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# Effect of irrigation scheduling and nutrient management on productivity and nutrient uptake by sweet corn (*Zea mays* var. *saccharata*) under vertisols of Marathwada

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## ABSTRACT

*A field experiment was carried out during rainy (kharif) seasons of 2016 and 2017 at the instructional/research farm of M.G.M. college of Agricultural Biotechnology, Aurangabad, Maharashtra to evaluate the effect of irrigation scheduling and nutrient management on yield and nutrient uptake by corn green fodder (cv. Sugar-75).Experiment comprised of three irrigation scheduling in main plot and sub plot consisted three fertility levels and two methods of zinc application. Results revealed that four irrigations at knee height, tasseling, silking and early dough stage registered maximum yield attributes; green cob and fodder yield (32.77 and 63.61 t ha$^{-1}$) over three and two irrigations, respectively. Significantly higher values of NPK uptake by grain(58.0, 19.8 and 31.8 kg ha$^{-1}$) was registered with four irrigations. The contents of protein and sugar were maximum with four irrigations. Application of 180:90:90 kg NPK ha$^{-1}$ recorded significantly highest yield attributes; green cob and stover yield (30.25 and 59.56 t ha$^{-1}$) and NPK uptake by grain (54.4, 18.5 and 29.7 kg ha$^{-1}$) over other two nutrient management. Application of 100:90:90 kg NPK ha$^{-1}$ also resulted in higher in higher contents of protein and sugar in sweet corn. Methods of Zn application did not differ significantly in respect of yield parameter, yield and nutrient uptake by the crop. The protein and sugar content in sweet corn were not affected with methods of Zn application.*

**Keywords:** Yield, irrigation scheduling, nutrient management, sweet corn

## INTRODUCTION

Maize (*Zea mays* L.) is the third most important cereal in India after rice and wheat. It is one of the most versatile emerging crops having wider adaptability under varied agro-climatic conditions. Sweet corn (*Zea mays* var. *saccharata*) has earned admiration across the world in arrears to its sweet, creamy, tender, crispy and almost shell-less kernels. The intensity of drought and duration of stress decides the extent of damage on maize, but also on the plant developmental stage at the time of exposure. The losses of 63–87 % when the crop was exposed to drought during the productive stage. One of the most popular approach is IW/CPE approach but considering utility of this method, it is less popular amongst the farmer due to lack of handheld CPE knowledge and data. On the contrary, performing irrigation as per critical growth stage approach is more suitable and adoptable for farmers. Among important growth stages of sweet corn crop, few stages are critical to water stress viz. Emergence (4-5 DAS), knee height stage (25-30 DAS), tasseling stage (52-55 DAS), silking stage (62-65 DAS) and early dough stage (72-76 DAS).Maize is a heavy feeder crop which requires adequate quantities of macro and micro nutrients for getting better growth and maximum yield potential. Maize was proved to be more responsive to the fertilizer application (Mehta *et al.*, 2011, Singh *et al.*, 2018) due to its vigorous plant growth and higher productivity. Nitrogen is an important input in agriculture and is a powerful tool for enhancing the grain yield in cereals. Maize has maximum nitrogen use efficiency of about 50% but its efficiency varies from 30 – 40% under poor management. Phosphorus (P) ranks next to N in its importance on account of the vital role being played in major life processes and its availability is of very important for crop. Potassium plays essential roles in enzyme activation, protein synthesis, photosynthesis, osmoregulation, stomatal movement, energy transfer, phloem transport and stress resistance. Zinc is an important micronutrient required for several biochemical processes including chlorophyll production and membrane integrity. There are various methods of adding micronutrients to crops: soil application, foliar spraying, seed priming and seed coating. Soil application is generally considered as the most promising method for applying micronutrients. Application of zinc through seed priming has many benefits over

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soil application, i.e., quantity applied are significantly lower than soil applications, uniform application is possible, crop response to applied micronutrient is almost immediate. Seed priming of Zn is found to escape most of the soil reactions. The balanced application of major nutrients such as nitrogen, phosphorus and potassium with zinc are also important for maximization of yield in sweet corn. Sweet corn produces green cob and it needs balanced and enough supply of water and nutrients for higher yield and better quality. Therefore, it is necessary to investigate proper irrigation at critical growth stages and optimum NPK levels for higher yields. Keeping in view the above review, the present study was undertaken to determine the effect of irrigation scheduling and nutrient management on yield and nutrient uptake in sweet corn.

