IMPACT OF TILLAGE AND NITROGEN MANAGEMENT PRACTICES ON GROWTH AND YIELD OF RABI MAIZE (*Zea mays* L.).

ABSTRACT

A field experiment was conductedin sandy loam soils of Agricultural Research Station, Karimnagarduring *Rabi*, 2022 in a split-plot design with three replications. Main plots includes three tillage practices viz., Zero tillage, Reduced tillage and Conventional tillage and sub plotsincludes three nitrogen levelsviz., 75 %N, 100%N and 125%N. The results revealed that, maize cultivation under conventional tillage recorded significantly highergrain yield (8324 kg ha^{-1}) which is statistically on par with reduced tillage treatment (7775 kg ha^{-1}). In turn reduced tillage was statistically comparable to zero-tillage treatment (7353kg ha^{-1}).Among different nitrogen levels examined, maize sown with 125% N application achieved significantly highest grain yield (8055 kg ha^{-1}). This yield was statistically comparable to grain yield observed with 100% N application (7896 kg ha^{-1}). While, significantly lowest grain yield (7501 kg ha^{-1}) was recorded with 75% N application.Significantly highest grain yield in conventional tillage which is statistically on par with reduced tillage and among nitrogen levels, highest grain yield with 125%N which is on par with 100% N may attributed to increase in crop growth parameters viz., plant height, leaf area index and higher yield attributes viz., cob length and diameter, kernel rows number. The study concludes thatmaize cultivation with conventional tillage or reduced tillage results in higher grain yield. Concerning different nitrogen levels, higher grain and economic yield was obtained with 100% N application.

Key words: *Maize, Tillage practices, Nitrogen management and Yield*

Introduction

Maize is the most important cereal crop of the world having wider adaptability under varied agro climatic conditions and assumes great importance in human nutrition, animal feed as well as industrial segment. It is the third major crop in India after rice and wheat contributing about 9 % of the total food grain production in India. It has varied utilization pattern such as 51% as poultry feed, 20-25% as human food, 10-12% as cattle feed and 1% as a seed. Stalks of maize are used for paper board, husk is used as filling material, cobs for fuel make, charcoal and preparation of industrial products like starch and brewery, oil, protein, alcoholic beverages, food sweeteners, pharmaceutical, cosmetic, film, textile, gum etc. It can play a vital role in ensuring food and national security. Its adaptability and economic uses is probably unmatched for India by any other cereals which made maize as important industrial crop. In India maize is currently grown in 9.86 m ha with a production and productivity of 31.51 mt and 3195 kg ha^{-1} respectively. In Telangana area, production and productivity of maize for the year 2020-2021 was 6.3 lakh acres, 1.75 mt and 6721 kg ha^{-1} respectively (Directorate of Economics & Statistics).

Tillage methods are used as basic and important operations to achieve higher yields. The appropriate tillage practices are required to provide a suitable environment for seed germination, for improvement of the soil structure, increase in soil aeration, reduction of surface runoff by increasing infiltration, weed control, moisture availability, organic N mineralization, availability of N for plant use and has beneficial effect on plant growth and as a result yield increases (Memon *et al.,* 2013).Use of proper tillage method may contribute to higher profit, crop yield, soil improvement, weed control and optimum use of water resources since tillage has a direct impact on soil and water quality (Sornpoon*et al.,* 2013). Therefore, specific knowledge on prevailing tillage systems is required for evaluating the best alternative strategies to increase crop productivity.

Among the major plant nutrients, nitrogen is the most important element required for improving the maize growth and development. Maize is a heavy feeder of nutrients, especially nitrogen, the deficiency of which limits the growth and yield of the crops. Over dependence on chemical fertilizers alone would lead to gradual decline in organic matter content and fertility of the soil, which in turn reflects on productivity, growth and yield of maize crop and hence requires better nitrogen management practices.Inclusion of legumes in the cropping system may play a vital role in increasing indigenous nitrogen production, helps in solubilizing insoluble phosphorous in soil, improving the soil physical environment, increasing soil microbial activity and restoring organic matter and also has smothering effect on weed.Legume crop residues after the harvest of the economic part are the good source of plant nutrients and serves as readily available energy for soil microbes because of their relatively high nutrient content, low lignin content and easy decomposition. Therefore, a strategy of integrated use of nitrogen through fertilizers in combination with cheaper sources of organic matter from the residues of legumes should be tried to satisfy the higher nitrogen requirement of the maize crop to produce higher quantity and quality yield of maize without impairing the soil health.Among the legumes, Soybean [*Glycine max* L.] known as the “golden bean” is the second largest oilseed crop in India after groundnut and is aptly termed as ‘miracle bean’ and ‘gold of soil’ due to its symbiotic nitrogen fixation to around 125-150 kg N ha^{-1} apart from residual nitrogen to an extent of 30-40 kg N ha^{-1} to succeeding crops (Lowrance *et al.,* 2017) and is recognized for its apparent nitrogen contributions and yield enhancing effects in crop sequences.

