

**Original Research Article**

**EFFECT OF TILLAGE, CROP RESIDUE MANAGEMENT AND NUTRIENT LEVELS ON  
GROWTH AND YIELD OF MAIZE (*Zea mays* L.)**

**ABSTRACT**

A field study on “Effect of tillage, crop residue management and nutrient levels on performance of growth and yield of maize (*Zea mays* L.)” was conducted during *rabi* season of 2022 at Maize Research Centre, Professor Jayashankar Telangana State Agriculture University, Agricultural Research Institute, Rajendranagar, Hyderabad, Telangana. The experiment comprised of 12 treatment combinations laid out in a split-plot design with three replications. The main-plot treatments included four different tillage practices: M<sub>1</sub>-Conventional tillage (Plough + Cultivator + Rotovator), M<sub>2</sub>-Residue incorporation (After 10 days of spreading the haulms, only rotovator was run), M<sub>3</sub>- Residue incorporation (After spreading the haulms, microbial consortium was sprayed and after 10 days only rotovator was run) and M<sub>4</sub>- Zero-tillage (Only-only microbial consortium was sprayed on the haulms). Sub-plot treatments included three nutrient levels: N<sub>1</sub>- 100% RDF (240-80-80 N-P<sub>2</sub>O<sub>5</sub>-K<sub>2</sub>O kg ha<sup>-1</sup>), N<sub>2</sub>: 100% RDN & P and 50% RDK (240-80-40 N-P<sub>2</sub>O<sub>5</sub>-K<sub>2</sub>O kg ha<sup>-1</sup>), and N<sub>3</sub>: 87.5% of RDN, 75% RDP and 75% RDK (210-60-60 N-P<sub>2</sub>O<sub>5</sub>-K<sub>2</sub>O kg ha<sup>-1</sup>). Results revealed that, among the tillage practices, residue incorporation (M<sub>3</sub>) had recorded significantly higher growth attributes like plant height, leaf area, dry matter production and chlorophyll content (SPAD) at 30, 60 DAS and at harvest stages and yield of maize and it was on par with zero-tillage (M<sub>4</sub>) whereas all the parameters were significantly lower in conventional tillage (M<sub>1</sub>). Among the different nutrient levels, N<sub>1</sub>(100% RDF) had shown significantly superior performance in terms of growth attributes and yield of maize and it was on par with N<sub>2</sub> (100% RDN & P and 50% RDK) whereas N<sub>3</sub>(87.5% of RDN, 75% RDP and 75% RDK) recorded significantly lower growth attributes and yield of maize. The interaction effect due to tillage and nutrient levels on plant height, leaf area, dry matter production, chlorophyll content (SPAD) at 30,

*Keywords: - Maize; microbial consortium; nutrient levels; residue incorporation; tillage.*

**1. INTRODUCTION**

Maize (*Zea mays* L.) is the third most important cereal crop in India after rice and wheat and is grown in a wide range of environments. It has enormous potential to provide food, feed nutritional security and qualifies as a potential crop for doubling farmer's income. Maize is a less water-demanding crop and substantial savings in water and power usage could reach up to 90% and 70%, respectively, when compared to paddy cultivation. (Maize outlook report-April, 2023).

The area under maize in India accounts for 10.04 M ha with a production and productivity of 33.62 MMT & 3349 kg ha<sup>-1</sup> respectively and contributed to 9% of the national food basket (Directorate of Economics and Statistics, GOI 2022).

Globally, sustainable management of agricultural wastes is a great challenge, especially in developing nations like India with a burgeoning population, production rate and economic growth

(Agoramoorthy *et al.*, 2008). India generates more than 500 million tons of crop residues annually (Gupta *et al.*, 2012). Burning of crop residues causes ~~the~~ air pollution and leads to loss of soil biota, huge biomass, organic carbon and plant nutrients. Approximately 80– 90% of N, 25% of P, 20% of K and 50% of S present in crop residues are lost in the form of various gaseous and particulate matters, resulting in atmospheric pollution and global warming (Kaure *et al.*, 2019).

