity in both the crop seasons. The GDD (2552.6 and 2611.1 °C day) was recorded highest in wider crop geometry (60 × 10 cm) followed by 40 × 10 cm and 30 × 10 cm at physiological maturity in both the crop seasons. The HTU (17628.3 and 15893.6 °C day hour) was recorded highest in wider crop geometry (60 × 10 cm) followed by 40 × 10 cm and 30 × 10 cm at physiological maturity in both the crop seasons. The PTU (31469.3 and 32155.8 °C day hour) was recorded highest in wider crop geometry (60 × 10 cm) followed by 40 × 10 cm and 30 × 10 cm at physiological maturity in both the crop seasons. Among the pigeonpea varieties Pusa 992 recorded highest GDD, HTU and PTU at physiological maturity followed by Manak, Paras and PAU 881 in both the crop seasons.

Keywords: Pigeonpea, GDD, HTU, PTU

Introduction
The Pigeonpea (*Cajanus cajan* (L.) Millspp) is consumed on a vast scale in South-Asia and also a major source of protein for the population of the Indian subcontinent. In India pigeonpea is generally known as Red gram or Arhar or Tur. In India pigeonpea is usually grown as tropical crop, mainly grown as a sole crop or as an intercrop during *kharif* season, though sown in wide range of Agro-Ecological zones. Due to deep and penetrating root it efficiently survived in drought conditions (Varshney *et al*., 2017; Singh *et al*., 2020) [1, 2].
Pigeonpea is a leguminous crop, able to restore the nitrogen levels in the soil as pigeonpea is capable to fix the atmospheric nitrogen into the soil. Phenological development from sowing to physiological maturity is dependent on the accumulation of thermal units above threshold or base temperature. A slow process of developmental events provides longer growing period and gives opportunity for the plant parts to survive with more number of pods and grains per pod. The specific temperature requirement of plants such as below 10 °C or above 25 °C, the optimum (12 to 25 °C) alter phenology, growth and development and finally reduce the yield (Hakim *et al*. 2012) [5]. Heat use efficiency depicted that the heat utilized to produce one unit of plant biomass (Rajbongshi *et al*. 2016) [6]. Heat and photoperiodic units are considered as the fundamental units used to examine the phenology of crops over climatic variations (Sreenivas *et al*. 2010) [7].

Experimental site
The study was conducted at research farm of Department of Agricultural Meteorology, Chaudhary Charan Singh Haryana Agricultural University, Hisar, during *Kharif* seasons 2020 and 2021. Hisar is situated in the sub-tropics at longitude 75º46 / E, latitude 29º 10 / N and altitude of 215.2 meters above mean sea level.

Climatic conditions
The climate of Hisar region owes to its continental location on the outer margins of the monsoon region *i.e.* 1600 Km away from the ocean. It has arid subtropical monsoonal climate. South westerly monsoon current in the summer brings rain generally from first week of July to middle of September. From October to the end of June next, the weather remains extremely dry, except for a few light showers received due to western disturbances. About 80 per cent of annual precipitation is received in the south-west monsoon season.

Summers are very hot (maximum temperature reached up to 45 ºC or sometimes more) winters are fairly cool (minimum temperature reached around 1 to 2 ºC or sometimes less). Minimum temperature may fall sometime below 0 ºC in the month of December and January. The average annual rainfall is 460 mm.

Technical programme of work

The field experiments were conducted on pigeonpea crop with all recommended package of practices during *kharif* seasons of 2020 and 2021 on the Research Farm of CCS Haryana Agricultural University, Hisar.

Experimental Details

The experiments were laid out in factorial randomized design with three replications (Figure 1). The details of experiment given below:

Treatments

Crop	Pigeonpea
Crop seasons	*Kharif* 2020 and 2021
Factor A	Three Plant Spacing
S_1	30 x 10 cm
S_2	40 x 10 cm
S_3	60 x 10 cm
Factor B	Four Cultivars
V_1	Paras
V_2	Manak
V_3	PAU 881
V_4	Pusa 992
Replication	3
Experimental design	Factorial RBD
Plot size	3.6 x 4.0 m^2

Agro meteorological Indices

Growing degree days (GDD)

