International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
www.chemijournal.com
IJCS 2020; 8(5): 2525-2528

Received: 14-06-2020
Accepted: 21-08-2020

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Studies on the effect of crop growing environment on growth and yield of Kharif maize (*Zea mays* L.) cultivars

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DOI: https://doi.org/10.22271/chemi.2020.v8.i5ai.10697

Abstract
A field experiment was carried out at Agrometeorological Research Farm, Acharya Narendra Deva University of Agriculture & Technology, Kumarganj- Ayodhya (UP) during kharif season of 2019 to study the effect of crop growing environment on growth and yield of kharif maize (*Zea mays* L.) cultivars. The experiment comprised of nine treatment combinations and conducted in Randomized block design and replicated four times. Treatment consisted of three crop growing environment viz. 5th July, 15th July and 25th July with three cultivars Viz, Kanchan, Azad hybrid-1 and Azad hybrid-2.Results reveal that Crop growing Environment of 5th July (100000 plants ha^{-1}) was found suitable for optimum growth and yield of Kharif maize. Among crop growing environments on 5th July recorded higher days taken from sowing to maturity. Crop growing Environment on 5th July and cultivar Kanchan recorded higher heat use efficiency from sowing to maturity of Kharif maize.

Keywords: Maize, Dry Matter, GDD, HUE, Yield etc.

Introduction
Maize (*Zea mays* L.) belongs to family poaceae is one of the most 3rd important cereal crops in the world after rice and wheat. Maize is called 'queen of cereal' as it grown throughout year due to its photo-thermo-insensitive character and highest genetic yield among the cereals. Being a C_4 plant, it is very efficient in converting solar energy into dry matter. Over 85% of maize produced in the country is consumed as human food. The importance of maize lies in its wide industrial applications besides serving as human food and animal feed. Green cobs are roasted and consumed by people with great interest. Maize seed contains 10% protein, 4% oil and 2-3% crude fiber. Several food dishes including chapaties are prepared out of maize flours and grains. Green maize plants are used as succulent fodder. Popping the corn is a method of starch cookery. Maize is a raw material for a number of products viz., starch, glucose, dextrose, sorbitol, dextrine, high fructose syrup, maltodextrine, germ oil, germ meal, fiber rand gluten products which have application in industries such as alcohol, textile, paper, pharmaceuticals, organic chemicals, cosmetics and edible oil. Maize has got very high yield potentiality and wide adaptability under various agro climatic conditions than any other cereal crops Singh, 2013.

It has got the highest genetic yield potential among the cereals and is cultivated on nearly 191.26 m ha in about 168 countries having wide diversity of soil, climate, biodiversity and management practices that contributes (1122.17 m t) in the global grain production. USA is the largest producer of maize contributing nearly 39 percent of the total production in the world, and maize has the highest productivity (5.87 t ha^{-1}).whereas, area under maize production in India is about 9.47 m ha area and production about 28.72 m t with the average productivity of about 3.03 t ha^{-1}. In Uttar Pradesh, maize occupies an area of 0.75 million hectares with a production of 1.48 million tonnes and productivity of 1.98 t ha^{-1}. Anonymous, 2017-18.

In India, maize is grown in diverse environments-from the dry area of Chitradurga, Karnataka to the warm wet plateau of Chindwara, (M.P). Since maize is largely grown under rainfed conditions during the rainy season, the crop is sown with the onset of the monsoon. Sowing

window of maize occurs during Ist fortnight of June to the Ist fortnight of July depending upon the onset of the monsoon. Maize yields during the winter season are higher than yields during the rainy season. During winter, maize enjoys a favorable environment of cool temperatures, clear sky and higher solar radiation interception with less infection of insect pests and there by better yields Joshi *et al.*, 2005 [2].

It is traditionally a rainy season crop in India and is extensively grown as an important Kharifcrop under rainfed or irrigated condition, but Kharifcrop suffers due to vagaries of monsoon, excessive rainfall leading to water stagnation, poor drainage, erratic and insufficient rainfall leading to moisture stress condition, severe infestation of insect-pest-diseases, fertilizer losses, greater weed menace and high temperature throughout the growth period which tend to reduce grain yield in Kharifmaize. On the contrary, the risk of damage to the crop from excessive rainfall, water stagnant, less soil moisture, insect-pest- diseases during winter season is less. *Rabi* maize may either be grown with residual soil moisture or with the supply of irrigation water which can be controlled relatively better during winter season. *Rabi* maize makes best use of low temperature, bright sunshine and has longer duration than Kharif maize. Winter maize crop which makes the best use of low temperature and sunshine hours has longer growth duration of about 150-170 days than 100-120 days under Kharif crop. As such in winter it synthesizes more food material resulting in higher yields Singh, 2013 and also reported similar results.

