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Evaluate the Integrated Nutrient Use on Growth and Yield of Hybrid Maize under Central Plain Zone of Uttar Pradesh, India

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A B S T R A C T

An experiment was conducted during *Kharif* 2016 on Soil Conservation and Water Management Farm, C.S. Azad 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), and 50% RDF (50+30+20+10) along with three Levels of organic manure viz., 15, 20 and 25 ton FYM/ha. On the basis of overall results it can be concluded that the fertility level 100% RDF + 25t FYM/ha (F_1+O_3) was found better in all respect as compared to other combinations of fertility management in all respect of growth parameter so, it may be recommended that growing of hybrid maize crop in *Kharif* season was found most suitable and remunerative in central plain zone of Uttar Pradesh in Kanpur.

Introduction

Maize is an important crop in India and ranked fifth in area, fourth in production and third in productivity. In term of world acreage, India stands only next to USA, Brazil, China and Maxico, where as in production it ranks 11th. Maize is predominant crop of tribal area of southern part of India, where it is used as food and feed. Normal maize, have poor nutritional value because of lower contents of essential amino-acids such as lysine and tryptophan. But quality protein maize contains higher amount of these amino acids in the endosperm than normal maize. The balance combination of amino acids in quality protein maize results in to its higher biological value ensuring more availability of protein to human and animal as compared to normal maize. The productivity of quality protein maize is low due to inherent low soil fertility and poor nutrient management practices like- low use of inorganic fertilizers, no use of organic manures, poor recycling of crop residue and no use of secondary and micronutrient in tribal region. The conjunctive use of organic manure and chemical fertilizers can augment the nutrient use efficiency and also enhance the productivity of quality protein maize (Kumar *et al.*, 2005).

Maize occupies an area about 7.7 million hectare in India with production of 13.85 million tonnes resulting of 17.83 q/ha. Andhra Pradesh ranks Ist in productivity with 51.25 q/ha followed by Rajasthan with 26.67 q/ha.

With respect to Uttar Pradesh, the area, production and productivity is about 0.94 million hectare, 1.57 million tonnes and 16.10 q/ha, respectively. In Uttar Pradesh, cultivation of winter maize is concentrated in eastern parts. Bihar ranks first place in respect of area of winter maize (190.7 thousand hectare) followed by Andhra Pradesh (185.1 thousand hectare) and Tamilnadu (183.3 thousand hectare). However, Andhra Pradesh ranks first in term of production (574.0 thousand tonnes) followed by Karnataka (485.1 thousand tonnes) while, Andhra Pradesh gained first positioning respect of winter maize productivity (5125 kg/ha) followed by Karnataka (3267 kg/ha).

A number of maize hybrids are being developed. Grain yield is important criteria for selection of hybrids in maize breeding programme. To make selection for grain yield effective which is a complex phenomenon and interdependent on various other yield contributing factors, it is highly essential to study the association between the yields contributing factors and grain yield.

Materials and Methods

A field experiment was conducted during *Kharif* season of 2016 at Soil Conservation and Water Management Farm of the Chandra Shekhar Azad University of Agriculture and Technology, Kanpur. Geographical Situation and Climate Kanpur is situated in the central part of Uttar Pradesh at an elevation of 129.0 meters above the Mean Sea Level. It lies between 25°26' and 26° 58' North latitude and 79° 31' and 80° 34' East longitude. The Kanpur district falls in the sub-tropical zone having semi-arid climate. The weather data regarding to total rainfall (351.1), average maximum (32.80) and average minimum (25.24) temperatures, relative average humidity maximum (88.0), average humidity minimum (74.0), average wind speed (km/hr) (5.12) and average evaporation rate (mm/day) (3.97) for the experimental period as recorded at the University's Meteorological Observatory. The experiment was carried out in Randomized Block Design (RBD) with the three replications having 09 treatments combination which are allocated randomly in all plots. The details of treatments are given below.

A. Levels of inorganic fertilizer - 3

100% R.D.F. (100 + 60+ 40+ 20) F_1
75% RDF (75+45+30+15) F_2
50% RDF (50+30+20+10) F_3

B. Levels of organic manure - 3

15 ton FYM/ha O_1
20 ton FYM/ha O_2
25 ton FYM/ha O_3

Results and Discussion

Plant population (000' ha^{-1})

The data on plant population (Initial and harvest) are presented in table - 1

Initial plant stand (000' ha^{-1})

The initial plant stand recorded after completion of germination and final plant thinning and data revealed that the different treatments methods and fertility management practices were non significantly affected in initial plant population.

The fertility management practices also influenced plant population at all the treatments. When the treatment in-combination of inorganic 100 percentage RDF with organic 25 t/ha FYM shows the superior performance. The highest plant stand from at initial stage (164.550 ha^{-1}) was found with the treatment 100% RDF and 163.237 000 ha^{-1}

was found under the treatment 25 t/ha FYM and the lowest (161.347 000ha^{-1}) was recorded under 50% RDF and 162.610 000ha^{-1} was recorded as 15 t/ha FYM) respectively. Germination percentage is severely affected by combined application of RDF and FYM.

Final plant stand (000' ha^{-1})

The variations in the final plant population due to fertility management were found non-significant. The highest plant stand was found under F_1 and O_3 (100% RDF and 25 t/ha FYM) the treatment and the lowest was found under F_3 and O_3 (50% RDF and 25 t/h FYM respectively.

