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Effect of energy requirement on growth and yield at Rabi maize (*Zea mays* L.) on various moisture regimes

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Abstract
A field experiment was carried out at Agronomy Research Farm, Narendra Deva University of Agriculture & Technology, Narendra Nagar (Kumarganj), Faizabad (U.P.) during Rabi season of 2016-17 to study the "Effect of energy requirement on growth and yield at Rabi maize (*Zea mays* L.) on various moisture regimes." The experiment comprised of nine treatment combinations and conducted in Split plot design and replicated four time. Experiment consisted of three crop growing environment viz. 60x 20 cm spacing, 60 x 25 cm and 60 x 30 cm spacing were kept in main plots with three moisture regimes Viz. 0.6 IW/CPE ratio, 0.9 IW/CPE ratio and 1.2 IW/CPE ratio were kept in sub plot. Result reveal that Crop growing Environment of 60x20 cm spacing (83,333 plants/ha) was found suitable for optimum growth and yield of Rabi maize. Among crop growing environment, sowing done at 60x20 cm spacing recorded higher days taken from sowing to maturity while among moisture regime 1.2 IW/CPE ratio recorded higher days taken from sowing to maturity. Moisture regimes of 1.2 IW/CPE ratio was found suitable for higher growth and yield of Rabi maize. Crop growing Environment of 60x20 cm spacing and Moisture regimes of 1.2 IW/CPE ratio recorded higher heat use efficiency from sowing to maturity of Rabi maize.

Keywords: Maize, dry matter GDD, HUE, yield

Introduction
Maize (Z*ea mays* L.) is an ideal crop owing to its quick growing habit, high yielding ability, palatability and nutritious ness. It can be grown in any season and is one of the most important cereal crop of the world human and feed for animals. Maize is very efficient utilizer of solar energy and has immense potential for higher yield. Each climatic zone has its own characteristics and as such different hybrids, composites and local varieties maturing in 60 to 150 days are being grown (Jain *et al.*, 1981) [3]. It can be fed to cattle at any stage, as there is no problem of poisoning to cattle with HCN or oxalic acid in plant unlike sorghum and therefore it is called as Queen of cereals and King of fodder. The father of green Revolution Renowned Nobel Laureate Dr. Norman E. Borlaug, has mentioned maize as the crop of future. In future maize can play vital role in ensuring food security as well as nutritional security by use of quality protein maize for the country as well as world as a whole. In Maharashtra, maize is principally a rainy season crop but the climatic variability and eco-physiological limitations are the major constraints to achieve potential yield of maize in traditional rainfed *kharif* season in the state. Recent studies conclusively proved that maize is a potential winter season crop having three times higher yield potential than *kharif* crop (Desai and Deore, 1980; Nayak *et al.*, 1987) [2, 5]. Water and nutrient is the key factor to increase the productivity of this crop. 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 during the rainy season. During winter, maize enjoys a favorable environment of cool temperatures, clear sky and higher solar radiation interception with less nutrient losses; less infection of insect pests and thereby better yields (Joshi *et al.*, 2005) [4]. Winter maize crop which makes the best use of low temperature and sunshine hours has longer growth duration of about 150-170days than 100-120 days under *Kharif* crop. As such in winter it synthesizes more food material resulting in higher yields. Yield obtained in *Rabi* season is invariably higher (>6t/ha) than the *Kharif* season yield (2-2.5t/ha). In the world, maize occupies an area of 185.12 million hectares with a production of 872.06 million tonnes and with a productivity of 4900 kg ha^{-1}.

In India, maize is cultivated in an area of 8.49 million hectares, with a production of 21.28 million tonnes and with a productivity of 2507kgha^{-1}.*Rabi* maize is grown in an area of 1.2 million hectares with the grain production of 5.08 million tonnes, with an average productivity of 4.00t/ha (Singh, 2013) [7]. 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 *et al.*, 2017) [6]. Water requirement of crop mostly depends on evapotranspiration. Evapotranspiration mainly depends on climate. The amount of water lost by evapotranspiration is estimated from climatological data and When ET reaches a particular level, irrigation is scheduled. The amount of irrigation given is either equal to ET or fraction of ET. In IW/CPE approach, known amount of irrigation water is applied when cumulative pan evaporation reaches predetermine level. ET by a full crop cover is closely associated with the evaporation from an open pan (Dastane, 1967) [1].