Maize yield is a function of climate, soil, variety and cultural practices. Correlating these functions to produce the highest possible yields with the greatest efficacy has been the aim of research workers ever since the maize production began. Since there is a limited scope to increase the area under maize cultivation because of competition from other cereals and commercial crops, the only alternative is through enhancement of productivity by various management factors. Among the factors limiting yield of maize in many areas is inadequate irrigation and low plant population Reddy, 2017 [3].

Materials and Methods

The experiment was conducted at Agro-meteorological Research Farm of A.N.D university of Agriculture & Technology, Kumarganj, Ayodhya (UP). The present investigation entitled "Studies on the effect of crop growing environment on growth and yield of kharif maize (*Zea mays* L.) cultivars."Geographically experimental site falls under sub-tropical climate of Indo-gangetic plains having alluvial soil and is located at 26° 47' N latitude and 82° 12' E longitude and at an altitude of 113 meters above mean sea level. The average weekly weather data during crop period obtained from Agro meteorological observatory of A.N.D university of Agriculture & Technology, Kumarganj, Ayodhya (U.P).The experiment was comprised of Nine treatment combinations comprised of three Crop growing environment and three cultivars. Randomized Block Design was used with four replications.

Results

The results of the present investigation entitled "Studies on the effect of crop growing environment on growth and yield of kharif maize (*Zea mays* L.) cultivars.'' obtained with respect to plant growth, yield attributing characters and yield etc. it is quite obvious from the data that growing environment of 5thJuly recorded higher days taken to different phenophases followed by 15thJuly. Crop growing environment of 25thJuly however reduced the crop duration by 10 days over 5th July and 7 days over 15thJuly. Among the varieties, Kanchan took relatively longer duration and ultimately matured 4 days delayed over Azad hybrid-2 in 25thJuly sowing. Increase in days taken from emergence to maturity of maize was due to increased plant density which accommodates more number of plants per unit area there by increased the functional leaves and in turn enhanced the days taken, from emergence to maturity of maize. The finding conformity with those of Rehana Mohi-ud-din et., al. 2017 and S.A. Shinde *et al*., 2014 [4]. It is obvious from the data that crop growing environment had significant effect on dry matter at all the stages. Significantly its higher value were obtained when maize was sown on 5th July growing environment as compared to rest both of the sowing dates. Sowing done on 25thJuly recorded lowest dry matter accumulation. Varieties had significant influenced on dry matter at all the successive stages. Kanchan exhibited superiority (1207.0 gm^{-2}) over rest both of varieties at all the stages of maize growth under investigation. While comparable with which has resulted in the lowest dry matter accumulation of maize. Higher dry matter production was due to more plant height and increased LAI together produced higher dry matter production. These observations were in agreement with Jiotode *et al*., 2002. The maximum heat Unit (GDD) requirement from sowing to maturity were recorded (1879.0 ºC days) at crop growing environment, while minimum accumulated growing degree days from sowing to maturity (1171.7 ºC days) was observed under crop growing environment. This finding confirms that of Thimme Gowda *et al*., 2013. The maximum heat use efficiency requirement from sowing to maturity was recorded with (0.65) at crop growing environments 5th July while minimum heat use efficiency from sowing to maturity (0.60) was observed under crop growing environments of 25th July. This finding confirms that of Girijesh, *et al*., 2011 [1].

Table 1: Days taken to different phenophases of kharif maize cultivars as affected by Crop growing environments

Treatments	Days taken to different phenophases						
	Emergence	Knee high stage	Tasseling	Silking	Milking	Dough stage	Maturity
5th July							
Kanchan	4	38	47	56	65	75	100
Azad hybrid-1	4	34	45	53	63	73	98
Azad hybrid -2	4	32	42	51	60	72	95
15th July							
Kanchan	5	36	46	55	62	74	97
Azad hybrid-1	5	34	43	51	60	73	95
Azad hybrid-2	5	32	41	50	58	71	92
25th July							
Kanchan	5	32	44	50	60	75	90
Azad hybrid-1	5	31	42	48	58	72	88
Azad hybrid-2	5	30	40	46	57	70	86

Table 2: Dry matter accumulation (g m^{-2}) of Kharif maize cultivars as affected by crop growing environments

