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RESPONSE OF FERTILIZERS AND ORGANIC MANURES ON GROWTH AND PRODUCTIVITY OF MAIZE (*Zea mays* L.)

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ABSTRACT

A field experiment was conducted on clay loam soils at Instructional Farm of, Mewar University, Chittorgarh during *Kharif* 2024. The experiment consisted of 16 treatment combinations comprises of four fertility levels (control, 50% RDF, 75% RDF and 125% RDF) in main plots and four levels of organics (control, FYM @ 5 t ha^{-1}, FYM @ 10 t ha^{-1} and FYM @15t ha^{-1} in sub plots. These 16 combinations were evaluated under Split Plot Design (SPD) with three replications during the *Kharif* season of 2024 where the impact of different fertility levels and organic manures application on soil properties and productivity of Maize (*Zea mays* L.)" were studied. The study revealed that among the different fertility levels 125% RDF significantly gave the maximum plant height, number of cobs $plant^{-1}$, number of grains cob^{-1} and seed index. The research showed that the 125 % RDF also had a higher impact on the seed, stover and biological yield. Results further revealed that among the different organic levels the application of FYM @ 5 t ha^{-1} significantly increased the plant height and yield attributes (number of cobs $plant^{-1}$, number of grains cob^{-1} and seed index) along with the maximum increase in seed, stover, biological yield.

Keywords **:** Maize, plant height, biological yield, fertility levels.

Introduction

Maize (*Zea mays* L.) is one of the most important cereal crops globally, ranking third in total production after wheat and rice (FAO, 2018). It is a short-duration, fast-growing crop with remarkable productivity potential, which has earned it the title "Queen of Cereals" (Abd El-Gawad *et al.,* 2017). Maize is a versatile traditional crop cultivated for multiple purposes, including food, animal feed, and fodder (AG *et al.,* 2017). It is also considered a highly nutritious crop, containing approximately 72% starch, 10% protein, 9.5% fiber, and 4% fat, with an energy value of about 365 kcal per 100 grams.

The incorporation of manure is widely recognized as a fundamental strategy for replenishing soil organic matter and serves as a sustainable alternative to chemical fertilizers for enhancing soil fertility and crop productivity (Jjagwe *et al.,* 2020). Application of farmyard manure has been shown to significantly improve maize yields and increase soil organic matter content by 44%, alongside enhancing soil porosity and water-holding capacity (Mahmood *et al.,* 2017). In contrast, prilled urea, a commonly used nitrogenous fertilizer, is rapidly soluble and typically applied in split doses, which often results in substantial nitrogen losses through mechanisms such as ammonia volatilization, immobilization, denitrification, and surface runoff. However, the deep placement of slow-release nitrogen fertilizers, such as granular urea, has been reported to reduce these losses and improve nitrogen use efficiency, particularly in dryland *rabi* cropping systems (Zhihui *et al.,* 2016). Compared to prilled urea, the appropriate application of granular urea can enhance wheat yield and nitrogen use

efficiency while simultaneously minimizing nitrogen losses (Xin *et al.,* 2017).

Maize is a crop that requires large quantities of nitrogen fertilizer due to its high growth efficiency and capacity for dry matter accumulation. As a C4 plant, maize exhibits a highly efficient photosynthetic pathway, enabling rapid biomass production. Nitrogen application rates can reach up to 400 kg N/ha, which is approximately equivalent to one ton of urea. This makes maize cultivation economically costly due to the high price of nitrogen fertilizers, as well as environmentally concerning due to the potential for pollution associated with excessive fertilizer use. Nitrogen is essential for the growth and development of maize, and its proper application can significantly enhance yield. However, overuse of nitrogen fertilizers may lead to environmental degradation, including water contamination, greenhouse gas emissions, and depletion of natural resources. Zhou *et al.,* (2022) reported that while nutrients from mineral fertilizers primarily support early crop establishment, those released through the mineralization of organic manures contribute significantly to yield enhancement when both sources are applied in combination. Similarly, Choudhary *et al.,* (2024), in an experiment involving poultry manure, cattle manure, and rice husk applied either individually or in combination with mineral fertilizers (using urea or ammonium sulfate as nitrogen sources) found that a 50:50 ratio of organic amendments and mineral fertilizers significantly improved the growth and yield of rice. Burke *et al.* (2017) also demonstrated that the integrated application of poultry manure and urea effectively promoted tomato growth and yield while enhancing the physical, chemical, and biological properties of the soil. Furthermore, Gao *et al.* (2020) reported that the combined use of chicken manure, urea, and muriate of potash significantly improved maize growth and yield in soils derived from the coastal plain sands of India.

