



Performance of *Kharif* Maize (*Zea mays* L.) with Integrated Nutrient Application

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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 "Performance of *Kharif* maize (*Zea mays* L.) with integrated nutrient application" during *Kharif* 2017, on Soil Conservation and Water Management Farm, CSA University of Agriculture and Technology, Kanpur on hybrid Maize with three level of inorganic fertilizers (kg/ha) i.e. 100% R.D.F. (100 N + 60 P + 40 K + 20 Z), 75% RDF (75+45+30+15), & 50% RDF (50+30+20+10) along with three Levels of organic manure viz; 15, 20 & 25 ton FYM/ha. On the basis of overall results it can be concluded that the fertility level 75% RDF + 25 t FYM/ha (F₂+O₃) was found superior over all other treatment combinations of fertility management maximum yield of grain (26.47 q/ha), stover (89.01 q/ha) and water use efficiency is 9.76 kg ha⁻¹ mm⁻¹. The treatment combination F₂+O₃ (75% RDF + 25 t FYM/ha) is very suitable among over all treatments.

Keywords: Hybrid maize; yield; harvest index; water use efficiency.

1. INTRODUCTION

Maize (*Zea mays* L.) is the third most important cereal crop next to rice and wheat in the world's agricultural economy, both as a food for human and as feed for livestock. It is known as "queen of cereals" because of its maximum yield potential among the cereals and expanded use in different agro-industries. It is recognized as a leading commercial crop of great economic value. It is grown worldwide over an area of 185 million hectares with a production of 1018 million tonnes and productivity of 5.49 tonnes ha⁻¹. In India, it is grown over an area of 9.5 million hectares with a production of 23.3 million tonnes with 2452 kg ha⁻¹ of productivity [1]. Exploitive agriculture involving modern production technology with the introduction of high yielding sweet corn, coupled with use of high analysis fertilizers lead to deficiency of micronutrients, particularly zinc and iron. In future, it may emerge as an alarming situation in the intensively cultivated areas [2, 3].

About half of the world's population suffers from micronutrient malnutrition, including iron, zinc and iodine which are mainly associated with low dietary intake of micronutrients in diets with less diversity of food. Recent reports indicate that nearly 5,00,000 children under 5 years of age die annually because of Zn and Fe deficiencies. Iron and zinc are essential minerals for humans. Deficiencies in both contribute to severe cases of malnutrition. Among the micronutrients, zinc deficiency is most common in the world [3]. Worldwide incidence of zinc deficiency in soils is becoming more important due to its impact on human health [4]. Zinc deficiency in Indian soils is expected to increase from 42 percent in 1970 to 63 per cent in 2025 due to continuous depletion of soil fertility. Zinc plays an important role in chlorophyll formation, carbohydrate metabolism and protein synthesis.

Overall crop nutrition plays a vital role in plant development and it is generally comprised of macronutrients and micronutrients with major role of macro ones, but the micronutrients (Zn, B, Co, Mn, Mo, Cu, Ni and Fe), even being required in smaller amounts are of equally vital for plant growth and development [5]. It is due to the fact that micronutrients not only enhance the grain yields but contribute to improvement of the quality in terms of grain nutrients as well [6].

Balanced nutrition of NPK is an essential component of nutrient management and plays a significant role in increasing crop production and its quality. The recommended nitrogen dose varies for the hybrids and the same may not be applicable for the composites. As the information on fertilizer requirement for sweet corn is very meager, the present experiment was planned to study the influence of planting methods and fertilizer doses on yield and quality of hybrid maize. However, very limited or no scientific information is available in respect of hybrid maize in integrated nutrient management for central Uttar Pradesh region.

2. MATERIALS AND METHODS

The field experiment was conducted during *Kharif* season of 2017 at Soil Conservation and Water Management Farm of the Chandra Shekhar Azad University of Agriculture and Technology, Kanpur.

2.1 Experimental Details

The experiment was laid out in Randomized Block Design (RBD) with three replications. The layout plan and other details of the experiment are given as under:

List 1: Treatments details

Treatments	Symbols
(A) Three level of inorganic fertilizers (N, P,K & Zn kg/ha)	
(i) 100% R.D.F. (100 + 60+ 40+ 20)	F ₁
(ii) 75% RDF (75+45+30+15)	F ₂
(iii) 50% RDF (50+30+20+10)	F ₃
(B) Levels of organic manure	
(i) 15 ton FYM/ha	O ₁
(ii) 20 ton FYM / ha	O ₂
(iii) 25 ton FYM/ha	O ₃

The overall total number of treatment combinations (3x3=9) areas follows:

- (1) F₁O₁ (4) F₂O₁ (7) F₃O₁
- (2) F₁O₂ (5) F₂O₂ (8) F₃O₂
- (3) F₁O₃ (6) F₂O₃ (9) F₃O₃

List 2:

Number of replications	=	3
Number of treatment combinations	=	(3 x 3) = 9
Total number of plots	=	(9 x 3) = 27
Plot size	=	4.8 m x 4.0 m = 19.2 m ²
Replication border	=	1.0 m
Field bund	=	0.50m
Field border	=	2.0 m
Plot Border	=	0.5 m
Crop	=	Maize
Variety	=	Malika NMH-920
Seed Rate	=	20 kg/ ha

2.2 Cultural Operations**2.2.1 Field preparation**

The field was prepared by one ploughing with Disc plough and two ploughings with cultivator followed by planking.

