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INFLUENCE OF TILLAGE AND NUTRIENT MANAGEMENT PRACTICES ON YIELD AND YIELD ATTRIBUTES OF MAIZE (*ZEA MAYS* L.)

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ABSTRACT

An investigation was carried out at Agricultural research farm of Banda university of Agriculture and Technology Banda U.P. during the Kharif season 2021. The comprehensive aim of experiment was to explore the most appropriate tillage practices for the maize crop that could produce optimum yield more remunerative along with better profitability and also to find out effective nutrient management practices that suited well to the region. The experiment comprises of two factor treatments conducted in split plot design with three main plot factor and three sub-plot factors. The total combination of treatments was nine and each treatment replicate thrice. The main plot consisted of the tillage practices namely, zero tillage, conventional tillage and permanent bed. Further, each main plot had divided in to 3 sub-plots held three nutrient management practices viz. 33% recommended dose of nitrogen (40 kg N ha^{-1}), 100% recommended dose of fertilizer (N:P:K-120:60:50 kg ha^{-1}) and site specific nutrient management (N:P:K-160:50:60 kg ha^{-1}). The soil in which experiment conducted was silty clay and their pH value 7.89, EC 0.55 dSm^{-1} and total organic carbon was 0.76%. The observation in growth parameter and quantitative and qualitative attributes of maize were recorded as per schedule. During the field study it was observed that the highest yield attributes (number of cobs ha^{-1}, number of rows cob^{-1}, number of grains row^{-1}, number of grain cob^{-1}, nob length (cm), nob girth (cm) and Seed index), grain yield and biological yield recorded under zero tillage. Among the nutrient management practices the site-specific nutrient management (SSNM) practice produced maximum yield (economic yield and biological yield) and yield attributes. Among all interaction of tillage and nutrient management practices, the zero-tillage practice along with SSNM produced maximum output, more remunerative and this combination practically feasible and economically viable to production of maize.
***Keywords* :** SSNM, Zero tillage, Yield, Girth, Yield

