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Effect of tillage practices, seed priming and nutrient management on growth and yield of maize under rainfed conditions

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Abstract

A field experiment was carried out for two years from 2020-2022 on maize to evaluate the effect of seed priming, tillage practices and nutrient management on growth parameters and yield of the crop in rainfed conditions. The experiment was laid in a factorial randomized block design, consisting of three factors. Factor A (Tillage practices) consisted of Conventional tillage (CT), Conventional tillage+ mulch (CT+M) and Zero tillage+ mulch (ZT+M); Factor B (Seed priming) consisted of Hydropriming and micronutrient priming; Factor C (Nutrient management practices) consisted of the recommended dose of fertilizers (RDF) and Integrated nutrient management. An additional treatment of control was also kept as an independent module for a general comparison of results. Significant differences in growth parameters and yield were observed as affected by tillage practices and nutrient management. All growth parameters and yield were found to be significantly better under conventional tillage+mulch (CT+M) as compared to other tillage practices. Moreover, integrated nutrient management proved to be comparatively superior to recommended dose of fertilizers in terms of growth studies as well as the yield of maize.

Key words: Seed priming, zero tillage, maize, integrated nutrient management, growth studies, mulch

Maize is the third most important food crop after rice and wheat in India. Maize is the primary source of food energy in the world, and it also includes considerable amounts of proteins, vitamins, and minerals, all of which are important nutrients for human health. In Himachal Pradesh, maize is the most important annual crop and is grown under rainfed conditions in the *Kharif* season and is cultivated over an area of 295.4 lakh ha with an average production of 543.2 lakh metric tons (Kumar 2015). Earlier, the focus was on increasing food grain production to achieve self-sufficiency, but indiscriminate use of resources such as fertilizers, water, energy and agrochemicals has resulted in resource exploitation and environmental degradation. This has further led to reduced total productivity and increased cost of cultivation. So, a resource conservation system through improved tillage and crop establishment methods is the only solution to sustain environmental resources and increase productivity. Due to erratic and non-uniform rainfall in the north-western Himalayas, crops suffer from lower germination rates and poor stand establishment as a result of low moisture availability. Seed priming technology is a pre-sowing treatment which increases the seed emergence and early establishment of crop due to which plants are able to efficiently absorb available natural resources *i.e.* soil moisture, plant nutrient and solar energy and produce synchronize plant stand per unit area (Subedi and Ma 2005). Along with conservation tillage, the addition of farmyard manure can also play an important role in improving soil properties by increasing soil organic matter content and water storage capacity of the soil. Continuous use of chemical fertilizers is leading to an imbalance of nutrients in the soil, which has an adverse effect on soil health and also on crop growth. The sustainable practice of integrated nutrient management provides balanced nutrients to crops and maintains soil fertility. Under rainfed conditions characterized by moisture stress, poor fertility and crop establishment; integration of practices which assure crop establishment, provide nutrients and maintain moisture can enhance the productivity of crops. The literature on conservation practice and nutrient management is available but they are area and situation-specific. Hence, the present investigation was carried out to evaluate the effect of tillage practices, seed priming and nutrient management on growth parameters and yield in maize under rainfed conditions.