Keeping the above views under consideration, the present experiment has been planned and executed.

MATERIALS AND METHODS

This investigation was executed during *rabi* season of 2022 at Agricultural Research Station, Karimnagar, Professor Jayashankar Telangana State Agricultural University. The Agricultural Research Station was located at an altitude of 259.15 m above mean sea level on 18◦44’31” N latitude and 79◦09’52” E longitude and it is categorized under Northern Telangana Zone. The soil texture of experimental field was sandy loam, medium in organic carbon (0.37%), low available nitrogen (198kg ha^{-1}), and high in available phosphorus (26.4 kg ha^{-1}) and high in available potassium (335kg ha^{-1}).

The experiment was sown in split plot design with three replications. Main plots includes three tillage practices viz., Zero tillage, Reduced tillage and Conventional tillageand subplots includes three nitrogen levels viz., 75 %N, 100%N and 125%N with spacing of 60 x 20 cm.All recommended package ofpractices done pertaining to managementpractices.

The data collected on growth parameters at different crop growth stages, yield attributes, grain and stover yield from the experiment was statistically analysed by analysis of variance utilizing split plot design (Gomez and Gomez (1984).

RESULTS AND DISCUSSION

Crop growth parameters

Plant height (cm): The data pertaining to maize plant height at different growth stages is significantly influenced by tillage and nitrogen management practices (Table 1.). While interaction was found non-significant.

The tillage practices have a substantial impact on maize plant height, indicates an ascending trend at different growth stages – six leaf, silking, dough and physiological maturity. Maize cultivated with conventional tillage recorded significantly increased plant height at all the growth stages (61, 204, 213, 226 cm) followed by reduced tillage (54,192, 202,217 cm). While significantly lowest was recorded in zero tillage treatment (45, 178, 187, 200 cm).The increase in plant height in conventional tillage may be attributed to several factors. These include improved soil structure, good soil tilth, which reduces competition from weeds, as well as enhanced aeration, soil moisture level and nutrient availability. These factors collectively may have promoted better root growth, ultimately leading to significant increase in plant growth. Similar outcomes were documented by Anjum *et al*. (2014) and Karki *et al*. (2014), Memon *et al.* (2013) reinforcing the validity of these findings.

Among different nitrogen levels, higher nitrogen application of 125% N was consistently linked to increased plant height at all growth stages i.e., six leaf, silking, dough and physiological maturity with 56, 196, 206, 219 cm respectively. Which is found to be statistically on par with 100 % N application (54, 192, 203, 217 cm) across all growth stages respectively. On the other hand, 75% N application resulted in significantly lower plant height (50, 185, 193, 208 cm) respectively at all growth stages.
Throughout the vegetative growth stage of crop, nitrogen uptake by plant significantly governs its growth rate, primarily due to the active protein metabolism within meristematic tissues. The observed increase in plant height positively correlated with higher nitrogen application, indicates an enhanced vegetative

growth resulting from improved nitrogen availability.These results are in conformity with the results obtained by Stesi*et al.* (2020), Assefa *et al.* (2019).

Table 1. Plant height at different crop growth stages in maize as influenced by tillage and nitrogen management practices.