Materials and Methods

The experiment was conducted at Agronomy Research Farm of N.D university of Agriculture & Technology, Kumarganj, Faizabad (UP). On the topic entitled "Effect of energy requirement on growth and yield at Rabi maize (*Zea mays* L.) On various moisture regimes." It is situated on Faizabad-Raibareily road at the distance of 42km from Faizabad district head quarter. 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 details of materials and methods employed & techniques adopted during the course of experimentation have been described in this experiment. The experiment was conducted in Split Plot Design (SPD) and replicated the four times. The different growth parameters studied were maize as Dry Matter, GDD, HUE, Yield and yield Component.

Results

Dry Matter Production of maize affected by planting geometry and moisture regimes at different growth stages have been presented in (Table-1) dry matter production increased progressively with advance in the age of the crop. Dry matter production of maize recorded at different growth stages was significantly influenced by planting geometry and moisture regimes. Significantly higher Dry Matter Production of maize was recorded with a spacing of 60×20 cm spacing which was at par with 60 x 25 cm while significantly taller than 60 × 30 cm. shortest plants were recorded in 60 x 30 cm spacing. The higher dry matter production were produced with the highest level of irrigation tried with IW/CPE ratio of 1.2 which was at par with IW/CPE ratio of 0.9 while significantly taller than with those under IW/CPE ratio of 0.6. Interaction effect of crop growing environment and moisture regimes on Dry Matter Production was significant.

Heat Unit requirement of rabi maize at different phenophases as affected by different crop growing and moisture regimes have been presented in (Table-2) maximum heat Unit (GDD) requirement from sowing to maturity were recorded (1995.2 ºC days) at crop growing environment of 60x20 spacing while minimum accumulated growing degree days from sowing to maturity (1969.0 ºC days) was observed under crop growing environment of 60x25 spacing. Different moisture regime had marked influence on the Accumulated heat unit of rabi maize at all the phenophases. Accumulated GDD ranged from 1946.2 ºC days to 1981.1 ºC days irrespective of different moisture regimes. Maximum heat unit/Accumulated heat unit requirement from sowing to maturity was recorded with 2019.3 ºC days was in 1.2IW/CPE ratio, while minimum heat unit was obtained in 0.6IW/CPE ratio with 1946.2 ºC days from sowing to maturity of crop growing environment.

Heat use efficiency requirement of rabi maize at different phenophases as affected by crop growing environment and moisture have been presented in (Table-3) maximum heat use efficiency requirement from sowing to maturity was recorded with (0.69) at crop growing environment 60x20 spacing while minimum heat use efficiency from sowing to maturity 0.64 was observed under crop growing environment of 60x30 spacing. Different moisture regimes had marked influence on the heat use efficiency of rabi maize at all the phenophases. Heat use efficiency ranged from 0.62 to 0.70 g/m^2 / ºC days irrespective of different moisture regime. Maximum heat use efficiency (0.70) requirement from sowing to maturity was obtained in moisture regime of 1.2IW/CPE ratio while minimum heat use efficiency (0.62) was obtained in moisture regimes of 0.61IW/CPE ratio from sowing to maturity of rabi maize.

Weight of grains per cob of Rabi maize was significantly influenced by crop growing environment and moisture regimes have been presented in (Table-4). As regards the crop growing environment, the higher Weight of grains per cob of maize was recorded with the crop growing environment of 60 × 30 cm which was significant over 60 x 25 cm and 60 x 20 cm. The higher Weight of grains per cob of maize was recorded with the highest level of moisture regime *i.e.*, IW/CPE ratio of 1.2 which was significantly superior to that with IW/CPE ratio of 0.9 and IW/CPE ratio 0.6. Interaction effect of crop growing environment and moisture regimes on weight of grains per cob was not significant.

Weight of cob of Rabi maize was significantly influenced by crop growing environment and moisture regimes**.** (Table-4) The higher Weight of grains per cob of maize was recorded with the crop growing environment of 60 × 30cm which was at par with 60 x 25cm while significant superior over 60 x 20 cm spacing. The higher Weight of cob of maize was recorded with the highest level of moisture regime *i.e.*, IW/CPE ratio of 1.2 which was at par with IW/CPE ratio of 0.9 while significantly superior over IW/CPE ratio 0.6. Interaction effect of crop growing environment and moisture regimes on weight of cob was not significant.