Introduction

Maize (*Zea mays* L.) is one of the most versatile and miracle crops grown throughout the world because of its production potential, industrial use and adoptability to wide range of environments. Maize is photo insensitive crop that helps to grown irrespective of the season. It is grown from 60-degree N in temperate countries like Canada and Russia to 40-degree S latitude in tropical countries such as Argentina, Brazil, Nigeria from the sea level to an altitude of >4000 m in Peruvian Andes, in region with <25 cm rainfall in semi-arid plains of Russia to >1000 cm rainfall in north east India (Prasad, 2018). It seems that, there is no cereal on the earth which has immense potentiality and that is why it is called 'queen of cereals. Several workers say Maize is originated in Mexico. Cultivated maize originated from pod corn, a form in which the individual kernels are enclosing in floral bract. Maize is originated from its closest relative, teosinte, by direct selection, by mutation, or by hybridization of teosinte with an unknown grass now extinct. Maize grows in almost all the state of India. In India, maize covers 10.04 mha acreage and produces 33.62 mt with an average productivity 3349 kg ha^{-1} (DAC&FW 2022). India is the fifth largest producer of maize after USA, China, Brazil and Mexico in the world contributing 3% of the global production. In India, nearly 75% of maize production is from kharif season and remaining 25% during rabi and spring/summer season. Maize grains contain about 10% protein, 4% oil, 70% carbohydrate, 2.3% crude fiber, 10.4% albuminoides, 1.4% ash. However Maize protein 'zein' is deficient in tryptophan and lysine, the two essential amino acids (Prasad, 2018). Food security is major concerned of India. At present, it is difficult to increase acreage as well as irrigation because of stiff competition among different sectors; therefore, to enhance the crop productivity is the only option to increase food and nutritional security of the country (Kumar and Kumar, 2018). For improving maize productivity, suitable hybrid along side of tillage and nutrient practices are key resource therefore these aspects have taken in to consideration of research problem proposed. Tillage is one of the basic agro-technical operations in agriculture because of its influence on soil properties, environment and crop growth. Since, continuous soil tillage strongly influences the soil physico-chemical and biological environment. Therefore, tillage has been an integrated component of all crops includes maize also mainly because it provides good soil tilth, improves water holding capacity, increase aeration, enhances microbial activity of soil to enhance nutrients uptake and also moderates soil hydraulic conditions (Karmi *et al.*, 2012). Farmer should adopted appropriate tillage practices according to their situation because role of tillage in production of all crops includes maize also very important. Permanent Bed planting helped in increased aeration of the root zone and assured plant stand by the increasing emergence, particularly in crusting type soils, which resulted in higher growth, and yield attributes of maize as compared to conventional tillage (Yadav *et al.,* 2016). In contrast many beneficial effects of no-till/zero-till and minimum tillage have also been reported like increased porosity, aggregation, organic carbon, water holding capacity, better infiltration and decreases bulk density. Adoption of no-till practice helps in timely seeding either of the crops in sequence, hence leads to increase in productivity (Jat *et al.,* 2011). The productivity of maize is largely dependent on its nutrient management. Existing nutrient management practices are not able to capture the momentum change in the scenario of soil nutrient supply capacity and plant nutrient demand for achieving higher yield target. Maize grown in a wide range of climatic conditions in India, proper assessment of the limiting conditions for maize production and productivity is difficult but inappropriate nutrient management is one of the most important factors limiting maize production. It is a general practice in our country to provide blanket recommendation of fertilizer for production of various crops. The general recommendation may not be equally effective across diverse agro-ecological regions, and soil types as nutrient uptake and crop yield are affected by the soil type and climate. The blanket fertilizer recommendations do not account the change in ecology and the genetic potential of the genotype (Kumar *et al*., 2014). Among the essential plant nutrients, nitrogen (N) is the most limiting one. However, both excess and deprived application could be detrimental to plants. Nitrogen shortage during the vegetative growth period directly affects root development, stem elongation, cell division and uptake of other nutrients, while impairs pollen shedding, fertilization, grain filling, and premature senescence of leaves, if it extends to flowering and later stages. In contrast, excess supply of N with a low potassium dose promotes vigorous vegetative growth, taller plant stature, and higher risk to lodging (Dhakal *et al.,* 2021). The huge yield gap exists due to the mismatch between state recommendation and farmer's practice which not only decreases the yield but also causes nutrient mining. In addition, it increases environment risk associated with loss of unutilized nutrient through emission or leaching. Therefore, the intervention on plant nutrition's like Site-Specific Nutrient Management (SSNM) and Recommended Dose of Fertilizer (RDF) based on proper field experimentations and crop response, covering special variability in indigenous nutrient supplying capacity of soil are urgently required.

Material and Method

Experimental site

The experiment was conducted at University research farm 'Banda university of Agriculture and Technology Banda-210001 (Uttar Pradesh) during the kharif season 2021, is situated between latitudes 24º 53′ and 25º 55′ N and longitudes 80º 07′ and 81º 34′ E and having an altitude of 168m above sea level. This region falls under agro climatic zone VIII (Central Plateaus & Hills Region) of India. All required facilities to conduct the experiment are available on this farm.

Climatic Condition

Bundelkhand is situated in the hot and semi-arid climatic zone, and is characterized by temperature extremes that reach peak 49°C in the summer and 1°C in the winter. Hot waves, a powerful, dusty and hot wind in dry summer that blows across the entire region during the summer months, especially in May and June, sometimes causes fatal heat strokes. This zone's rainfall distribution pattern is erratic, with the part of rain falling during the monsoon months of June to September. The average annual precipitation is 850 mm, but due to undulated topography and a lack of infrastructure for water harvesting for future use, the majority of the rain is lost to runoff. Soil types in Bundelkhand are bleck and a mix of black and red; the latter being formed recently. The black soils are deep, having medium organic carbon content with high moisture holding capacity while mixed soils are gravelly and shallow in depth, and thus unable to retain enough moisture.