Treatment	Plant height (cm) at			
	Six leaf stage	Silking stage	Dough stage	Physiological maturity stage
Tillage practices				
Zero tillage	45	178	187	200
Reduced tillage	54	192	202	217
Conventional tillage	61	204	213	226
SEm±	1.0	2.0	1.7	0.8
CD (0.0.5)	4.8	8.1	6.8	3.4
Nitrogen levels				
75% N +100%P&K	50	185	193	208
100 NPK	54	192	203	217
125% N +100% P&K	56	196	206	219
SEm±	0.8	1.4	1.1	1.6
CD (0.0.5)	2.6	4.4	3.3	4.9
Tillage practices at same level of nitrogen levels				
SEm±	1.7	2.8	2.3	2.4
CD (0.05)	NS	NS	NS	NS
Nitrogen levels at same level of tillage practices				
SEm±	2.1	3.5	2.9	1.5
CD (0.05)	NS	NS	NS	NS

Leaf area index: Examination of data indicates that throughout all stages, the conventional tillage method (1.60, 4.51, 4.74, 2.84) consistently displayed significantly highest leaf area index. This was followed by reduced tillage approach (1.42, 4.14, 4.50, 2.49). While significantly lowest leaf area index was found in zero tillage treatment (1.23, 3.74, 4.26, 2.26) respectively at six leaf, silking, dough and physiological maturity stages.The increase in leaf area could potentially be attributed to improved plant growth and maximized photosynthetic area, facilitated by enhanced soil tilth, improved aeration, improved water retention capacity in the soil, as well as more favorable root growth and proliferation. Comparable results were documented by Kumar *et al.* (2018).

At six leaf, silking, dough and physiological maturity stages, maize crop with 75% N application is recorded significantly lowest leaf area index (1.35, 3.90, 4.41, 2.42 respectively). While application of 100% N (1.42, 4.20, 4.53, 2.57) is statistically comparable to the leaf area index registered with 125% N (1.46, 4.30, 4.57, 2.61) at respective growth stages. Leaf area index showed a steady increase up to 60

DAS and thereafter a declining trend was noticed towards physiological maturity stage. The increase in LAI was possibly due to higher N level which increased chlorophyll content of plants influencing the cell and tissue growth with higher photosynthetic efficiency (Manjulatha and Sumalini 2021).Similar results are conformed byStesi*et al.* (2020). Interaction effect due to tillage and nitrogen management on leaf area index was found to be non-significant (Table.2).

Table.2. Leaf area index at different growth stages as influenced by tillage and nitrogen management practices in maize succeeding soybean crop.

Treatment	**Leaf area index at**			
	Six leaf stage	**Silking stage**	**Dough stage**	**Physiological maturity stage**
Tillage practices				
Zero tillage	1.23	3.74	4.26	2.26
Reduced tillage	1.42	4.14	4.50	2.49
Conventional tillage	1.60	4.51	4.74	2.84
SEm±	0.04	0.06	0.03	0.04
CD (0.0.5)	0.14	0.23	0.12	0.17
Nitrogen levels				
75% N +100%P&K	1.35	3.90	4.41	2.42
100 NPK	1.42	4.20	4.53	2.57
125% N +100% P&K	1.46	4.30	4.57	2.61
SEm±	0.01	0.03	0.02	0.02
CD (0.0.5)	0.04	0.10	0.05	0.06
Tillage practices at same level of nitrogen levels				
SEm±	0.04	0.07	0.04	0.05
CD (0.05)	NS	NS	NS	NS
Nitrogen levels at same level of tillage practices				
SEm±	0.06	0.10	0.05	0.07
CD (0.05)	NS	NS	NS	NS

Yield attributes

Cob length (cm): Among different tillage practices, Conventional tillage recorded significantly highest cob length (20.3 cm) and it was on par with reduced tillage (19.3 cm), which is inturn on par with zero tillage treatment (17.9 cm).In the context of different nitrogen levels tested, treatment with 125% N recorded significantly highest cob length (21.0 cm) which is on par with 100% N (19.6 cm). The treatment with 75% N application observed significantly lowest cob length of 17.7 cm (Table 3).

Cob length is significantly influenced by various tillage and nitrogen management practices. The highest cob length was consequent of good plant growth under conventional tillage because maximum number of leaves, leaf area index and taller plant increased the green surface area for light interception and more formation of photosynthates and their efficient translocation from source to sink. Among the nutrient management practices, increased nitrogen application (125%) produced highest cob length due to higher nitrogen availability lead to an enhanced growth attributes that increased the plant growth i.e., leaf area and dry matter accumulation of plant by more cell division and cell elongation and resulted in increased cob length. Similar results was reported by Singh *et al.* (2018), Pandey *et al.* (2019).

