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Effect of Land Configuration and Moisture Regimes on Productivity of Hybrid Maize (*Zea mays* L.) in Summer Season

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

An experiment was conducted on "Effect of land configuration and moisture regimes on productivity of hybrid maize (*Zea mays* L.) in summer season." during 2018-19 at Agronomy Research Farm, ANDUA and T, Kumarganj, Ayodhya (U.P.). The experiment accomplished of 12 treatment combinations and laid out in split plot design, replicated three times. The Experiment consisted of three land configuration *viz*. flat bed planting (P_1), ridge planting (P_2) and paired row planting on raised bed (P_3) were kept in main plots and four moisture regimes *viz*.0.5 IW/CPE ratio, 0.7 IW/CPE ratios, 0.9 IW/CPE ratios and 1.1 IW/CPE ratios were allotted in sub plots. The experimental results revealed that growth parameters, such as plant height, leaf area index, dry matter accumulation, days to 50 percent ear emergence and days to50 percent maturity and yield were obtained maximum with the paired row planting methods followed by ridge planting and flat bed planting and yield attributes such as number of cobs plant^{-1} , number grains row^{-1}, number of grains cob^{-1}, cob length (cm), cob girth (cm), grains weight cob^{-1}(g), cob weight (g), shelling percentage (%), grain yield (q ha^{-1}), stover yield (q ha^{-1}), and biological yield (q ha^{-1}) were also increased similarity in same treatment. In case of moisture regimes, the same trends were observed maximum when applied irrigation at 1.1 IW/CPE ratios as compared to other moisture regimes.

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1. INTRODUCTION

Maize (*Zea mays* L.) is one of the most important cereal crops in India and abroad and broadly used in industries and human food and animal feed. Maize belongs to family *Poaceae*. It is also called "queen of cereal" because it has got very high yield potential and wide adaptability under various regions than any other cereal crops. The world leading producer of maize in descending order are; United States of America (357.267 million tons), China (215.00 million tons), Brazil (95.00 million tons), Argentina (33.80 million tons), Ukraine (30.94 million tons), India (25.00 million tons), Mexico (23.27million tons) and Indonesia (19.00 million tons) [1]. In India, maize is the third most important food grain crop after wheat and rice. In India area under maize cultivation in both the seasons (*kharif,* 7.7 mha) and *rabi*, 1.6 mha) with a production of 19.5 and 7.6 mt respectively [1]

India produces about 2% of the world`s maize production, out of which Karnataka is leading producer state of maize about 16% of total maize production followed by Telangana and Bihar which together contribute about 20% of maize production. Maharastra, Madhya Pradesh, Tamilnadu, Andhra Pradesh, Rajasthan and Uttar Pradesh are other maize producing states of India. About 71% of maize in India is produced in the *kharif* season. Maize produced states are Karnataka, Madhya Pradesh, Tamilnadu, Maharashtra, Telangana, Uttar Pradesh and Rajasthan *etc*. out of which Bihar, Andhra Pradesh and Tamilnadu are major states which produces maize largely in *rabi* season out of which Tamilnadu is a leading state to share 40% of production.

Land configuration plays a major role in minimizing soil erosion and improving water and nutrient use efficiency of field crops. Easy and uniform germination as well as growth and development of plant are provided by manipulation of sowing methods Chiroma et al. [2] and also increases availability of nutrients to crops. Parihar et al. [3] reported that ridges and furrow method of sowing improved grain as well as stover yield of maize over the flat bed method of sowing. Water stress can affect growth, development and physiological processes of maize plants, which reduce biomass yield. Payero et al. [4] water requirement of crop mostly depends on Evapo-transpiration which mainly depends on climate. The amount of water lost by evapo-transpiration is estimated from climatological data and when ET reaches a particular level irrigation is scheduled. The amount of irrigation is given to be equal to ET or fraction of ET. Irrigation scheduling at IW/CPE approach is well known amount of irrigation water applied when cumulative pan evaporation reaches predetermine level. Parihar et al., [3] suggested relatively more practical meteorological approach of the ratio between a fixed amount of irrigation water and CPE as a basis of irrigation scheduling. It was found that irrigation maize crop at an IW/CPE ratio of 1.0 was significantly superior to 0.6 IW/CPE but at par with 0.8 IW/CPE regarding plant dry weight (g) at harvest stage, number of kernels/cob, kernel weight (g)/cob, kernel yield (kg ha^{-1}) and stover yield (kg ha^{-1}) Reddy et al. [5].