Growth characters

Plant height

The data on plant height recorded at 30, 60 DAS and at maturity stage starting from 30 days after sowing to harvest are presented in table – 1 and Figure 1. Fertilizer management practices significantly influenced the plant height at 30, 60 days and at maturity. The height of plant subjected to $F_1$and O_3 (100% RDF and 25t FYM/ ha) was consistently taller than the plants in fertility management practices treatments. The tallest plants height in F_1 and O_3 (100% RDF and 25t FYM/ ha) treatment were recorded a tall stage, than the other treatment. The plant height at maturity were 244.00 cm and 242.78 cm under F_1 and O_3 (100% RDF and 25t FYM/ ha) whereas lower in F_3 and O_1 (50% RDF and 15 t/ha FYM) i.e. 239.89 cm and 161.24, respectively. Similar findings have also been reported by Mohammed *et al.*, (2014).

Number of functioning leaves/plant

Data on number of functioning leaves per plant recorded at 30, 60 days intervals up to maturity are represented in table 1 and Figure 2.

Days to silking, tasselling and maturity

Days to silking

It is apparent from the table-1 and Figure 3 that day taken for silking was influenced significantly under fertility management practices. The higher days taken in silking was found in case of fertility management practices was recorded under F_1 (100% RDF) and O_3 (25t FYM/ha) among the rest treatments.

Days to tasseling

It is clear from the table 1 and Figure 3 that days taken to tassel were influenced significantly under fertility management practices. The higher days taken to tassel under method of F_1 and O_3 which was at par with paired fertility management methods and lower in F_3 and O_1 whereas fertility management practices increased significantly higher days taken to tassel. These similar findings are in accordance with Arun and Singh (2004) and Kaundal and Sharma (2006).

Days to maturity

Pertaining the data on days to maturity is presented in table-1 and Figure 3 showed that days taken to maturity was found significantly higher under F_1 and O_3 method of fertility management than F_3 and O_1 method of F_3 and O_1. In respect of fertility management practices was recorded higher in F_1 over rest of the fertilizer application. These similar findings are in accordance with Arun and Singh (2004) and Kaundal and Sharma (2006).

Yield attributing characters

The data pertaining to number of cobs per plant, length of cob (cm), grains per cob, grain weight (g) per main cob and 1000-grain weight are presented in table-2 and Figure 4. The result are in conformity with the findings

of Singh *et al.*, (1998), Nyamudeza *et al.*, (2003), Singh *et al.*, (2006) and Anjum *et al.*, (2014).

Number of cobs per plant

The data on number of cobs/plant have been presented in table-2 and Figure 4. It is evident that treatment of maize hybrid on F_1 and O_3 (100% RDF and 25 t/ha FYM) significantly more number of cobs per plant over F_3 and O_1 (50% RDF and 15 t/ha FYM) respectively. In case of fertility management practices 25t FYM along with 100% RDF produced higher number of cobs per plant than recommended dose of fertilizers.

Length of cob (cm)

The data on average length of cob revealed that the treatment combination F_1 and O_3 (100% RDF and 25 t/ha FYM) have better results over other treatment combination on length of cob (cm). Among the fertility management treatment combination $F_1$and O_3 (100% RDF and 25 t/ha FYM) registered significantly over F_3 and O_1 (50% RDF and 15 t/ha FYM) respect to length of cob (cm) respectively.

Number of grains/ cob

The data on number of grains per cob was presented in table-2 and Figure 4 which revealed that fertility management practices on number of grains per cob was influenced significantly.

In case of fertility management practices F_1 and O_3 (100% RDF and 25t FYM/ ha) was superior over rest of the treatments. Similarly, F_1 and O_3 (100% RDF and 25 t/ha FYM) application showed significant performance on grain row per cob over F_3 and O_1 (50% RDF and 15 t/ha FYM) respectively.

Fig.1 Effect of fertility management practices on plant height (cm) after 30, 60 days and at maturity of hybrid maize