Recycling of crop residues in the soil is a promising option for replenishing soil fertility, improving physico-chemical properties and sustaining crop yields (Choudhary *et al.*, 2019). However, additional resources such as water, nutrients and bio-inoculum are required ~~for promoting to promote the~~ decomposition of crop residue under in situ decomposition (Thakur *et al.*, 2019). Among the different crop residues legume crops provide sustainability by enriching soil fertility and increasing system productivity (substantial residual effects) and monetary returns (Dhaka *et al.*, 2016).

Maize being an exhaustive crop has very high nutrient demand and its productivity mainly depends upon nutrient management systems. The recent energy crisis, high fertilizer cost and low purchasing power of the farming community have made it necessary to rethink alternatives and to enhance crop yield per unit of applied nutrients by providing a better physical, chemical and microbial environment (Singh *et al.*, 2019).

Incorporation of leguminous (Soybean, cowpea, ~~and~~ chickpea etc.), crop residues has been shown to improve the soil's physical properties, such as water-holding capacity, soil permeability etc. and inclusion of leguminous crop residues also increases crop growth and productivity by enhancing the availability of nutrients for the root zone of the succeeding cereals (Maize and sorghum) (Sarkar *et al.*, 2020).

## 2. MATERIALS AND METHODS

This experiment was conducted at Agricultural Research Institute (ARI), Maize Research Centre, Professor Jayashankar Telangana State Agriculture University, Rajendranagar, Hyderabad, Telangana during ~~rabi~~ Rabi, 2022. The experimental site was geographically located at 17° 3' N latitude, 78° 39' E longitude and an altitude of 494 m above mean sea level (MSL) and 1 km away from IIMR (Indian Institute of Millets Research). According to Troll's climatic classification, it falls under Semi-Arid Tropical region (SAT). The experimental site was in ~~the~~ Southern Telangana Agro-Climatic Zone. The experiment comprised ~~of~~ 12 treatment combinations laid out in a split-plot design with three replications. The main-plot treatments included four different tillage and residue management practices (residue used was soybean haulm): M<sub>1</sub>-Conventional tillage (Plough + Cultivator + Rotovator), M<sub>2</sub>- Residue incorporation (After 10 days of spreading the haulms, only rotovator was run), M<sub>3</sub>- Residue incorporation (After spreading the haulms, microbial consortium was sprayed and after 10 days, only rotovator was run) and M<sub>4</sub>- Zero-tillage (Only microbial consortium was sprayed on the haulms). ~~Microbial-A microbial~~ consortium developed by PJTSAU was used which comprises ~~of~~ Trichoderma, Fenerocheta and Aspergillus @ 2% spray to the weight of added residue. Sub-plot treatments included three nutrient levels: N<sub>1</sub>- 100% RDF (240-80-80 N-P<sub>2</sub>O<sub>5</sub>-K<sub>2</sub>O kg ha<sup>-1</sup>), N<sub>2</sub>: 100% RDN & P and 50% RDK (240-80-40 N-P<sub>2</sub>O<sub>5</sub>-K<sub>2</sub>O kg ha<sup>-1</sup>), and N<sub>3</sub>: 87.5% of RDN, 75% RDP and 75% RDK (210-60-60 N-P<sub>2</sub>O<sub>5</sub>-K<sub>2</sub>O kg ha<sup>-1</sup>). Recommended nitrogen was applied to the maize crop in three (3) splits at the time of sowing (basal), ~~knee-knee~~-high and flowering stages in the form of urea as per treatments. Recommended phosphorus (80kg P<sub>2</sub>O<sub>5</sub>ha<sup>-1</sup>) was applied in ~~a~~ single dose at the time of sowing in the form of SSP as per the treatments and recommended potassium (80kg K<sub>2</sub>Oha<sup>-1</sup>) was applied to ~~the~~ maize crop in two (2) splits at the time of sowing (basal) and flowering stages in the form of muriate of potash as per treatments. ~~Soil-The soil~~ type of the experimental site was ~~Vv~~vertisols. The soil of the experimental site was medium clay loam, slightly alkaline, low in organic carbon and nitrogen, high in available phosphorus, and potassium. The maize hybrid DHM-121 was sown on 15<sup>th</sup> November 2022 with a seed rate of 20kg ha<sup>-1</sup>. ~~Spacing-The spacing~~ used was 60x20 cm. The climate of the experimental region is semi-arid (dry). The weekly mean maximum temperature ranged from 27.4°C to 33.9°C, with an average of 30.8°C, throughout the crop growth period, while the weekly mean minimum temperature ranged from 11.2°C to 18.9°C, with an average of 15.1°C. In terms of relative humidity, the weekly mean RH-I (morning) ranged from 74.6% to 97.1%, with an average of 84%, while the RH-II (afternoon) ranged from 17.4% to 63.9%,