Rainfall (mm) in crop season

Total rainfall was received in 28th week before sowing and 29th sowing week was 18.25 mm and 118 mm respectively. Vegetative growth period 30th to 35th week recorded total rainfall during this period was 393.5 mm. Reproductive phase of crop started from 36th and complete in 38th week during which received rainfall was 128 mm. the rainfall received during grain filling to harvesting was 41 mm. Total rainfall received during experiment was 750 mm and out of total rainfall 391.5 mm was received between 28th to 31th week which revealed that erratic rainfall distribution.

Experimental Details

The experiment was consisted of 2 factors with 9 treatment combinations. The treatment tillage practices, nutrient management practices allocated in main plot and sub plot respectively. The experiment was laid out in split plot design with 3 replications. In main plot tillage practices Zero tillage (T_1), Conventional tillage (T_2) and Permanent bed tillage (T_3) were allocated. In sub plot nutrient management practices 33% recommended dose of nitrogen (40 kg N/ha) F_1, Recommended dose of fertilizer ($N:P_2O_5:K_2O$ kg/ha, 120:60:50 kg/ha F_2 and Site specific nutrient management ($N:P_2O_5:K_2O$ kg/ha, 160:50:60 kg/ha) F_3 were allocated.

Treatment application

Preparation of field

The experimental area was prepared as per treatment detail, however in conventional tillage two deep ploughing followed by two cultivator and planking employed, similarly same practices were employed in permanent bed tillage and later permanent bed were marked with the help of bed maker. Nevertheless, in zero tillage no tillage was applied.

Fertilizer application

Application of fertilizer was scheduled as basal of 1/3rd of nitrogen and total amount of phosphorous and potassium of recommended dose as per treatment by seed-cum fertilizer drill. Remaining 2/3rd part of nitrogen were applied in two equal doses. First top dressing (sub-surface bending) of nitrogen was done at knee height (30 DAS) stage and second top dressing (surface bending) at tasseling (52 DAS) stage. Sub-surface nutrient placement is the method of putting essential crop nutrients like nitrogen, phosphorous and potassium below the soil surface in the root zone available for plant to uptake.

Observations recorded

Five plants were taken and tagged from net plot at initial stage and tagged plants remain kept available for the recording observation at different stages of growth to till maturity of crop.

Yield attributes

The following observations on yield attributes and yield studies were recorded during the experiment.

Number of cobs ha^{-1}

It was calculated by select the three rows and count the total number of plant and cobs in these rows then the average values of cob/plant were multiplied by total plant population.

Cob girth (cm)

The cob girth of five cobs was measured with the help of vernier caliper. It was measure the diameter of corn then diameter was changed in girth by multiplying with 3.14 (value of π) and the average value was expressed in cm.

Number of rows cob^{-1}

Five cobs were selected for count number of rows and average values were taken. Cob rows per cob were obtained always in even number.

Cob length (cm)

Five cobs were randomly selected from each plot at the time of harvesting. The husk was removed and length was measured with the help of scale and average value expressed in cm.

Number of grains row^{-1}

Five cobs were randomly selected from each plot at the time of harvesting. Count the number of grains in five rows and then average value was taken.

Number of grains cob^{-1}

Five cobs were randomly selected from each plot at the time of harvesting. Count the number of grains in five rows and the average value of these rows were multiplied by number of rows and then get number of grains cob^{-1}.

Seed index (g)

From each plot 100-grains were counted and their weight was recorded to obtain the seed index in gram.