## MATERIAL AND METHODS

The field experiments were carried out during the kharif season of 2016 and 2017 at the instructional/research farm of MGM college of Agricultural Biotechnology, Aurangabad, Maharashtra ($19^0$ 80'N Latitude and $75^0$ 39'E longitude). The average annual precipitation is 710 mm. The soil had 120.09 kg N $ha^{-1}$, 14.85 kg $ha^{-1}$ available phosphorus, 436.24 kg $ha^{-1}$ exchangeable potassium and 4.1 g $kg^{-1}$ organic carbon. The pH of the soil was 7.98. The DTPA extractable Zn in soil was 0.68 mg $kg^{-1}$.The field experiment was laid in a split-plot design, with the main plots consisting of three irrigation scheduling viz., $I_1$: Two irrigations at knee height and tasseling stage, $I_2$: three irrigations at knee height, tasseling and early dough stage, $I_3$: Four irrigations at knee height, tasseling, silking and early dough stage and sub-plots consisting of three fertility levels viz., $NPK_1$: 120:60:60 kg NPK $ha^{-1}$, $NPK_2$: 150:75:75 kg NPK $ha^{-1}$, $NPK_3$: 180:90:90 kg NPK $ha^{-1}$) and two methods of zinc application viz., $Zn_1$: Soil application @ 25kg $ZnSO_4.7H_2O$ $ha^{-1}$ and $Zn_2$: Seed priming @ 1% $ZnSO_4.7H_2O$) with three replications. Sweet corn was sown at spacing of 60 cm x 20 cm on 25 August 2016 and 27 August 2017, during 2016 and 2017, respectively. The full dose of phosphorus and potassium as basal dose was applied just before dibbling of sweet corn and nitrogen was applied in two equal splits i.e. ½ at planting and remaining ½ at 30 DAS by band placement method as per the treatment. Irrigation was applied immediately after sowing and subsequently second irrigation was applied on 4 days after sowing for better germination. Thereafter irrigations were applied as per the treatment. Yield attributes and yields of grain and green fodder were recorded at harvest. The nitrogen content in grain was determined by modified Kjeldahl method. Phosphorus and K content in diacid extract were determined by molybdovanadate yellow colour method and flame photometrically, respectively. The nutrient uptake by sweet corn was determined by multiplying the NPK concentrations with corresponding air-dry weight of grain. The total sugars were estimated following the Phenol-sulphuric acid method described by Dey (1990). All the data obtained from sweet corn crop were statistically analyzed as per procedure given by Gomez and Gomez (1984). LSD values at P = 0.05 were used to determine the significance of differences between treatment means. The analysis of data on growth, grain yield, and nutrient content for sweet corn was also performed using SPSS software.

## RESULTS AND DISCUSSION

### Yield attributes

The yield attributes (Table 1) were significantly influenced by different irrigation scheduling and nutrient management. Application of four irrigation significantly increased the length of cob with husk (30.0 cm), girth of cob with husk (23.7 cm), weight of cob with husk (404 g $plant^{-1}$) and number of grain rows $cob^{-1}$ (20.7) over three and two irrigations. Significantly higher yield attributes might be due to favourable soil moisture that helps uptake of nutrients resulting in increased length of cob with husk, girth of cob with husk, weight of cob with husk and number of grain rows $cob^{-1}$. The results were in accordance with those of Shiva kumar*et al.* (2011). Crop receiving 180:90:90 kg NPK $ha^{-1}$produced significantly maximum length of cob with husk (26.7 cm), girth of cob with husk (21.9 cm), weight of cob with husk (373 g $plant^{-1}$) and number of grain rows $cob^{-1}$ (20.0) over 150:75:75 and 120:60:60 kg NPK $ha^{-1}$. The higher and balanced fertilizer helps to increase the growth parameter which ultimately increases the yield parameters of sweet corn. Similar results were also reported by Chougale (2013). Zinc sulphate application through seed priming recorded marginally higher yield attributing parameters over soil application of zinc sulphate but the differences in yield attributes were statistically non-significant.

Table 1: Effect of irrigation scheduling and nutrient management on yield attributes and yield of sweet corn crop (pooled)

| Treatments | Length of cob with husk (cm) | Girth of cob with husk (cm) | Weight of cobs with husk(g plant$^{-1}$) | Number of grain rows cob$^{-1}$ |
|---|---|---|---|---|
| Irrigation scheduling | | | | |
| Two irrigations | 18.4 | 16.1 | 237 | 15.0 |
| Three irrigations | 25.6 | 19.6 | 320 | 18.8 |
| Four irrigations | 30.0 | 23.7 | 404 | 20.7 |
| SEm (±) | 0.62 | 0.54 | 9.2 | 0.55 |
| LSD at 5% | 2.42 | 2.13 | 36.2 | 2.15 |
| NPK levels (kg ha$^{-1}$) | | | | |
| 120:60:60 | 21.8 | 17.0 | 263 | 16.8 |
| 150:75:75 | 25.4 | 20.5 | 326 | 17.7 |
| 180:90:90 | 26.7 | 21.9 | 373 | 20.0 |
| SEm (±) | 0.45 | 0.45 | 6.8 | 0.45 |
| LSD at 5% | 1.30 | 1.28 | 19.7 | 1.15 |
| Method of zinc application | | | | |
| Soil application | 24.5 | 19.6 | 320 | 17.95 |
| Seed priming | 24.9 | 20.0 | 321 | 18.45 |
| SEm (±) | 0.37 | 0.37 | 5.6 | 0.35 |
| LSD at 5% | NS | NS | NS | NS |

