

Original Research Article

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Effects of Irrigation Regime and Nitrogen Level on Yield and Yield Attributes of Summer Maize (*Zea mays* L.)

A. Laxmi Prasanna^{1*}, Monotosh Das Bairagya², T. Madhuri Devi¹ and Aftabuz Uz Zaman¹

¹Department of Agronomy, Faculty of Agriculture, MSSSoA, CUTM, Parlakhemundi, Odisha, India

²Department of Agronomy, Faculty of Agriculture, IAS, SOA, Bhubaneswar, Odisha, India

*Corresponding author

ABSTRACT

Maize (*Zea mays* L.) is one of the most important cereal crop species and is grown throughout a wide range of climates. In India, maize is the most important food crop after rice and wheat. Since 1950, the area, production and productivity of maize have increased more than 3.4, 12 and 4.5 times from 3.2 m ha, 1.7 m t and 547 kg/ ha to current level of 8.17 m ha, 19.33 m t and 2414 kg/ha, respectively due to increase in maize demand for diversified uses. Maize could be grown in wide ranges of soils and climate throughout the year. Deficit irrigation scheduling on the other hand is the practice of irrigating crops below the full water requirement. The effects of water stress on crop growth and grain yield will depend on the timing and magnitude of water stress as well as crop type, since different crops have different levels of tolerance to water stress. For many field crops the most critical period of water stress is during the transition from vegetative to reproductive growth or from flowering to fruit setting. Nitrogen fertilizer played important role in improving soil fertility and increase in crop productivity. A study has been conducted during summer season of 2018 at Bagusala Farm (18.7783 N latitude and 84.0937 E longitude) of MSSSoA, CUTM, Parlakhemundi, Odisha under typical humid and sub-tropical climatic conditions to know the best irrigation scheduling and optimum nitrogen level for summer maize. The treatment combinations include three irrigation levels (I1, I2 and I3 at 0.6, 0.8 and 1.0 IW/CPE respectively) and four nitrogen levels (N1, N2, N3 and N4 at 100%, 50%, 25% and 0% organic sources respectively). The treatments were laid out using Factorial Randomised Block Design and replicated thrice with 12 treatment combinations. The variety taken for the experiment was NHM-666 and sown on the spacing of 60cm×30cm. Irrespective of nitrogen levels, I3 significantly produced highest grain yield (83.78 q/ha) and on the other hand, N1 produced highest grain yield (85.5 q/ha) which is statistical differ from other FYM levels. Green cob yield (171.22 q/ha), Stover yield (141.17 q/ha) and harvest index (26.7) were found highest in I3. Benefit cost ratio (4.0) was calculated highest in irrigation at IW/CPE is 0.8 with no application of FYM.

Keywords

Maize,
Zea mays L.
Irrigation regime
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Introduction

Maize is the third most important food crop of the world and India after rice and wheat. Maize is called as ‘miracle crop’ due to high genetic yield potential than other cereal crops and also known as ‘queen of cereals’. In India, maize is the most important food crop next to

rice and wheat. Since 1950, the area, production and productivity of maize have increased more than 3.4, 12 and 4.5 times from 3.2 m ha, 1.7 m t and 547 kg/ ha to current level of 8.17 m ha, 19.33 m t and 2414 kg/ha, respectively due to increase in maize demand for diversified uses. Maize could be grown in wide ranges of soils and climate

throughout the year. Maize is cultivated for grain as well as fodder purpose, and more recently used for fuel purpose. It is a rich source of raw material for industry where it is being extensively used for the preparation of by-products like corn starch, corn oil, dextrose, corn syrup, corn flakes, cosmetics, wax, alcohol and tanning material for leather industry (Khan *et al.*, 2008). Maize is gaining importance in India due to its versatile characteristics of suitability and adaptability to various agro-climates. Maize is the most efficient coarse cereal crop and less susceptible to environmental hazards and cost of production per kg of grain is less compared to other cereals, which lead to drawing the attention of the farmers of Andhra Pradesh and India. In India, maize has been widely cultivated as a rainfed crop during *kharif* season but it can also be successfully grown during *rabi* season as yield level of maize during *rabi* season is considerably higher than that of *kharif* season (Patel *et al.*, 2006).