2.2.2 Application of fertilizer

As per treatment of fertilizers levels of N + P₂O₅+ K₂O + ZnSO₄ (Kg/ha) were applied through Urea, Diammonium phosphate (DAP), Muriate of potash and Zinc sulphate, respectively. Full dose of phosphorus, potash as well as Zinc sulphate and half dose of nitrogen were applied through band placement 2-3 cm below the seed with the help of Nai (attached behind Deshi plough) at the time of sowing. Remaining half dose of nitrogen was topdressed at 20 days after sowing.

2.2.3 Seed rate and sowing

Sowing of maize (Malika NMH-920) was done on 16-07-2017 in furrows behind Deshi plough deploying seed @ 20 kg/ha with row spacing of 60x 15 cm at a depth of 5-6 cm from the soil surface. The furrows were covered by light planking just after sowing.

2.2.4 Thinning

Thinning was done with a view to maintain the desired plant geometry spaced at 60x15 cm, row to row and plant to plant. It was done on 29.07.2017.

2.2.5 Weeding and hoeing

At 20 days after sowing, the crop was weeded out and simultaneously surface soil was loosed by *khurpi* to check the growth of weeds.

2.2.6 Ridging and furrowing

As per treatment, furrows were formed in between the crop rows with the help of spade and soil of the furrows was put on the sides of the plants. Furrowing was done after 25 days of sowing.

2.2.7 Harvesting and processing

Crop was harvested at maturity. One row from each side and half metre crop from other two sides was harvested as border and then the net plot area was harvested. The plants were cut near to the ground and left in the plot for sun drying. After sun drying, the plants were gathered and weighed plot wise. The cobs from the sun dried plants were separated and shelling of maize seed through Hand Maize Sheller. The plot wise yield of the stover was recorded on sundry basis. The grain as well as stover yield of each plot was recorded separately and finally computed in terms of quintal per hectare.

2.3 Observation Recorded**2.3.1 Grain Yield (q/ha)**

After shelling of maize seed and winnowing the produce, the grain yield of each net plot was recorded. Finally, it was computed in terms of quintal/hectare for each treatment.

2.3.2 Stover Yield (q/ha)

Stover yield for each plot was obtained by deducting the cobs weight from the bundle weight of each plot. The figures of stover yield were also converted into quintal/hectare for each treatment.

2.3.3 Harvest Index (%)

The Harvest Index (HI) was worked out with the help of the following formula:

$$\text{Harvest Index} = \frac{\text{Grain yield}}{\text{Biological yield}} \times 100$$

2.3.4 Water use efficiency

The water use efficiency is the ration between dry matter production of a plant (the output) divided by evapotranspiration. Therefore the equation for Water use efficiency (WUE) will be calculated by:

Dry matter production (kg/ha) / ET or water use (in mm).

2.4 Statistical Analysis

The data collected during the experimental period and after the completion of the experiment were statistically analysed with the help of the following statistical techniques.

2.4.1 Analysis of variance

Since, the experiment was conducted in Randomized Block Design with 3 replications and 9 treatments (three level of inorganic fertilizer and three level of organic fertilizer) the analysis of variance of the data was worked out on the basis of the Randomized Block Design, as explained by Cochran and Cox [7].

3. RESULTS AND DISCUSSION

3.1 Grain and Stover Yield (q/ha)

It is clear from the data given in Table No. 1 that grain and stover yield was influenced significantly under fertility management practices. The highest grain yield was recorded under F₂ and O₃ (75% RDF and 25 Ton FYM/ha) 26.47 q/ha and 25.56 q/ha from fertility management parameter as compared to F₃ and O₁ (50% RDF and 15 Ton FYM /ha) of treatment (22.54 q/ha and 22.81 q/ha) respectively.

The highest stover yield was recorded 89.01 q/ha and 89.18 q/ha in F₂ and O₃ (75% RDF and 25 Ton FYM /ha) respectively in comparison of other treatments of hybrid maize. Under fertility management practices F₃ and O₁ (50% RDF and 15 Ton FYM /ha) grasped lower stover yield

i.e. 86.26 q/ha and 85.64 q/ha as compared to others.

Grain and stover yield increased significantly with increasing levels of fertilizer. Application of F₂ and O₃ (75% RDF and 25 Ton FYM /ha) increased significantly the grain and stover yield as influenced by fertility levels management practices recorded parallel to yield attributes (Table no 1). It is obvious that the highest grain yield obtained with F₂ and O₃ (75% RDF and 25 Ton FYM /ha) was computed 26.47 q/ha and 25.56 q/ha higher than the lowest grain yield obtained with 22.54 q/ha and 22.81 q/ha the higher stover yield obtained was found in F₂ and O₃ (75% RDF and 25 Ton FYM /ha). These results are in agreement with the finding of Ahmad et al. [2], Verma et al. [8], Chaudhary et al. [9].