2. MATERIAL AND METHODS

The experiment was conducted at Agronomy Research Farm of Acharya Narendra Deva University of Agriculture and Technology. Kumarganj, Ayodhya (U.P.). The farm situated on Ayodhya, Raibareily road at the distance of 42 km from Ayodhya district head quarter. Geographically, this experimental site falls under semi-arid sub tropical climate of Indo-genetic plains having alluvial plains (IGP) having alluvial calcareous soil and is located at 26 ° 47" N latitude and 82 ° 12" E longitude and an altitude 113 meters above mean sea level. Soil of experimental field was slightly alkaline in reaction (8.0 pH), low in organic carbon 0.32 per cent and low in available nitrogen (180 kg ha^{-1}), medium in phosphorus (15. 25 kg ha $^{-1}$) and potassium (270.0 kg ha^{-1}). Maize cv. Kanchan (K-25) was used for sowing at the rate of 25 kg ha^{-1}. The crop was sown on 07 April 2019 in distance of 60 cm in row and 20 cm apart from plant.

The experiment comprised of twelve treatment combinations with three land configuration *viz*. flat bed planting (P_1), ridge planting (P_2) and paired row planting on raised bed (P_3) were kept in main plots and four moisture regimes *viz*.0.5 IW/CPE ratios, 0.7 IW/CPE ratios, 0.9 IW/CPE ratios and 1.1 IW/CPE ratios were allotted in sub plots. The experiment was conducted in split plot design repeated with four times. In which, five plant were selected randomly from each plot for the observation of growth character and yield and its attributes *viz*, as plant height (cm), Leaf

area index, dry matter accumulation (gm^{-2}), number of cobs $plant^{-1}$, number of rows cob^{-1}, number of grains cob^{-1}, number of grains row^{-1}, grain weight cob^{-1}, girth of cob, length of cob, weight of cob (g) and shelling percentage, grain yield (qha^{-1}), stover yield (qha^{-1}), and biological yield (qha^{-1}), at 30, 60 DAS and at harvest stage.

2.1 Shelling Percentage

Five sample cobs taken from each plot for grain weight per cob were also used for this purpose. Those five sample cobs were weighed and grains were separated. Shelling percent was taken used the following formula.

$$\text{Shelling percent} = \frac{Grain\ weight\ per\ cob}{Cob\ weight} \times 100$$

3. RESULT AND DISCUSSION

3.1 Growth Parameter

All the growth parameters were significantly affected by land configuration at successive growth stages of maize crop. Crop sown on paired row planting on raised bed (L_3) produced maximum plant height, leaf area index and dry matter accumulation at all the growth stages, which was significantly superior over ridge planting (L_2) and flat bed planting (L_1) presented in Table 1. This might be due to increases soil aeration, nutrient and moisture availability to the plant as compared to other land configuration, Joshi et al. [6]. Plant height influenced significantly by the moisture regimes at successive growth stages of maize, except at 30 DAS. The taller plants were received when irrigation applied at IW/CPE ratios of 0.9, which was at par with IW/CPE ratios of 1.1 and significantly superior over IW/CPE ratios of 0.7, and IW/CPE ratios of 0.5, respectively at 60 DAS and at harvest stage. But it was found non-significant at 30 DAS and at harvest stage.

The maximum leaf area index was noted with irrigation done at 0.9 IW/CPE ratios than another moisture regimes. This rapid growth might be due to maintenance of adequate and continuous water supply to the crop which maintained good establishment of the roots and various metabolic processes which performed higher nutrient mobility and uptake contributed to rapid cell division and cell elongation which resulted in higher plant height and higher leaf area under the treatment. Minimum plant height and leaf area index was obtained under 0.5 IW/CPE ratio at all the stages due to poor root growth caused by moisture deficit. The results are in close proximity to those of Meena et al. [7] and Kumar et al. [8].

Different moisture regimes significantly affected on dry matter accumulation (gm^{-2}) at 60 DAS and at harvest stages except 30 DAS as presented in (Table 1) the maximum dry matter accumulation was recorded with the irrigation at 0.9 IW/CPE ratios. This might be due to increased plant height, leaf area index, girth of stem which is ultimately increased the nutrient uptake such as N. P. and K through adequate moisture supply. All these contributed to cell turgidity and opened leaves which increased the photosynthetic activity of crops resulting in higher dry matter accumulation. Initially, it increased slowly and thereafter rapidly till the harvest stage due to variable conditions. The lowest dry matter accumulation was obtained under 0.5 IW/CPE ratios. This might be due to lowest number of irrigations were given which results reduced in plant height, leaf area and nutrient uptake when lead to reduced the photosynthetic activity which ultimately reflected in lowest dry matter accumulation. Similar finding were reported by Singh [9] and Kumar et al. [8].