Maize responds relatively better to management factors especially irrigation and nitrogen (Prasad *et al.*, 1987). Irrigation is one of the important factors in agricultural practices. Optimal crop production is dependent on the time and amount of irrigation. The vital plant physiological processes like cell elongation, cell division, cell wall synthesis, nitrate reductase activity and photosynthesis are very sensitive to plant water status. Therefore, performance of a plant in terms of its growth and yield is mainly dependent on plant water status which can be maintained at optimum level by following an optimum irrigation schedule. Availability of optimum moisture in the soil enhances the efficiency of applied nutrients, and any reduction of soil moisture at these stages will considerably reduce the grain yield. So proper irrigation scheduling is essential for efficient use of water and crop production. Concept of IW/CPE ratio incorporates the climatic factors

into consideration while scheduling the irrigation and has been found to be a reliable, economical and practical basis for scheduling irrigation. Deficit irrigation scheduling on the other hand is the practice of irrigating crops below the full water requirement. The effects of water stress on crop growth and grain yield will depend on the timing and magnitude of water stress as well as crop type, since different crops have different levels of tolerance to water stress. Nitrogen fertilizer played important role in improving soil fertility and increase in crop productivity. Besides, nitrogen is an integral component of many compounds. It also mediates the utilization of potassium, phosphorus and other elements in plants. Nitrogen is a constituent of protein, enzymes, hormones, vitamins, alkaloids and chlorophyll hence nitrogen deficit in plants leads to improper growth and development. The kernel yield of maize and the quality of kernel is also depending on nitrogen availability. Maize has maximum nitrogen use efficiency of about 50 per cent, but under poor management, its efficiency varies from 30-40 per cent (Patel *et al.*, 2006). The optimal amount of these elements in the soils cannot be utilized efficiently if nitrogen is deficient in plants. In addition to supplying a nutrient for plant growth, N application could improve drought tolerance of plants to enhance yields. Water and nitrogen are two important resources for crop production. Yields in maize gave positive response with an increase in the amount of water and nitrogen applied and reaches the plateau at their optimum doses. Keeping this view in mind, a field experiment had been conducted during *summer* season of 2018 at Bagusala Farm (18.7783 N latitude and 84.0937 E longitudes) of M.S. Swaminathan School of Agriculture, CUTM, Parlakhemundi, Odisha under typical humid and sub-tropical climatic conditions to know the suitable irrigation scheduling and optimum nitrogen level through organic sources for *summer* maize.

Materials and Methods

A field trial was conducted during summer season of 2018 at Bagusala Farm (18.7783 N latitude and 84.0937 E longitude) of M. S. Swaminathan School of Agriculture, CUTM, Parlakhemundi, Odisha under typical humid and sub-tropical climatic conditions to know the best irrigation scheduling and optimum nitrogen level for *summer* maize. Three irrigation regimes was laid out in main plot and four levels of nitrogen from organic source in sub plots, 12 treatment combinations were replicated thrice. The spacing of maize crop was 60×30 cm and variety taken from the experiment was NHM-666. The treatment combinations include three irrigation levels (I₁, I₂ and I₃ at 0.6, 0.8 and 1.0 IW/CPE respectively) and four nitrogen levels (N₁, N₂, N₃ and N₄ at 100%, 50%, 25% and 0% through organic sources respectively). The treatments were laid out using Factorial Randomised Block Design and replicated thrice with 12 treatment combinations. The experimental plot size was 5m×4 m. The biometric (plant height, LAI and dry matter) and yield and yield attributes from each treatment were taken and tabulated after statistical test.