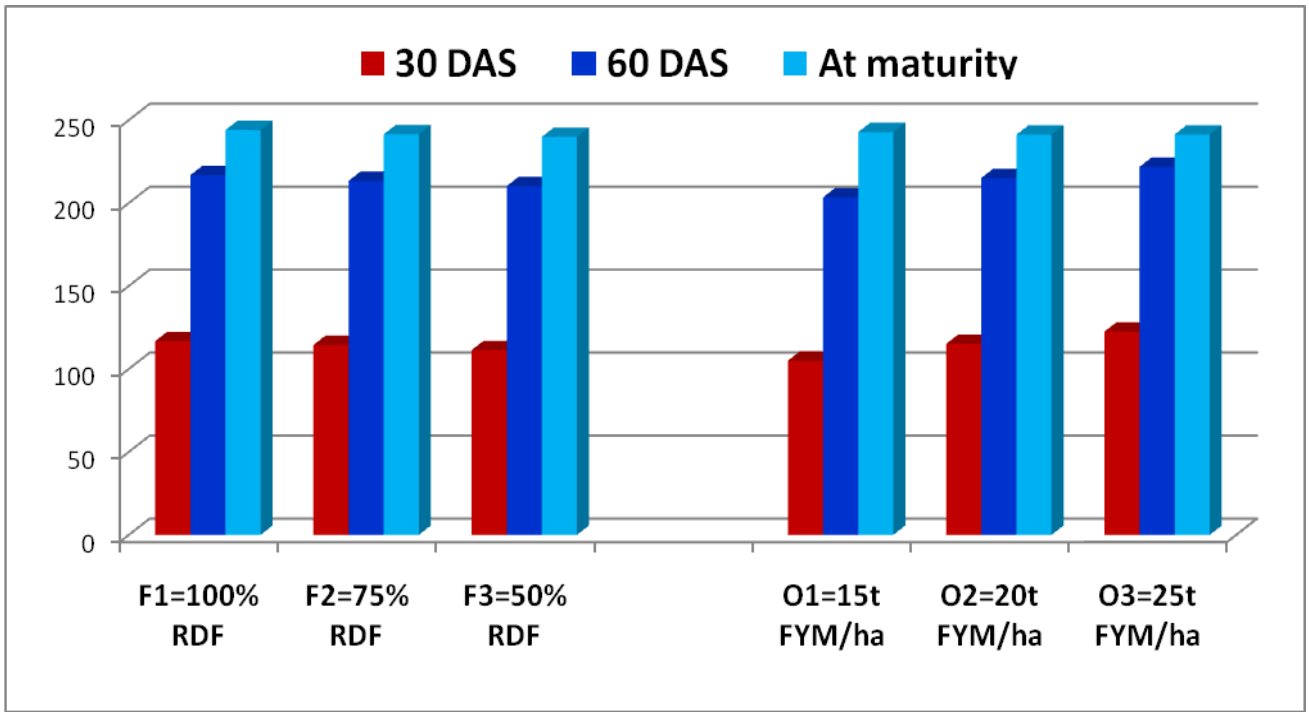

Fig.2 Effect of fertility management practices on no. of functional leaves/per plant after 30, 60 days and at maturity of hybrid Maize

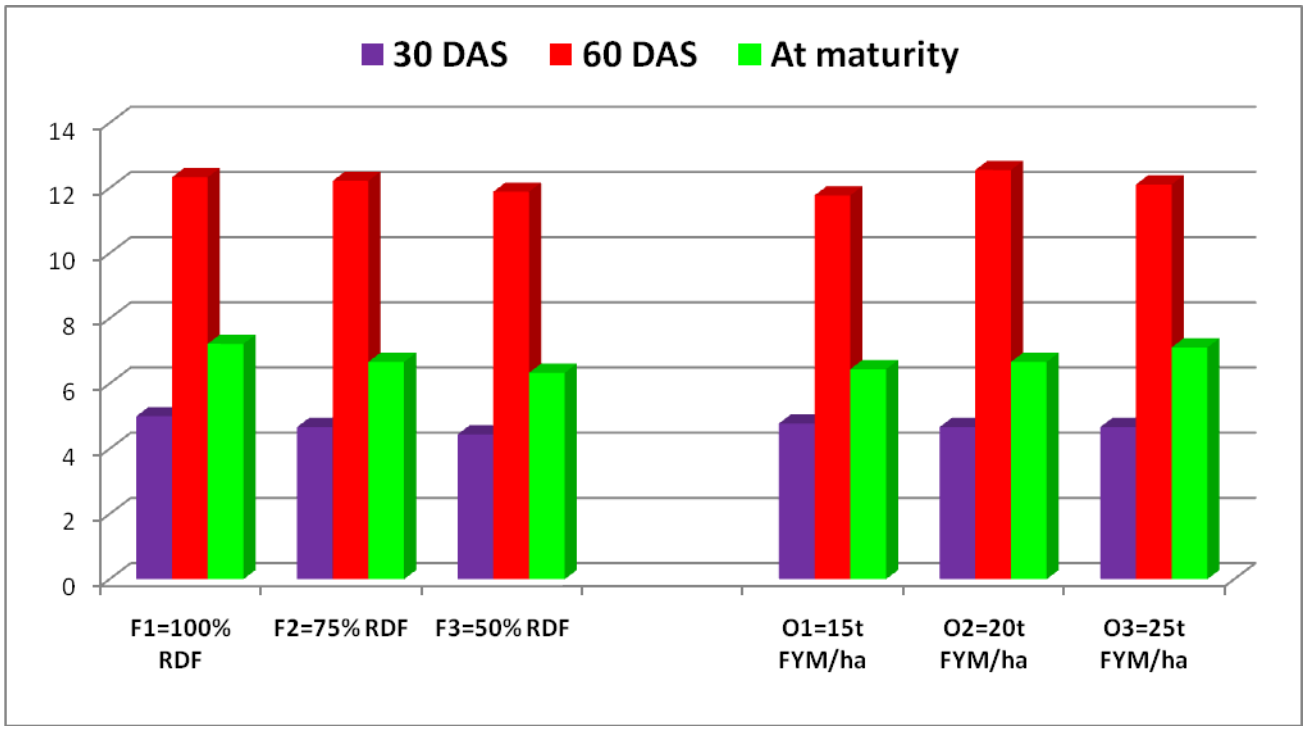

Fig.3 Effect fertility management practices on days to silking, days to tasseling and days to maturity