**Nutrient content in grain**

Results revealed that the crop grown under four irrigations at knee height, tasseling, silking, early dough stage at harvest stage recorded significantly higher nitrogen, phosphorus and potassium in grain (2.02, 0.69 and 1.11 %, respectively) over three and two irrigations (Table 2). Two irrigations to sweet corn crop at knee height and tasseling stage recorded lowest nitrogen, phosphorus and potassium in grain (1.70, 0.55 and 0.92 %, respectively). The higher N, P and K content in grain with four irrigations may be due to higher soil moisture content which facilitate the nutrients to bring into soil solution. These results are in agreement with those obtained by Singh *et al.* (2018). Crop receiving 180:90:90 kg NPK ha$^{-1}$ resulted significantly highest NPK content in grain (2.03, 0.69 and 1.11 %, respectively) and it was significantly higher over 150:75:75 and 120:60:60 kg NPK ha$^{-1}$. Application of 120:60:60 kg NPK ha$^{-1}$ to sweet corn recorded lowest NPK content in grain (1.76, 0.58 and 0.97, respectively). This increase in N concentration appears to be on account higher available N and enhanced translocation in plant system (Khan *et al.*, 2018).Similarly, the increase in P and K uptake may be due to more availability of P and K from the soil with their application (Paramesh *et al.*, 2014). There was no significant difference between seed priming and soil application of zinc sulphate with respect to NPK content in grain.

**Quality**

The four irrigations recorded significantly highest protein and total sugar content in grains (12.88 % and 14.24 %, respectively) over two irrigations (11.05 and 11.07%, respectively) (Table 2). Crop grown with 180:90:90 kg NPK ha$^{-1}$ resulted significantly highest protein and total sugar content in grains (12.99 and 13.43 %, respectively) over 150:75:75 kg NPKha$^{-1}$ and 120:60:60 kg NPK ha$^{-1}$, respectively. The response of sweet corn to applied NPK levels towards improving quality may be attributed to their role in synthesis of protein under N-metabolism (Singh *et al.*, 2018). The protein and total sugar content of sweet corn crop did not differ significantly due to the methods of zinc application.

Table 2: Effect of irrigation scheduling and nutrient management on per cent N, P, K, protein and sugar of sweet corn crop

| Treatments | Nitrogen | Phosphorus | Potassium | Protein | Sugar |
|---|---|---|---|---|---|
| Irrigation scheduling | | | | | |
| Two irrigations | 1.70 | 0.55 | 0.92 | 11.05 | 11.07 |
| Three irrigations | 1.92 | 0.66 | 1.06 | 12.47 | 12.33 |
| Four irrigations | 2.02 | 0.69 | 1.11 | 12.88 | 14.24 |
| SEm (±) | 0.06 | 0.02 | 0.03 | 0.35 | 0.35 |
| LSD at 5% | 0.23 | 0.09 | 0.13 | 1.39 | 1.39 |
| NPK levels (kg ha$^{-1}$) | | | | | |
| 120:60:60 | 1.76 | 0.58 | 0.97 | 11.40 | 11.82 |
| 150:75:75 | 1.85 | 0.63 | 1.02 | 12.01 | 12.39 |
| 180:90:90 | 2.03 | 0.69 | 1.11 | 12.99 | 13.43 |
| SEm (±) | 0.04 | 0.02 | 0.02 | 0.26 | 0.26 |
| LSD at 5% | 0.12 | 0.05 | 0.06 | 0.74 | 0.75 |
| Method of zinc application | | | | | |
| Soil application | 1.87 | 0.63 | 1.03 | 12.10 | 12.51 |
| Seed priming | 1.88 | 0.63 | 1.03 | 12.16 | 12.58 |
| SEm (±) | 0.03 | 0.01 | 0.02 | 0.21 | 0.21 |
| LSD at 5% | NS | NS | NS | NS | NS |