Soil data

Data from soil and plant were taken periodically. The soil type of experimental field was sandy loam in texture with pH of 6.3 and EC was 0.19dSm⁻¹. The available soil N was 115 kg/ha which is low, P₂O₅ was 252 kg/ha which is high and K₂O was 541 kg/ha which is high in range (Table 1).

Meteorological parameters

The maximum temperature during cropping season was ranged between 33.9⁰ C and 41.8⁰ C whereas minimum temperature ranged from 16.9⁰ C to 22⁰ C. Total rainfall

occurred during cropping season was 444.8 mm. Average BSS from Feb to May was also shown in (Table 2).

Results and Discussion

Effect on plant parameters

In both occasions, (60 DAS and Harvest) I₃ produced highest plant height (173.6 and 269.1 cm respectively) followed by I₂ (171.7 and 259.4cm respectively) and the same trend was observed in case of GGR and LAI during 60 DAS (3.14 and 2.74 respectively) and at harvest (1.83 and 0.70 respectively). At 60DAS and harvest plant height (53.2 cm and 273.7cm), CGR (3.1 and 1.68) and LAI (2.67 and 0.77) found statistically highest in N₁ followed by N₂. Lowest plant height (50.8 cm and 246.3 cm), CGR (1.64g/m²/day) and LAI (2.32 and 0.52) were observed in no FYM (0% FYM) applied for plot (Table 3). The increase in plant height in response to more number of irrigations was also reported by Adamu *et al.*, (2014).

Effect on yield and yield attributes

Average cob weight was recorded highest in I₃ (171.22 q/ha) due to more no of irrigations followed by I₂ (162.06 q/ha). Lowest cob weight was recorded in I₁ (152.93 q/ha). It may be due to water stress. Cob girth was recorded 13.7 cm (I₁ and I₂) and 13.4 (I₃) respectively. Maximum Stover yield and seed yield was observed in I₃ (141.17q/ha and 83.78q/ha respectively) and lowest yield had been seen in I₁ (134.13 q/ha and 70.69 q/ha respectively). Harvest index has been recorded as 24.61, 26.37 and 26.70 respectively in I₁, I₂ and I₃.

Cob weight was recorded significantly highest in N₁ (171.22 q/ha) due to more applied nitrogen through FYM followed by N₂ (167.59 q/ha).

Table.1 Physico-chemical properties of experimental soil

S. No	Properties	Value
A	Physical properties	
1.	Sand (%)	40.58
2.	Silt (%)	38.97
3.	Clay (%)	20.47
4.	Textural class	Sandy loam
B	Chemical Properties	
1.	Available nitrogen (kg/ha)	115
2.	Available phosphorus (kg/ha)	252
3.	Available potassium (kg/ha)	541
4.	Soil reaction(Ph)	6.3
5.	Electrical conductivity (dsm ⁻¹)	0.19
6.	Organic carbon (ppm)	0.45

Table.2 Meteorological observations during cropping season

Month	Temperature (° C)		Relative humidity (%)		Rainfall (mm)	ET (mm)	BSS (Hr)
	Maximum	Minimum	Morning	Afternoon			
February	33.9	16.9	90	36	0.0	9	8.8
March	41.4	22.0	89	56	102.3	104	6.6
April	41.8	20.8	89	59	32.8	127.4	7.2
May	41.7	21.2	92	74	309.7	111.8	6.6

Table.3 Effect of treatments on plant height, CGR and LAI of *summer* maize

Treatment	Plant height (cm)		CGR (g/m ² /day)		LAI	
	60 DAS	Harvest	30-60	90 DAS-Harvest	60	Harvest
Irrigation levels						
I₁	167.4	251.2	3.01	1.62	2.31	0.54
I₂	171.7	259.4	3.06	1.55	2.45	0.62
I₃	173.6	269.1	3.14	1.83	2.74	0.70
SEM ±	0.74	1.29	0.024	0.01	0.01	0.007
CD(p=0.05)	2.17	3.80	0.07	0.04	0.03	0.02
Nitrogen levels						
N₁	53.2	273.7	3.10	1.68	2.67	0.77
N₂	52.8	264.8	3.05	1.61	2.59	0.67
N₃	51.3	254.8	3.06	1.74	2.43	0.53
N₄	50.8	246.3	3.07	1.64	2.32	0.52
SEM±	0.29	1.73	0.03	0.02	0.16	0.01
CD(p=0.05)	0.87	5.07	0.09	0.06	0.04	0.02
CV%	5.19	5.99	9.6	11.7	5.96	14.4

