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Impact of integrated nutrient management on dry matter production and nutrient uptake of hybrid maize (*Zea mays* L.) COH (M) 8 in coastal Alluvial soil

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Abstract

Maize (*Zea mays* L.) is important cereal crop around the world. In addition to being a staple diet for people, maize is also a vital source of feed for animals. It is also extensively utilized in the manufacturing of industrial goods and biofuels. As a result, raising maize yield is essential for both economic growth and food and nutritional security. This study was investigated the integrated nutrient management strategies by balanced fertilization and the application of both organic and inorganic amendments, aimed at enhancing soil fertility and optimizing nutrient use efficiency. An investigation was carried out at the Experimental farm, Department of Agronomy, Faculty of Agriculture, Annamalai University, Annamalai Nagar, Tamil Nadu, India during June 2025 - September 2025 to study the response of integrated nutrient management Practices (INM) on nutrient uptake and economics of hybrid maize (*Zea mays* L.) COH(M) 8. The experiment was laid out in Randomized Block Design (RBD) comprised of twelve treatments and replicated thrice. The treatments included of recommended fertilizer doses (RDF) with organics such as FYM, and Maize Maxim applied through foliar spray. The study revealed that it found that the nutrient uptake of Nitrogen ($165.12 \text{ kg ha}^{-1}$), Phosphorous (26.19 kg ha^{-1}), Potassium ($137.09 \text{ kg ha}^{-1}$) and Dry matter production ($10,712 \text{ kg/ha}$) were significantly differed and registered the highest in the treatment comprising of T_{12} - Deep ploughing + FYM @ 12.5 t/ha + RDF + Maize Maxim + Push and Pull Strategy + Sun hemp.

Keywords: Hybrid Maize, INM, Nutrient concentration, Uptake, physico- chemical properties

Introduction

Maize (*Zea mays* L.) is one of the most important cereal, next to rice and wheat and is used as both human food and animal feed. The annual C_4 plant belongs to the family Poaceae with its origin in Central America. (Ramesh *et al.*, 2023) ^[12]. It is cultivated throughout the world as it has higher genetic yield potential than any other cereal crop and hence referred to as "Queen of cereals" (Walia *et al.*, 2021) ^[16]. In India maize is primarily a kharif crop which is sown just before monsoon starts. This crop usually grows well under temperatures varying from 22°C to 30°C . It requires at least 50 to 90 mm of rainfall. For better yield of maize, soils should consider good organic matter content having high water holding capacity. Well drained soils with pH of 5.5 to 7.0 are preferred for maize farming. Among the countries that grow maize, India ranks fourth in area and seventh in production, accounting for about 4% of global maize area and 2% of total production (Makwana *et al.*, 2023) ^[10]. Around the world, it is grown on 206.19 million hectares producing 1228.09 million metric tonnes with a productivity of 5960 kg ha^{-1} (USDA, 2025).

Chemical fertilizers plays a significant role in providing readily available nutrients to crops and can greatly enhance yield potential. However, relying solely on chemical fertilizers have adverse effects on soil health over time. To maintain soil fertility and sustainability, a balanced approach that integrates organic manures becomes essential (Makwana *et al.*, 2023) ^[10]. Sustainable yield levels could be achieved by applying appropriate combination of organic manures with chemical fertilizers and biofertilizers (Balemi *et al.*, 2019) ^[2]. Integrated nutrient management (INM) aims to maintain soil fertility by supplying plant nutrients to an optimal level for sustaining crop productivity. (Priyavart *et al.*, (2022) reported that Maximum uptake of N, P and K by maize crop was higher when N, P, K, S, Zn were noted

with T₁₂ (Deep ploughing + FYM @ 12.5 t/ ha +RDF + Maize Maxim + Push and Pull Strategy + Sun hemp). Bindra *et al.*, (2019) reported that Higher content and uptake of nitrogen was observed with 25% N through fortified vermicompost + 75% N through inorganic fertilizer. Krishnendu *et al.*, (2020) concluded that 125% RDF (250 kg N 75 kg P and 75 kg K/ha) was proved to be giving the highest growth, yield, nutrient uptake and economics when supplied for cultivar 'P 3396'. Keeping this in view, the study was planned with the objective, to study the response of INM on dry matter production and uptake of nutrients of Hybrid maize COH(M) 8.