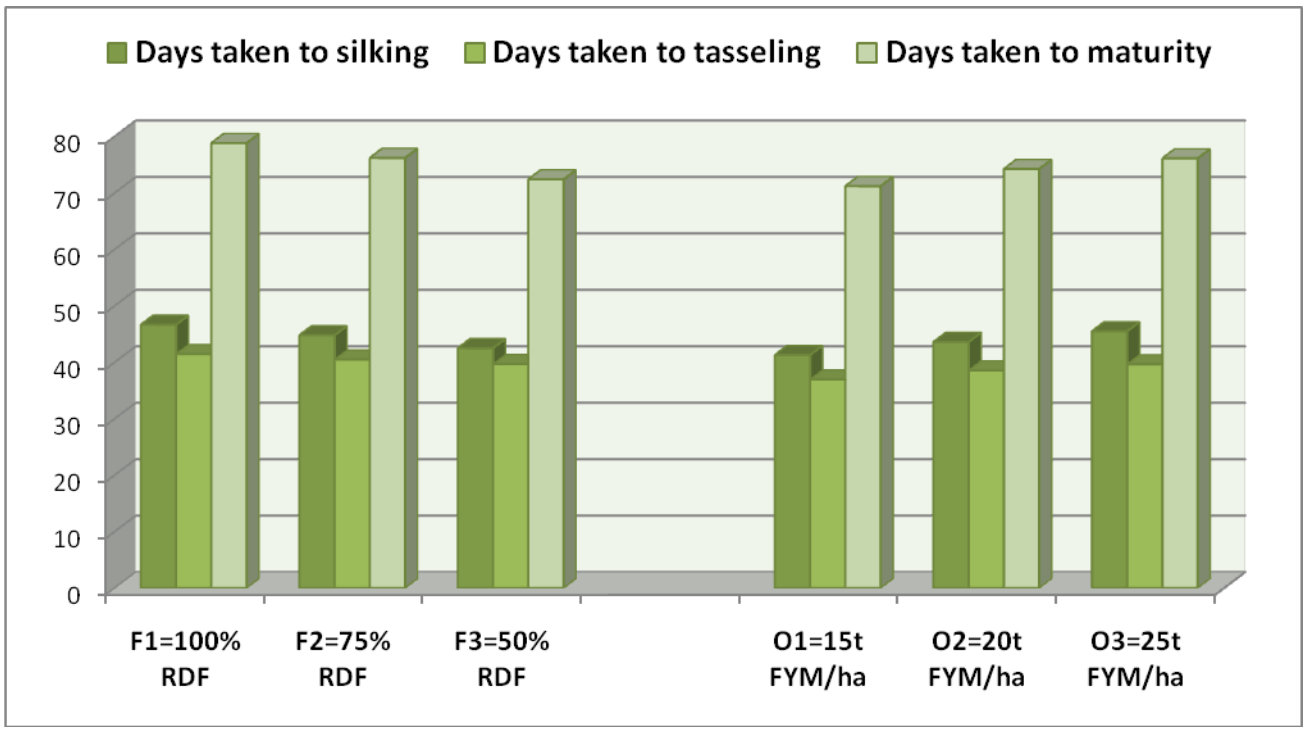

Fig.4 Effect of fertility management practices on number of cob/plant, length of cob (cm), no. of grains/cob, grain row /cob, girth of cob and 1000- grain weight (g) of hybrid maize

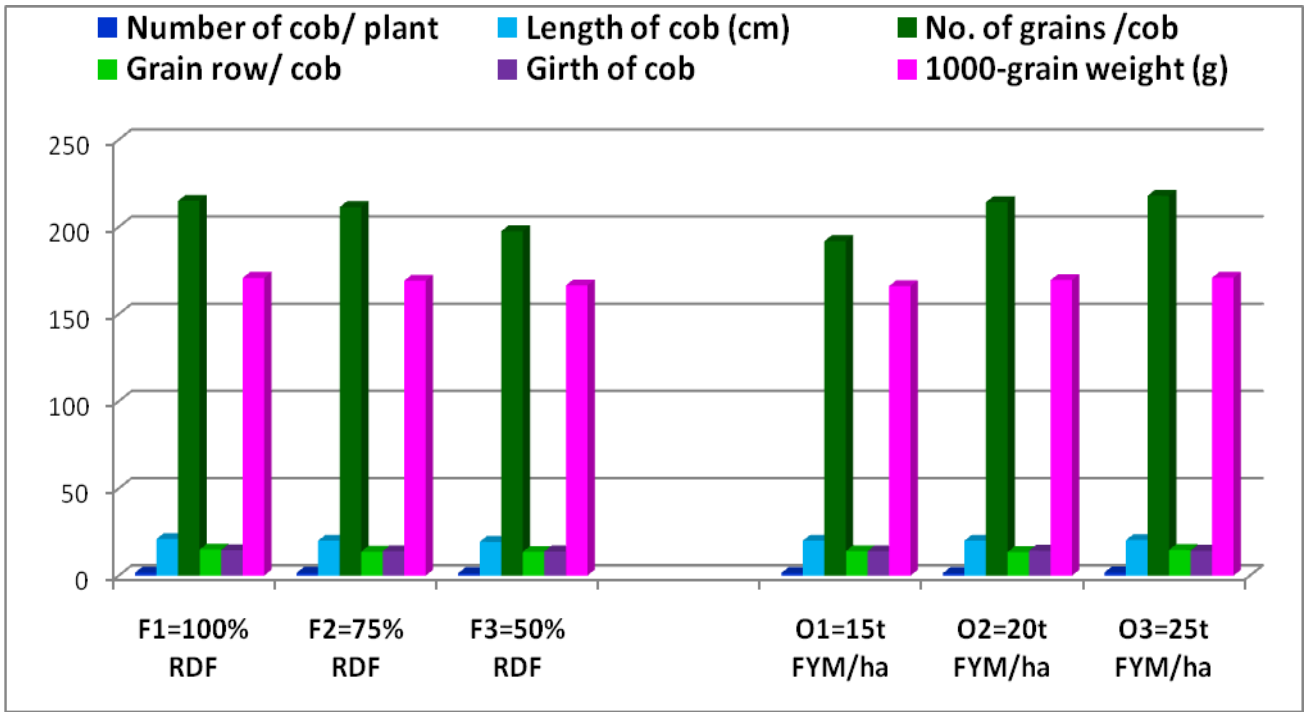

Fig.5 Effect of fertility management practices on yield (q/ha) and harvest index (%) of hybrid maize