Crop yield

Economic yield (q ha^{-1})

The cobs were dehusked and moisture taken from the sample of each plot. Grain weight was taken from each plot in kg plot^{-1} converted into q ha^{-1} by using following formula.

$$\text{Economic yield (q/ha)} = \text{Grain weight (kg/plot)} \times \frac{100 - \text{moisture \% in grains}}{100} \times \frac{1.176 \times 0.8 \times 10000}{\text{Plot size}\left(m^2\right) \times 100}$$

Where,

1.176 = Constant used for 15 % moisture level

0.8 = shelling per cent

Biological yield (q ha^{-1})

Biological yield was obtained by plants of each plot cut from ground level with the assistance of sickle after removal of cobs. Plants and cobs were kept for sundry to obtain a constant weight which gave the biological yield in kg plot^{-1} and then converted into q ha^{-1} after summing the gross cob weight which was harvest before cutting of stover and stover weight.

Biological yield = Gross cobs weight + stover yield.

Harvest index (%)

The harvest index was calculated by dividing the economic (grain) yield to the total biological yield (gross cob weight + stover weight) and multiplying the factor by 100.

$$\text{Harvest index (\%)} = \frac{\text{Economic yield}}{\text{Biological yield}} \times 100$$

Statistical analysis

The data obtained from different perception on growth, yield and yield attributes net return, gross return and B:C ratio were subjected to statistical analysis by utilizing Split Plot Design as described by Gomez and Gomez (1984) with the help of standard procedures of Analysis of Variance (ANOVA).

Result and Discussion

Effect of tillage and nutrient management practices on yield attributes

Number of cobs ha^{-1}

The data regarding number of cobs ha^{-1}at harvest (table 1.0) showed that none of the treatments and treatment combinations lucidly affects the total number of cobs produced irrespective of treatments (tillage practices and nutrient management practices). The number of cob ha^{-1} among different tillage and nutrient management could not touch the level of significance because it was determined by plant population. Non-remarkable variation in plant population was the reason for at par differences on number of cobs among different treatments.

Number of rows cob^{-1}

The data regarding number of rows cob^{-1} are summarized in table (1.0). It is clearly showed that none of the treatment and treatment combinations caused marked differences in producing more. In general maximum and minimum number of rows cob^{-1} was recorded with zero tillage and permanent bed while, increasing rate of fertilizer increases number of rows. None of the treatment exerted marked variation on the number of rows cob^{-1}. However, cob girth and rows are highly stable character of a distinct variety hybrid. The cob girth and number of rows cob^{-1} are basically representing the genetic behavior of variety. Therefore, cob girth under investigation indicated non-significantly varied among tillage and nutrient management practices.

Number of grains cob row^{-1}

Data pertaining to number of grains cob row^{-1} presented in table 1.0. Number of grain cob row $^{-1}$ distinctly influenced by various tillage and nutrient management practices. A close study of data revealed that zero tillage recorded remarkable number of grain cob row^{-1} (32.52) over permanent bed (29.38) while it was remained statistically comparable with conventional tillage practice (30.72). Among the tillage practices, zero tillage recorded a greater number of grains row^{-1} might be ascribe to the longest cob observed under zero tillage. The cob length directly influences the number of grains row^{-1} as it directly dependent on the cob length. Scrutiny of data once again imposed marked variation under various nutrient management practices for the number of grain cob row^{-1}. Under Site specific nutrient management noted lucidly maximum (31.75) number of grains cob row^{-1} over 33% recommended dose of nitrogen (29.29) while, it was similar to 100% recommended dose of fertilizer (31.59). The SSNM produced more grain in a single row may be due to it meet out the nutrient demand of crop and application of fertilizer according to 4R principle which fulfill the nutrient demand at critical growth stage attributed to better growth, sink-source ratio and partitioning of photosynthates. This line was earlier confirmed by Biradar *et al. (*2006) and Bana *et al.* (2020).

Number of grains cob^{-1}

A perusal of data presented in 1.0, various treatment exerted lucid effect on number of grain cob^{-1} during field experimentation on maize. It could be seen that number of grain cob^{-1} was significantly affected by different tillage operations. However, it could be noted that zero tillage recorded remarkably maximum (473) number of grain cob^{-1} hence forth significantly minimum value was recorded with permanent bed (417) while, statistically close to the conventional tillage (446) practice. Zero tillage recorded the higher number of grains cob^{-1} might be due to lower bulk density, more aggregation might have facilitated the root proliferation in the soil and increased the rate of water, air and nutrient uptake and movement. The last plays an important role in tissue development, cell division, enhance plant growth, and thereby increased number of grains per cob (Ramadhan, 2021).

