Original Research Article

# Effect of land configuration and moisture regimes on productivity of hybrid maize (*Zea mays* L.) in summer season.


## Abstract

A field 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&T, Narendra Nagar (Kumarganj), Ayodhya (U.P.). The experiment comprised of 12 treatment combinations and laid out in split plot design with replicated four 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 ratio, 0.9 IW/CPE ratio and 1.1 IW/CPE ratio were allotted in sub plots. The experimental results revealed that growth parameters, such as plant height, leaf area index, dry matter accumulation, 50 percent ear emergence and days to50 percent maturity and yield, its 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 observed significantly maximum except test weight and harvest index under paired row planting on raised bed followed by ridge planting and flat bed planting. In case of moisture regimes, the same trends were observed more with the irrigation at 1.1 IW/CPE ratio as compared to other moisture regimes.



**Keywords-** Maize, Land configuration, Moisture regimes, Yield, Growth. Leaf area index


## Introduction :

Maize (*Zea mays* L.) is one of the most important cereal crop in the world. It belongs to family Poaceae, broadly used in industries besides serving as human food and animal feed. Maize is called "queen of cereal" because maize has got very high yield potentiality and wide adaptability under various agro climatic conditions than any other cereal crops (Singh, 2013). The world leading producer of maize in descending order are United States of America (357.267million 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) (Anonymous, 2017). 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. (Anonymous, 2017)

India produces about 2% of the world`s maize production out of which Karnataka is leading producer of maize about 16% of total maize production followed by Telangana & 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. It is generally grown in Karnataka, Madhya Pradesh, Tamilnadu, Maharashtra, Telangana, Uttar Pradesh & Rajasthan etc. Bihar, Andhra Pradesh & Tamilnadu are major states which produced maize 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.* (2008) and also increases availability of nutrients to crops. The superiority of ridges and furrow system could be described to proper drainage of excess water coupled with adequate aeration at the time of irrigation or heavy rainfall. Parihar *et al.* 2009, 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.* (2008).Water requirement of crop mostly depends on Evapotranspiration. Evapotranspiration mainly depends on climate. The amount of water lost by evapotranspiration is estimated from climatologically data and when ET reaches in a particular level irrigation is scheduled. The amount of irrigation is given equal to ET or fraction of ET. IW/CPE approach is well known amount of irrigation water applied when cumulative pan evaporation reaches predetermine level. ET by a full crop cover in closely associated with the evaporation from an open pan, Dasten (1967). Parihar *et al*., (2009) 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 $ha^{-1}$) Malla Reddy *et al*., (2012).

**Material and methods**

The experiment was conducted at Agronomy research Farm of Acharya Narendra Deva University of Agriculture & 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$^{-1}$). Kanchan (K-25) variety of maize was used for sowing @ 25 kg ha$^{-1}$. The crop was sown at 07 April 2019 with keeping the distance of 60 cm in row and 20 cm apart from plant.

The experiment was 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 ratio, 0.7 IW/CPE ratio, 0.9 IW/CPE ratio and 1.1 IW/CPE ratio were allotted in sub plots. It was conducted in split plot design with four replications. 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 and at harvest stage.

**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.

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

**Harvest Index (%)**

Harvest index is defined as the ratio of economic yield to total biological yield (Donald, 1962) and expressed in percentage. The harvest index for maize was worked out as indicated below.

Economic yield (kg/ha)

Harvest index % = ---------------------------- × 100

Biological yield (kg/ha)

**Result and discussion**

**Growth parameter**

The growth parameters *viz*., plant height, leaf area index, and dry matter accumulation were significantly affected by land configuration at successive growth stages. Crop sown on paired row planting on raised bed ($L_3$) produced higher plant height, leaf area index and dry matter accumulation at all the stages, which was significant 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. Similar result reported by Kumar (2008) and Joshi *et al*. (2018).

In case of moisture regimes increasing moisture supply with increased the plant height significantly at all the growth stage, except 30 DAS. Maximum plant height at 60 DAS and at harvest stage was observed under 0.9 IW/CPE ratio which was at par with 1.1 IW/CPE ratio and significantly superior over 0.7 IW/CPE ratio, and 0.5 IW/CPE ratio and Moisture regimes were influenced significant on leaf area index at 60 DAS, while it was found non- significant at 30 DAS and at harvest stage. The maximum leaf area index was recorded under irrigation at 0.9 IW/CPE ratio as compared to the 1.1 IW/CPE ratio, 0.7 IW/CPE ratio and 0.5 IW/CPE ratio. This might be due to rapid growth caused by 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 Hussaini *et al*. (2002), Meena *et al*. (2017) and Kumar *et al*. (2011).

Dry matter accumulation ($gm^{-2}$) was influenced significantly due to different moisture regimes at 60 DAS and at harvest stages except 30 DAS were presented in (Table 1) the maximum dry matter accumulation was recorded with the irrigation at 0.9 IW/CPE ratio. This might be due to increased plant height, leaf area index, girth of stem and increase in uptake of nutrient *viz*., N. P. and K through adequate moisture supply. All these contributed for cell turgidity and opened leaves which increased the photosynthetic activity of crops resulted 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 ratio. 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 (2001), Hussaini *et al*. (2002) and Kumar *et al*. (2011).

**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 is presented in Table 2 except test weight. Significantly higher values was 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*. (2014) and Singh *et al*. (2015).

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 influenced due to different moisture regimes. Highest values of all the yield attributes were recorded under 0.9 IW/CPE ratio which was at par with 1.1 IW/CPE ratio. This might be due to favorable 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 photosynthates 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*. (1998) and Reddy *et al*. (2012).

**Yield**

Grain and stover yield of maize were affected significantly by land configuration data 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 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 (2002), Mishra *et al.*(2009) and Joshi *et al*. (2018).

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 ratio. 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*. (1998), Singh (2001), Hussaini *et al*. (2002) and Manna *et al*. (2018).

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 Mehta *et al*. (2010) and Meena *et al*. (2015).

The biological yield was influenced significantly by different moisture regimes. The maximum biological yield was obtained under irrigation at 0.9 IW/CPE ratio. This might be due to adequate supply of water, which contributed to increasing in dry matter accumulation. Better vegetative growth coupled with high yield attributes resulted into higher biological yield. The minimum biological yield recorded under 0.5 IW/CPE ratio this might be due to both poor growth and yield attributes. Similar finding were reported by Meena *et al*. (2015).

**Table-1. Plant height (cm) and leaf area Index (LAI) 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 |



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