3.2 Biomass Yield (q/ha)

It is apparent from the data given in Table No.1 that fertility management practices was significantly superior the F₂ and O₃ and obtained higher biomass yield (115.48 q/ha and 114.75 q/ha) while lower in F₃ and O₁ (108.81 q/ha and 108.46 q/ha). In case of fertility management practices was found significantly higher biomass yield in F₂ and O₃ (75% RDF and 25t FYM/ha) in comparison to other fertility management practices.

In the case of Fertility levels as influenced the yield in hybrid maize during investigation. Yield in hybrid maize showed increasing trend with increases in nutrient application, being lowest with F₃ and O₁ (50% RDF and 15 Ton FYM /ha) and highest under F₂ and O₃ (75% RDF and 25 Ton FYM /ha) treatment during experimentation. The higher grain, biomass and stover yields with increasing addition of nutrients might be attributed to availability of different crops nutrients under rainfed condition. These findings are related to the findings of Kumar et al. [10].

3.3 Harvest Index (%)

It is obvious from the data given in the Table No.1 showed that harvest index (%) was influenced under fertility management practices. The maximum harvest index 22.91 and 22.25 was found in F₂ and O₃ (75% RDF and 25t FYM/ha) as compared to other treatments. The fertility levels exhibited significant increase in harvest index. Increasing level of fertilizers application resulting in higher harvest index and

minimum in F₃ and O₁ (50% RDF and 15 Ton FYM /ha). The harvest index F₂ and O₃ (75% RDF and 25 Ton FYM /ha) was probably higher due to more nutrient availability in grain and stover yield. The view is supported by the findings of Wani et al. [11], Mahale et al. [12], Jat and Gaur [13] and Memon et al. [14].

3.4 Water Use & Water Use Efficiency

Data pertaining to total water use and water use efficiency of hybrid maize crop have been given in Table 2. The water use efficiency was recorded at different fertility management practices, F₂ i.e. 75% RDF treatment of fertility was recorded higher water use efficiency as compared to other practices.

Whereas, organic manures data depicted in Table 2 showed highest water use efficiency with O₃ and followed O₂ however lowest value was observed in case of O₁. There is a close

relationship between yield and water use efficiency. It was increased with an increase in yield under the influence of different fertility management practices. The different fertility management practices resulted in to more water use 271mm and low water use efficiency 9.76 kg grain ha⁻¹mm⁻¹ over F₃ 261mm and water use efficiency 8.63 kg ha⁻¹ mm⁻¹ during investigation. The result are in full agreement with the findings of Parihar and Tiwari [15].

In the case of fertility level the treatment F₂ and O₃ (75% RDF and 25 Ton FYM /ha) exhibited highest water use (271 mm) and water use efficiency (9.76 kg ha⁻¹ mm⁻¹) which gradually decreased with the RDF, the minimum water use and water use efficiency in F₃ and O₁ (50% RDF and 15 Ton FYM /ha). (261 mm & 8.63 kg ha⁻¹ mm⁻¹). The improvement in water use and water use efficiency with increasing does of fertilizers has also been reported by Kumar et al. [16].

Table 1. Effect of fertility management practices on yield (q/ha) and harvest index (%) of hybrid maize

Treatments	Yield (q/ha)			Harvest index (%)
	Grain yield (q/ha)	Stover yield (q/ha)	Biomass Yield (q/ha)	
Inorganic Fertilizer				
F ₁ =100% RDF	23.65	87.14	110.80	21.32
F ₂ =75% RDF	26.47	89.01	115.48	22.91
F ₃ =50% RDF	22.54	86.26	108.81	20.71
SE(d)	0.66	0.80	1.66	0.35
C.D. (P=0.05)	1.41	1.71	3.53	0.74
Organic manure level				
O ₁ =15t FYM/ha	22.81	85.64	108.46	21.01
O ₂ =20t FYM/ha	24.29	87.59	111.88	21.69
O ₃ =25t FYM/ha	25.56	89.18	114.75	22.25
SE(d)	0.66	0.80	1.66	0.35
C.D. (P=0.05)	1.41	1.71	3.53	0.74

Table 2. Water use (mm) and water use efficiency (kg grain ha⁻¹mm⁻¹ of water) on hybrid maize

Treatment	Grain Yield (kg/ha)	Irrigation water use (mm)	Water use efficiency (kg ha ⁻¹ mm ⁻¹)
Inorganic Fertilizer			
F ₁ =100% RDF	2365	266	8.89
F ₂ =75% RDF	2647	271	9.76
F ₃ =50% RDF	2254	261	8.63
Organic manure level			
O ₁ =15t FYM/ha	2281	268	8.51
O ₂ =20t FYM/ha	2429	270	8.99
O ₃ =25t FYM/ha	2556	271	9.43

4. CONCLUSION

It can be concluded that in the case of fertility levels of 75% RDF + 25 t FYM/ha (F₂+O₃) was found superior in yield of grain, stover and gave maximum water use efficiency as compared to other combinations of fertility management. So, it may be recommended that growing of hybrid maize in Kharif season was found most suitable and remunerative in central plain zone of Uttar Pradesh .

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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