Data regarding to number of grain cob^{-1} was lucidly affected by different nutrient management practices. Among the nutrient management practices site specific nutrient management exerted marked variation and it recorded maximum number of grain cob^{-1} (462). However, 100% recommended dose of fertilizer (453) and 33% recommended dose of nitrogen (419) failed to cause distinct differences between each other during field experiment. SSNM produced a greater number of grains cob^{-1} might be ascribe to it provided adequate amount of N, P and K in balance dose at appropriate time and place which enhance, the synthesis and translocation of phtosynthates efficiently to the cob resulted better grain filling (Khanal *et al.,* 2017).

Cob length (cm)

The scrutiny of data on cob length presented in table 1.0 illustrates that none of the tillage practices expressed marked variation. However, different nutrient management practices and their combinations with tillage caused remarkable variation. Scanning of data revealed that none of the tillage operation imposed significant variation on cob length. But in general, zero tillage recorded slightly long cob as compare to other tillage operations.

Study of data again exhibited that site specific nutrient management produced lucidly longer cob (17.83 cm) however, it proved significantly superior over 33% recommended dose of nitrogen (16.94 cm) but it again remained non-significant to the 100% recommended dose of fertilizer (17.37 cm). SSNM produced the highest cob length due to balanced application of the nutrients lead to enhanced growth attributes that increased the plant growth by more cell division and cell elongation resulted cob gain maximum length (Singh *et al.,* 2018). Increased nitrogen dose resulted in more availability of N which helped in crop growth as evident by leaf area and dry matter accumulation per plant due to this it caused longer cobs in SSNM.

Cob girth (cm)

A close study of data presented in table 1.0 revealed that none of the tillage and nutrient management practices expressed either alone or in combinations lucid variation on the cob girth during field experimentation. In general, the maximum and minimum cob girth were observed with zero tillage and permanent bed among tillage practices applied. Likewise, SSNM recorded the maximum cob girth and minimum was associated with 33% RDN when compare among nutrient management practices. In general, zero tillage produced high cob girth might be due to more number of leaves, leaf area index which increase the total leaf surface area for photosynthesis resulted more production of photosynthates and efficiently translocated from sink to source helped better development of cob. The SSNM recorded higher cob girth may be due to application of balance nutrition resulted enhancement in growth attributes lead to good photosynthate partitioning and better source–sink relationship, which ultimately resulted in the form of enhanced cob girth. This line was also confirmed by Kumar *et al*, 2014.

Seed index (g)

The data on seed index in table 1.0 illustrated that no lucid variation was reported among the tillage practices employed however, among the nutrient management practices exerted distinct differences for the seed index of hybrid maize. A close examination of data revealed that the lightest and heaviest seed index of hybrid maize was noticed in zero tillage and conventional tillage respectively, and the differences between both could failed to touch the level of significance during field study conducted. The grain weight mainly depends on dry matter accumulation in source and its translocation to sink. The significantly heavy seed weight recorded under zero tillage might be due to good physical condition of soil and moisture holding capacity and microbial activity supported more availability of essential nutrients and better plant growth attributes consequently produced heavy seed. These factors positively reflected on higher photosynthesis rate and accumulation of more assimilates during the reproductive phase which in turn increased the sink size i.e., produced bold grains in the cob. This line confirmed by Parihar *et al.* (2016), Kumar *et al.* (2018) and Kumar *et al.* (2018).

