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PERFORMANCE OF *RABI* MAIZE UNDER DIFFERENT GREEN MANURING PRACTICES AND NITROGEN LEVELS

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ABSTRACT

A field experiment entitled "Performance of *rabi* maize under different green manuring practices and nitrogen levels" was conducted during the *rabi* season of 2024–25 at the College Farm, School of Agricultural Sciences, Malla Reddy University, Hyderabad. The experimental site had sandy loam soil, moderately alkaline in reaction, non-saline, low in organic carbon and medium in available nitrogen, phosphorus and potassium. The experiment was laid out in a randomized block design with nine treatments replicated thrice. Treatments consisted of combinations of cowpea and dhaincha under green and brown manuring practices with two nitrogen levels (100% and 75% recommended dose of nitrogen, RDN), along with a control receiving 100% RDN. The maize hybrid P3302 was used, and the recommended fertilizer dose was 240:80:80 NPK kg ha^{-1}. Green manuring was incorporated 30 days after sowing, while brown manuring was knocked down using herbicide at 30 DAS.

Among the treatments, dhaincha green manuring with 100% RDN (T_5) recorded significantly superior performance across all parameters. Plant height under this treatment reached (236 cm) at harvest, compared to control (151 cm). Leaf area index was also higher (3.1) compared to the control (1.6). Correspondingly, dry matter accumulation increased from (26,075 kg ha^{-1}) and (16,528 kg ha^{-1}) in the control, indicating improved vegetative growth and biomass production due to better nitrogen availability and organic matter contribution from dhaincha.

Yield was markedly enhanced under dhaincha green manuring with 100% RDN, where grain yield increased to (8,994.5 kg ha^{-1}) and stover yield to (12,821 kg ha^{-1}), compared to (6,105.2 kg ha^{-1}) and (8,803.4 kg ha^{-1}) in the control. The harvest index also improved slightly from (40.9%) in the control to (41.2%) under the best treatment.

In conclusion, dhaincha green manuring combined with 100% recommended dose of nitrogen (240:80:80 NPK kg ha^{-1}) significantly improved growth and yield of *rabi* maize. This integrated approach effectively enhanced soil fertility and maize productivity, proving most suitable for sandy loam soils under semi-arid conditions of Hyderabad. Hence, dhaincha green manuring with full nitrogen dose can be recommended for sustainable and profitable maize cultivation.
***Keywords*:** *Rabi* maize, green manuring, brown manuring, dhaincha, cowpea.

Introduction

Maize (*Zea mays* L.) is one of the most widely cultivated cereal crops across the world, valued for its high productivity and multiple uses as food, feed and industrial raw material. In India, maize occupies a significant position in both rainfed and irrigated cropping systems. Though primarily grown during the *kharif* season, the *rabi* maize area has been steadily increasing, particularly in southern and eastern India due to its higher productivity under controlled water and input conditions (Kumar and Singh, 2020). The favourable climatic conditions during *rabi* season such as low pest pressure, cool nights and extended sunshine hours often translate into higher yields compared to *kharif* maize (Ramesh and Ramana, 2018).

However, one of the critical challenges in *rabi* maize cultivation is the efficient and sustainable management of nutrients, particularly nitrogen which is required in large amounts by the crop throughout its growth period. Nitrogen plays a vital role in several physiological and biochemical processes including cell division, chlorophyll formation, enzyme activity and protein synthesis (Singh and Yadav, 2016). Despite its importance, nitrogen use efficiency in maize remains low, often in the range of 30–50%, due to substantial losses through leaching, denitrification and volatilization (Roy and Singh, 2006). These losses are more pronounced in coarse-textured soils with low organic matter content, which are commonly found in maize-growing areas of India (Verma and Singh, 2010).

Excessive application of nitrogen fertilizers not only raises the cost of cultivation but also contributes to environmental issues such as nitrate contamination of groundwater and emissions of nitrous oxide, a potent greenhouse gas (Ali and Kumar, 2009). Therefore, there is a growing need for integrated nutrient management strategies that combine organic and inorganic sources to enhance nutrient use efficiency and sustain long-term soil fertility. In this context, green manuring has emerged as a viable option to supplement nitrogen and improve soil health.

Green manuring involves the growing and incorporation of specific leguminous crops in the soil while they are still green with the objective of enriching the soil with organic matter and biologically fixed nitrogen (Sarkar and Singh, 2007). Legumes such as dhaincha (*Sesbania aculeata*), cowpea (*Vigna unguiculata*), moong bean (*Vigna radiata*) and sunnhemp (*Crotalaria juncea*) are commonly used for green manuring due to their ability to fix atmospheric nitrogen through symbiotic associations with *Rhizobium* bacteria (Bandyopadhyay and Roy Chowdhury, 2005). Upon decomposition, these crops release nutrients back into the soil, improve soil structure and increase microbial activity (Meena *et al*., 2017).