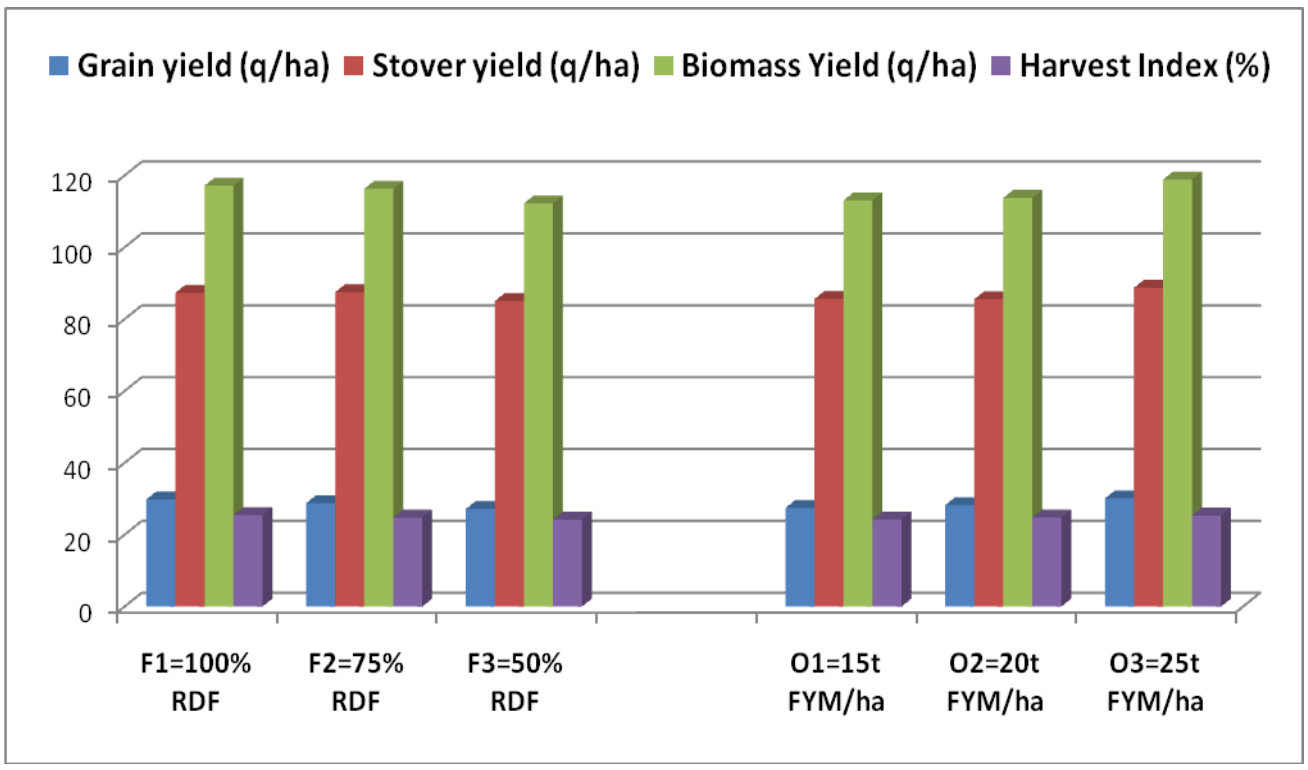

Fig.6 Water use (mm) and water use efficiency (kg grain ha^{-1} mm^{-1} of water) on hybrid maize