Materials and Methods

The experiment was conducted at the Water Management Research Farm of the Department of Soil Science, CSK Himachal Pradesh Krishi Vishvavidyalaya, Palampur. The experimental site was at 32°6' N latitude, 76°32' E longitude, and 1290 m altitude. The site falls in the sub-temperate mid-hill zone of Himachal Pradesh. The region is endowed with mild summers and cool winters. The soil of the test site was silty clay loam in texture, acidic in reaction, high in OC and phosphorus, and medium in available N and K. The experiment was laid in a factorial randomized block design, consisting of three factors. Factor A (Tillage practices) consisted of Conventional tillage (CT), Conventional tillage+ mulch (CT+M) and Zero tillage+ mulch (ZT+M); Factor B (Seed priming) consisted of Hydropriming and micronutrient priming; Factor C (Nutrient management practices) consisted of the recommended dose of fertilizers (RDF) and Integrated nutrient management. An additional treatment of control was also kept as an independent module for a general comparison of results. In conventional tillage, preparatory cultivation was done using a power tiller, followed by harrowing and levelling. In zero tillage treatments, sowing was done using a zero till seed drill without any preparatory tillage. Hydropriming was done by soaking the seed in water (1:2) for 12 hours and then shade dry it. In micronutrient priming, seeds were soaked in a solution containing Zn (0.5%) and Mn (0.1%), for six hours which was followed by shade drying. The recommended dose of fertilizers was applied as 120:60:40 kg/ha N: P_2O_5: K_2O for maize. The nitrogen, phosphorus and potassium were supplied through urea (46% N), SSP (16% P_2O_5) and MOP (60% K_2O), respectively. In the case of integrated nutrient management, 50% nitrogen was provided by FYM and 50% of nitrogen, the rest phosphorus and potassium was given through chemical fertilizers. The seeds of maize variety 'Kanchan 517 hybrid' were sown in rows 45 cm apart in the last week of May and harvested at the end of September each year. The sowing was done with hand plough by the *kera* method. One-third of nitrogen and whole of P_2O_5 and K_2O were applied at the time of sowing. The remaining two-thirds of nitrogen was applied in two equal splits, one at knee high and the other at the tasseling stage. The data on growth parameters were recorded at 30 days interval. Five randomly selected plants in each plot were tagged for height measurement. Plant height was measured in centimetres from the base of the plant to the top. The average height of the five plants was calculated and expressed as plant height (cm). For recording dry matter accumulation, plant samples (0.5 m row length from each side) from the sampling rows of both the sides of the plot next to border rows were taken from each plot at 30 days interval up to harvest. The plants were cut close to the ground and kept in an oven at 70^0C till constant weight. Samples were weighed down when they attained constant weight. The crop growth rate was calculated using the formula:

$$CGR = \frac{(w_2 - w_1)}{t_2 - t_1}$$

Relative growth rate was calculated as follows:

$$RGR = \frac{(log_e w_2 - log_e w_1)}{t_2 - t_1}$$

Where, w_1 and w_2 are dry weight per unit area at t_1 and t_2 time, respectively.

On maturity, cobs were picked from the net plot area and dried for 4 days. After threshing, grain yield from each net plot was noted and converted to ton/ha. The de-cobbed maize plants were harvested close to the ground and dried in sun. The weight of stover of each net plot was recorded and converted to ton per hectare.

Results and Discussion

Plant height

The data on the plant height of maize at different intervals is presented in Table 1. During the initial stages (30 and 60 DAS), significantly taller plants were observed under conventional tillage+ mulch which was followed by conventional tillage. However, in later stages, conventional tillage+ mulch was followed by zero tillage + mulch, in terms of plant height of maize. Significantly lower plant height was found under conventional tillage in later stages. Taller plants with conventional tillage and mulch may be due to improved physical properties of soil and crop residue retention which altered the soil environment, which in turn influences the microbial population and activity in the soil and subsequent nutrient transformation. Less growth in zero tillage in the initial stages may be due to poor water-air regime in soil. Similar results were reported by Zamir *et al*. (2013), who found the maximum height of maize under conventional tillage and mulch. Kumar and Rana (2021) also reporter shorter plants of maize under zero tillage. Different seed priming methods had no significant influence on the plant height. Integrated nutrient management (50% N through FYM +50% N and the rest of P and K through inorganic sources) resulted in significantly taller plants of maize as compared to RDF (recommended dose of fertilizers) in both years of study. Increased plant height with combined application of FYM and chemical fertilizers may be due to the fact that organic matter functioned as a source of energy for soil microflora, which brings about transformations of inorganic nutrients in the form of fertilizers to readily available form that is easily utilized by growing plants. The findings are in line with those reported by Mahesh *et al*. (2010) in maize. Similar results were also reported by Gangmei *et al*. (2022) in wheat.