Girth of cob of Rabi maize was significantly influenced by crop growing environment and moisture regimes. (Table-4) As regards the crop growing environment, the higher Girth of cob of maize was recorded with the crop growing environment of 60 × 30cm which was at par with 60 x 25cm while significant over 60 x 20 cm spacing. The higher Girth of cob of maize was recorded with the higher level of moisture regime *i.e.*, IW/CPE ratio of 1.2 which was at par with 0.9 IW/CPE ratio while significantly superior over 0.6 IW/CPE ratio. Interaction effect of crop growing environment and moisture regimes on Girth of cob was not significant.

Test weight (g) thousand seed weight of maize was significantly influenced by crop growing environment and moisture regimes. (Table-4) Thousand seed weight was higher with 60x30 cm spacing which was at par with 60 x 25 cm while significant over 60 x 20cm spacing. Higher thousand seed weight was recorded with IW/CPE ratio of 1.2 which was at par with IW/CPE ratio of 0.9 while significant over 0.6 IW/CPE moisture regime. Interaction effect of crop growing environment and moisture regimes on Test weight was not significant.

Yield per plant of maize as affected by crop growing environment and moisture regimes have been presented in (Table-4). As regards the crop growing environment, the higher yield per plant of maize was recorded with the crop growing environment level of 60 × 30 cm which was significant both 60x 25 cm and 60x20 cm spacing. The highest yield per plant maize was recorded with the highest level of irrigation tried *i.e.*, IW/CPE ratio of 1.2 while significantly higher than IW/CPE ratio of 0.9 and 0.6 IW/CPE.

Grain yield of maize as affected by crop growing environment and moisture regimes have been presented in (Table-4). As regards the crop growing environment, the highest grain yield of maize was recorded with the crop growing environment of 60 × 20 cm while was at par with 60 x 25cm which was significant over 60x 30 cm spacing. The higher Grain yield maize was recorded with the 1.2 IW/CPE ratio which was at par with IW/CPE ratio of 0.9 while significantly higher than IW/CPE ratio of 0.6.

Stover yield of maize was significantly influenced by different crop growing environment and moisture regimes have been presented in (Table-4). Higher stover yield was recorded with 60 × 20 cm spacing which was significant over 60 x 25 cm and 60 x 30 cm which produced the lowest stover yield. Among the irrigation levels tried, IW/CPE ratio of 1.2 recorded the higher stover yield which was at par with 0.9 IW/CPE ratio while significant over IW/CPE ratio of 0.6.

Table 1: Dry matter accumulation (g m^{-2}) of Rabi maize as affected by crop growing environment and moisture regimes.

Treatments		**Dry matter production (g/m^2)**			
	30 DAS	**60 DAS**	**90 DAS**	**120 DAS**	**At harvest**
Crop growing environment					
60 × 20 cm	37.95	121.90	467.97	1062.5	1386.96
60 × 25 cm	36.52	117.30	456.97	1022.97	1333.41
60 × 30 cm	32.94	105.80	445.97	997.97	1285.42
SEm±	0.887	2.845	22.85	31.48	18.58
CD at 5%	3.069	9.845	79.09	108.86	64.33
Moisture regimes					
0.6IW/CPE ratio	34.01	75.76	522.85	1007.01	1211.92
0.9IW/CPE ratio	36.16	81.81	532.01	1113.26	1297.95
1.2IW/CPE ratio	37.23	84.23	534.56	1199.97	1413.95
SEm±	0.691	1.478	17.67	26.91	19.38
CD at 5%	2.053	4.392	51.57	78.60	56.56

Table 2: Accumulated heat unit requirement at different phenophases of Rabi maize influenced by Crop growing environment and Moisture regime**.**

Treatments	**Accumulated Heat unit requirement at different phenophases**				
	Emergence	**Knee high stage**	**Tasseling**	**Silking**	**Maturity**
Crop growing environment					
60 × 20 cm	103.9	280.6	1174.9	1300.6	1995.2
60 × 25 cm	123.1	274.8	1153.1	1289.3	1969.0
60 × 30 cm	123.1	274.8	1151.2	1291.7	1982.2
Moisture regimes					
0.6IW/CPE ratio	110.3	274.8	1140.3	1304.0	1946.2
0.9IW/CPE ratio	129.5	279.5	1159.5	1285.9	1981.1
1.2IW/CPE ratio	110.3	275.9	1151.2	1291.8	2019.3

Table 3: Heat use efficiency of Rabi maize as affected by Crop growing environment and moisture regimes.