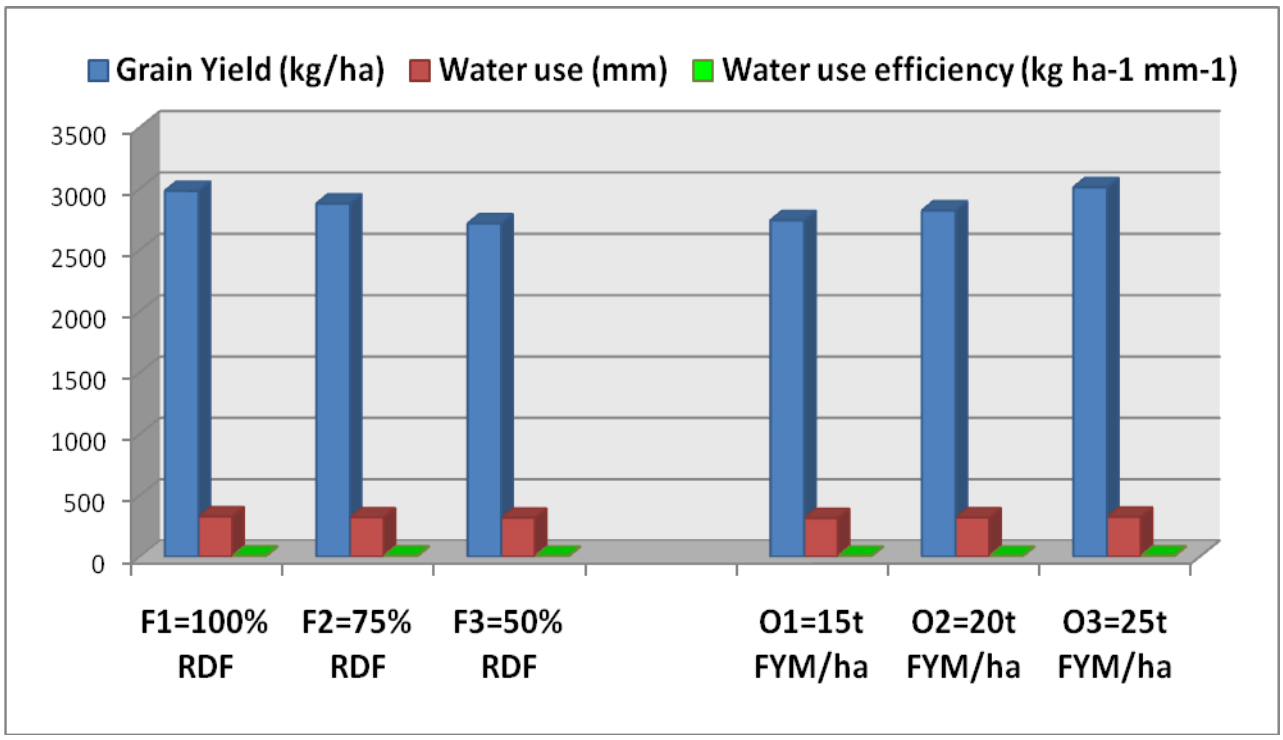

Fig.7 Treatment wise cost of cultivation of hybrid maize, gross income and Net return (in Rs. ha^{-1})

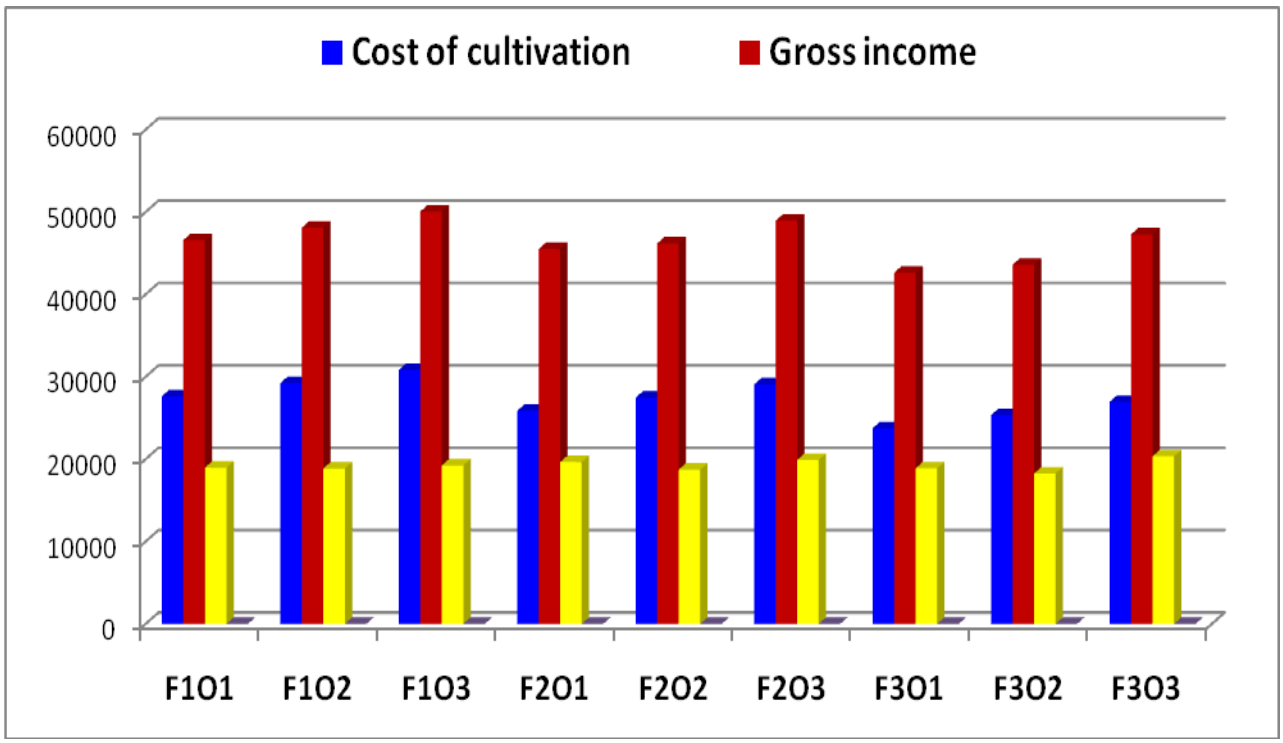

Table.1 Effect of fertility management (combination of Inorganic and Organic fertilizers (Kg/ha) practices on plant population (000ha^{-1}), plant height (cm), number of functional leaves/plant and day taken to silking, tasseling and maturity at during 2016