3.2 Yield Attributes

Yield attributes likes number of cobs $plant^{-1}$, number of rows cob^{-1}, number of grains cob^{-1}, number of grains row^{-1}, grain weight cob^{-1}, girth of cob, length of cob, weight of cob (g) and shelling percentage were significantly influenced due to land configuration that as presented in Table 2 except test weight. Significantly higher values were recorded in paired row planting on raised bed as compared to ridge planting and flat bed planting. Flat bed planting restricted the crop growth and induced early ear emergence. This might be due to the low aeration and low nutrient to crop, which resulted in reduced value of all attribute, also reported by several others Tanveer et al. [10] and Singh et al. [11].

In case of moisture all the attributes *viz*., number of cobs $plant^{-1}$, number of rows cob^{-1}, number of grains cob^{-1}, number of grains row^{-1}, grain weight cob^{-1}, girth of cob, length of cob, weight of cob and shelling percentage were significantly affected by different moisture regimes. There was value enhanced of all the yield attributes recorded with irrigation applied at 0.9 IW/CPE ratios, which was at par with 1.1 IW/CPE ratios. This might be due to plant get favorable

Table-1. Plant height (cm) and leaf area Index as influenced by land configuration and moisture regimes at successive growth stages of maize crop in summer season

Treatments	Plant height (cm)			Leaf area Index			Dry matter accumulation (gm^{-2})		
	30 DAS	60 DAS	At harvest	30 DAS	60 DAS	At harvest	30 DAS	60 DAS	At harvest
A- Land configuration									
Flat bed planting	22.90	103.00	158.40	0.99	3.30	0.89	86.70	583.24	852.69
Ridge planting	26.70	113.00	176.72	1.16	3.65	1.04	94.70	642.54	939.38
Paired row planting	29.30	120.00	187.61	1.28	3.95	1.15	100.00	742.65	1085.74
Sem±	0.52	2.45	3.50	0.023	0.079	0.021	1.73	14.81	19.99
CD at 5%	1.22	5.75	8.21	0.053	0.18	0.049	4.05	34.68	46.81
B- Moisture regimes									
6 cm irrigation at 0.5 IW/CPE ratio	26.10	100.00	154.44	1.11	3.23	1.00	91.00	496.38	725.71
6 cm irrigation at 0.7 IW/CPE ratio	25.80	110.00	173.25	1.13	3.54	1.01	93.60	582.48	851.58
6 cm irrigation at 0.9 IW/CPE ratio	26.90	121.00	186.12	1.17	3.99	1.05	96.30	784.97	1147.62
1.1 IW/ CPE ratio	26.40	117.00	183.15	1.16	3.77	1.04	94.30	760.73	1112.18
Sem±	0.47	2.45	3.02	0.02	0.06	0.018	1.73	11.94	16.42
CD at 5%	N.S	5.75	6.35	N.S	0.12	N.S	N.S	25.08	34.47

Table 2. Yield attributes as influenced by land configuration and moisture regimes of maize in summer season

Treatments	No. of cobs Plant^{-1}	No. of rows Cob^{-1}	No. of grains cob^{-1}	No. of grains row^{-1}	Length of cob (cm)	Girth of cob (cm)	Weight of grains cob^{-1} (g)	Weight of cob (g)	Weight of 1000 grain	Shelling %
A- Land configuration										
Flat bed planting	1.33	17.61	342.00	28.50	16.05	8.02	72.70	129.40	203.60	55.79
Ridge planting	1.43	18.53	373.00	31.31	16.88	8.44	80.00	134.50	205.10	59.07
Paired row planting	1.50	19.88	425.00	36.20	18.07	9.03	104.40	148.00	208.10	70.05
Sem±	0.02	0.40	7.80	0.62	0.37	0.19	1.84	3.76	4.48	1.71
CD at 5%	0.06	0.95	18.28	1.47	0.87	0.44	4.30	8.80	N.S	4.00
B- Moisture regime										
6 cm irrigation at 0.5 IW/CPE ratio	1.34	17.07	260.43	21.73	15.57	7.79	64.15	125.60	203.90	50.79
6 cm irrigation at 0.7 IW/CPE ratio	1.41	18.50	306.03	25.77	16.82	8.41	84.35	133.20	205.80	62.93
6 cm irrigation at 0.9 IW/CPE ratio	1.48	19.73	481.33	40.67	17.95	8.98	106.00	150.40	206.50	70.08
6 cm irrigation at 1.1 IW/ CPE ratio	1.45	19.38	472.21	39.84	17.65	8.83	88.35	140.00	206.20	61.64
Sem±	0.02	0.33	7.28	0.55	0.28	0.14	1.29	3.23	3.728	1.49
CD at 5%	0.05	0.71	15.29	1.15	0.59	0.30	2.71	6.78	NS	3.14