Dry matter accumulation

Data on dry matter accumulation per square metre

Table 1. Effect of tillage practices, seed priming and nutrient management on plant height of maize at periodic intervals

	Plant height (cm)							
	30 DAS		60 DAS		90 DAS		Harvest	
Tillage practices	2020-21	2021-22	2020-21	2021-22	2020-21	2021-22	2020-21	2021-22
CT	68.7	70.0	182.4	184.0	186.8	189.1	191.3	194.4
CT + Mulch	72.9	74.5	192.1	195.8	201.4	205.1	206.0	210.2
ZT + Mulch	65.2	66.3	175.9	177.5	194.3	196.7	199.1	202.2
SEm±	0.6	0.7	1.2	1.6	1.0	1.2	1.0	1.2
LSD (P=0.05)	**1.7**	**2.2**	**3.5**	**4.6**	**3.1**	**3.6**	**2.8**	**3.4**
Seed priming								
Hydro priming	69.5	70.8	183.9	186.4	195.0	197.9	199.8	203.3
Micronutrient priming	68.4	69.7	183.0	185.1	193.3	196.1	197.8	201.3
SEm±	0.5	0.6	1.0	1.3	0.9	1.0	0.8	1.0
LSD (P=0.05)	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**
Nutrient management								
RDF	68.2	69.3	181.9	183.8	192.5	195.2	197.0	200.4
Integrated	69.7	71.1	185.0	187.7	195.8	198.8	200.6	204.1
SEm±	0.5	0.6	1.0	1.3	0.9	1.0	0.8	1.0
LSD (P=0.05)	**1.4**	**1.8**	**2.9**	**3.7**	**2.5**	**3.0**	**2.3**	**2.8**
Control vs others								
Control	61.2	62.0	171.3	172.9	182.5	184.3	184.7	187.2
Others	68.9	70.2	183.5	185.8	194.1	197.0	198.8	202.3
SEm±	0.9	1.1	1.8	2.3	1.5	1.8	1.4	1.7
LSD (P=0.05)	**2.5**	**3.2**	**5.2**	**6.7**	**4.5**	**5.3**	**4.2**	**5.0**

*CT: Conventional tillage, ZT: Zero tillage, Micronutrient priming: Zn (0.5%), Mn (0.1%), RDF: Recommended dose of fertilizers, Integrated: 50% N through FYM + 50% N and rest of P and K through inorganic sources, Control: CT, no priming, RDF

at different intervals of maize has been depicted in Table 2. Significantly higher dry matter accumulation in the initial stages (30 and 60 DAS) was noted in conventional tillage + mulch in both years of study. Conventional tillage being the second best treatment was significantly better than zero tillage +mulch. In later stages of growth, zero tillage+ mulch was found to be superior to conventional tillage. The lowest dry matter production under zero tillage practices in the initial stages may be due to soil compaction, which may have improved with the effect of mulch in a later period of crop growth. Higher dry matter accumulation in conventional tillage and mulch may be due to reduced weed growth which provided more availability of nutrients and a favourable environment for microbial activities which further helped in the increase of cell division and elongation of leaves, resulting in higher biomass production. These findings are supported by Ma *et al*. (2017) who reported higher dry matter production in maize with mulch application. There was no significant difference in hydro priming and micronutrient priming in terms of dry matter accumulation in maize in both years of study. Dry matter accumulation at different intervals was significantly higher in integrated nutrient management (50% N through FYM +50% N and the rest of P and K through inorganic sources) as compared to RDF (recommended dose of fertilizers) in both years of study. This was due to the higher nutrient availability in the case of combined use of organic and inorganic sources. Furthermore, the addition of FYM enhanced soil organic carbon, resulting in a more favourable rhizosphere for maize crop, a high rate of aeration, improved soil microbial

Table 2. Effect of tillage practices, seed priming and nutrient management on dry matter accumulation of maize at 30 days periodic interval