Materials and Methods

A Field study was carried out during July 2025 to October 2025. at the Experimental Farm, Department of Agronomy, Annamalai University, Annamalai Nagar, Tamil Nadu. The experimental farm is situated at 11° 24' N latitude and 79°24'E longitude and an altitude of +5.79m above mean sea level. The weather at Annamalai Nagar is moderately warm with hot summer months. During cropping period recorded maximum temperature ranges from 32.2 °C and 37.8°C with a mean of 37.0 °C while the minimum temperature ranges from 19.2 °C to 20.8 °C with a mean of 19.87°C. The relative humidity ranges from 65 to 75 percent with a mean of 68.81 percent and crop received a total rainfall of 386 mm in 21 rainy days. The soil was medium black with the initial soil fertility status of 230 kg/ha low in available nitrogen, 21.50 kg/ha medium in available phosphorous and 279 kg/ha high in available potassium.

The experiment was laid out in RBD with twelve treatments and replicated thrice. The treatments were viz., T₁- Control (100% RDF + FYM @ 12.5 t/ha), T₂ - Deep ploughing + FYM @ 12.5 t/ha+ RDF + Maize Maxim, T₃ - Push and Pull Strategy + FYM @ 12.5 t/ha +RDF + Maize Maxim, T₄ - Deep ploughing + FYM @ 12.5 t/ha +RDF + Maize Maxim + Cowpea, T₅ - Deep ploughing + FYM @ 12.5 t/ ha +RDF + Maize Maxim + Lablab, T₆ - Deep ploughing + FYM @ 12.5 t/ha +RDF + Maize Maxim + Sun hemp, T₇ - Push and Pull Strategy + FYM @ 12.5 t/ ha +RDF + Maize Maxim + Cowpea, T₈ - Push and Pull Strategy + FYM @ 12.5 t/ha +RDF + Maize Maxim + Lablab, T₉-Push and Pull Strategy + FYM @ 12.5 t/ ha +RDF + Maize Maxim + Sun hemp, T₁₀-Deep ploughing + FYM @ 12.5 t/ha +RDF + Maize Maxim + Push and Pull Strategy + Cowpea, T₁₁-Deep ploughing + FYM @ 12.5 t/ ha +RDF + Maize Maxim + Push and Pull Strategy + Lablab, T₁₂-Deep ploughing + FYM @ 12.5 t/ ha +RDF + Maize Maxim + Push and Pull Strategy + Sun hemp. Hybrid maize CO(H)M-8 was selected for this study and obtained from TNAU. Seeds were sown at a depth of 4-5 cm with a spacing 60 cm × 25 cm. Recommended nutrient dose of 250:75:75 kg N, P₂O₅, K₂O were applied as Urea (46% N), single super phosphate (16% P₂O₅) and muriate of potash (60% K₂O) fertilizers, to supply N, P and K nutrients, respectively. The entire dose of phosphorus and potassium were applied basally. A half dose of nitrogen was applied basally and the remaining half doses of nitrogen were applied as two splits on the 25th and 45th days after sowing. In addition, as per the treatment schedule, the prescribed quantities of the organic manures FYM @ 12.5 t/ha, were applied along with prescribed quantities of inorganic fertilizers. Maize Maxim @ 0.5 % Foliar spray was carried out at tasseling initiation and grain filling stages. The experiment was carried out in a randomized block

design (RBD) with three replications. Standard agronomic practices were adopted as per the crop production guide. The statistical method used for the data analysis is two-way anova with the software name is Statistical Package for Social Sciences (SPSS). The data on various studies recorded during the investigation were subjected to statistical scrutiny suggested by Gomez and Gomez (2010).

Table 1: Physio- chemical properties of the experimental field soil

S. No.	Particulars	Values
A. Mechanical analysis		
1.	Coarse Sand	13.0
2.	Fine sand	34.2
3.	Silt	16
4.	clay	36.8
5.	Textural class	Clay loam
B. Physico-chemical properties		
1.	Soil pH	7.8
2.	EC (dSm ⁻¹)	0.64
3.	Availabe Nitrogen (kg ha ⁻¹)	230
4.	Availabe Phosphorous (kg ha ⁻¹)	21.5
5.	Availabe potassium (kg ha ⁻¹)	279

Plant Analysis

Plant samples were dried first in air then kept in oven at 70°C for 8 hours to make the sample free from excess moisture. The samples were grinded in a Wiley mill having stainless parts and stored in polythene bags. The plant extract was prepared by grinding the plant samples in fine texture and were digested in triacid mixture of Conc. Nitric acid, sulphuric acid and perchloric acid for P and K determination in 10:4:1 ratio.