with an average of 36.6%. Using the USWB Class - A open pan evaporimeter, the weekly mean bright sunshine hours per day ranged from 3.6 to 10.1 hours, with an average of 7.6 hours. Weekly mean evaporation ranged from 2.3 to 5.3 mm per day, with an average of 3.7 mm per day. The wind speed stretched from 2.0 to 4.1 km hr<sup>-1</sup>. No rainfall was observed during the crop growth period. The effect of tillage and nutrient levels on plant height, leaf area, dry matter accumulation, chlorophyll content (SPAD) at 30, 60 DAS and at harvest stages and grain yield has been recorded.

## RESULTS AND DISCUSSION

### Growth parameters

#### 1. Plant height (cm)

Data pertaining to plant height (cm) as influenced by tillage and nutrient levels is presented in Table 1. ~~Perusal~~ ~~A perusal~~ of the data indicated that, the tillage had a significant influence on the plant height at 30, 60 DAS and at harvest stages of maize. Among the treatments, M<sub>3</sub> (residue incorporation along with microbial consortium spray) recorded significantly higher plant height at 30, 60 DAS and at harvest stages (65, 165 and 253 cm respectively) and it was on par with M<sub>4</sub> (zero tillage) (63, 160 and 250 respectively). However, significantly lowest plant height was with M<sub>1</sub> (conventional tillage) (56, 150 and 234 cm respectively). The improvement in plant height of maize with the incorporation of legume crop residues was due to the accumulation of a high amount of nutrients through the addition of residues which was returned to the soil. In addition, spraying of microbial consortium helped in quicker decomposition and mineralization of residues and in turn quicker release of nutrients. As residues have contributed ~~for to~~ the high amount of nutrients to the succeeding maize crop the results were visible at later stages also. The present findings are in corroboration with the reports of Egbe and Ali (2010), Ammaji (2014) and Ndiso *et al.* (2018).

Nutrient levels have shown a significant influence on plant height of maize at 30, 60 DAS and at harvest stages. Application of 100% RDF (N<sub>1</sub>) recorded significantly highest plant height at 30, 60 DAS and at harvest stages (63, 163 and 250 cm respectively) and it was on par with (N<sub>2</sub>) i.e., 100% RDN & P and 50% RDK (61, 158 and 246 cm respectively) whereas significantly lowest plant height was with (N<sub>3</sub>) i.e., 87.5% of RDN, 75% RDP and 75% RDK (56, 151 and 234 cm respectively). The increase in plant height was due to adequate availability of NPK attributed to a better nutritional environment for plant growth at the active vegetative stage. This resulted in enhancement in cell multiplication, cell elongation and cell expansion in the plant body which further helped in increasing plant height at all the stages. The results of the present investigation are also in agreement with the findings of Shanti *et al.* (1997), Shivay *et al.* (1999), Singh *et al.* (2003) ~~and~~ Bakht *et al.* (2006) and De Vita *et al.* (2007).

The interaction effect due to tillage and nutrient levels on plant height of maize at 30, 60 DAS and at harvest was found non-significant.

#### 2. Leaf area (cm<sup>2</sup>)

Data pertaining to leaf area (cm<sup>2</sup>) as influenced by tillage and nutrient levels is presented in Table 1.