Table.4 Effect of treatments on average cob weight, cob girth, Stover yield, seed yield and harvest index of *summer* maize

Treatment	Average cob weight (q/ha)	Cob girth (cm)	Stover yield(q/ha)	Seed Yield(q/ha)	Harvest index
Irrigation					
I ₁	152.93	13.70	134.13	70.69	24.61
I ₂	162.06	13.70	140.93	79.90	26.37
I ₃	171.22	13.43	141.17	83.78	26.70
SEM±	0.80	0.059	0.585	0.38	0.13
CD(p=0.05)	2.37	0.175	1.71	1.11	0.38
Nitrogen					
N ₁	177.72	13.58	152.43	85.50	25.88
N ₂	167.59	13.59	140.53	79.58	25.80
N ₃	157.83	13.53	133.91	75.03	25.69
N ₄	147.81	13.74	128.09	72.39	26.20
SEM±	1.07	0.079	0.78	0.50	0.17
CD(p=0.05)	3.16	0.023	2.29	1.49	0.50
CV%	5.9	5.2	5.06	5.85	6.02

Table.5 Interaction effect of treatments on grain yield, Stover yield, harvest index and water use efficiency of *summer* maize

Treatment	Grain yield (kg/ha)	Stover yield (q/ha)	Harvest index	WUE (kg/ha/mm)
I ₁ N ₁	7818.3	146.28	24.96	32.31
I ₁ N ₂	7169.7	133.77	24.74	29.63
I ₁ N ₃	6839.0	130.88	24.21	27.90
I ₁ N ₄	6451.3	125.59	24.52	26.66
I ₂ N ₁	8758.3	153.6	26.51	26.70
I ₂ N ₂	8249.7	145.29	26.54	25.27
I ₂ N ₃	7605.3	134.21	26.25	24.02
I ₂ N ₄	7348.0	130.61	26.15	22.77
I ₃ N ₁	9075.0	157.42	26.16	22.50
I ₃ N ₂	8456.7	142.50	26.11	20.97
I ₃ N ₃	8064.7	136.66	26.60	20.00
I ₃ N ₄	7918.3	128.08	27.91	19.63
SEM ±	1.52	2.34	0.52	
CD(p=0.05)	4.47	6.87	1.52	
CV%	5.85	5.06	6.02	

Table.6 Effect of treatments on economics of *summer* crop

Treatment	Grain yield(q/ha)	Cost of cultivation(Rs/ha)	Gross returns(Rs/ha)	Net returns (Rs/ha)	B:C ratio
I ₁ N ₁	78.18	35475	93820.00	58345.00	2.64
I ₁ N ₂	71.69	31625	86036.00	54411.00	2.72
I ₁ N ₃	68.39	29700	82068.00	52368.00	2.76
I ₁ N ₄	64.51	21175	77416.00	56241.00	3.66
I ₂ N ₁	87.58	36355	105100.00	68745.00	2.89
I ₂ N ₂	82.49	32505	98996.00	66491.00	3.05
I ₂ N ₃	76.05	30580	91264.00	60684.00	2.98
I ₂ N ₄	73.48	22055	88176.00	66121.00	4.00
I ₃ N ₁	90.75	37125	108900.00	71775.00	2.93
I ₃ N ₂	84.56	33275	101480.00	68205.00	3.05
I ₃ N ₃	80.64	31350	96776.00	65426.00	3.09
I ₃ N ₄	79.1	29700	95020.00	65320.00	3.20