	Dry matter accumulation (g/m^2)							
	30 DAS		60 DAS		90 DAS		Harvest	
Tillage practices	2020-21	2021-22	2020-21	2021-22	2020-21	2021-22	2020-21	2021-22
CT	210.3	212.9	884.0	887.4	1243.2	1244.5	1292.5	1308.0
CT + Mulch	221.0	225.2	916.5	921.7	1297.6	1304.8	1386.9	1409.1
ZT + Mulch	198.8	201.4	851.4	854.4	1267.6	1271.3	1346.7	1363.4
SEm±	1.6	1.9	4.8	5.1	8.7	9.9	9.7	11.2
LSD (P=0.05)	**4.7**	**5.6**	**14.1**	**15.0**	**25.4**	**29.0**	**28.4**	**32.7**
Seed priming								
Hydro priming	211.0	214.3	887.9	891.8	1272.5	1276.9	1345.6	1364.3
Micronutrient priming	209.1	212.1	880.1	883.9	1266.4	1270.2	1338.4	1356.1
SEm±	1.3	1.6	4.0	4.2	7.1	8.1	8.0	9.1
LSD (P=0.05)	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**
Nutrient management								
RDF	206.8	209.9	875.9	879.6	1259.1	1261.6	1330.3	1346.4
Integrated	213.2	216.5	892.1	896.1	1279.8	1285.5	1353.8	1373.9
SEm±	1.3	1.6	4.0	4.2	7.1	8.1	8.0	9.1
LSD (P=0.05)	**3.8**	**4.6**	**11.5**	**12.2**	**20.8**	**23.7**	**23.2**	**26.7**
Control vs others								
Control	190.6	192.5	834.5	837.0	1221.6	1221.3	1256.5	1267.2
Others	210.0	213.2	884.0	887.8	1269.4	1273.5	1342.0	1360.2
SEm±	2.4	2.8	7.1	7.5	12.8	14.6	14.3	16.5
LSD (P=0.05)	**6.9**	**8.2**	**20.8**	**22.0**	**37.4**	**42.7**	**41.8**	**48.1**

*CT: Conventional tillage, ZT: Zero tillage, Micronutrient priming: Zn (0.5%), Mn (0.1%), RDF: Recommended dose of fertilizers, Integrated: 50% N through FYM + 50% N and rest of P and K through inorganic sources, Control: CT, no priming, RDF

activity and increased nutrient mineralisation. Sahoo *et al*. (2021) also reported increased dry matter accumulation in maize with integrated nutrient management.

Crop growth rate

Data pertaining to the crop growth rate of maize have been reported in Table 3. Conventional tillage+ mulch resulted in a significantly higher crop growth rate of the crop, which was followed by zero tillage +mulch; at all intervals except at 90 DAS. At 90 DAS, zero tillage+mulch resulted in a significantly higher crop growth rate. The lowest crop growth rate was observed in conventional tillage during both years. This may be due to better plant growth under conventional tillage with mulch as a result of improved soil physical and chemical properties when compared to no mulch treatments. Moriaque *et al*. (2019) also reported higher crop growth in maize under mulch treatments over no mulching. The crop growth rate of maize remained statistically unaffected by seed priming methods, during both years of study. Integrated nutrient management (50% N through FYM +50% N and the rest of P and K through inorganic sources) resulted in a significantly higher crop growth rate of maize as compared to RDF (recommended dose of fertilizers) at 30 DAS in both years of trial. The addition of FYM increased crop growth rate because organic matter served as a source of energy for all soil microflora, transforming inorganic nutrients present in the soil or added in the form of fertilisers into forms that are easily accessible to growing plants, thus increasing their growth. The findings are in line with Mahesh *et al*. (2010).

