*Indian Journal of Ecology* (2022) 49(5): 1724-1727
DOI: https://doi.org/10.55362/IJE/2022/3724

**Manuscript Number: 3724**
**NAAS Rating: 5.79**

# Assessing Performance of Maize (*Zea mays* L.) Hybrids under Different Regimes of Irrigation and Organic Manure in Semi-Arid Region of Haryana

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***Abstract***: A field investigation was conducted in a sandy loam during the spring 2020 at CCS Haryana Agricultural University Hisar, Haryana to study the effect of irrigation source and organic manure source's on performance of maize (*Zea mays* L.) hybrids. The treatments consisted of two single cross hybrids (HQPM-1 and HQPM-5) and two irrigation sources [Canal water and treated sewage water] in main plots and four organic manure sources [No manure, 100% recommended dose of nitrogen (RDN) through FYM, 100% RDN through vermicompost and 50% of RDN through FYM + 50% of RDN through vermicompost] in sub-plot. The higher growth parameters and yield of maize were recorded in HQPM-1 as compared to HQPM-5. Treated sewage water performed statistically at par in different growth parameters and significantly higher in yield of maize, in comparison to canal water. Application of 100% RDN through vermicompost resulted in significantly higher plant height, dry matter accumulation per plant, yield (grain, straw and biological) of maize as compared to rest of the treatments. This study concluded that treated sewage water can be a replacement to the conventional water sources under use and application of 100% RDN through vermicompost can improve the growth and yield of maize.

***Keywords***: FYM, Growth, Maize, Organic manure, RDN, Vermicompost, Yield

Maize is one of the most important cereal crops of the world as well as India. It is cultivated under diverse conditions of soil and climate. In India, it is the third most important crop, after rice and wheat. In 2019-20, maize was cultivated on an area, of 9.57 Million hectare with a production of 28.77 Million tonnes and productivity of 3.00 t/ha respectively, in India. In Haryana (2019-20), the area, production and average productivity of maize in *kharif* was 6,000 ha, 17,000 tonnes and 2.83 t/ha respectively (DES 2021). Maize is highly sensitive to water stress as well as excess irrigation. Cities generate a huge amount of domestic wastewater. Pollution of soil, groundwater and air results from indiscriminate disposal of such water. Because of rising population and progressive industrial development, the resources are depleting on a daily basis throughout the world, which encouraged people to reuse, recycle and adopt strategies to reduce the existing load on resources rather than polluting them through discharging in environment. The reuse of wastewater for irrigation in agricultural crop can reduce the amount of water that is extracted from water resources. Such wastewater contains the high nutrient load and can possibly be utilised to irrigate crops, which can in turn will lead to increase in agricultural yield and planting. Addition of organic material to the soil aids in the preservation of soil fertility and productivity. Organic manures improve soil organic carbon, which is important for maintaining soil physical quality as well as plant nutrients. Farmyard manure (FYM) and vermicompost (VC) are particularly important for use in maize in this context. It helps in nutrient recycling, transformation and availability to the crop by boosting soil microbiological activity. It also improves physical properties such as soil's water holding capacity, porosity and structure, as well as reducing compaction, crusting and salt accumulation in root zone. The present studies aimed at finding the appropriate irrigation source and organic manure source by assessing the growth and yield of maize single cross hybrids.

## MATERIAL AND METHODS

The field experiment was conducted at CCS Haryana Agricultural University Hisar during spring 2020 ($29^0$10' N and $75^0$46' E, of 215.2 meter above mean sea level). The soil was sandy loam, having a pH 8.01 and EC 0.39 dS/m. The soil initially contained organic carbon (0.34 %), available nitrogen (105 kg/ha), available phosphorous (15.4 kg/ha) and available potassium (302 kg/ha). The experiment was laid down in split plot design with three replications. The treatments comprised of 2 single cross hybrids (SCH) ['HQPM-1' ($A_1$) and 'HQPM-5' ($A_2$)] and 2 irrigation sources [canal water (B1) and treated sewage water (B2)] as main plots and 4 organic manure sources [No manure ($C_1$) = No manure or fertilizer, 100% FYM ($C_2$) = 100 % recommended dose of nitrogen (RDN) though FYM, 100% VC ($C_3$) = 100 % RDN though vermicompost and 50% FYM + 50% VC ($C_4$) = 50% of RDN through FYM and 50% of RDN through vermicompost] in sub-plot. Each experimental units consisted of 6.0 m × 5.0 m plots. The FYM contains 0.62-0.20-0.50 % and vermicompost contains 2.5-1.0-1.5 % N-P-K respectively. The maize crop was sown on 26 February 2020 at recommended spacing of 60 cm × 20 cm. The nutrients were applied according to the treatments at the time of field preparation for the crop. Other practices were carried out as per package of practices of CCS HAU Hisar (Anonymous, 2020). The plant population was counted from five randomly selected central rows of two meter row length and then average out to get number of plants per square meter. The plant height was measured from the base of plant to the tip of fully opened top leaf. Five plants were randomly selected from each plot and carefully uprooted to take dry matter accumulation. These samples were firstly sun dried and then oven dried at $70^0$C to achieve constant weight and then averaged to get dry matter accumulation per plant. The data of plant height (cm), dry matter (g/plant) were taken from each plot at 30, 60, 90 days after sowing (DAS) and at maturity. The crop was harvested manually, at maturity. The harvested cobs were then threshed to estimate grain yield. Grain and straw yield (kg/ha) were determined from each plot and converted to tonnes per hectare (t/ha). The following formula was used to work out biological yield:

Biological yield = Grain yield + Straw yield

Harvest index (%) was calculated by the following formula:

$$\text{Harvest index (\%)} = \frac{\text{Grain yield}}{\text{Biological yield}} \times 100$$

All the data recorded were analysed as per the standard statistical technique as described by Panse and Sukhatme (1978). The significance of difference were compared by using critical difference (C.D.) at 5 % level of probability using OPSTAT software.

## RESULTS AND DISCUSSION

### Growth Parameters

**Plant height:** Plant height varied significantly due to different SCH at all crop growth stages except at 30 DAS. HQPM-1 produced significantly taller plants, *viz*. 135.95, 165.12 and 166.29 cm at 60, 90 DAS and at maturity, respectively as compared to HQPM-5 (Table 1). Taller plant were recorded with HQPM-1, plant height is strongly influenced by considerable varietal variation in this characteristics and environmental conditions during stem elongation and growth of plants. These results are in conformity with Kumar (2016) and Gaile (2012). Irrigation source had no significant effect on plant height at all crop growth stages except at 60 DAS. Treated sewage water had higher plant height at all crop growth stages than canal water. This could be due to treated sewage water causing higher nutrient inputs, accumulation

**Table 1.** Effect of sewage water and organic manure on plant height and dry matter accumulation per plant of maize hybrids at different crop growth stages

| Treatments | 30 DAS | | 60 DAS | | 90 DAS | | At maturity | |
|---|---|---|---|---|---|---|---|---|
| | Plant height (cm) | Dry matter (g/plant) | Plant height (cm) | Dry matter (g/plant) | Plant height (cm) | Dry matter (g/plant) | Plant height (cm) | Dry matter (g/plant) |
| A. Single cross hybrid | | | | | | | | |
| $A_1$: HQPM-1 | 40.61 | 14.87 | 135.95 | 53.21 | 165.12 | 98.50 | 166.29 | 138.51 |
| $A_2$: HQPM-5 | 40.22 | 14.32 | 130.80 | 51.18 | 161.38 | 93.29 | 163.76 | 125.44 |
| C.D. (p=0.05) | NS | NS | 2.61 | 1.36 | 3.35 | 2.63 | 1.91 | 4.249 |
| B. Irrigation source | | | | | | | | |
| $B_1$: Canal water | 40.27 | 14.48 | 131.91 | 51.79 | 162.44 | 94.97 | 164.13 | 130.82 |
| $B_2$: Treated sewage water | 40.56 | 14.71 | 134.84 | 52.60 | 164.06 | 96.81 | 165.92 | 133.12 |
| C.D. (p=0.05) | NS | NS | 2.61 | NS | NS | NS | NS | NS |
| C. Organic manure source | | | | | | | | |
| $C_1$: No manure | 35.10 | 11.39 | 107.30 | 39.85 | 130.40 | 70.20 | 131.10 | 87.50 |
| $C_2$: 100% FYM | 41.16 | 14.20 | 140.90 | 50.92 | 172.90 | 93.55 | 174.60 | 130.20 |
| $C_3$: 100% VC | 43.40 | 17.60 | 143.70 | 63.28 | 175.80 | 118.33 | 178.40 | 167.02 |
| $C_4$: 50% FYM + 50% VC | 42.00 | 15.20 | 141.60 | 54.73 | 173.90 | 101.49 | 176.00 | 143.16 |
| C.D. (p=0.05) | 1.71 | 1.05 | 3.25 | 6.41 | 4.00 | 16.97 | 3.78 | 46.46 |

and uptake of nutrients. Similar results were reported by earlier researchers (Chandrikapure et al 2017, Mousavi and Shahsavari 2014). Organic manure significantly improved plant height at all crop growth stages and application of 100% VC recorded significantly taller plant at all the crop growth stages which was statistically at par with 50% FYM + 50% VC and 100% FYM than control except at 30 DAS whereas 100% VC was statistically at par with 50% FYM + 50% VC. Increased plant height might be due to quick and higher availability of nutrients especially nitrogen under vermicompost treated plots. These results are in close conformity with Prasad et al (2018) and Gunjal and Chitodkar (2017).