**Yield**

Results (Table 3) revealed that four irrigations at knee height, tasseling, silking and early dough stage ($I_3$) recorded significantly higher green cob yield of 32.77 t ha$^{-1}$ and green fodder yield (63.61 t ha$^{-1}$) over three and two irrigations. Two irrigation recorded statistically lowest green cob and fodder yield of 19.18 and 39.73 tha$^{-1}$, respectively. The higher yield with four irrigations might be due to better yield parameters and supply of adequate moisture throughout the growing period which reflecting the overall growth of the grain and its weight. The results are in agreement with (Datta *et al.*, 2019). Crop receiving 180:90:90 kg NPK ha$^{-1}$ produced significantly higher green cob and fodder yield (30.25 and 59.56 t ha$^{-1}$) and it was significantly superior to the application of 150:75:75 kg NPK ha$^{-1}$ (26.43 and 51.60 t ha$^{-1}$) and 120:60:60 kg NPK ha$^{-1}$ (21.26 and 42.26 t ha$^{-1}$), respectively. It has been well established that balanced application of NPK play three important vital roles i.e., formation of vegetative structure for nutrient absorption, photosynthesis and strong sink length through development of reproductive structure and production of assimilates to fill economically improved sink (source strength). The observed results are in close conformity those of (Singh *et al.*, 2018 and Rino *et al.*, 2020) There was no significant difference between seed priming and soil application of $ZnSO_4.7H_2O$ in respect of green cob and green fodder yield.

**Nutrient uptake**

Results revealed that the crop grown under four irrigations recorded significantly higher nitrogen, phosphorus and potassium uptake by grain (58.0, 19.8 and 31.8 kg ha$^{-1}$, respectively)over three and two irrigations (Table 3). The lowest nitrogen phosphorus and potassium uptake by grain (25.3, 8.1 and 13.7 kg ha $^{1}$, respectively) was recorded with two irrigations. This ncrease in NPK uptake might be due to increase in grain yield. This increase in nutrient uptake may be due to higher soil moisture content which facilitate the nutrients to bring into soil solution. These results are in agreement with the results obtained by Singh *et al.* (2018). Crop receiving 180:90:90 kg NPK ha$^{-1}$ produced significantly highest NPK uptake by grain (54.4, 18.5 and 29.7 kg ha$^{-1}$, respectively) and it was significantly superior to 150:75:75 and 120:60:60 kg NPK ha$^{-1}$.This increase in N uptake may be due to increase in grain yield (Canatoy, 2018). Similarly, the increase in P and K uptake may be due to more availability of P and K from the soil with their application (Paramesh *et al.*, 2014). There was no significant difference between seed priming and soil application of zinc sulphate with respect to NPK uptake by grain.

Table 3: Effect of irrigation scheduling and nutrient management on yield and nutrient uptake by sweet corn (pooled)

| Treatments | Yield (t $ha^{-1}$) | | Grain (kg $ha^{-1}$) on dry weight basis | | |
|---|---|---|---|---|---|
| | Cob | Green fodder | N | P | K |
| Irrigation scheduling | | | | | |
| Two irrigations | 19.18 | 39.73 | 25.3 | 8.1 | 13.7 |
| Three irrigations | 25.98 | 50.09 | 41.5 | 14.3 | 23.0 |
| Four irrigations | 32.77 | 63.61 | 58.0 | 19.8 | 31.8 |
| SEm (±) | 0.73 | 1.58 | 2.84 | 0.92 | 1.45 |
| LSD at 5% | 2.88 | 6.21 | 11.13 | 3.62 | 5.70 |
| NPK levels (kg $ha^{-1}$) | | | | | |
| 120:60:60 | 21.26 | 42.26 | 28.6 | 9.6 | 15.8 |
| 150:75:75 | 26.43 | 51.60 | 41.7 | 14.2 | 23.0 |
| 180:90:90 | 30.25 | 59.56 | 54.4 | 18.5 | 29.7 |
| SEm (±) | 0.55 | 1.3 | 1.50 | 0.51 | 0.80 |
| LSD at 5% | 1.58 | 3.76 | 4.33 | 1.45 | 2.33 |
| Method of zinc application | | | | | |
| Soil application | 25.94 | 51.13 | 41.3 | 14.0 | 22.6 |
| Seed priming | 26.01 | 51.16 | 41.9 | 14.1 | 23.0 |
| SEm (±) | 0.45 | 1.06 | 1.23 | 0.42 | 0.66 |
| LSD at 5% | NS | NS | NS | NS | NS |

The present study brings out that higher yield of cob and fodder as well as quality and nutrient uptake by grain were recorded with four irrigations and application of 180:90:90 kg $NPKha^{-1}$ and zinc application either seed priming or soil application. This package of practice may be recommended in sweet corn cultivation in vertisols of Marathwada region.

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