Varietal selection plays a crucial role in determining crop yield. Cultivars should be chosen based on their adaptability to specific agro-ecological conditions, seasonal suitability, intended use, and maturity duration to ensure optimal productivity (Hui *et al.,* 2017). Two main types of maize cultivars commonly used are synthetic and hybrid varieties. The choice of hybrid maize significantly influences decisions regarding the type and quantity of fertilizer required to support growth and development throughout the crop's life cycle (Kandil *et al.,* 2020; choudhary *et al.,* 2024). Moreover, hybrid and improved maize varieties exhibit greater responsiveness to nitrogen fertilization compared to traditional local cultivars (Xin *et al.,* 2017).

Materials and Methods

Experimental site: The experiment was conducted in the field of Instructional Farm, Mewar University, Chittorgarh situated at an altitude of 565.5 meters above mean sea level and at 25º03' latitude and 74º63' longitude. The region is categorized under agro-climatic zone-IVa (Sub-humid Southern Plain and Aravalli Hills) of Rajasthan. The split plot design was used for conducting of experiment. For the study 16 combinations were evaluated under Split Plot Design (SPD) with three replications during the *Kharif* season of 2024. In experiment, Two factors are taken *viz.,* Main factor includes the fertility levels [Control (F_0), 50%RDF (F_1), 75%RDF (F_2), 125 %RDF (F_3)], while the sub plots includes the Organic levels [(Control (O_1, FYM 5 t ha^{-1} (O_2), FYM 10 t ha^{-1} (O_3), FYM 15 t ha^{-1} (O_4)]. DHM 121 is a hybrid maize variety known for its good yield potential and is popular in various Indian states, especially in the south. It is a result of cross-breeding two different maize varieties and is known to produce a good yield, typically between 55 to 60 quintals per ha^{-1}. The crop matures within 80 to 90 days. The crop geometry was 4 m x 3 m = 12 m^2 and the seed rate was 25 kg ha^{-1}. Plant height was recorded from five randomly selected plants from the net plot area and marked with tags. The heights of the tagged plants were measured from ground level to the top of the plant at 25, 50 and at harvest. The average height was then calculated and expressed in cm. Dry matter accumulation was measured from five randomly sampled plants from each plot. These samples were subsequently chopped and subjected to oven drying at a temperature of 65 °C until reaching a constant weight. The mean weight of the dried plant samples was calculated to assess dry matter accumulation and expressed in g $plant^{-1}$. The observations including tasseling, silking and DAS to maturity were also taken. The shelled seeds from each net plot were collected after threshing, dried in the sun, weighed, and the seed yield for each plot was recorded as seed yield per plot. Subsequently, the seed yield was converted into kg ha^{-1} by multiplying it by the appropriate conversion factor. After harvesting the cobs from each plant, the labeled bundles of maize stover were weighed. The weight of stover yield was then recorded and further converted into kg ha^{-1}.

Table 1 : Treatment details

Symbols	Main Plots (Fertility levels)	Symbols	Sub Plots (Organic levels)
F_0	Control	O_1	Control
F_1	50%RDF	O_2	FYM (5tha^{-1})

F_2	75%RDF	**O_3**	FYM (10tha^{-1})
F_3	125%RDF	**O_4**	FYM (15tha^{-1})