Incorporating green manure crops before the sowing of *rabi* maize can significantly improve nitrogen availability, soil physical properties and crop productivity. Studies have shown that the addition of legume biomass leads to higher microbial biomass nitrogen improved mineralization rates and better root development in maize (Roy and Singh, 2006; Islam and Badole, 2020). For instance, Singh and Yadav (2016) reported that green manuring with cowpea followed by 75% recommended nitrogen dose (RDN) produced comparable yields to 100% RDN alone, indicating the potential of organic-inorganic nutrient combinations in reducing fertilizer inputs.

An alternative approach to green manuring is brown manuring, where the legume crop is grown simultaneously or just before the main crop and then killed *in-situ* using an herbicide such as 2,4-D or glyphosate without soil incorporation. This practice provides surface mulch, suppresses weeds and allows for slow nutrient release making it suitable for conservation agriculture systems (Bandyopadhyay and Roy Chowdhury, 2005; Singh *et al*., 2022). Brown manuring also helps in moisture retention and reduces soil erosion, which are critical during the *rabi* season when irrigation water is limited in many regions.

Several researchers have emphasized the synergistic benefits of combining green or brown manuring with graded nitrogen levels in maize production. According to Ramesh and Ramana (2018) integrating dhaincha green manuring with 75% RDN significantly improved growth attributes, grain yield and net returns compared to 100% RDN alone. Similarly, Thapa and Shrestha (2017) reported from Nepal that brown manuring with cowpea and 50% RDN improved soil N content and yielded comparable maize grain production to the 100% RDN treatment. These findings suggest that strategic use of green manures can partially substitute synthetic nitrogen, reduce input costs and maintain yield stability.

Moreover, the decomposition rate and nutrient release pattern of green manuring crops depend on their biomass quality, carbon-to-nitrogen (C: N) ratio and the soil microbial population (Kaur *et al*., 2021). For instance, fast-decomposing legumes with a low C:N ratio such as dhaincha and cowpea release nitrogen rapidly making them ideal for short-duration crops like *rabi* maize. On the other hand, dhaincha offers a higher biomass yield and long-term soil fertility benefits (Patel and Maurya, 2019).

Experimental Site and Soil Characteristics

The field experiment was carried out during the *rabi* season of 2024–25 at the Research Farm, School of Agricultural Sciences, Malla Reddy University, Dulapally, Hyderabad, Telangana, India. The site is geographically located at 17°19'16.4" N latitude and 78°24'43" E longitude, with an elevation of 542.3 meters above mean sea level. The soil of the experimental field was classified as sandy clay loam, moderately alkaline in reaction (pH 8.58), and non-saline (EC 0.31 dS m^{-1} at 25°C). It was low in available nitrogen (164 kg ha^{-1}) and potassium (91 kg K_2O ha^{-1}) and medium in available phosphorus (17 kg P_2O_5 ha^{-1})

as estimated by standard analytical procedures described by Jackson (1973) and Piper (1966).

Experimental Material

The experiment was conducted using maize (*Zea mays* L.) hybrid 'Pioneer 3302', a high-yielding, leafy and disease-tolerant hybrid well-suited for *rabi* cultivation. The seeds were procured from a certified source and sown at a spacing of 60 cm × 20 cm, maintaining two plants per hill to ensure uniform crop stand and optimum plant population.

Experimental Design and Treatments

The experiment was laid out in a Randomized Block Design (RBD) with 15 treatments, each replicated three times. The plot size for each treatment was 5.4 m × 3.8 m, with 1 m border rows to avoid lateral nutrient movement. The treatments involved different sources and doses in combination with recommended dose of fertilizers (RDF: 240:80:80 kg $N:P_2O_5: K_2O$ ha^{-1}), with basal application of 1/3 N along with full P and K at sowing (0 DAS), the first top dressing of 1/3 N at knee-height stage (34 DAS) and the second top dressing of the remaining 1/3 N at tassel initiation stage (56 DAS).