Ear diameter (mm): A review of the data highlights the notable impact of tillage practices on ear diameter. The conventional tillage recorded significantly greatest ear diameter (45.8 mm). This was on par with reduced tillage (43.0 mm) in maize crop succeeding soybean. Similarly, ear diameter noticed in reduced tillage was statistically comparable to zero-tillage (39.9 mm).Treatment with 125% N recorded significantly highest ear diameter (44.1 mm) which is statistically comparable with 100 % N (43.1 mm).and significantly lowest was found in 75% N treatment (41.3 mm). Interaction effect due to tillage practices and nitrogen levels on ear diameter was found non- significant.

Ear diameter of cob was recorded numerically higher under conventional tillage and on par with reduced tillage. In general, conventional tillage or reduced tillage recorded higher growth parameters as more number of leaves, leaf area index which increased total photosynthesis and inturn yield. Pandey *et al.* (2016) confirmed the above result earlier.

The enhanced nitrogen application recorded higher ear diameter may be due to availability of more nutrition resulted enhancement in growth attributes lead to good photosynthate partitioning and better source–sink relationship, which ultimately resulted in the form of enhanced Ear diameter. This line was also confirmed by Kumar *et al.* (2014).

Kernel rows cob^{-1}: The kernel rows cob-1 was subjected to the influence of various tillage practices. The data in Table No.3. demonstrates that conventional tillage displayed significantly highest number of kernel rows cob^{-1} (17.7). It was on par with reduced tillage (16.5) kernel rows cob^{-1}. In similar way, zero tillage practice resulted in significantly lowest kernel rows cob^{-1} (15.3 mm) and it is statistically comparable with reduced tillage. Even though it might be genetical trait, the better crop growth under conventional and reduced tillage succeeding soybean realized good cob size with higher number of grain rows cob^{-1}.

Enhanced dose of nitrogen (125%N) resulted in significantly highest no.of kernel rows cob^{-1} (18.0) which is statistically comparable with 100% N treatment (17.0). While, significantly lowest kernel rows cob^{-1} recorded in 75 % N application (14.6). Interaction effect due to tillage practices and nitrogen levels on Kernel rows cob1was found non- significant (Table No.3).

Kernel number row^{-1}: The results pertaining to kernels row^{-1} indicated that, significantly highestno.of kernels row^{-1} were observed under conventional tillage (36.4) which is on par with reduced tillage (34.7). Inturn, reduced tillage practice resulted in on par kernel number rows^{-1} that of zero tillage treatment (33.0 mm).

The assessment of different nitrogen levels, indicated that maize crop sown with 125%N (37.0) registered significantly higher no. of kernels row^{-1} which was on par with 100% N treatment (35.6). In contrast, significantly lowest kernel number rows^{-1} was observed with 75%N application (32.0).

Among the tillage practices, conventional and reduced tillage recorded more number of grains row $^{-1}$ might be ascribed to the highest cob length observed under conventional and reduced tillage in maize crop succeeding soybean. The cob length directly influence the number of grains row $^{-1}$ as it directly dependent on the cob length. The treatments involved in enhanced nitrogen produced more grain in a single row may be due to the application of fertilizer fulfills the nutrient demand at critical growth stage attributed to better growth and partitioning of photosynthates. This line was earlier confirmed by Biradar *et al.* (2006) and Bana *et al.* (2020).The interaction effect due to tillage practices and nitrogen levels on number of kernels row^{-1} was found to be non- significant (Table *3*).

Table 3. Yield attributes in maize as influenced by tillage and nitrogen management practices.

Treatment	cob length (cm)	Ear diameter (mm)	Kernel row cob $^{-1}$	Kernel number row^{-1}
Tillage practices				
Zero tillage	17.9	39.9	15.3	33.0
Reduced tillage	19.3	43.0	16.5	34.7
Conventional tillage	20.3	45.8	17.7	36.4
SEm±	0.4	0.8	0.3	0.4
CD (0.0.5)	1.6	3.1	1.2	1.7
Nitrogen levels				
75% N +100%P&K	17.7	41.3	14.6	32.0
100 NPK	19.6	43.1	17.0	35.6
125% N +100% P&K	21.0	44.1	18.0	37.0
SEm±	0.4	0.4	0.2	0.6
CD (0.0.5)	1.4	1.3	1.0	1.8
Tillage practices at same level of nitrogen levels				
SEm±	0.5	1.0	0.4	0.9
CD (0.05)	NS	NS	NS	NS
Nitrogen levels at same level of tillage practices				
SEm±	0.7	1.3	0.5	0.7
CD (0.05)	NS	NS	NS	NS