Result and Discussion

Effect of fertilizer levels on plant Hight was observed highest at 25, 50 DAP in (F_3: 125% RDF 49.07, 153.68 cm), followed by F_2 (75 % RDF) 45.77, 140.55 cm and lowest was observed in F_0 (control) 42.13, 132.88 cm. while in prospect of organic manure levels highest plant Height was observed in O_3 (FYM 15 t ha^{-1}) 47.45, 149.06 cm those was at par with O_2 (FYM 10 t ha^{-1}) 47.23, 143.34 cm followed by O_1 (FYM 5 t ha^{-1}) 46.08, 141.99 cm. while lowest plant height was observed in O_0 (control) plot. While Effect of fertilizer levels on plant Hight was observed highest at harvesting in (F_3: 125% RDF 212.64 cm), followed by F_2 (75 % RDF) 195.03 cm and lowest was observed in F_0 (control) 183.03 cm. while in prospect of organic manure levels highest plant Height was observed in O_3 (FYM 15 t ha^{-1}) 214.73 cm those was at par with O_2 (FYM 10 t ha^{-1}) 190.76 cm followed by O_1 (FYM 5 t ha^{-1}) 187.49 cm. while lowest plant height was observed in O_0 (control) plot same result was observed by (Wang *et al.,* 2017).

While Effect of fertilizer levels on dry matter accumulation was observed highest at harvesting in (F_3: 125% RDF 155.09 g plant^{-1}), followed by F_2 (75 % RDF) 145.95 g plant^{-1} and lowest was observed in F_0 (control) 132.95 g plant^{-1}. while in prospect of organic manure levels highest dry matter accumulation was observed in O_3 (FYM 15 t ha^{-1}) 151.04 g plant^{-1} those was at par with O_2 (FYM 10 t ha^{-1}) 149.87 g plant^{-1} followed by O_1 (FYM 5 t ha^{-1}) 143.76 g plant^{-1}. while lowest dry matter accumulation was observed in O_0 (control) plot results are supported by (Baghdadi *et al.,* 2018). Effect of fertilizer levels on Days to tasseling was observed highest in F_0 (control) 53.75, those are at par with F_1 (50% RDF), F_2 (75 % RDF). While lowest days to tasseling was observed in F_3 (125% RDF) 52.25. while in prospect of organic manure levels highest Days to tasseling was observed in O_0 (control) 53.92, those was at par with O_1 (FYM 5 t ha^{-1}), O_2 (FYM 10 t ha^{-1}). While lowest Days to tasseling was seems in O_3 (FYM 15 t ha^{-1}) 52.30 (Bei *et al.,* 2018).

Effect of fertilizer levels on Days to silking was observed highest in F_0 (control) 60.05, those are at par with F_1 (50% RDF), F_2 (75 % RDF). While lowest Days to silking was observed in F_3 (125% RDF) 58.60. while in prospect of organic manure levels highest Days to silking was observed in O_0 (control) 60.28, those was at par with O_1 (FYM 5 t ha^{-1}), O_2 (FYM 10 t ha^{-1}). While lowest Days to silking was seems in O_3 (FYM 15 t ha^{-1}) 58.65. The 125% RDF and FYM provides a balanced nutrition throughout their growth cycle to achieve optimal development. Adequate nutrition supports vigorous vegetative growth, leading to taller plants, increased cob formation, and higher grain production. The enhanced availability of water and nutrients promotes healthier plant growth, resulting in taller plants with more robust cob formation and grain production. The 125% RDF provides essential macro in the right proportions. The combination of RDF, farmyard manure promotes vigorous root growth and proliferation. The optimal soil fertility, nutrient availability, soil structure and microbial activity are achieved with the combined application of 125% RDF, farmyard manure, leading to improved maize plant height, cob formation and number of seeds cob^{-1} (AG *et al.,* 2017). Effect of fertilizer levels on Days to maturity was observed highest in F_0 (control) 92.60, those are at par with F_1 (50% RDF), F_2 (75 % RDF). While lowest Days to maturity was observed in F_3 (125% RDF) 90.70. while in prospect of organic manure levels highest Days to maturity was observed in O_0 (control) 92.86, those was at par with O_1 (FYM 5 t ha^{-1}), O_2 (FYM 10 t ha^{-1}). While lowest Days to maturity was seems in O_3 (FYM 15 t ha^{-1}) 90.53 Gao *et al.* (2020).

