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# Response of *kharif* maize on growth parameters and protein yield under different lateral arrangement and nutrient levels using drip irrigation

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**Abstract**
Field experiment was conducted at Indira Gandhi Krishi Vishwavidyalaya, Raipur during *kharif*, 2017 to study the Performance of maize under different lateral arrangements and nutrient management practices using drip irrigation system. The lateral arrangements and conventional practice and four nutrient management (50, 100, 150% RDF and STCR- based fertilizer recommendation) were included as treatments in this study. Crop imposed with lateral at 45 cm ($W_1$) recorded maximum protein yield and growth parameters *viz.* plant height, numbers of leaves plant $^{-1}$, stem girth, leaf area index, dry matter accumulation, crop growth rate (CGR) and relative growth rate (RGR) at 0-30 days while lowest protein yield and growth parameters were recorded under conventional practice ($W_3$). In respect to nutrient management, STCR- based fertilizer recommendation ($N_4$) recorded maximum protein yield and growth parameters and it was found statistically at par with 150% RDF ($N_3$). However the minimum protein yield and growth parameters were recorded under 50% RDF ($N_1$). Thus study revealed that, lateral arrangement at 45 cm (W1) with STCR- based fertilizer recommendation (N4) could be the optimal management practice for obtaining higher protein yield and growth parameters of maize.

**Keywords:** Maize, growth parameters, protein yield, lateral arrangement, STCR- based fertilizer recommendation

## Introduction
Maize is one of the most important cereal crops in the world after wheat and rice and has great importance in the world agricultural economy. It has many possible uses such as food, feed, fodder for livestock and raw material for industry. Corn oil is becoming popular due to its non-cholesterol character. In addition, its products like corn starch, corn flakes, gluten germ cake, lactic-acid, alcohol and acetone are either directly consumed as food or used by various industries like paper, textile, foundry and fermentation (Nazir *et al*., 1994) [10]. Drip irrigation allows precise timing and uniform distribution of fertilizer nutrients. Maize is one of the amenable crops for a drip irrigation system, which is an efficient system of irrigation (Zhu *et al.*, 2007) [16]. In Indian agriculture, water is becoming a scarce natural resource particularly due to changing the climate. Agriculture is the largest freshwater user, consuming about 83 percent of the total available water (Lawgali, 2008) [9]. Increased demand for fresh water in industrial and domestic sectors will result in a reduction of water diversions to agriculture (Seckler *et al*., 1998) [12]. Owing to various reasons, the demand for water for different purposes has been continuously increasing in India, but the potential water available for future use has been decreasing at a faster rate (Saleth, 2000) [11]. This indicates us that day-after- day population will be increased and available water for agriculture will be decreased, there is a need to increase the food production by efficient use of agricultural inputs especially water and fertilizer. Considering the low potential of water resource and growing of water demand for other than agricultural purpose, it is necessary to adopt water-saving technologies like micro-irrigation to avoid water stress for future generation. By introducing drip with fertigation, it is possible to increase the yield of crops by 3- times from the same quantity of water. When fertilizer is applied through the drip, it is observed that besides the yield increase of about 30 percent of the fertilizer could be saved (Sivanappan and Ranghaswami, 2005) [14]. Drip fertigation improves crop productivity by 60-100 percent (Sritharan, 2010) [15]. Looking to importance of drip fertigation study was carried out to study the pattern of growth and protein yield of maize under vertisols of Chhattisgarh condition.

## Materials and Methods

A field experiment was conducted at Indira Gandhi Krishi Vishwavidyalaya, Raipur during *kharif* (July -October) season of 2017.Experimental soil was clay with 1.40 g cc $^{-1}$, 31.24 and 16.34 per cent bulk density, field capacity and permanent wilting point, respectively. Soil fertility was low (225.24 kg ha$^{-1}$), medium (14.26 kg ha$^{-1}$) and high (343.73 kg ha$^{-1}$) for available nitrogen, phosphorus and potassium. The experiment comprised 3 lateral arrangements in horizontal strips *viz* $W_1$- laterals at 45 cm (1LPH/0.3 metre spacing),$W_2$- laterals at 90 cm (2LPH/0.3 metre spacing) and $W_3$- conventional practice and 4 nutrient management practices in vertical strips *viz* $N_1$- 50% RDF, $N_2$- 100% RDF (120:60:40 kg ha$^{-1}$ NPK), $N_3$- 150% RDF, $N_4$- STCR- based fertilizer recommendation (188:64:50). The experiment was laid out in strip plot design with three replications. Maize hybrid NMH 731 was sown with a spacing of 45cm X 20 cm. Maize was sown at the rate of 25 kg ha$^{-1}$. Seeds were hand dibbled at the rate of two seeds per hole. Thinning was done after emergence. Drip irrigation plots were irrigated through drip irrigation system as per treatments (Open pan evaporation). It was calculated for every day with the help of meteorological data recorded by meteorological observatory of Indira Gandhi Krishi Vishwavidyalaya, Raipur. Water requirement of crop was calculating with help of following formula:

$$WR = (Ep \times Kc \times Kp) – eR$$

Where, WR = water requirement, Ep= Pan evaporation (mm day$^{-1}$), Kc= The crop factor, Kp= The pan factor (0.75) and eR = effective rainfall

**Table 1:** Kc value for different period

| Days | Stage | Kc value |
|---|---|---|
| 1-19 | Initial stage | 0.40 |
| 20-49 | Development stage | 0.80 |
| 50-89 | Mid-stage | 1.15 |
| 90-94 | Late stage | 0.70 |

(Brouwer and Heibloem, 1986) [4].

Fertilizer in the conventional plot was applied as basal dose in the form of single super phosphate and murate of potash. Nitrogen was applied in the form of urea in three equal splits *i.e.*, basal, at knee height and tasseling stage of crop. However, nutrient from drip fertigation was applied in the form of urea, phosphoric acid and sulphate of potash as a source of nitrogen, phosphorus and potassium respectively. Fertilizers were applied through drip as per treatments with 5 day interval schedule. Five plants were selected at random and tagged for recording of observation. Growth parameters *viz.* plant height, numbers of leaves plant $^{-1}$, stem girth, dry matter accumulation were recorded at 30 60 DAS and at harvest and leaf area index crop growth rate (CGR) and relative growth rate (RGR) were also computed at 0-30 30-60 DAS and at harvest. The N content of the grain was multiplied with 6.25 (Dubez and Wells, 1968) [5] to get the protein content and expressed in percentage. Protein yield was calculated by using following formula protein yield = protein content in grain x Grain yield (kg ha$^{-1}$) / 100. The data pertaining to the experiment were subjected to statistical analysis suggested by Gomez and Gomez (1984) [6].

## Results and Discussion

The growth parameters of maize *viz.* plant height (cm), numbers of leaves plant $^{-1}$, stem girth (cm), leaf area index, dry matter accumulation plant$^{-1}$ (g) and CGR were significantly influenced by lateral arrangements and nutrient management. Lateral arrangement at laterals at 45 cm (1LPH/0.3 metre spacing; W1) recorded significantly maximum values of all growth parameters at 30 60 DAS and at harvest. However, lowest growth parameters were recorded under conventional practice ($W_3$). Growth parameters were higher under closer lateral spacing, this might be due to the fact that uniform and easy availability of nutrient and moisture at active root zone of maize which led to increase cell division, cell enlargement, cell differentiation and cell multiplication than wider lateral spacing and conventional practices. Among nutrient management, STCR- based fertilizer recommendation ($N_4$) significantly recorded higher values of growth parameters *viz.* plant height (cm), numbers of leaves plant $^{-1}$, stem girth (cm), leaf area index, dry matter accumulation plant$^{-1}$ (g) and CGR, however it was at par with the application of 150% RDF ($N_3$). Further the lowest value of growth parameters was recorded with the application of 50% RDF ($N_1$). The increased levels of nutrient increase cell volume, meristematic activities, formation and functioning of protoplasm which consequently increase the crop growth rate as well as the growth parameters of maize plant (Asok Kumar *et al.*, 1994) [1]. Similar linear response to higher doses of fertilizers was obtained by Padmaja (2014) [8], Basava (2012) [3], Selva Rani (2009) [13] and Hassanein *et al.* (2006) [7].

RGR (relative growth rate) of maize was significantly influenced by lateral arrangements and nutrient management. RGR was highest at initial stage of crop (0 – 30 DAS) and after that decreasing in trends. During 0-30 DAS, numerically maximum RGR of maize was recorded with laterals at 45 cm (1LPH/0.3 metre spacing, $W_1$). Among nutrient management STCR- based fertilizer recommendation ($N_4$) recorded maximum RGR. While lowest RGR was recorded under conventional practice ($W_3$) and 50% RDF ($N_1$) in lateral arrangement and nutrient management respectively. Whereas during 30-60 DAS maximum RGR was recorded under lateral arrangement conventional practice ($W_3$) and lowest RGR was observed under laterals at 45 cm (1LPH/0.3 metre spacing, $W_1$). In respect to nutrient management maximum RGR was recorded with 50% RDF ($N_1$). While, minimum RGR was recorded with 150% RDF ($N_3$). At later stages RGR showed similar trend and did not show variation with different lateral arrangement as well as nutrient management. Similar trend in RGR of maize was reported by Awasthy (2014) [2].