Grainand stover yield (kg ha^{-1})

Grain yield(kg ha^{-1}): The results of the experiment indicate a noteworthy effect of tillage practices on grain yield. Among different tillage approaches studied, the conventional tillage treatment stood out with significantly highest grain yield (8324 kg ha^{-1}) which is statistically on par with the reduced tillage treatment (7775 kg ha^{-1}). In turn reduced tillage was statistically comparable to zero-tillage treatment (7353kg ha^{-1}). Among different nitrogen levels examined, maize sown with 125% N treatment achieved significantly highest grain yield (8055 kg ha^{-1}). This yield was comparable to the grain yield observed with 100% N application (7896 kg ha^{-1}). Conversely, significantly lowest grain yield (7501 kg ha^{-1}) was recorded with 75% N application (Table 4).Grain yield is significantly higher in conventional tillage practice. This could be ascribed to the fine soil tilth, perfect land levelling which might have contributed to better germination and establishment with efficient utilization of resources including available soil moisture, nutrients and solar energy at all stages of crop growth and lower weed infestation under conventional tillage practice inturn resulted in better plant growth, maximum dry matter accumulation, higher yield attributes and ultimately final grain yield. The grain yield of maize with reduced tillage was on par with conventional tillage. The possible reason might be maize crop sown after soybean exhibited good crop growth in terms of dry matter, crop growth rate and absolute growth rate and cob length, diameter kernel rows cob^{-1}, kernel number row^{-1}, are inturn resulted in higher grain yield in reduced tillage on par with conventional tillage.The grain yield of maize is dependent on the quantity of nitrogen fertilizer applied. Which is involved in regulating the biological, physiological and chemical process of growth in maize plant. The treatment receiving highest dosage of N ultimately produced highest grain yield due to the better availability and assimilation of nutrient at different growth stages.These results are similar with the findings of Kamsu*et al.* (2022), Ray *et al.* (2020) and Gul *et al.* (2015).

Stover yield (kg ha^{-1}): Upon examining the data, it becomes evident that choice of tillage practices significantly impacts stover yield. Among various tillage methods, conventional tillage treatment showed significantly highest stover yield (9700 kg ha^{-1}) and it was statistically on par with reduced tillage treatment (9273 kg ha^{-1}). In similar way treatments involved in reduced tillage was statistically comparable to zero tillage (9042 kg ha^{-1}). The stover yield was notably affected by varying nitrogen levels. Among different nitrogen levels tested, maize sown with 125% N application achieved significantly highest stover yield (9488 kg ha^{-1}). This outcome was statistically comparable with stover yield obtained from the 100% N application (9408 kg ha^{-1}). In contrast, significantly lowest stover yield was observed with the 75% N (9118 kg ha^{-1}) application (Table 4).Growth parameters viz., plant height, leaf area, crop growth rate, absolute growth rate, dry matter production have a positive correlation with the stover yield, which are greater in treatments involved in conventional and reduced tillage. Enhanced nitrogen application treatments recorded highest stover yield due to cumulative effect of greater value of growth attributes of higher plant height, leaf area, crop growth rate, absolute growth rate, dry matter production which to higher stover yield. These findings are in line with Hasnain *et al.* (2021), Modak *et al.* (2019), Sharma and Gautam (2010).

Table 4. Grain yield (kg ha^{-1}), stover yield (kg ha^{-1}) in maize as influenced by different tillage practices and nitrogen levels.

Treatment	Grain yield (kg ha^{-1})	Stover yield (kg ha^{-1})
Tillage practices		
Zero tillage	7353	9042
Reduced tillage	7775	9273
Conventional tillage	8324	9700
SEm±	136	106
CD (0.0.5)	549	429
Nitrogen levels		
75% N +100%P&K	7501	9118
100 NPK	7896	9408
125% N +100% P&K	8055	9488

SEm±	92	74
CD (0.0.5)	287	229
Tillage practices at same level of nitrogen levels		
SEm±	188	149
CD (0.05)	NS	NS
Nitrogen levels at same level of tillage practices		
SEm±	236	184
CD (0.05)	NS	NS

CONCLUSIONS

Based on the above results, the study concluded that maize cultivation with conventional tillage or reduced tillage results in higher grain yield. Concerning different nitrogen levels, higher grain and economic yield was obtained with 100% nitrogen application.

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