The experimental findings demonstrated that, tillage had a significant influence on the leaf area of maize. Among the various treatment combinations evaluated, M<sub>3</sub> (residue incorporation along with microbial consortium spray) exhibited significantly elevated leaf area at 30, 60 DAS and at harvest stages (101.83, 384.39 and 397.91 cm<sup>2</sup> respectively) and this was on par with M<sub>4</sub> (zero tillage) (98.10, 378.62 and 391.14 cm<sup>2</sup> respectively). However, the significantly lowest leaf area was with M<sub>1</sub> (conventional tillage) (94.84, 367.97 and 382.72 cm<sup>2</sup> respectively). The better performance with M<sub>3</sub> treatment was due to the availability of residual soil nutrients by the incorporation of soybean residue and microbial consortium sprayed on the haulms. This helped in ~~improved~~ ~~improving~~ photosynthetic

capacity and the source strength in the source-sink relationship. The increased nutrient availability seemed to prolong the vegetative phase of the plant and also decreased the rate of senescence which led to more leaf area. Similar results were also reported by Uhart and Andrade (1995), Cheruiyot *et al.* (2001), Beary *et al.* (2002) and Ali *et al.* (2015).

Various nutrient levels have exerted significant influence on the leaf area of maize. Application of 100% RDF (N<sub>1</sub>) resulted in significantly highest leaf area at 30, 60 DAS and at harvest stages (99.85, 381.97 and 396.38 cm<sup>2</sup> respectively) and it was on par with (N<sub>2</sub>) i.e., 100% RDN & P and 50% RDK (98.38, 376.08 and 389.75 cm<sup>2</sup> respectively), whereas significantly lowest leaf area was recorded with (N<sub>3</sub>) i.e., 87.5% of RDN, 75% RDP and 75% RDK (94.95, 367.76 and 380.09 cm<sup>2</sup> respectively). An adequate supply of nutrients had helped the maize plants to increase their growth, which in turn put forth more photosynthetic surface thus ~~resulted~~ resulting in the production of a greater number of leaves per plant with a larger area. Increased leaf area with each increment in the level of N application was due to the role of nitrogen in increasing cell division and cell elongation. The positive response of nutrients on leaf area across different soils and regions ~~were was~~ also reported by Shanti *et al.* (1997), Patel *et al.* (2006), Bindhaniet *et al.* (2007), Hokmalipour and Darbandi (2011), Imran *et al.* (2015), Singh *et al.* (2015) and Meena *et al.* (2016).

The interaction effect due to tillage and nutrient levels on leaf area at 30, 60 DAS and at harvest was non-significant.

### **3. Dry matter production (kg ha<sup>-1</sup>)**

Data pertaining to dry matter production (kg ha<sup>-1</sup>) as influenced by tillage and nutrient levels is presented in Table 2.

Examination of the data revealed that, tillage exerted a substantial impact on the dry matter production of maize. Within the various experimental treatments, M<sub>3</sub> (residue incorporation along with microbial consortium spray) achieved significantly superior dry matter production at 30, 60 DAS and at harvest stages (565, 3718 and 15396 kg ha<sup>-1</sup> respectively) and it exhibited comparable results with M<sub>4</sub> (zero tillage) (553, 3669 and 14913 kg ha<sup>-1</sup> respectively). Conversely, treatment M<sub>1</sub> (conventional tillage) exhibited markedly lower dry matter production (494, 3390 and 14055 kg ha<sup>-1</sup> respectively). The higher dry matter accumulation in maize with preceding soybean was attributed to the biological fixation of nitrogen by the soybean which resulted in a continuous supply of nitrogen during mineralization of soybean crop residues. ~~And~~ also, spraying of microbial consortium helped in quicker decomposition and mineralization of soybean residues and release of nutrients to the succeeding maize which enhanced the dry matter production when compared to residue removed plots. Similar findings were observed by Rahim *et al.* (1994), Cheruiyot *et al.* (2001), Beary *et al.* (2002), Sangakkara *et al.* (2003), Nyalemegba and Osakpa (2012), Tamiru Hirpa (2013) and Shah *et al.* (2014).