A critical analysis of data exhibited that various nutrient management practices *viz.* 33% RDN, 100% RDF and SSNM influenced significantly on seed index of hybrid maize. Seed index increases successfully with increasing amount of fertilizer application. Likewise Site specific nutrient management practice produced the heaviest seed index (19.97 g) and expected it lucid superiority over the 33% recommended dose of nitrogen that produced the lightest seed index (18.56 g) among the nutrient management practices during kharif 2021. Both the heaviest and lightest seed index remained statistically on par with the medium seed index that could achieve by the 100% recommended dose of fertilizer applied to the crop. The SSNM produced bold and heavy seed may be due to meet out the nutrient requirement which increased the availability of nutrients at critical physiological phases resulted better translocation of photosynthates from source to sink, consequently better growth and yield attributing characters, and finally increasing the boldness of grain. Boldness of grain also might be due to efficient adjustments in applying nutrients to accommodate field specific needs of the crops for supplementing plant nutrients (Pooniya *et al.* 2015).

Table 1 : Effect of tillage and nutrient management practices on Number of cobs ha^{-1}, Number of rows cob^{-1}, Number of grains row^{-1}, Number of grain cob^{-1}, Cob length (cm), Cob girth (cm) and Seed index (g) of maize.

Treatments	**Number of cobs ha^{-1}**	**Number of rows cob^{-1}**	**Number of grains row^{-1}**	**Number of grains cob^{-1}**	**Cob length (cm)**	**Cob girth (cm)**	**Seed index (g)**
Tillage practices							
Zero tillage	63852	14.53	32.52	473	**17.31**	12.65	18.86
Conventional tillage	62704	14.51	30.73	445	**17.12**	12. 50	19.83
Permanent bed	63481	14.20	29.38	417	**17.72**	12.45	19.16
SEm±	1514	0.11	0.47	7.68	0.33	0.15	0.32
C.D (P=0.05)	NS	NS	**1.84**	**30.14**	NS	NS	NS
CV (%)	**7.20**	**2.30**	4.54	5.04	5.85	**8.10**	**5.03**
Nutrients management							
RDN 33%	61815	14.33	29.29	419	**16.94**	12.33	18.56
RDF 100%	63556	14.36	31.59	453	**17.37**	12.55	19.32
SSNM	64667	14.56	31.75	462	**17.83**	12.71	19.97
SEm±	914	0.10	0.70	11.37	0.21	0.18	0.30
C.D (P=0.05)	NS	NS	**2.15**	**35.03**	0.66	NS	**0.93**
CV (%)	**4.30**	**1.98**	6.78	7.91	3.68	**6.20**	4.71
RDN 33%= 33% of recommended dose of nitrogen, *100% RDF= 100% of recommended dose of fertilizer, *SSNM= Site specific nutrient management.							

Effect of tillage and nutrient management practices on economic yield, biological yield and harvesting index

Economic yield (q ha^{-1})

As evident from the data reported in table 2.0 expressed that, marked improvement was noted in grain yield of hybrid maize by the treatments applied either of nutrient management practices or of tillage practices. A close examination of data revealed that the maximum yield grain yield was achieved under zero tillage and it showed its remarkable advantage over the tillage practices followed. However, the minimum grain yield was associated with conventional tillage practice and it stood statistically comparable with permanent bed practice applied to maize crop. Similarly, zero tillage had on advantage of 8.08% and 6.95% over conventional tillage and permanent bed respectively, during field study conducted. The economic yield significantly varied among different tillage and nutrient management practices. The maximum grain yield (57.88 q ha^{-1}) achieved under zero tillage due to cumulative effect of greater value of growth and growth attributes like plant height, LAI and dry matter accumulation resulted it recorded the highest yield attributes such as cob ha^{-1}, grains cob^{-1}, cob girth, cob length and seed index on the economic yield. These lines were confirmed by Sharma and Majumdar *et al* (2012) and Parihar *et al* (2016).