Treatment	Plant population (000 ha^{-1})		Plant height (cm)			Number of functional leaves/plant			Days taken to		
	Initial	**Final**	**30 DAS**	**60 DAS**	**Maturity**	**30 DAS**	**60 DAS**	**maturity**	**Silking**	**Tasseling**	**Maturity**
Levels of inorganic fertilizer											
100% R.D.F.	164.55	162.18	116.77	216.77	244.00	5.00	12.33	7.22	46.66	41.46	78.83
75% R.D.F.	162.51	161.14	114.44	213.33	241.44	4.66	12.22	6.66	44.79	40.49	76.21
50% R.D.F.	161.34	159.71	111.33	210.22	239.88	4.44	11.88	6.33	42.51	39.68	72.41
SE(d)	3.45	2.89	1.57	2.31	1.41	0.2	0.30	0.27	0.55	0.49	0.88
C.D. (P=0.05)	NS	NS	3.34	4.90	2.99	NS	NS	0.57	1.66	1.48	2.67
Levels of organic manure											
15 ton FYM/ha	162.61	161.23	105.00	203.44	242.77	4.77	11.77	6.44	41.3	36.96	71.21
20 ton FYM/ha	162.56	160.51	115.11	215.11	241.22	4.66	12.55	6.66	43.6	38.58	74.25
25 ton FYM/ha	163.23	161.29	122.44	221.77	241.33	4.66	12.11	7.11	45.5	39.66	76.13
SE(d)	3.45	2.89	1.57	2.31	1.41	0.23	0.30	0.27	0.55	0.49	0.88
C.D. (P=0.05)	NS	NS	3.34	4.90	NS	NS	NS	NS	1.66	1.48	2.67

Table.2 Effect of fertility management (combination of inorganic and organic fertilizers (Kg/ha) practices on number of cob/plant, length of cob (cm), no. of grains/cob, grain row / cob, girth of cob and 1000- grain weight (g) of hybrid maize at during 2016

Treatment	No. of cob/ plant	Length of cob (cm)	No. of grains /cob	Grain row/ cob	Girth of cob	1000-grain wt. (g)
Levels of inorganic fertilizer						
100% R.D.F.	1.66	21.00	214.88	14.88	14.54	170.73
75% R.D.F.	1.55	20.00	211.33	13.66	13.98	169.08
50% R.D.F.	1.33	19.33	197.44	13.55	13.85	166.40
SE(d)	0.18	0.31	3.41	0.29	0.19	0.91
C.D. (P=0.05)	NS	0.66	7.23	0.62	0.41	1.93
Levels of organic manure						
15 ton FYM/ha	1.44	20.00	191.77	14.00	13.90	165.95
20 ton FYM/ha	1.33	20.00	214.11	13.44	14.26	169.44
25 ton FYM/ha	1.77	20.33	217.77	14.66	14.22	170.82
SE(d)	0.18	0.31	3.41	0.29	0.19	0.91
C.D. (P=0.05)	NS	NS	7.23	0.62	NS	1.930

Table.3 Effect of fertility management (combination of inorganic and organic fertilizers (Kg/ha) practices on yield (q/ha), harvest index (%), water use (mm) and water use efficiency (Kg ha^{-1} mm^{-1}) of hybrid maize at during 2016

Treatment	Yield (q/ha)			Harvest Index (%)	Water use (mm)	Water use efficiency (kg ha^{-1} mm^{-1})
	Biomass Yield	**Stover yield**	**Grain yield**			
Levels of inorganic fertilizer						
100% R.D.F.	117.16	87.34	29.82	25.43	328	9.09
75% R.D.F.	116.29	87.51	28.78	24.74	322	8.94
50% R.D.F.	112.23	85.06	27.17	24.20	318	8.54
SE(d)	0.96	0.81	0.21	0.213	328	9.09
C.D. (P=0.05)	2.05	1.72	0.45	0.45	322	8.94
Levels of organic manure						
15 ton FYM/ha	113.06	85.62	27.43	24.25	318	8.62
20 ton FYM/ha	113.77	85.54	28.23	24.80	323	8.73
25 ton FYM/ha	118.85	88.74	30.10	25.32	327	9.20
SE(d)	0.96	0.81	0.21	0.21	318	8.62
C.D. (P=0.05)	2.05	1.72	0.45	0.45	323	8.73

Table.4 Treatment wise cost of cultivation of hybrid maize, gross income and net return (in Rs. ha^{-1}) at during 2016

Treatment	Cost of cultivation	Gross income	Net Return	B:C Ratio
F_1O_1	27626	46588	18961	2.46
F_1O_2	29226	48092	18865	2.55
F_1O_3	30826	50058	19231	2.60
F_2O_1	25863	45514	19650	2.32
F_2O_2	27463	46188	18724	2.47
F_2O_3	29063	48951	19887	2.46
F_3O_1	23744	42633	18888	2.26
F_3O_2	25344	43597	18253	2.39
F_3O_3	26944	47288	20344	2.32

Grain weight per cob (g)

The data pertaining to grain weight per cob is presented in table-2 and Figure 4 showed that fertility management practices influenced significantly higher grain weight (g) per cob of hybrid maize.

The fertility management treatment $F_1$and O_3 (100% RDF and 25t FYM/ ha) was superior over all others treatments and achieved significantly higher value than other treatments. In case of fertility management practices 25 t/ha FYM along with 100 % RDF was attended higher value than F_3 and O_1 (50% RDF and 15 t/ha FYM) respectively.