Application of 100% RDF (N<sub>1</sub>) recorded significantly highest dry matter production at 30, 60 DAS and at harvest stages (559, 3708 and 15272 kg ha<sup>-1</sup> respectively) and it was on par with (N<sub>2</sub>) i.e., 100% RDN & P and 50% RDK (550, 3617 and 15001 kg ha<sup>-1</sup> respectively) whereas significantly lowest dry matter production was with (N<sub>3</sub>) i.e., 87.5% of RDN, 75% RDP and 75% RDK (489, 3350 and 13904 kg ha<sup>-1</sup> respectively). Higher nutrient doses increased the leaf area which leads to higher rates of photosynthesis and more assimilation of photosynthates, thus increasing dry matter production. Moreover, nitrogen is the constituent of proteins and is also involved in many physiological reactions, thereby, increased increasing the dry matter production. Similar results were reported by Shanti *et al.* (1997), Bangarwa *et al.* (1988), Meena *et al.* (2013), Rekha (2014) and Singh *et al.* (2015).

The interaction effect due to tillage and nutrient levels on dry matter production at 30, 60 DAS and at harvest was non-significant.

### **4. Chlorophyll content (%) (SPAD)**

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Data pertaining to chlorophyll content (%) as influenced by tillage and nutrient levels is presented in Table 2.

The experimental results indicated that ~~the~~ chlorophyll content of maize was significantly influenced by tillage. Among the treatments, M<sub>3</sub> (residue incorporation along with microbial consortium spray) recorded significantly highest chlorophyll content at 30, 60 DAS and at harvest stages (36.2, 49.7 and 20 % respectively) and it was on par with M<sub>4</sub> (zero tillage) (34.7, 49.5 and 19.2 % respectively). However, ~~the~~ significantly lowest chlorophyll content was with M<sub>1</sub> (conventional tillage) (32.1, 44.5 and 15.1% respectively). Soybean crop has the ability to nodulate and fix atmospheric nitrogen and converts atmospheric nitrogen into a plant-usable form. Incorporation of soybean residue along with microbial consortium spraying enhanced the aeration and better physico-chemical environment in soil ~~there~~ by plants had higher uptake of all essential nutrients particularly those required for chlorophyll synthesis. Similar results of higher chlorophyll content were reported by Beary *et al.* (2002), Gholizadeh *et al.* (2009), Hokmalipour and Darbandi (2011), Rekha (2014), Singh *et al.* (2015), Meena *et al.* (2016) and Xie *et al.* (2017).

Diverse nutrient levels have exhibited a pronounced impact on the chlorophyll content in maize. Application of 100% RDF (N<sub>1</sub>) exhibited a significant increase of chlorophyll content at 30, 60 DAS and at harvest stages (35.8, 49.1 and 19.8 % respectively) and it was on par with (N<sub>2</sub>) i.e., 100% RDN & P and 50% RDK (34.7, 47.9 and 19.1 % respectively). In contrast, the chlorophyll content was notably lower with treatment (N<sub>3</sub>) i.e., 87.5% of RDN, 75% RDP and 75% RDK (31.6, 43.9 and 14.7 % respectively). Increased chlorophyll content with increasing nutrients, especially nitrogen was because of ~~the~~ direct involvement of nitrogen as a constituent of protein and chlorophyll molecules. Nitrogen ~~being~~ is the major constituent of chlorophyll therefore ~~increase~~ increases in nitrogen availability lead to ~~an~~ increase in chlorophyll content. Similar results of higher chlorophyll content were reported by Subramanian and Janardan, (1992), Hokmalipour and Darbandi (2011), Baharvand *et al.* (2014), Rekha (2014), Singh *et al.* (2015) and Meena *et al.* (2016).

The interaction effect due to tillage and nutrient levels on chlorophyll content at 30, 60 DAS and at harvest was non-significant.

### 5. Grain yield (kg ha<sup>-1</sup>)

Data pertaining to grain yield (kg ha<sup>-1</sup>) as influenced by tillage and nutrient levels is presented in Table 2.