**Table 2:** Growth parameters of maize as influenced by lateral arrangement and nutrient levels.

| Treatments | Plant height (cm) | | | Number of leaves plant$^{-1}$ | | | Stem girth (cm) | | | Dry matter accumulation (g plant$^{-1}$) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 30 DAS | 60 DAS | At harvest | 30 DAS | 60 DAS | At harvest | 30 DAS | 60 DAS | At harvest | 30 DAS | 60 DAS | At harvest |
| Lateral Arrangement | | | | | | | | | | | | |
| $W_1$: laterals at 45 cm (1LPH/0.3 meter spacing) | 109.11 | 210.22 | 253.17 | 9.25 | 12.56 | 13.94 | 4.42 | 7.24 | 7.90 | 26.99 | 198.31 | 271.68 |
| $W_2$: laterals at 90 cm (2LPH/0.3 meter | 106.96 | 204.92 | 249.33 | 9.03 | 12.0 | 13.64 | 4.11 | 7.01 | 7.56 | 25.79 | 193.03 | 262.59 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| spacing) | | | | | | | | | | | | |
| $W_3$: conventional practice | 105.99 | 202.02 | 246.11 | 8.86 | 11.72 | 13.42 | 3.98 | 6.83 | 7.45 | 24.32 | 189.78 | 259.27 |
| SEm ± | 0.66 | 1.30 | 0.67 | 0.0423 | 0.1327 | 0.0671 | 0.04 | 0.05 | 0.02 | 0.23 | 1.04 | 1.82 |
| CD (P=0.05) | NS | 5.12 | 2.67 | 0.17 | 0.52 | 0.24 | 0.17 | 0.21 | 0.11 | 0.92 | 4.10 | 7.18 |
| Nutrient Management | | | | | | | | | | | | |
| $N_1$: 50% RDF | 102.40 | 192.64 | 241.19 | 8.63 | 11.00 | 13.26 | 3.71 | 6.39 | 6.78 | 22.24 | 177.76 | 245.70 |
| $N_2$: 100% RDF (120:60:40) kg $ha^{-1}$ $N:P_2O_5:K_2O$ | 105.75 | 204.04 | 247.44 | 8.93 | 11.96 | 13.37 | 4.04 | 6.85 | 7.63 | 24.25 | 190.04 | 259.69 |
| $N_3$: 150% RDF | 110.30 | 212.69 | 254.07 | 9.30 | 12.63 | 13.89 | 4.42 | 7.39 | 8.03 | 28.01 | 201.81 | 273.18 |
| $N_4$: STCR- based fertilizer recommendation (for 8 tonne) | 110.96 | 213.51 | 255.44 | 9.33 | 12.78 | 14.15 | 4.51 | 7.47 | 8.11 | 28.31 | 205.22 | 278.15 |
| SEm ± | 1.01 | 2.36 | 1.19 | 0.07 | 0.16 | 0.08 | 0.05 | 0.07 | 0.04 | 0.50 | 1.71 | 1.90 |
| CD (P=0.05) | 3. 48 | 8.16 | 4.11 | 0.25 | 0.57 | 0.28 | 0.19 | 0.26 | 0.15 | 1.72 | 5.98 | 6.57 |