Effect of fertilizer levels on seed and stover yields (Kg ha^{-1}) was observed respectively highest at in (F_3: 125% RDF 4437, 9116 Kg ha^{-1}), followed by F_2 (75 % RDF) 3925, 8428 Kg ha^{-1} and lowest was observed in F_0 (control) 3370, 7114 Kg ha^{-1}. while in prospect of organic manure levels highest seed and stover yields (Kg ha^{-1}) was observed in O_3 (FYM 15 t ha^{-1}) 4316, 8854 Kg ha^{-1} those was at par with O_2 (FYM 10 t ha^{-1}) 4166, 8671 Kg ha^{-1} followed by O_1 (FYM 5 t ha-^{1}) 3816, 8201 Kg ha^{-1}. while lowest seed and stover yields (Kg ha^{-1}) was observed in O_0 (control) plot (Zhihui *et al.,* 2016). Application of various fertility levels with FYM significantly influenced grain, stover and biological yield. Among the treatments, 125% RDF + 15t ha^{-1} FYM recorded higher grain yield, stover yield and biological yield. This may be because of the addition of nutrients through combination of FYM and inorganic fertilizers resulted in higher grain and stover yield. It may also be attributed to better uptake of essential nutrients because of improvement in soil properties (physical and chemical) which promoted greater nutrient availability thereby increased the nutrients uptake and its translocation to economic parts which resulted in improvement in yield of maize (Xin *et al.,* 2017).

Effect of fertilizer levels on Harvesting index % was observed highest in (F_3: 125% RDF 32.69), followed by F_2, F_3, and lowest was observed in F_2 (75

% RDF) 31.78. while in prospect of organic manure levels effect on Harvesting index % highest was observed in O_3 (FYM 15 t ha^{-1}) 32.76 those was at par with O_2 (FYM 10 t ha^{-1}) 32.40. while lowest Harvesting index % was observed in O_1 (FYM 5 t ha^{-1}) plot (Abd El-Gawad *et al.,* 2017). Effect of fertilizer levels on seed index was observed highest in (F_3: 125% RDF 28.26g), followed by F_2 (75 % RDF) 27.86 g, and lowest was observed in F_0 (control) 25.35 g. while in prospect of organic manure levels effect on seed index highest was observed in O_3 (FYM 15 t ha^{-1}) 28.30 g those was at par with O_2 (FYM 10 t ha^{-1}) 27.78 g followed by O_1 (FYM 5 t ha-^{1}) 27.30 g. while lowest seed index was observed in O_0 (control) plot (AG *et al.,* 2017).

Table 2 : Effect of fertility and organic manure on plant height dry matter accumulation, days to tasselling, silking and maturity.

Treatments	Plant height (cm) at			dry matter accumulation (g $plant^{-1}$) at	Days to tasseling	Days to silking	Days to maturity
	25 DAS	50 DAS	At harvest				
Fertility levels (% RDF)							
F_0 (control)	42.13	132.88	183.03	132.95	53.75	60.05	92.60
F_1 (50% RDF)	44.70	137.60	186.06	142.14	53.19	59.54	91.72
F_2 (75% RDF)	45.77	140.55	195.03	145.95	53.03	59.08	91.02
F_3(125% RDF)	49.07	153.68	212.64	155.09	52.25	58.60	90.70
SEm±	0.64	0.88	3.43	3.67	0.61	1.07	1.28
C.D.(P=0.05)	2.22	3.04	11.87	12.70	NS	NS	NS
Organic level							
O_0 (control)	40.91	130.32	183.78	131.46	53.92	60.28	92.86
O_1 (FYM 5 t ha^{-1})	46.08	141.99	187.49	143.76	53.05	59.25	91.28
O_2 (FYM 10 t ha^{-1})	47.23	143.34	190.76	149.87	52.95	59.09	91.36
O_3 (FYM 15 t ha^{-1})	47.45	149.06	214.73	151.04	52.30	58.65	90.53
SEm±	0.61	0.49	1.65	1.31	0.49	0.72	1.09
C.D.(P=0.05)	1.77	1.43	4.80	3.83	NS	NS	NS
Interaction	NS	NS	Sig.	Sig	NS	NS	NS