Table 1: Details of Treatments

Treatment	Treatment details
T_1	Cowpea green manuring with 100%RDN
T_2	Cowpea green manuring with 75%RDN
T_3	Cowpea brown manuring with 100% RDN
T_4	Cowpea brown manuring with 75%RDN
T_5	Dhaincha green manuring with 100% RDN
T_6	Dhaincha green manuring with 75%RDN
T_7	Dhaincha brown manuring with 100%RDN
T_8	Dhaincha brown manuring with 75% RDN
T_9	Control (100% RDN)

Data Collection

Growth Parameters: Plant height (cm) was measured from the base to the tip of the main stem at 30, 60, 90 DAS and at harvest. Leaf area index was calculated using the method described by Watson (1952). Dry matter production (kg ha^{-1}) was determined by collecting plant samples, which were initially shade-dried and subsequently oven-dried at 60°C until a constant weight was obtained. The final dry weight of the plants was recorded and expressed in kilograms per hectare (kg ha^{-1}).

Yield Parameters: Grain yield (kg ha^{-1}), stover yield (kg ha^{-1}) and harvest index (%) were calculated using standard procedures (Ayyar and Appavoo, 2017).

Statistical Analysis

The experimental data were statistically analysed using the Analysis of Variance (ANOVA) method suitable for a Randomized Block Design (RBD) as suggested by Gomez and Gomez (1984) When the F-test indicated significant differences among treatments, comparisons were made at a 5% level of probability. The term "NS" denotes non-significant differences between treatments.

Results and Discussion

Growth Parameters

Application of dhaincha green manuring with 100% RDN significantly influenced the growth of maize at harvest (Table-2). Among the treatments, dhaincha green manuring with 100% RDN (T_5) produced the tallest plants (236 cm), largest leaf area index (4.1) and maximum dry matter production (26075 kg ha^{-1}), followed by closely cowpea green manuring with 100% RDN (T_1). The lowest was recorded in control (T_9), plant height (151 cm), leaf area index (1.6) and dry matter production (16528 kg ha^{-1}). Though non-significant, treatments with 100% RDN plus green manuring of cowpea and dhaincha maintained more green leaves throughout the crop period, likely due to improved nitrogen availability supporting sustained leaf retention and canopy growth. In contrast, control and brown manuring with reduced RDN showed fewer green leaves due to nutrient limitations. The better LAI under dhaincha green manuring with 100% RDN might be attributed to the combined effect of green manuring and full recommended dose of nitrogen, which could have enhanced leaf expansion and plant vigor. The higher dry matter in dhaincha green manuring with 100% RDN may be due to improved soil fertility and nitrogen availability, leading to better nutrient uptake, leaf area development, photosynthesis, and biomass accumulation. These results align with findings of Kumar *et al.* (2020), Rani *et al.* (2021), Mahapatra and Verma (2022), Yogesh *et al.* (2020), and Kumari and Patel (2023), who reported that dhaincha green manuring combined with recommended nitrogen levels significantly enhanced plant height, leaf area index and biomass of maize through improved nutrient uptake and root growth.

Table 2 : Plant height (cm), leaf area index and dry matter production (kg ha^{-1}) of *rabi* maize as influenced by green manuring practices and nitrogen levels during 2024-2025

Treatment details	Plant height (cm)	Leaf area index	Dry matter production (kg ha^{-1})
T_1: Cowpea green manuring with 100% RDN	218	3.0	23612
T_2: Cowpea green manuring with 75% RDN	179	2.6	18890
T_3: Cowpea brown manuring with 100% RDN	175	1.7	18771
T_4: Cowpea brown manuring with 75% RDN	160	1.6	16634
T_5: Dhaincha green manuring with 100% RDN	236	3.1	26075
T_6: Dhaincha green manuring with 75% RDN	198	2.9	21521
T_7: Dhaincha brown manuring with 100% RDN	195	2.7	21497
T_8: Dhaincha brown manuring with 75% RDN	161	1.7	16772
T_9: Control	151	1.6	16528
S.Em±	4.03	0.17	450.83
CD (p = 0.05)	12.1	0.5	1351.5

Yield

Application of dhaincha green manuring with 100% RDN significantly influenced maize yield and its components (Table-3). Among the treatments, dhaincha green manuring with 100% RDN (T_5) produced highest grain yield (8994.5 kg ha^{-1}), stover yield (12821 kg ha^{-1}) and harvest index (41.2 %), followed by closely cowpea green manuring with 100% RDN (T_1). the lowest was recorded in control(T_9), grain yield (6105.2kg ha^{-1}), stover yield (8803.4 kg ha^{-1}) (4.1) and harvest index (40.9 The superior performance of dhaincha and cowpea green manuring with 100% RDN (T_5 and T_1) is attributed to enhanced soil nitrogen availability and microbial activity, improving nutrient use efficiency and vegetative growth, which in turn increased photosynthesis, grain filling, and yield. The significant difference between 100% and 75% RDN highlights the importance of adequate nitrogen supply. Higher stover yield under green manuring resulted from improved soil fertility and dry matter accumulation, with dhaincha contributing substantial organic matter and nitrogen. Though differences were non-significant, stover yield ranged from 40.9% in control to 41.9% in dhaincha brown manuring with 100% RDN. These results agree with Das and Baruah (2020) and Kumar and Sharma (2020), who reported that green manuring, particularly with dhaincha, enhanced maize grain and stover yields through improved nitrogen nutrition and dry matter accumulation. Similar non-significant differences in harvest index under varied nutrient management were also noted by Pal *et al.* (2022).