Among the nutrient management practices, increasing application of nutrients correspondingly increased the grain yield of maize. However, site specific nutrient management produced noteworthy more yield (56.52 q ha^{-1}) over 33% recommended dose of nitrogen (52.13 q ha^{-1}) though remained statistically similar with 100% recommended dose of fertilizer (56.29 q ha^{-1}) during the course of field study. Similarly, the SSNM proved batter over, 100% RDF and 33% RDN and gave yield advantage of 0.40% and 7.76% respectively. SSNM produced highest economic yield due to cumulative effect of growth and yield attributes. Similar trends under SSNM produced maximum yield confirmed by Biradar *et al.* (2006), Khanal *et al.* (2017), Singh *et al.* (2018), Singh *et al.* (2020), Shahi *et al.* (2020).

Biological yield (q ha^{-1})

The data pertaining to biological yield presented in table 2.0 showed marked variation was observed in the production of biological yield under different tillage and nutrient management practices.

The data regarding biological yield of maize produced significantly varied amount with different tillage operations fallowed. Zero tillage produced remarkably the highest biological yield (168.52 q ha^{-1}) which stood superior over both tillage practices permanent bed and conventional tillage. Sharma and Gautam (2010) confirmed that zero tillage produced higher biological yield. The conventional tillage (155.17 q ha^{-1}) and permanent bed (147.12 q ha^{-1}) exerted non-significant variation to the biological yield of maize during course of field investigation.

A close study of data exhibited that biological yield increases due to progressive increase in fertilizer doses however, under site specific nutrient management applied to maize produced remarkably the highest biological (162.08 q ha^{-1}) yield than 33% recommended dose of nitrogen (151.30) while it again remained statistically similar to the 100% recommended dose of fertilizer (157.43 q ha^{-1}) during course of field experimentation. The SSNM produced a higher biological yield and it might be due to balance dose of nutrition at appropriate stage which ultimately resulted in higher value of growth and yield attributes. This line was also confirmed by Singh *et al.* (2018) and Hasnain *et al*. (2021).

Harvest index (%)

The data pertaining to harvesting index presented in table 2.0 indicated that none of treatments was exerted marked variation on the harvest index but the highest HI obtained with permanent bed because it produced the lowest stover yield consequent lower biological yield. Regarding different nutrition aspect the 100% RDF was recorded the highest HI because not remarkable difference among 100% RDF and SSNM for the economic yield and biological yield but it was produced lower stover yield resulted low biological yield and ultimately a high harvest index.

Table 2 : Effect of tillage and nutrient management practices on Economic yield (q ha^{-1}), Biological yield (q ha^{-1}) and Harvest index (%) of maize

Treatment	Economic yield (q ha^{-1})	Biological yield (q ha^{-1})	Harvest index (%)
Tillage practices			
Zero tillage	57.88	168.52	34.45
Conventional tillage	53.21	155.17	34.34
Permanent bed	53.86	147.12	36.63
SEm±	0.93	2.20	0.70
C.D (P=0.05)	**3.64**	**8.63**	NS
CV (%)	5.05	4.20	**5.98**
Nutrients management			
RDN 33%	52.13	151.30	34.62
RDF 100%	56.29	157.43	36.03
SSNM	56.52	162.08	34.77
SEm±	0.89	2.67	0.88
C.D (P=0.05)	**2.74**	**8.24**	NS
CV (%)	4.84	5.11	**7.48**
Interaction tillage × nutrient management	NS	NS	NS

RDN 33%= 33% of recommended dose of nitrogen, *100% RDF= 100% of recommended dose of fertilizer, *SSNM= Site specific nutrient management.

Conclusion

The zero tillage is the best option among tillage practices that facilitate to achieve good plant with greater canopy and has better cumulative effect on yield attributes and yield of maize. Among the nutrient management practices, tested the site-specific nutrient management practices is found the most effective and it produced the enhanced yield parameters resulted in increasing in the crop productivity. Among the tillage and nutrient management practices, the zero-tillage coupled with site specific nutrient management is recommended for significantly maximum yield and economic return of maize crop during kharif season.

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Author contribution:

Abhinav Yadav has designed, Conceived and performed the field experiment and wrote the original draft. Reviewed and edited the paper. All authors have read and agreed to the published version of the manuscript.

Competing interests

Authors have declared that no competing interests exist.

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