Table 3. Grain & Stover yield, biological yield and harvest index as influenced by land configuration and moisture regimes of maize in summer season

Treatments	Grain yield (q ha^{-1})	Biological yield (q ha^{-1})	Stover yield (q ha^{-1})	Harvest index (%)
A- Land configuration				
Flat bed planting	33.50	85.27	51.77	39.20
Ridge planting	37.00	93.94	56.94	39.30
Paired row planting	43.20	108.57	65.37	39.70
Sem±	0.785	1.900	1.206	0.859
CD at 5%	1.839	4.450	2.824	N.S
B- Moisture regimes				
6 cm irrigation at 0.5 IW/CPE ratio	28.10	72.57	44.47	38.70
6 cm irrigation at 0.7 IW/CPE ratio	33.40	85.16	51.76	39.20
6 cm irrigation at 0.9 IW/CPE ratio	45.70	114.76	69.06	39.80
6 cm irrigation at 1.1 IW/ CPE ratio	44.40	111.22	66.82	39.90
Sem±	0.651	1.645	1.006	0.626
CD at 5%	1.367	3.455	2.112	N.S

vegetative growth and development because it received adequate water during entire period of plant growth. As per need which increased the all growth parameters and increased photosynthetic activity of leaves, beside translocation of photosynthesis from source to sink also increased under wettest regime through higher uptake of potassium which led to better yield attributes. Lowest values of yield attributes was found in 0.5 IW/CPE ratio because plant were unable to extract more water and nutrient under moisture deficit condition which resulted in poor growth and yield attributes. Similar finding was also reported by Talu et al. [12] and Reddy et al. [5].

3.3 Yield

Grain and stover yield of maize were affected significantly by land configuration as presented in (Table 3). Crop sown on paired row planting raised bed recorded significantly higher grain yield as compared to ridge planting and flat bed panting. A similar trend was also recorded in straw yield of maize. This might be due to poor growth and translocation of photosynthates from source to sink. All the growth and yield attributes which determined the grain and stover yield of maize crop, were adversely influenced when the sowing on flat bed planting. Significant reduction in grain and stover yield of maize in flat bed method has also been reported by several Aggarwal and Goswami [13], Mishra et al*.* [14] and Joshi et al. [6].

Grain and straw yield was influenced significantly by different moisture regimes have been presented in Table 3. The maximum grain yield was obtained under irrigation at 0.9 IW/CPE ratios. This might be due to optimum moisture availability as per demand of crop, which contributed to better growth parameters and yield attributes. Productivity of crop collectively determined by vigour of vegetative growth and yield attributes. Irrigation at 0.5 IW/CPE ratio recorded lowest grain yield due to poor moisture supply during crop growth period. Poor moisture supply during critical stages reduced the yield attributes and resulted in poor grain and stover yield. Similar finding were reported by Talu et al. [12], Singh [9] and Manna et al. [15].

The biological yield was influenced significant by land configuration. The maximum biological yield was obtained under treatment paired row planting on raise bed (L_3). This might also be increased due to better soil environment. Similar result reported by Meena et al. [16].

The biological yield was influenced significantly by different irrigation levels. The maximum biological yield was achieved with the application of irrigation at 0.9 IW/CPE ratios. This is due to continuously water supply as per demand of crop, which contributed to increasing in dry matter accumulation, better vegetative growth results maximum yield and yield attributes resulted. The minimum biological yield recorded under 0.5 IW/CPE ratios this might be due to both poor growth and yield attributes. Similar finding were reported by Meena et al. [16].

4. CONCLUSION

Maize crop produced maximum yield when it was sown on raised bed method as compared to another methods of land configuration. However, 1.1 IW/CPE ratios of moisture regime proved to most effective in respect of maximizing the growth and yield related parameters than other moisture regimes.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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