Table 3. Effect of tillage practices, seed priming and nutrient management on the crop growth rate of maize at periodic intervals

	Crop growth rate (g/m^2/day)							
	30 DAS		**60 DAS**		**90 DAS**		**Harvest**	
Tillage practices	2020-21	2021-22	2020-21	2021-22	2020-21	2021-22	2020-21	2021-22
CT	7.01	7.10	22.46	22.48	11.97	11.91	1.65	2.12
CT + Mulch	7.37	7.51	23.18	23.22	12.70	12.77	2.98	3.48
ZT + Mulch	6.63	6.71	21.75	21.77	13.87	13.90	2.64	3.07
SEm±	0.05	0.06	0.14	0.15	0.30	0.35	0.25	0.31
LSD (P=0.05)	**0.16**	**0.19**	**0.42**	**0.44**	**0.88**	**1.02**	**0.72**	**0.90**
Seed priming								
Hydro priming	7.03	7.14	22.56	22.58	12.82	12.84	2.44	2.91
Micronutrient priming	6.97	7.07	22.37	22.39	12.88	12.88	2.40	2.86
SEm±	0.04	0.05	0.12	0.12	0.25	0.28	0.20	0.25
LSD (P=0.05)	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**
Nutrient management								
RDF	6.89	7.00	22.30	22.32	12.77	12.73	2.38	2.83
Integrated	7.11	7.22	22.63	22.65	12.92	12.98	2.46	2.95
SEm±	0.04	0.05	0.12	0.12	0.25	0.28	0.20	0.25
LSD (P=0.05)	**0.13**	**0.15**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**
Control vs others								
Control	6.35	6.42	21.46	21.48	12.90	12.81	1.16	1.53
Others	7.00	7.11	22.46	22.49	12.85	12.86	2.42	2.89
SEm±	0.08	0.09	0.21	0.22	0.44	0.51	0.36	0.45
LSD (P=0.05)	**0.23**	**0.27**	**0.62**	**0.65**	**NS**	**NS**	**1.06**	**1.33**

*CT: Conventional tillage, ZT: Zero tillage, Micronutrient priming: Zn (0.5%), Mn (0.1%), RDF: Recommended dose of fertilizers, Integrated: 50% N through FYM + 50% N and rest of P and K through inorganic sources, Control: CT, no priming, RDF

Relative growth rate

The data on the relative growth rate of maize at different intervals are presented in Table 4. Conventional tillage+ mulch resulted in a significantly higher relative growth rate; followed by zero tillage+ mulch at all stages except at 90 DAS. In 90 DAS, the relative growth rate was significantly higher in zero tillage+ mulch. Conventional tillage without mulch resulted in a significantly lower relative growth rate of crop. The reason may be enhanced moisture availability and improved ecological environment of soil under conventional tillage and mulch, which in turn may have increased the growth rate of the crop. The results are in close conformity with Khurshid *et al*. (2006). Seed priming methods had no significant effect on the relative growth rate of maize, during both years of research. A significantly higher relative growth rate was observed under Integrated nutrient management (50% N through FYM +50% N and rest of P and K through inorganic sources) over RDF (recommended dose of fertilizers) at 30 DAS, during both years. The continual steady release of nutrients that may have allowed the leaf area duration to rise and favoured the plants' ability to improve their photosynthetic rate could be the cause of the increased growth rate in FYM-treated plots. Ponmozhi *et al*. (2019) also found that higher growth rate of maize under integrated nutrient management as compared to RDF.

Table 4. Effect of tillage practices, seed priming and nutrient management on the relative growth rate of maize at periodic interval

	Relative growth rate (g/g/day)							
	30 DAS		**60 DAS**		**90 DAS**		**Harvest**	
Tillage practices	2020-21	2021-22	2020-21	2021-22	2020-21	2021-22	2020-21	2021-22
CT	0.178	0.179	0.048	0.048	0.011	0.011	0.0013	0.0017
CT + Mulch	0.180	0.181	0.047	0.047	0.012	0.012	0.0022	0.0026
ZT + Mulch	0.176	0.177	0.048	0.048	0.013	0.013	0.0020	0.0023
SEm±	0.0003	0.0003	0.0002	0.0003	0.0003	0.0003	0.0002	0.0002
LSD (P=0.05)	**0.001**	**0.001**	**0.001**	**0.001**	**0.001**	**0.001**	**0.0005**	**0.0007**
Seed priming								
Hydro priming	0.178	0.179	0.048	0.048	0.012	0.012	0.0019	0.0022
Micronutrient priming	0.178	0.179	0.048	0.048	0.012	0.012	0.0018	0.0022
SEm±	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0001	0.0002
LSD (P=0.05)	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**
Nutrient management								
RDF	0.178	0.178	0.048	0.048	0.012	0.012	0.0018	0.0022
Integrated	0.179	0.179	0.048	0.047	0.012	0.012	0.0019	0.0022
SEm±	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0001	0.0002
LSD (P=0.05)	**0.001**	**0.001**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**
Control vs others								
Control	0.175	0.175	0.049	0.049	0.013	0.013	0.0009	0.0012
Others	0.178	0.179	0.048	0.048	0.012	0.012	0.0018	0.0022
SEm±	0.0004	0.0004	0.0003	0.0004	0.0004	0.0004	0.0003	0.0003
LSD (P=0.05)	**0.001**	**0.001**	**0.001**	**0.001**	**NS**	**NS**	**0.0008**	**NS**