The experimental findings revealed that tillage exerted a significant impact on the grain yield of maize. Within the various treatments, M<sub>3</sub> (residue incorporation along with microbial consortium spray) recorded significantly ~~the~~ highest grain yield (9239 kg ha<sup>-1</sup>) but, it was on par with M<sub>4</sub> (zero tillage) (8896 kg ha<sup>-1</sup>). However, ~~the~~ significantly lowest grain yield was with M<sub>1</sub> (conventional tillage) (8340 kg ha<sup>-1</sup>). Incorporation of the residues after picking the economic yield of soybean, interacted positively with the soil and the release of nutrients ~~have~~ enabled the maize to get ensured and continuous nutrient supply during ~~the~~ entire crop growth period. In addition, spraying of microbial consortium helped in quicker decomposition and mineralization of residues which had coincided with the ~~nutrient-nutrient~~ demanding growth stages of succeeding maize. This contributed ~~for~~ to the better growth, yield attributes and ultimately the grain yield of maize over no residue incorporation. The present findings are with the results reported by McDonalgh *et al.* (1993), Bahl and Pasricha (2000), Cheruiyot *et al.* (2001), Kouyate *et al.* (2001), Beary *et al.* (2002), Mubarak *et al.* (2002), Sidhu *et al.* (2003), Okito *et al.* (2004), Sakonnakhon *et al.* (2005), Shafie *et al.* (2007), Adeboye (2008), Okonofua *et al.* (2008), Lelei *et al.* (2009), Egbe and Ali (2010), Amusan *et al.* (2011) and Arif *et al.* (2011), Ammaji (2014), Rajkumara *et al.* (2014) and Shah *et al.* (2014).

Various nutrient levels have exhibited a notable influence on the grain yield of maize at the time of harvest. Application of 100% RDF (N<sub>1</sub>) recorded significantly highest grain yield (9140 kg ha<sup>-1</sup>) and it was on par with (N<sub>2</sub>) i.e., 100% RDN & P and 50% RDK (8930 kg ha<sup>-1</sup>) whereas significantly lowest grain yield was with (N<sub>3</sub>) 87.5% of RDN, 75% RDP and 75% RDK (8193 kg ha<sup>-1</sup>). The favorable

response and advantageous outcomes resulting from [the](#) increased nutrient application on grain yield can be attributed to the enhanced availability of essential nutrients necessary for crop growth. This reflected in overall improvement in crop growth in terms of more leaf area and dry matter which helped in [the](#) preparation of more photosynthates and translocated them to the sink. In addition to these, increasing [the](#) level of fertilization ~~improved~~ [improves](#) the cation exchange capacity of plant roots and thus makes them more efficient in absorbing nutrient ions. All these reflected in [an](#) increase in various yield attributes ~~and~~ which finally reflected in higher grain yield. The present findings are with the results reported by Chauhan (2010), Khan *et al.* (2011), Raskare *et al.* (2012), Meena *et al.* (2013), Imran *et al.* (2015), Singh *et al.* (2015), Meena *et al.* (2016) and Sindhi *et al.* (2016). The interaction effect due to tillage and nutrient levels on grain yield ( $\text{kg ha}^{-1}$ ) of maize at harvest was found non-significant.