Table 2: Determination of N, P and K in plant

Nutrient	Method	Reference
Nitrogen	Microkjeldahl's method	Yoshida <i>et al.</i> , (1971)
Phosphorous	Vanado molybdophosphoric yellow colour method using tri acid extract	Piper (1966)
Potassium	Flame photometry method using tri acid extract	Piper (1966)

Uptake

To calculate the uptake of N, P and K in plants, the following formula is used-

$$\text{Uptake of Nutrients (kg/ha)} = \frac{\text{Nutrient content (\%)} \times \text{Dry matter production (kg /ha)}}{100}$$

Results and Discussion Nutrient uptake

Nutrients uptake (N, P and K) are vital in enhancing yield and nutrient content. The uptake of any nutrient is the function of its content and dry matter production by the crop. Higher nutrient content of produce and higher biomass production of maize might be the pertinent reason for higher uptake of nutrients (Singh *et al.*, 2025) [7]. The highest amount of N, P, K uptake by maize crop was recorded with an application of Deep ploughing + FYM @ 12.5 t/ ha +RDF + Maize Maxim + Push and Pull Strategy + Sun hemp (T₁₂). It clearly showed that application of balanced fertilization based on target yield resulted in significantly higher NPK content and uptake by grain and stover (Jat *et al.*, 2025). This might be due incorporation of FYM along

with macro and micro inorganic nutrients and hence increased availability of N and P which added in the soil through organic and inorganic resources. Synergistic effect of FYM improved soil organic matter content, nutrient availability and moisture retention, while the inorganic nitrogen ensured targeted nutrient delivery during critical growth phases (Arumugam *et al.* 2025)^[1]. Integrated use of organic and inorganic nutrient sources offers a viable approach to improve nutrient synchrony, enhance soil moisture retention, increase resource use efficiency and restore soil health in inherently low-fertility rainfed soils. Similar improvements in maize productivity through organic-inorganic nutrient integration have also been reported by (Sahoo *et al.* (2025). The treatments having FYM resulted in maximum uptake of nutrients which might be due to efficient conservation of soil moisture and enhanced availability of nutrients. The slow decomposition and mineralization of FYM also benefited the maize and wheat crops in terms of yield and nutrient uptake (Barman *et al.*, 2025)^[3]. The enhanced nutrient uptake with FYM is likely due to its higher content of N, P, and K, which supports better root growth and nutrient absorption. Additionally, the greater OC content in FYM may have stimulated microbial activity, increased organic acids, and improved nutrient solubility and mobility. This also helped reduce phosphorus fixation in the soil, making it more feasible to plants.

Nitrogen Uptake

Improvement in uptake of nutrients the manures applied in these treatments have also a positive effect with respect to soil physical properties viz., water holding capacity and structural stability of a soil and improve the soil microbial population which are responsible for N- fixation and phosphorus solubilization. Quick absorption and assimilation of micro and macro nutrients present in the FAA, improved the metabolic activity and thus improve the nitrogen uptake. The use of organic manure increases the amount of nitrogen available to the crop while also improving the soil's nutritional status. (Jamakhadi *et al.*, 2026)^[6].

Phosphorus uptake

Addition of organic sources of nutrients enhanced the microbial activity of soil resulting in maximum leaf litter decomposition and thereby increasing the level of accessible phosphorus. The application of integrated source of nutrients produces more organic anions and stimulating microbial activity resulting in increased phosphorus availability and its uptake by maize crop (Mahato *et al.*, 2020)^[9]. The higher phosphorus uptake observed with organic nutrient inputs may be attributed to improved soil biological activity and greater availability of phosphorus in the soil. Application of organic manures can stimulate microbial activity and enhance nutrient cycling, thereby increasing the availability of phosphorus to maize. Organic amendments also improve soil conditions and facilitate the conversion of relatively unavailable forms of phosphorus into forms that can be readily utilized by plants.