Cumulative growing degree days/heat units were determined by summing the daily mean temperature above base temperature and are expressed in °C day. This was calculated using the following formula:

$$GDD\ (°C\ day) = \Sigma \frac{(Tmax + Tmin)}{2} - Tbase$$

Where,
T max. =Daily maximum temperature (ºC)
T min. =Daily minimum temperature (ºC)
Tb = Minimum threshold/base temperature (ºC)

Heliothermal unit (HTU)

Heliothermal units for a day represent the product of GDD and actual bright sunshine hours for that day and are expressed in °C day hours. The sums of HTU for particular phenophases of interest were determined according to the equation:

$$HTU\ (°C\ day\ hours) = \Sigma\ (GDD \times BSS)$$

Where,
BSS = Bright sunshine hours

Photothermal unit (PTU)

Day and night is one of the basic factors controlling the period of vegetative growth in a photosensitive crop. Photothermal units are cumulative value of GDD multiplied by maximum possible sunshine hours and are expressed in °C day hours. PTU was calculated using the following formula:

$$PTU\ (ºC\ day\ hours) = \Sigma\ (GDD \times N)$$

Where,
N = Maximum possible sunshine hours or day length

Results

Agro meteorological indices

Growing degree days

The growing degree day (GDD) or heat unit (HU) accumulated for completion of different phonological stages of pigeonpea under different crop geometry were worked out and was presented in table 1. In both the crop seasons 2020 and 2021 the cumulated GDD increase with advancement of phonological stages and maximum was recorded at physiological maturity.

In both the crop seasons 2020 and 2021 maximum GDD at physiological maturity accumulated by the crop sown under wider crop geometry 60 × 10 cm (2552.6 and 2611.1 °C day) followed by 40 × 10 cm (2545.9 and 2610.4 °C day) and 30 × 10 cm (2537.7 and 2609.5 °C day) in both crop seasons 2020 and 2021, respectively. Among pigeonpea varieties (Table 1), Pusa 992 (2576.5 and 2646.3 °C day) accumulated maximum GDD at physiological maturity followed by Manak (2573.4 and 2644.1 ^{0}C day), Paras (2569.2 and 2640.6 °C day) and PAU 881(2462.4 and 2510.3 °C day) in both crop seasons 2020 and 2021, respectively. Bhuva and Detroja (2018) reported that lower consumption of heat indices under delayed sowing.

Helio-thermal Unit (^{0}C day hr)

The helio thermal unit day (HTU) accumulated for completion of different phonological stages of pigeonpea under different crop geometry were worked out and was presented in table 2. In both the crop seasons 2020 and 2021 the cumulated HTU increase with advancement of phonological stages and maximum was recorded at physiological maturity.

In both the crop seasons 2020 and 2021 maximum HTU at physiological maturity accumulated by the crop sown under wider crop geometry 60 × 10 cm (17628.3 and 15893.6 °C day hr) followed by 40 × 10 cm (17604.3 and 15891.8 °C day hr) and 30 × 10 cm (17564.0 and 15882.5 °C day hr) in both crop seasons 2020 and 2021, respectively. Among pigeonpea varieties (Table 2), Pusa 992 (17746.1 and 16094.4 °C day hr) accumulated maximum HTU at physiological maturity followed by Manak (17722.7 and 16091.3 ^{0}C day hr), Paras (17687.7 and 16081.1 °C day hr) and PAU 881(17239.0 and 15290.5 °C day hr) in both crop seasons 2020 and 2021, respectively. Similar types of results were found by Singh and Singh (2015) [4].

Photothermal Unit (°C day hr)

The photo thermal unit day (PTU) accumulated for completion of different phonological stages of pigeonpea under different crop geometry were worked out and was presented in table 3. In both the crop seasons 2020 and 2021 the cumulated PTU increase with advancement of phonological stages and maximum was recorded at

physiological maturity.