Lowest plant cob weight was recorded in N₄ (147.81 q/ha). It may be due to no application of FYM. Cob girth was recorded in N₁, N₂, N₃ and N₄ as 13.58, 13.59, 13.53 and 13.74 cm respectively. Maximum Stover yield and seed yield was observed in N₁ (152.43q/ha and 85.50 q/ha respectively) and lowest yield had been seen in N₄ (128.09 q/ha and 72.39 q/ha respectively). Highest harvest index has been recorded as 26.20 in N₄ (Table 4). Higher yield at increased levels of nitrogen might be owing to better nutrient uptake leading to greater drymatter production and higher photosynthetic rate and increased translocation of photosynthates from source to sink. Similar results were reported by Aulakh *et al.*, (2013) and Mahesh *et al.*, (2016).

Interaction on Grain Yield, Stover yield, Harvest Index and Water use efficiency

In interaction of irrigation regimes and nitrogen levels, highest grain yield was recorded in I₃N₁ (9075.0kg/ha) by providing more no of irrigations and high nitrogen followed by I₂N₁ (8758.3kg/ha).Lowest grain yield was recorded in I₁N₄ (6451.3kg/ha) for the moisture and nutrient (nitrogen) stress.

Maximum Stover yield and seed yield observed in I₃N₁ (157.42 and 90.75q/ha) and lowest yield had been seen in I₁N₄ (125.59 and 64.51 respectively) in all levels of ‘N’. Highest water use efficiency computed in I₁ and it ranged from 32.3 to 26.6 kg/ha/mm. Similar results were reported by Dutta *et al.*, (2015) (Table 5).

Economics of crop

Highest gross return (Rs/ha 108900/-) and net return (Rs/ha 71775/-) obtained in I₁N₁ whereas least gross return and net return calculated in I₁N₃ (Rs/ha 82068/- and Rs/ha 52368/- respectively) (Table 6). Benefit cost ratio (4.0) was calculated highest in irrigation at IW/CPE is 0.8 with no application of FYM.

Irrigation of IW/CPE at 0.8 saves water without any significant reduction of green cob as well as seed yield. Application of FYM @10t/ha produced highest grain yield.

References

Adamu, C., Kumar, B.N.A., Rajkumara, S., Patil, B.R., Patil, H.Y and Kuligod,

- V.B. 2014. Physiological response, molecular analysis and water use efficiency of maize (*Zea mays* L.) hybrids grown under various irrigation regimes. *African Journal of Biotechnology*. 13(29): 2966-2976.
- Aulakh, G.S., Vashist, K.K and Mahal, S.S. 2013. Effect of different irrigation regimes and nitrogen levels on growth parameters and yield of late kharif sown maize (*Zea mays* L.). *Crop Research*. 45(1, 2 & 3): 96-105.
- Dutta, D., Mudi, D.D and Thentu, T.L. 2015. Effect of irrigation levels and planting geometry on growth, cob yield and water use efficiency of baby corn (*Zea mays* L.). *Journal of Crop and Weed*. 11(2): 105-110.
- Khan, H.Z., Malik, M.A and Saleem, M.F. 2008. Effect of rate and source of organic material on the production potential of spring maize (*Zea mays* L.). *Pakistan Journal of Agricultural Sciences*. 45: 40-43
- Mahesh, N., Rani, P. L., Sreenivas, G and Madhavi, A. 2016. Performance of kharif maize under different plant populations and nitrogen levels in southern Telangana. *International Journal of Farm Sciences*. 6(1): 205-213.
- Patel, J.B., Patel, V.J and Patel, J.R. 2006. Influence of different methods of irrigation and nitrogen levels on crop growth rate and yield of maize (*Zea mays* L.). *Indian Journal of Crop Sciences*. 1 (1&2): 175-177.
- Prasad, U.K., Thakur, H.C., Pandey, S.S., Pandey, R.D and Sharma, N.N. 1987. Effect of irrigation and nitrogen on winter maize in calcareous saline alkali soils. *Indian Journal of Agronomy*. 32: 217-210.

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