*CT: Conventional tillage, ZT: Zero tillage, Micronutrient priming: Zn (0.5%), Mn (0.1%), RDF: Recommended dose of fertilizers, Integrated: 50% N through FYM + 50% N and rest of P and K through inorganic sources, Control: CT, no priming, RDF

Grain yield

Data pertaining to the grain yield of maize is presented in Table 5. Conventional tillage+ mulch resulted in significantly higher grain yield of maize in both years. Zero tillage+ mulch proved to be second best treatment in terms of grain yield. This may be because of mulching which preserved the humidity of soil, promoting a favourable microclimate, which has the direct consequence of improving the physicochemical properties of the soil; thus increasing crop productivity. Similar results were reported by Jaswal *et al*. (2022) where addition of mulch increased the yield of maize as compared to conventional tillage. Moriaque *et al*. (2019) also reported 28% increase in grain yield of maize with mulch as compared to no mulch. Seed priming methods had no significant effect on the grain yield of maize. Integrated nutrient management (50% N through FYM +50% N and the rest of P and K through inorganic sources) resulted in significantly higher grain yield of maize over RDF (recommended dose of fertilizers) in both years. This may be due to the application of FYM in combination with inorganic fertilizers which helps in proper nutrition and enhancement of soil fertility which increases the yield of the crop. The results are in line with Omar (2014) who reported increased grain yield of maize with the addition of farmyard manure. Further, it was observed that all treatments except T_1 (CT,Hydro,RDF), T_3 (CT,Micro,RDF) and T_4 (CT,Micro,Int) during first year; and T_1 (CT,Hydro,RDF), T_2 (CT,Hydro,Int), T_3 (CT,Micro,RDF) and T_4 (CT,Micro,Int) during second year proved to be significantly better than control in terms of maize grain yield. T_6 (CT+M,Hydro,Int) resulted in highest grain yield of maize in both years (Table 6).

Stover yield

The data on the straw yield of maize are presented in Table 5. Significantly higher stover yield of maize was observed under conventional tillage+ mulch,

Table 5. Effect of tillage practices, seed priming and nutrient management on grain yield and stover yield of maize

	Grain yield (t/ha)		Stover yield (t/ha)	
Tillage practices	2020-21	2021-22	2020-21	2021-22
CT	5.22	5.52	7.91	8.08
CT + Mulch	6.54	7.03	8.35	8.56
ZT + Mulch	5.85	6.21	8.12	8.29
SEm±	0.10	0.11	0.07	0.08
LSD (P=0.05)	**0.28**	**0.33**	**0.22**	**0.23**
Seed priming				
Hydro priming	5.93	6.31	8.15	8.34
Micronutrient priming	5.81	6.19	8.10	8.28
SEm±	0.08	0.09	0.06	0.06
LSD (P=0.05)	**NS**	**NS**	**NS**	**NS**
Nutrient management				
RDF	5.72	6.07	8.03	8.20
Integrated	6.02	6.43	8.22	8.42
SEm±	0.08	0.09	0.06	0.06
LSD (P=0.05)	**0.23**	**0.27**	**0.18**	**0.19**
Control vs others				
Control	4.92	5.24	7.72	7.88
Others	5.87	6.25	8.13	8.31
SEm±	0.14	0.16	0.11	0.12
LSD (P=0.05)	**0.42**	**0.48**	**0.32**	**0.34**