In both the crop seasons 2020 and 2021maximum PTU at physiological maturity accumulated by the crop sown under wider crop geometry 60 × 10 cm (31469.3 and 32155.8 ^{0}C day hr) followed by 40 × 10 cm (31396.1 and 32142.2 ^{0}C day hr) and 30 × 10 cm (31306.9 and 32133.9 ^{0}C day hr) in both crop seasons 2020 and 2021, respectively. Among pigeonpea varieties (Table 3), Pusa 992 (31727.5 and 32532.4 ^{0}C day hr) accumulated maximum PTU at physiological maturity followed by Manak (31694.0 and 32508.2 ^{0}C day hr), Paras (31648.8 and 32470.6 ^{0}C day hr) and PAU 881(30492.7 and 31064.6 ^{0}C day hr) in both crop seasons 2020 and 2021, respectively.

Table 1: Growing degree days (°C day) requirement of pigeonpea varieties at different phenophases under different crop geometry during *kharif* 2020 and 2021

Treatment	2020						2021					
Spacing	Seedling emergence	Emergence of first trifoliate	initiation of primary branches	50% flowering	50% podding	Physiological maturity	Seedling emergence	Emergence of first trifoliate	initiation of primary branches	50% flowering	50% podding	Physiological maturity
30 x 10 cm	144.9	277.8	844.6	1985.9	2272.5	2537.7	159.7	312.5	871.8	2040.6	2331.0	2609.5
40 x 10 cm	153.9	264.8	855.2	2000.0	2281.8	2545.9	151.3	304.3	887.9	2069.1	2352.3	2610.4
60 x 10 cm	150.0	258.3	873.2	2007.1	2290.2	2552.6	147.4	289.1	921.9	2087.8	2370.3	2611.1
SE (m) ±	4.0	2.9	5.0	4.9	2.6	2.0	5.1	3.1	3.9	3.6	2.8	1.5
CD@ 5%	NA	8.7	14.8	14.5	7.6	6.0	NA	9.1	11.4	10.5	8.3	NA
Varieties												
Paras	148.5	257.3	876.6	2021.0	2297.1	2569.2	141.6	289.3	913.7	2110.3	2375.2	2640.6
Manak	146.1	263.6	885.8	2033.6	2305.5	2573.4	149.9	298.9	928.0	2127.8	2381.9	2644.1
PAU 881	155.4	276.6	761.4	1876.3	2209.8	2462.4	164.1	314.1	791.4	1886.5	2260.1	2510.3
Pusa 992	148.4	270.3	906.9	2059.7	2313.7	2576.5	155.6	305.7	942.3	2138.7	2387.5	2646.3
SE (m) ±	4.7	3.4	5.8	5.7	3.0	2.4	5.9	3.6	4.5	4.1	3.3	1.8
CD@ 5%	NA	10.1	17.1	16.8	8.8	6.9	NA	10.6	13.2	12.1	9.6	5.3

Table 2: Heliothermal units (°C day hour) requirement of pigeonpea varieties at different phenophases under different crop geometry during *kharif* 2020 and 2021

Treatment	2020						2021					
Spacing	Seedling emergence	Emergence of first trifoliate	initiation of primary branches	50% flowering	50% podding	Physiological maturity	Seedling emergence	Emergence of first trifoliate	initiation of primary branches	50% flowering	50% podding	Physiological maturity
30 x 10 cm	1262.1	2310.8	6178.5	14222.0	16310.7	17564.0	1266.5	2237.4	4678.5	12199.2	14300.9	15882.5
40 x 10 cm	1344.2	2211.2	6249.1	14336.3	16383.7	17604.3	1188.7	2223.0	4824.8	12431.0	14476.1	15891.8
60 x 10 cm	1290.9	2161.4	6374.0	14393.7	16437.0	17628.3	1154.1	2202.5	5138.3	12581.4	14614.1	15893.6
SE (m) ±	33.8	22.4	33.8	39.6	18.1	9.1	47.6	5.1	35.5	28.8	21.8	5.2
CD@ 5%	NA	66.1	98.2	116.9	53.3	26.7	NA	15.1	104.7	85.0	64.4	NA
Varieties												
Paras	1293.9	2156.2	6413.6	14509.6	16486.7	17687.7	1098.6	2196.8	5016.5	12722.5	14650.3	16081.1
Manak	1272.7	2199.8	6459.8	14611.9	16536.6	17722.7	1175.9	2218.9	5155.2	12865.9	14704.3	16091.3
PAU 881	1333.4	2299.4	5600.9	13323.1	15898.4	17239.0	1309.3	2240.1	4058.1	11074.1	13759.5	15290.5
Pusa 992	1296.1	2255.8	6594.5	14824.7	16586.8	17746.1	1228.5	2228.0	5292.4	12953.0	14740.7	16094.4
SE (m) ±	39.1	25.9	38.4	45.7	20.9	10.5	55.0	5.9	41.0	33.2	25.2	6.0
CD@ 5%	NA	76.4	113.4	135.0	61.6	30.9	NA	17.4	120.9	98.1	74.4	17.8