1000-grain weight (g)

It is evident from the data given in table-2 and Figure 4 that 1000-grain weight was influenced significantly under method of higher fertility management practices. 1000 grain weight was maximum recorded under F_1 and O_3 (100% RDF and 25 Ton FYM /ha) practices than other combinations treatments.

In case of fertility management practices on 1000 grain weight was found higher i.e. 170.67 (q/ha) with F_1 and O_3 followed by other combinations and lowest in F_1 and O_3 treatment respectively.

Girth of cob (cm)

Effect of fertility management practices on girth of cob (cm) at maturity stage of the crop presented in the Table table-2 and Figure 4 showed that the girth of cob (cm) was influenced significantly under fertility management practices.

The maximum girth was recorded under $F_1$and O_3 (100% RDF and 25t/ha FYM) and lower in F_3 and O_1 (50% RDF and 15t /ha FYM) at maturity stage of crop.

Yield

Biomass yield (q/ha)

It is apparent from the data given in table-3 and Figure 5 that fertility management practices was significantly superior over the $F_1$and O_3 and obtained higher biomass yield (117.16 q/ha and 118.85 q/ha) while lower in F_3 and O_1 (112.23 q/ha and 113.06 q/ha). In case of fertility management practices was found significantly higher biomass yield in $F_1$and O_3 (100% RDF and 25t FYM/ha) in comparison to other fertility management practices (Ahmad *et al.,* 2008; Verma and Midha, 2006; Chaudhary *et al.,* 2008).

Stover Yield (q/ha)

It is evident from the data given in table-3 and Figure 5 that stover yield was influenced significantly under fertility management practices. The highest stover yield was recorded 87.34 q/ha and 88.74 q/ha in F_1 and O_3 (100% 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. 85.06 q/ha and 85.62 q/ha as compared to others. Similar findings had also been reported by Kumar *et al.,* (2008).

Grain Yield (q/ha)

It is clear from the data given in table-3 and Figure 5 that grain yield was influenced significantly under fertility management practices. The highest grain yield was recorded under F_1 and O_3 (100% RDF and 25 Ton FYM/ha) 29.82 q/ha and 30.10 q/ha from fertility management parameter as compared to F_3 and O_1 (50% RDF and 15 Ton FYM /ha) of treatment (24.20q/ha and 24.25 q/ha) respectively (Ahmad *et al.,* 2008; Verma and Midha, 2006; Chaudhary *et al.,* 2008).

Harvest index (%)

It is clear from the data given in the table-3 and Figure 5 showed that harvest index (%) was influenced under fertility management practices. The maximum harvest index 25.43 and 25.32 was found in F_1 and O_3 (100% RDF and 25t FYM/ha) as compared to other treatments. The view is supported by the findings of Wani *et al.,* (1997), Mahale *et al.,* (1998), Jat and Gautam (2000) and Memon *et al.,* (2007).

Water use and water use efficiency

Data pertaining to total water use and water use efficiency of hybrid maize crop have been given in table 3 and Figure 6. The water use efficiency was recorded at different fertility management practices. The F_1 i.e. 100% RDF treatment of fertility was recorded higher water use efficiency as compared to other practices. Whereas, organic manures data depicted in Table 4.7 showed highest water use efficiency with O_3 and followed O_2 however lowest value was observed in case of O_1. The result is in full agreement with the findings of Parihar *et al.,* (2003).

Economics

Data pertaining to economics of different treatment are summarized in table 4 and Figure 7. Both fertility management practices registered higher net return over (F_1 and O_3). The highest net return of Rs. 19231.45/ha was obtained from the treatment (F_1 and O_3) respectively. Highest B: C ratio 2.60 was found in (F_1 and O_3) treatment as compared to rest treatments and combined fertility management practices. Similar observations were recorded by Suroshe *et al.,* (2009).

Different fertility levels played significant role in increasing all growth characters viz. plant population among the fertility levels the F_1+O_3 (100% RDF + 25t FYM/ha) enhanced the plant population. The inorganic fertilizer applications of 100% RDF + 25t FYM/ha were found most effective in respect to plant height and number of functioning leaves per plant. The maximum number of cobs per plant, length of cob (cm), number of grains per cob, grain weight (g) per cob, 1000 grain weight were recorded and highest reported under the fertility level of 100% RDF + 25 t FYM/ha followed by 75% RDF + 20 t FYM/ha and 50% RDF + 15 t FYM/ha in combination. Grain, biomass and stover yield were significantly increased with increasing levels of fertility. The water use and water use efficiency was recorded at different fertility management practices. The 100% RDF treatment of fertility was recorded higher water use efficiency as compared to other treatments. Both the fertility management practices registered higher net return over other treatments. The highest net return of Rs. 19231 ha^{-1} was obtained from the treatment F_1 (100% RDF) and O_3 (25 t FYM/ha) and lowest of Rs. 18888 ha^{-1} with F_3 (50%RDF) and O_1 (15 t FYM/ha) treatments. However, highest B: C ratio 2.60 was found in F_1 (100% RDF) and O_3 (25 t FYM/ha) technique as compared to rest fertility management practices. On the overall consideration of results described and discussed in the preceding chapters, it can be concluded that in the case of fertility levels 100% RDF + 25 t FYM/ha (F_1+O_3) was found better in all respect as compared to other combinations of fertility management. So, it may be recommended that growing of hybrid maize crop in *Kharif* season was found most suitable and remunerative in central plain zone of Uttar Pradesh in Kanpur.

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