*CT: Conventional tillage, ZT: Zero tillage, Micronutrient priming: Zn (0.5%), Mn (0.1%), RDF: Recommended dose of fertilizers, Integrated: 50% N through FYM + 50% N and rest of P and K through inorganic sources, Control: CT, no priming, RDF

Table 6. Effect of different treatments conbinations on grain yield and stover yield of maize

Treatments	Grain yield (ton/ha)		Stover yield (ton/ha)	
	2020-21	2021-22	2020-21	2021-22
T_1 CT,Hydro,RDF	5.15	5.43	7.76	8.00
T_2CT,Hydro,Int	5.35	5.69	8.10	8.22
T_3CT, Micro,RDF	5.07	5.31	7.70	7.91
T_4CT, Micro,Int	5.29	5.63	8.10	8.19
T_5CT+M,Hydro,RDF	6.40	6.85	8.32	8.51
T_6CT+M,Hydro,Int	6.88	7.40	8.43	8.69
T_7CT+M, Micro,RDF	6.28	6.73	8.26	8.44
T_8CT+M, Micro,Int	6.60	7.14	8.38	8.62
T_9ZT+M,Hydro,RDF	5.73	6.08	8.09	8.18
T_{10}ZT+M,Hydro,Int	6.04	6.40	8.20	8.47
T_{11}ZT+M, Micro,RDF	5.66	6.02	8.05	8.17
T_{12}ZT+M, Micro,Int	5.96	6.33	8.13	8.34
T_{13}Control	4.92	5.24	7.72	7.88
SEm±	0.14	0.16	0.11	0.12
LSD control vs others (P=0.05)	**0.42**	**0.48**	**0.32**	**0.34**

*CT: Conventional tillage, ZT: Zero tillage, M: Mulch, Hydro: Hydropriming, Micro: Micronutrient priming Zn (0.5%), Mn (0.1%), RDF: Recommended dose of fertilizers, Int: 50% N through FYM + 50% N and rest of P and K through inorganic sources, Control: CT, no priming, RDF

which was followed by zero tillage+ mulch in both years of study. The increase in the stover yield of maize under mulching conditions may be due to increased soil moisture conservation and suppressed weed growth. Bhatt *et al*. (2004) also found higher straw yield of maize in mulched plots. Stover yield remained statistically unaffected by seed priming methods. Among, nutrient management practices; significantly higher stover yield was observed under Integrated nutrient management (50% N through FYM +50% N and rest of P and K through inorganic sources) over RDF (recommended dose of fertilizers) during both years. This may be due to the integrated application of organic and inorganic sources which may have improved soil fertility status by providing a balanced and wide range of nutrients. Similar results were reported by Brar *et al*. (2015). In the comparison of control with other treatments, it was found that all treatments except T_1 (CT,Hydro,RDF) and T_3 (CT,Micro,RDF) during first year; and T_1 (CT,Hydro,RDF), T_3 (CT,Micro,RDF) and T_4 (CT,Micro,Int) during second year of research were found to be significantly better than control in terms of stover yield of maize. T_6 (CT+M,Hydro,Int) resulted in highest stover yield in both years of study (Table 6).

Conclusion

Results from the present study showed that conventional tillage+ mulch resulted in taller plants and enhanced growth parameters and yield of maize. However, during the initial stages zero tillage+ mulch resulted in poor growth which was improved in later stages. In the later stages of maize; conventional tillage resulted in inferior growth of plants. Integrated nutrient management practices resulted in better growth and higher yields of maize as compared to a recommended dose of fertilizers. Based on the results of present study, it is advised to follow conventional tillage along with mulch and adoption of integrated nutrient management in maize under rainfed conditions of Himachal Pradesh.

Conflict of Interest: The authors declare no conflict of interest.

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