Treatments	**Heat use efficiency (g/m^2 /^oC days)**				
	Emergence	**Knee high stage**	**Tasseling**	**Silking**	**Maturity**
Crop growing environment					
60 × 20 cm	0.09	0.10	0.39	0.81	0.69
60 × 25 cm	0.07	0.42	0.38	0.79	0.67
60 × 30 cm	0.06	0.38	0.38	0.77	0.64
Moisture regimes					
0.6IW/CPE ratio	0.07	0.27	0.45	0.76	0.62
0.9IW/CPE ratio	0.06	0.29	0.45	0.86	0.65
1.2IW/CPE ratio	0.08	0.30	0.46	0.92	0.70

Table 4: Yield attributes of maize as influenced by crop growing environment and moisture regimes.

Treatments	Weight of grains per cob(g)	Weight of cob (g)	Girth of cob (cm)	Test weight (g)	Yield per plant (g)	Grain Yield (kg ha^{-1})	Stover Yield (kg ha^{-1})
Crop Growing Environment							
60 × 20cm	76.06	144.40	14.25	213.40	103.60	52.70	85.32
60 × 25 cm	88.69	152.00	15.00	220.00	124.54	47.87	77.42
60 × 30 cm	99.71	159.60	15.75	226.60	144.22	45.87	74.26
SEm±	2.13	3.58	0.28	5.62	3.03	1.13	1.94
CD	7.39	12.41	0.97	19.44	10.48	3.91	6.73
Moisture regimes							
0.6IW/CPE ratio	76.08	145.92	14.40	215.60	102.53	45.87	74.26
0.9IW/CPE ratio	90.52	152.00	15.00	220.00	128.33	49.53	80.19
1.2IW/CPE ratio	97.86	158.08	15.60	224.40	141.50	51.00	82.56
SEm±	1.64	2.86	0.26	4.30	2.39	0.90	1.53
CD at 5%	4.87	8.50	0.77	12.80	7.12	2.69	4.56

Conclusion

It is concluded that study in Crop growing Environment of 60x20 cm spacing (83,333 plants/ha) was found suitable for optimum growth and yield of Rabi maize. Among crop growing environment, sowing done at 60x20 cm spacing recorded higher days taken from sowing to maturity, Moisture regimes of 1.2 IW/CPE ratio was found suitable for higher growth and yield of Rabi maize. Crop growing Environment of 60x20 cm spacing and Moisture regimes of 1.2 IW/CPE ratio recorded higher heat use efficiency from sowing to maturity of Rabi maize.

Reference

1. Dastane NG. A practical manual for water use research, Poona navabharatprakashans. 1967; 13(16):46-50.
2. Desai SN, Deore DD. Performance of maize cultivares in rabi season J Maharashtra Agric. univ. 1980; 5(2):181-182.
3. Jain GL, Jangir RP, Manohar RS, Jain OP. Agronomic advances in maize research. Indian soc. Agron. NT symp, 1981, 196-201.
4. Joshi PK, Singh NP, Singh NN, Gerpacio RV, Pingali PL. Maize in India: Production Systems, Constraints, and Research Priorities. Mexico, D.F.: CIMMYT, 2005.
5. Nayak RL, Chatterjee BN, Das M. Production potentiality of maize in mild winter of west Bengal. Indian J Agron. 1987; 26(2):175-179.
6. Reddy MM, Padmaja B, Reddy VVD. Response of Maize (*Zea mays* L.) to irrigation scheduling and nitrogen doses under no till condition in rice fallows. J Res. ANGRAU. 2017; 40(1):6-12.
7. Singh C. Modern technique of raising field crops: A book second edition, 2013, 85p.