**Dry matter production:** Dry matter production was significantly affected due to different SCH treatment at all crop growth stages except at 30 DAS (Table 1). HQPM-1 had higher dry matter accumulation per plant (53.21, 98.50 and 138.51 g) at 60, 90 DAS and at maturity, respectively as compared to HQPM-5. These results are in agreement with Kumar (2016) and Gul et al (2015). Irrigation source failed to bring any significant variation in dry matter accumulation per plant at all crop growth stages. However, treated sewage water had numerically higher dry matter accumulation per plant than canal water at all crop growth stages. Organic manure had significant effect on dry matter accumulation at all crop growth stages. Maximum dry matter accumulation was found under 100% VC (17.60 and 63.28 g/plant), which was significantly higher than rest of treatments at 30 and 60 DAS, respectively; while it was statistically at par with 50% FYM + 50% VC at 90 DAS and significantly higher than no manure ($C_1$) and 100% FYM ($C_2$). At maturity, 100% VC recorded highest dry matter accumulation per plant, which was statistically at par with 50% FYM + 50% VC and 100% FYM while significantly higher than no manure ($C_1$). This might be due to slow release of nutrients over time with using organic manure and improved physio-chemical properties, which ked to better growth. The increment in plant height by use of organic manure consequently increase the dry matter. These results are in close conformity with Prasad (2019) and Raman and Suganya (2018).

**Yield**

**Plant population:** The number of plants per square meter at maturity was non-significantly affected by different SCH, irrigation source and organic manure treatments (Table 2).

**Harvest index:** Different SCH, irrigation source and organic manure treatments had non-significant effect on harvest index of maize (Table 2).

**Grain, straw and biological yield:** The significantly higher yield of grain, straw and biological (5.808, 8.375 and 14.183 t/ha) of maize was obtained with HQPM-1 than HQPM-5 (Table 2). Treated sewage water recorded significantly higher grain, straw and biological yield (5.726, 8.260 and 13.986 t/ha) than canal water. This might be due to increased nutrient inputs in treated sewage water plots, higher dry

**Table 2.** Effect of sewage water and organic manure on number of plants per square meter, grain yield, straw yield, biological yield and harvest index of maize hybrids

| Treatments | At maturity | | | | |
|---|---|---|---|---|---|
| | No. of plants/m$^2$ | Yield (t/ha) | | | Harvest index (%) |
| | | Grain | Straw | Biological | |
| A. Single cross hybrid | | | | | |
| $A_1$: HQPM-1 | 8.259 | 5.808 | 8.375 | 14.183 | 40.85 |
| $A_2$: HQPM-5 | 8.231 | 5.523 | 7.989 | 13.512 | 40.79 |
| C.D. (p=0.05) | NS | 0.120 | 0.153 | 0.214 | NS |
| B. Irrigation source | | | | | |
| $B_1$: Canal water | 8.245 | 5.605 | 8.103 | 13.708 | 40.79 |
| $B_2$: Treated sewage water | 8.245 | 5.726 | 8.260 | 13.986 | 40.85 |
| C.D. (p=0.05) | NS | 0.120 | 0.153 | 0.214 | NS |
| C. Organic manure source | | | | | |
| $C_1$: No manure | 8.217 | 1.414 | 2.084 | 3.499 | 40.44 |
| $C_2$: 100% FYM | 8.245 | 6.921 | 10.028 | 16.950 | 40.86 |
| $C_3$: 100% VC | 8.273 | 7.288 | 10.449 | 17.737 | 41.08 |
| $C_4$: 50% FYM + 50% VC | 8.245 | 7.038 | 10.165 | 17.203 | 40.91 |
| C.D. (p=0.05) | NS | 0.389 | 0.573 | 0.921 | NS |

matter, plant height and yield attributes. The interaction between SCH and irrigation source had significant effect on grain yield of maize. Higher grain yield was recorded in HQPM-1 with treated sewage water. These results are in close conformity with Chandrikapure et al (2017), Nahhal et al (2013) and Galavi et al (2009).

Organic manure had significant effect on grain, straw and biological yield of maize. Highest grain, straw and biological yield (7.288, 10.449 and 17.737 t/ha, respectively) was recorded under 100% VC which was statistically at par with 50% FYM + 50% VC and 100% FYM, but was significantly higher than no manure ($C_1$). This might be due to more supply of nutrients through organic manure, higher number of plants, dry matter. Application of organic manure might have improved the soil physical, chemical and biological properties resulting in increased nutrient uptake causing higher yield. The interaction was significant between SCH and organic manure source. Highest grain yield was obtained in HQPM-1 with 100% VC. These results are in close conformity with Gunjal and Chitodkar (2017) and Prasad (2019).

## CONCLUSIONS

The application of 100% recommended dose of nitrogen through vermicompost, the single cross hybrid HQPM-1 produced higher growth parameters (plant height, dry matter accumulation) and yield (grain, straw and biological) of maize (*Zea mays* L.) as compared to HQPM-5 irrespective of irrigation source. Hence, treated sewage water can be successfully used for replacement of conventional irrigation water.

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*Received 20 May, 2022; Accepted 22 September, 2022*