Thus, the combined application of organic and inorganic nutrient sources may provide a more favourable environment for phosphorus availability and uptake. Recent findings have shown that integrated nutrient management significantly improves nutrient acquisition, including phosphorus uptake, in maize (Singh *et al.*, 2025)^[7]. Similarly, the application of FYM along with inorganic fertilizers has been reported to improve phosphorus availability and uptake by maize, indicating a beneficial interaction between organic and inorganic nutrient sources (Jamakhadi *et al.*, 2026)^[6]. The higher phosphorus uptake may also be associated with increased microbial activity and improved nutrient cycling under integrated nutrient management. Furthermore, long-term integrated nutrient management can improve soil fertility and maintain the availability of phosphorus and other essential nutrients in maize-based production systems.

Potassium uptake

Dry matter accumulation and nutrient content in plant parts are the primary determinant of nutrient uptake by a crop. the organic sources of N made P and K in available forms for longer period in soil which improved P and K uptake with integrated nutrient supply. (Singh *et al.*, 2025)^[7]. Addition of FYM also influenced K accumulation in grain. So higher value of dry matter accumulation in plant in the above treatment warranting higher potassium uptake. Availability of nitrogen also increased the uptake of potassium (Mandal *et al.*, 2026). integrated crop-management practices enhanced dry matter production and nutrient accumulation and improved potassium translocation in maize compared with conventional management. Thus, the higher K uptake recorded in the integrated treatment may be attributed to the combined effect of improved soil nutrient availability, greater biomass production and efficient nutrient acquisition. (Barman *et al.* 2025)^[3]. thus increased the K uptake in maize. Whereas, the lowest nutrient uptake was recorded in absolute control (T₁) plots.

Dry matter production

The study revealed that the significant variation was recorded on dry matter production. The application of Deep ploughing + FYM @ 12.5 t/ha + RDF + Maize Maxim + Push and Pull Strategy + Sun hemp (T₁₂) produced significantly the higher dry matter production (10,712 kg/ha) which was significantly higher over rest of the treatments. The dry matter accumulation in the plant was attributed to higher supplementation of essential nutrients and phytohormones which results in increased specific leaf weight and improved photosynthesis. Application of ample N might increase the nutrient availability and uptake and maintained better canopy. Further, split applications of N through SI-based nutrient management practice resulted in a promising effect on DMA. The results are similar with the findings of (Zhang *et al.*, 2023) Whereas, the lowest dry matter production was recorded in absolute control (T₁) plots.

Table 3: Effect of INM on nutrient uptake and Economics of Hybrid maize

Treatments	Nutrient uptake (kg ha ⁻¹)			Dry matter production	
	N	P	K	30 DAS	60 DAS
T1	75.49	11.18	89.02	2039	5996
T2	92.19	12.79	98.84	2910	6883
T3	110.72	14.38	106.75	3496	7535
T4	129.42	17.92	117.04	4448	8899
T5	118.12	16.03	113.12	3912	8387
T6	133.11	16.83	118.39	4558	9095
T7	145.04	20.04	125.21	4843	9677
T8	138.96	18.41	122.09	4688	9407
T9	150.94	21.66	128.36	5005	9940
T10	159.29	24.60	133.95	5267	10452
T11	153.43	22.95	130.87	5142	10090
T12	165.12	26.19	137.09	5392	10712
S.Ed	2.89	0.77	1.54	61.88	125.98
CD(0.05)	5.79	1.55	3.08	123.77	251.96

S.Ed: Standard Error of difference, CD- Critical Difference

Conclusion

From the results obtained of experiment, it could be concluded that to obtain a higher profitable yield of Hybrid maize COH(M)8, as well as to increase the uptake of nutrient and dry matter production the crop should be fertilized with of Deep ploughing + FYM @ 12.5 t/ ha +RDF + Maize Maxim + Push and Pull Strategy + Sun hemp(T₁₂). Adoption of this Push and pull Strategy practice also helped the maize growing farmers to alleviate many issues such as poverty by cutting cost of products and food insecurity and enhancing crop production and improving quality of produce, Also this practice is ecologically safe for small and marginal maize growing farmers of Tamil Nadu. The suitability of Push and Pull Strategy techniques in India's various agroclimatic zones must be investigated in future studies.

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Compliance with ethical standards

Conflict of interest: Authors do not have any conflict of interests to declare.

Ethical issues: None

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