Treatments	Dry matter accumulation (g/m^{-2})					
	15 DAS	30 DAS	45 DAS	60 DAS	75 DAS	At harvest
Crop growing environment						
5th July	44.41	111.03	271.00	673.49	962.13	1202.67
15th July	43.60	109.00	251.17	627.95	897.07	1121.33
25th July	41.60	104.00	237.10	592.76	846.80	1058.50
SEm±	0.896	2.515	6.255	11.069	11.535	25.045
CD at 5%	2.099	5.889	14.648	25.924	27.013	58.655
Cultivars						
Kanchan	45.60	114.00	270.93	675.94	965.60	1207.00
Azad Hybrid -1	44.00	110.00	258.43	645.21	921.73	1152.17
Azad Hybrid -2	40.01	100.03	229.90	573.07	818.67	1023.33
SEm±	0.693	1.857	4.077	11.731	16.736	18.185
CD at 5%	1.455	3.899	8.560	24.630	35.139	38.181

Table 3: Yield attributes of kharif maize cultivars as influenced by crop growing environments

Treatments	Weight of grains per cob(g)	Weight of cob (g)	Test weight (g)	Yield per plant (g)	Grain Yield (kg ha^{-1})	Stover Yield (kg ha^{-1})
Crop Growing Environment						
5th July	118.76	154.39	202.33	177.87	4623.33	7403.33
15th July	89.51	116.36	200.33	123.85	4293.33	6920.00
25th July	86.27	112.15	196.33	115.61	3981.67	6603.33
SEm±	1.906	1.534	4.487	3.175	105.557	146.562
CD at 5%	4.465	3.592	10.508	7.436	247.207	343.238
Cultivars						
Kanchan	117.85	153.21	203.33	181.82	4640.00	7430.00
Azad Hybrid -1	107.96	140.35	200.33	152.32	4398.33	7123.33
Azad Hybrid -2	68.73	89.35	195.33	83.19	3860.00	6373.33
SEm±	1.894	2.332	3.259	2.379	66.979	110.403
CD at 5%	3.978	4.89	6.842	4.995	140.630	231.803

Table 4: Accumulated heat unit requirement at different phenophases of Kharifmaize cultivars influenced by Crop growing environments: (GDD)

Sowing Date	Accumulated Heat unit requirement at different phenophases						
	Emergence	Knee high stage	Tasseling	Silking	Milking	Dough Stage	Maturity
Kanchan							
05-july-19	81.50	747.50	926.30	1092.50	1277.20	1471.00	1879.00
15-july-19	102.80	678.30	884.70	1049.20	1227.50	1436.00	1791.20
25-july-19	93.30	622.20	866.00	1004.70	1166.00	1353.50	1171.70
Azad hybrid-1							
05-july-19	81.50	705.80	906.50	1072.50	1207.00	1435.00	1828.50
15-july-19	102.80	678.30	843.50	1008.00	1189.50	1419.50	1774.70
25-july-19	93.30	604.20	804.20	985.70	1131.20	1336.00	1676.20
Azad hybrid-2							
05-july-19	81.50	666.50	826.80	1031.20	1174.70	1435.00	1828.50
15-july-19	102.80	639.00	843.50	1008.00	1149.20	1402.00	1774.70
25-july-19	93.30	587.00	783.20	905.20	1112.20	1318.70	1587.50

Conclusion

The present investigation entitled "Studies on the effect of crop growing environment on growth and yield of kharif maize (*Zea mays* L.) cultivars.'' was carried out at Agrometeorological Research Farm of Acharya Narendra Deva University of Agriculture and Technology, Kumarganj, Ayodhya during Kharif season of 2019. The experiment comprised of 9 treatment combinations and conducted in Randomized Block design with four (4) replications. Experiment consisted of three Crop growing environment viz. 5th July (D_1), 15th July (D_2), 25th July (D_3) and three cultivars viz. Kanchan (V_1), Azad hybrid-1 (V_2), Azad hybrid-2 (V_3).

- Maize sowing on 5th July recorded higher days to different phenophases followed by sown on 15th July. Sowing on 25th July however reduced the crop duration by 10 days over 5th July and 7 days over 15th July. Among the varieties, Kanchan took relatively longer duration and ultimately matured 4 days delayed over Azad hybrid-2 in 5th July crop growing environments.
- Maximum temp. Of 36 ^{0}C, 28.5 ^{0}C and 27 ^{0}C during emergence, tasseling and dough stage, respectively were favoured to get higher yield and yield attributing characters of maize. Among the varieties 28.5 ^{0}C, 35 ^{0}C and 27 ^{0}C during tasseling. Silking and dough stages of variety Kanchan were recorded optimum, maximum, and minimum temp. For achieving higher yield as compared to other varieties.
- Higher accumulated heat unit of 747.5, 1277.2 and 1471.0 ^{0}C days during knee high, milking and dough stage, respectively were recorded in the timely sown (5th July) crop as compared to subsequent delayed sowing for achieving higher dry matter production. The decrease in accumulated heat unit was recorded with delay in sowing.

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