Table 3: Photothermal units (°C day hour) requirement of pigeonpea varieties at different phenophases under different crop geometry during *kharif* 2020 and 2021

Treatment	2020						2021					
Spacing	Seedling emergence	Emergence of first trifoliate	initiation of primary branches	50% flowering	50% podding	Physiological maturity	Seedling emergence	Emergence of first trifoliate	initiation of primary branches	50% flowering	50% podding	Physiological maturity
30 x 10 cm	1932.0	3698.0	11107.5	25109.1	28388.4	31306.9	2129.6	4160.6	11468.3	25770.1	29081.2	32133.9
40 x 10 cm	2052.7	3525.8	11244.3	25272.8	28492.5	31396.1	2018.0	4051.9	11674.2	26098.4	29319.0	32142.2
60 x 10 cm	2000.7	3439.7	11474.6	25354.8	28587.8	31469.3	1965.7	3849.9	12109.4	26313.9	29520.4	32155.8
SE (m) ±	53.7	39.2	64.3	57.2	29.4	22.7	67.9	41.1	49.4	40.4	32.5	14.0
CD@ 5%	NA	115.7	189.7	168.9	86.7	66.9	NA	121.4	145.8	119.2	95.9	NA
Varieties												
Paras	1980.8	3426.9	11519.4	25519.4	28665.7	31648.8	1888.4	3852.1	12006.4	26579.2	29576.4	32470.6
Manak	1948.3	3510.0	11637.8	25666.2	28759.1	31694.0	199.6	3979.9	12190.0	26780.4	29651.2	32508.2
PAU 881	2071.8	3682.2	10036.0	23829.3	27682.6	30492.7	2188.1	4181.4	10433.4	23978.5	28286.4	31064.6
Pusa 992	1979.7	3599.1	11908.7	25967.5	28850.8	31727.5	2074.9	4069.7	12372.7	26905.0	29713.6	32532.4
SE (m) ±	62.0	45.3	74.2	66.1	33.9	26.2	78.4	47.5	57.0	46.6	37.5	16.2
CD@ 5%	NA	133.6	219.1	195.1	100.1	77.2	NA	140.1	168.3	137.7	110.8	47.8

References

1. Varshney RK, Saxena RK, Jackson SA. The pigeonpea genome: An overview. The Pigeonpea Genome; c2017. p. 1-4.
2. Singh D, Mathimaran N, Boller T, Kahmen A. Deep-rooted pigeon pea promotes the water relations and survival of shallow-rooted finger millet during drought—Despite strong competitive interactions at ambient water availability. PLoS One, 2020, 15(2).
3. Bhuva HM, Detroja AC. Thermal requirement of pearl millet varieties in Saurashtra region. Journal of Agrometeorology. 2018;20(4):329-331.
4. Singh H, Singh G. Growth, phenology and thermal indices of mung bean as influenced by sowing time, varieties and planting geometry. Indian Journal of Agricultural Research. 2015;49(5):472-475.
5. Hakim MA, Hossain A, Teixeira D, Silva JA, Zvolinsky VP, Khan MM. Yield, protein and starch content of 20 wheat (*Triticum aestivum* L.) genotypes exposed to high temperature under late sowing conditions. J Sci. Res. 2012;4:477-489.
6. Rajbongshi R, Neog P, Sarma PK, Sarmah K, Sarma MK, Sarma D, *et al*. Thermal indices inrelation to crop phenology and seed yield of pigeon pea (*cajanus cajan* L *millsp.*) grown in the north bank plains zone of Assam. Mausam, 2016;67(2):397-404.
7. Sreenivas G, Devender Reddy M, Raji Reddy D. Agro-meteorological indices in relation to phenology of aerobic rice. J Agrometerol. 2010;12(2):241-244.