Table 3 : Grain yield (kg ha^{-1}), stover yield (kg ha^{-1}) and harvest index (%) of *rabi* maize as influenced by green manuring practices and nitrogen levels during 2024-25

Treatments details	Grain yield	Stover yield	Harvest index
T_1: Cowpea green manuring with 100% RDN	8406.9	11670	41.8
T_2: Cowpea green manuring with 75% RDN	6948.2	10051	40.8
T_3: Cowpea brown manuring with 100% RDN	6713.4	9730.3	40.8
T_4: Cowpea brown manuring with 75% RDN	6189.1	8930.5	40.9
T_5: Dhaincha green manuring with 100% RDN	8994.5	12821	41.2
T_6: Dhaincha green manuring with 75% RDN	7729.5	10981	41.3
T_7: Dhaincha brown manuring with 100% RDN	7566.3	10465	41.9
T_8: Dhaincha brown manuring with 75% RDN	6213.0	9080.8	40.6
T_9: Control	6105.2	8803.4	40.9
S.Em±	188.57	224.38	0.86
CD (p = 0.05)	565.3	672.6	NS

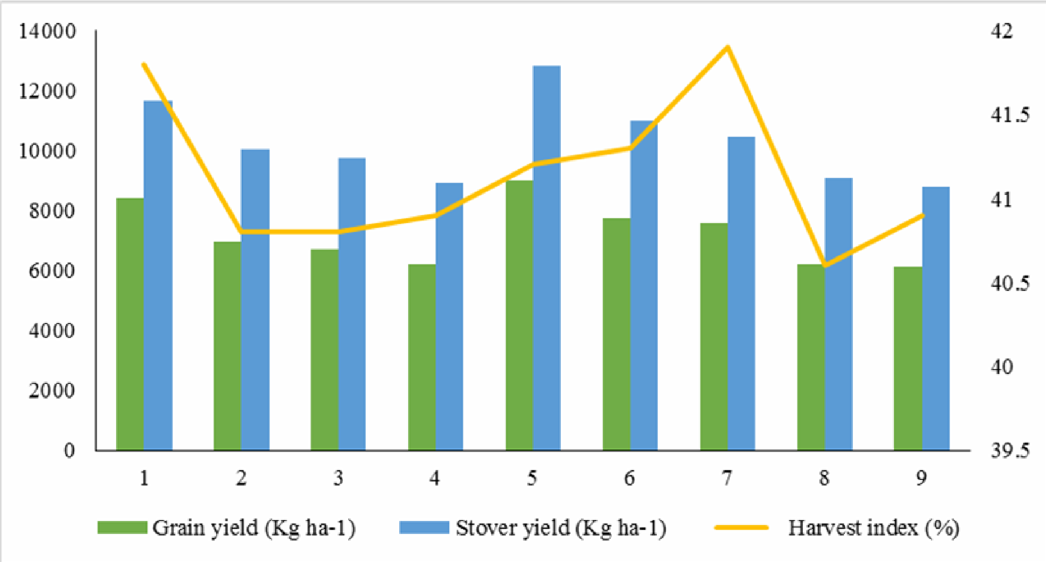

Fig. 1 : Grain yield and stover yield (kg ha^{-1}) and harvest index (%) of *rabi* maize as influenced by green manuring practices and nitrogen levels during 2024-25

Conclusion

Application of green manuring (dhaincha and cowpea) with 100% RDN proved most effective in improving the growth and productivity of *rabi* maize under semi-arid conditions of Telangana. These treatments consistently recorded higher plant height, leaf area index, dry matter production, grain and stover yields compared to brown manuring and reduced nitrogen levels. The improvement is mainly attributed to enhanced soil fertility, better nitrogen availability, and efficient nutrient uptake resulting from green manure decomposition. Although the differences were statistically non-significant, dhaincha and cowpea green manuring with 100% RDN performed better overall, highlighting the importance of combining green manuring with adequate nitrogen supply for achieving higher maize yield and maintaining soil health.

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