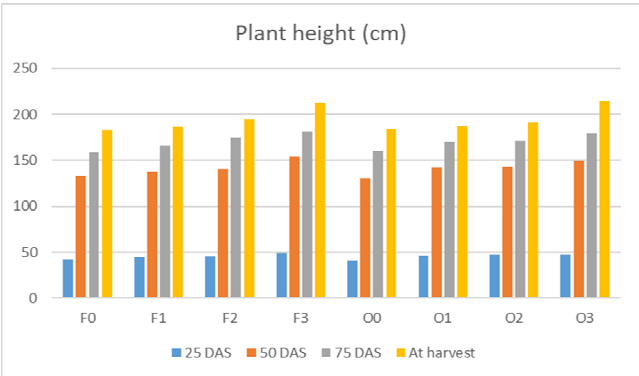

Fig. 1 : Effect of fertility and organic manure on plant height at different growth stages of maize

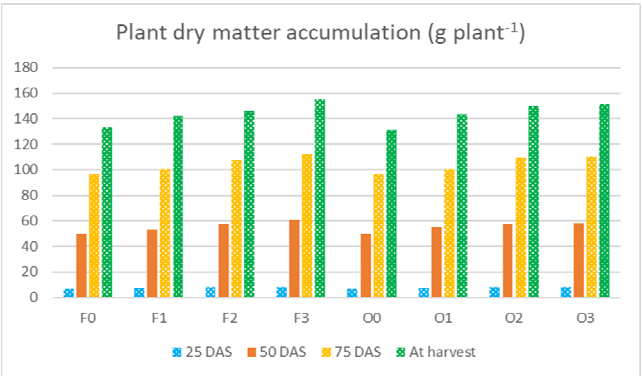

Fig. 2 : Effect of fertility and organic manure on plant dry matter accumulation at different growth stages of maize.

Fig. 3 : Effect of fertility and organic manure on morphological characters of maize

Table 3 : Effect of fertility and organic manure on seed index and yield parameters

Treatments	Yield (Kg ha^{-1})		HI (%)	Seed index (g)
	Seed yield	Stover yield		
Fertility levels (% RDF)				
F_0 (control)	3370	7114	32.23	25.35
F_1 (50% RDF)	3888	8145	32.25	27.08
F_2 (75% RDF)	3925	8428	31.78	27.86
F_3(125% RDF)	4437	9116	32.69	28.26
SEm±	100	176	0.65	0.27
C.D.(P=0.05)	345	609	NS	0.94
Organic level				
O_0 (control)	3322	7077	32.06	25.16
O_1 (FYM 5 t ha^{-1})	3816	8201	31.72	27.30
O_2 (FYM 10 t ha^{-1})	4166	8671	32.40	27.78
O_3 (FYM 15 t ha^{-1})	4316	8854	32.76	28.30
SEm±	69	110	0.56	0.20
C.D.(P=0.05)	200	320	NS	0.58
Interaction	NS	Sig.	NS	Sig.

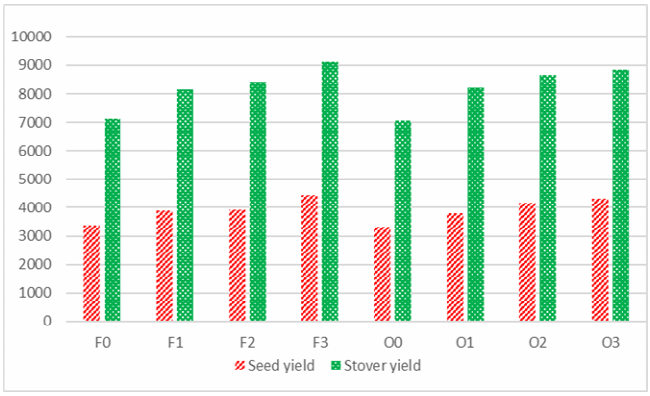

Fig 4: Effect of fertility and organic manure on yield and harvest index of maize

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