UNDER PEER REVIEW

**Table 1 Plant height and leaf area of maize at different intervals as influenced by tillage and nutrient levels.**

**Comment [4301]:** Put the description of the abbreviation under the table.

Treatments	Plant Height (cm)			Leaf Area (cm <sup>2</sup> )		
	30 DAS	60 DAS	At harvest	30 DAS	60 DAS	At harvest
<b>Main plots: Tillage</b>						
<b>M<sub>1</sub></b> : Conventional tillage	56	150	234	94.84	367.97	382.72
<b>M<sub>2</sub></b> : Residue incorporation	57	153	236	96.14	370.1	383.19
<b>M<sub>3</sub></b> : Residue incorporation (Residue incorporation along with microbial consortium spray)	65	165	253	101.83	384.39	397.91
<b>M<sub>4</sub></b> : Zero-tillage	63	160	250	98.1	378.62	391.14
SE.m ±	1.29	2.32	4.05	1.26	3.58	3.82
CD (p=0.05)	4	8	12	4.34	12.39	13.2
<b>Sub plots: Nutrient levels</b>						
<b>N<sub>1</sub></b> : 100% RDF	63	163	250	99.85	381.97	396.38
<b>N<sub>2</sub></b> : 100% RDN & P and 50% RDK	61	158	246	98.38	376.08	389.75
<b>N<sub>3</sub></b> : 87.5% of RDN, 75% RDP and 75% RDK	56	151	234	94.95	367.76	380.09
SE.m ±	2	3.04	4.33	1.4	4.5	4.38
CD (p=0.05)	5	9	12	4.17	13.39	13.01
<b>Interaction</b>						
<b>Nutrient levels at same level of tillage</b>						
SE.m ±	5.65	9.49	13.23	4.25	12.36	12.79
CD (p=0.05)	NS	NS	NS	NS	NS	NS
<b>Tillage at same level of nutrient levels</b>						
SE.m ±	7.32	12.11	16.99	5.01	14.25	16.31
CD (p=0.05)	NS	NS	NS	NS	NS	NS

**Table 2 Dry matter production, chlorophyll content and grain yield of maize at different intervals as influenced by tillage and nutrient levels.**

**Comment [4302]:** Put the description of the abbreviation below the table

Treatments	Dry matter (kg ha <sup>-1</sup> )			Chlorophyll content (%) (SPAD)			Grain yield (Kg ha <sup>-1</sup> )
	30 DAS	60 DAS	At harvest	30 DAS	60 DAS	At harvest	
<b>Main plots: Tillage</b>							
<b>M<sub>1</sub></b> : Conventional tillage	494	3390	14055	32.1	44.5	15.1	8340
<b>M<sub>2</sub></b> : Residue incorporation	519	3458	14538	33.2	46	17	8542
<b>M<sub>3</sub></b> : Residue incorporation (Residue incorporation along with microbial consortium spray)	565	3718	15396	36.2	49.7	20	9239
<b>M<sub>4</sub></b> : Zero-tillage	553	3669	14913	34.7	47.5	19.2	8896
SE.m ±	9.31	70.32	212.57	0.57	0.71	0.3	166.28
CD (p=0.05)	32	243	735	1.9	2.4	1.0	575
<b>Sub plots: Nutrient levels</b>							
<b>N<sub>1</sub></b> : 100% RDF	559	3708	15272	35.8	49.1	19.8	9140
<b>N<sub>2</sub></b> : 100% RDN & P and 50% RDK	550	3617	15001	34.7	47.9	19.1	8930
<b>N<sub>3</sub></b> : 87.5% of RDN, 75% RDP and 75% RDK	489	3350	13904	31.6	43.9	14.7	8193
SE.m ±	12.25	109.28	279.15	0.84	1.2	0.37	195.44
CD (p=0.05)	36	324	830	2.5	3.5	1.1	581
<b>Interaction</b>							
Nutrient levels at same level of tillage							
SE.m ±	44.09	269.66	872.22	2.65	3.41	2.63	592.72
CD (p=0.05)	NS	NS	NS	NS	NS	NS	NS
Tillage at same level of nutrient levels							
SE.m ±	76.14	369.97	1438.85	4.3	5.44	5.52	986.91
CD (p=0.05)	NS	NS	NS	NS	NS	NS	NS

## CONCLUSION

Tillage practices and nutrient levels have shown a significant impact on the growth and yield of maize. Residue incorporation with the microbial consortium (M<sub>3</sub>) and 100% recommended dose of fertilizer (N<sub>1</sub>) to maize consistently leads to significantly taller plants, larger leaf area, higher dry matter production, increased chlorophyll content and higher grain yield. Conversely, conventional tillage (M<sub>1</sub>) and reduced nutrient levels (N<sub>3</sub>) resulted in less favorable outcomes. These findings underscore the importance of sustainable practices and proper nutrient management in optimizing maize crop yields and quality. Implementing residue incorporation and balanced nutrient application holds promise for improving maize cultivation and food security, though further research is needed for broader validation.

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**Comment [4303]:** Try to replace the updated info in place of the old references

**Comment [4304]:** Adjust it with same referencing style with the others. Keep the consistency of the references

**Comment [4305]:** Make it correct

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