| Treatments | Leaf area index (LAI) | | | Crop growth rate (g $plant^{-1}$ $day^{-1}$) | | | Protein content (%) | Protein yield (kg $ha^{-1}$) |
|---|---|---|---|---|---|---|---|---|
| | 30 DAS | 60 DAS | At harvest | 30 DAS | 60 DAS | At harvest | | |
| Lateral Arrangement | | | | | | | | |
| $W_1$: laterals at 45 cm (1LPH/0.3 meter spacing) | 2.69 | 6.60 | 8.78 | 0.90 | 5.71 | 2.45 | 9.57 | 704.48 |
| $W_2$: laterals at 90 cm (2LPH/0.3 meter spacing) | 2.49 | 6.04 | 8.15 | 0.86 | 5.57 | 2.32 | 9.62 | 674.24 |
| $W_3$: conventional practice | 2.39 | 5.73 | 7.97 | 0.81 | 5.52 | 2.28 | 9.62 | 642.50 |
| SEm ± | 0.02 | 0.11 | 0.06 | 0.007 | 0.034 | 0.031 | 0.03 | 6.38 |
| CD (P=0.05) | 0.10 | 0.46 | 0.24 | 0.03 | 0.13 | 0.12 | NS | 25.05 |
| Nutrient Management | | | | | | | | |
| $N_1$: 50% RDF | 2.05 | 4.87 | 7.12 | 0.74 | 5.18 | 2.26 | 9.54 | 579.00 |
| $N_2$: 100% RDF (120:60:40) kg $ha^{-1}$ $N:P_2O_5:K_2O$ | 2.44 | 5.84 | 7.96 | 0.81 | 5.53 | 2.32 | 9.52 | 634.89 |
| $N_3$: 150% RDF | 2.77 | 6.79 | 8.96 | 0.93 | 5.79 | 2.38 | 9.69 | 736.61 |
| $N_4$: STCR- based fertilizer recommendation (for 8 tonne) | 2.83 | 6.99 | 9.16 | 0.94 | 5.90 | 2.43 | 9.67 | 744.46 |
| SEm ± | 0.04 | 0.14 | 0.06 | 0.02 | 0.05 | 0.02 | 0.08 | 12.44 |
| CD (P=0.05) | 0.13 | 0.48 | 0.21 | 0.06 | 0.16 | 0.06 | NS | 43.04 |

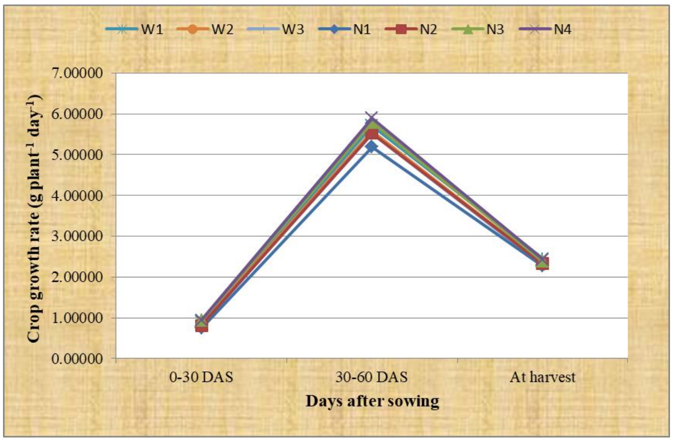


**Fig 1:** Crop growth rate (g $plant^{-1}$ $day^{-1}$) of maize at different intervals as influenced by lateral arrangement and nutrient levels

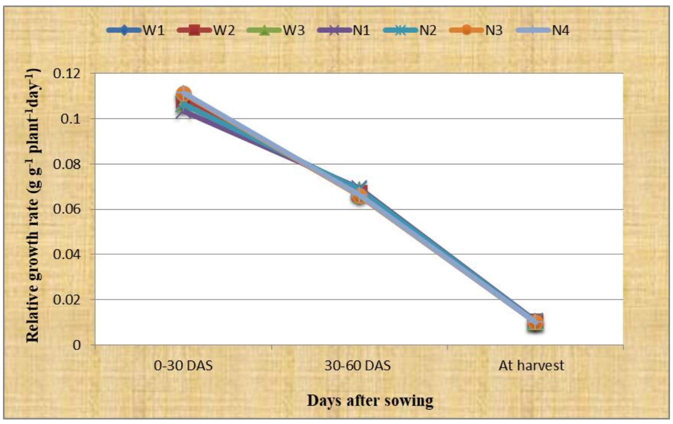


**Fig 1:** Relative growth rate (g $g^{-1}$ $plant^{-1}$ $day^{-1}$) of maize at different intervals as influenced by nutrient levels

protein yield of maize was significantly influenced by lateral arrangements and nutrient management. Significantly maximum protein yield was recorded with lateral at 45 cm ($W_1$) which was superior over rest of the treatment. However, lowest protein yield was recorded under conventional practice ($W_3$). In case of nutrient management STCR- based fertilizer recommendation ($N_4$) recorded significantly maximum protein yield over rest of the treatments except with the application of 150% RDF ($N_3$) which was statistically at par. However, lowest protein yield ware recorded with the application of 50% RDF ($N_1$).

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