The Pharma Innovation Journal 2022; 11(1): 1650-1655

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277- 7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2022; 11(1): 1650-1655

www.thepharmajournal.com
Received: 13-11-2021
Accepted: 21-12-2021

Abhishek Shori
Department of Agronomy, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi, Uttar Pradesh, India

Sudhanshu Verma
Department of Agronomy, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi, Uttar Pradesh, India

Avinash Patel
Department of Agronomy, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi, Uttar Pradesh, India

Tejram Banjara
Department of Agronomy, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi, Uttar Pradesh, India

SK Verma
Department of Agronomy, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi, Uttar Pradesh, India

JP Singh
Department of Agronomy, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi, Uttar Pradesh, India

Corresponding Author:
Abhishek Shori
Department of Agronomy, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi, Uttar Pradesh, India

Response of tillage and land surface modification of physiological growth of *kharif* maize (*Zea mays* L.) under dry land condition

Abhishek Shori, Sudhanshu Verma, Avinash Patel, Tejram Banjara, SK Verma and JP Singh

Abstract
The present experiment work aims to determine the effect of tillage and land surface modification of physiological growth of kharif maize under dry land condition of eastern Uttar Pradesh. The experiment was carried out at the Institute of agricultural sciences, agricultural research farm Banaras Hindu University. The treatment included tillage practices (Conventional tillage – 2 disking + 1 criss cross cultivation, Summer Ploughing + Conventional tillage) and land surface modification (Line sowing, Ridge Furrow Planting, Raised Bed planting (2 row), Ridge furrow planting + Straw mulch, Raised bed planting (2 row) + Straw mulch). Mulch used in this investigation was rice straw mulch applied @ 6t ha^{-1} uniformly at 20 DAS. Soil moisture content in soil is very important for increased physiological crop growth in the dry land region. During most physiological crop growth stages, the availability of soil moisture was increased by Summer ploughing over conventional tillage and Raised bed planting (2 row + straw mulch) as compare to ridge furrow planting + straw mulch, raised bed planting (2 row), ridge furrow planting, line sowing respectively. Present study will help to recognizing higher physiological growth stages under different tillage and land surface modification practices.

Keywords: Tillage, land surface modification, growth parameters

Introduction

Maize (*Zea mays* L.) is an important cereal crop which ranks third after wheat and rice in the world while in India stand third rank next to rice, wheat in terms of area and production. Queen of cereals maize is so named because of its unbelievably high yield potential that out yield any other cereal crop. This potential of maize cannot be manifested up to the brim due to several biotic and a biotic factors amongst which poor nutritional management and selection of genotype is the prime one. Thus proper nutrition and good genotype is very important to get high crop production. The maize cultivation in India is being practised on 6 million hectare area mainly as rain fed crop during rainy (*Kharif*) season and only 22.8% maize is grown under irrigated conditions.

Among the primary maize growing countries of the world, with respect to area and production USA rank first while India rank fifth both in terms of area and production The productivity of USA is also higher (11.1 m ton ha^{-1}). Followed by Argentina (7 m ton^{-1}). In India, it is grown in an area of 8.67 m ha (GOI 2015) with the production of 16.70 m tonnes. The average productivity of maize in India is 2.6 t ha^{-1} (Kaur and Arora, 2019) [9]. At present, about 35% of the maize production in the country is used for human consumption, 25% each in poultry feed and cattle feed and 15% in food processing and also wide range of utility in industries, such as for preparation of oil, starch, glucose, fermentation product, baby food and for confectionery preparation, acetaldehyde, acetone, *viz*., textiles, paper, pharmaceuticals, organic chemicals, cosmetics, edible oil, poultry, livestock and fish food are also prepared from maize. Therefore, maize crop is considered as a multipurpose crop which can contribute much to our national economy.

Maize crop is adapted to the divergent climatic conditions prevailing in the tropical to temperate regions throughout the country especially during *kharif, rabi* and spring seasons in Peninsular India, *kharif* and spring seasons of Indo-Gangetic plains and *kharif* season in the hilly areas. The most suitable temperature for the maximum productivity of the crop is 20-27^{0}c but it can also be grown at low temperature of 10^{0}c with a frost free season. There is a lot of scope to increase the present yield level in maize due to its wider soil and climatic adaptability.

In last decade, maize production has registered the highest growth rate among all cereals because of enhanced feed and industrial requirements. In India, the production of maize witnessed a critical increment of more than 14 times from a meagre 1.73 million tons in 1950-51 to 24.17 million tonnes in 2014-15 (ICAR-IIMR 2015) [6]. In the preceding decade (2003–04 to 2012–13), the area under maize was extended by 1.8% and production increased by 4.9% demonstrating growth rate in productivity at 2.6% per year in India. Maize, a vital crop for food and nutritional security in India, is grown in different agro-climatic conditions on an area of 8.71 m ha with production of 22.26 million tonnes. India positioned 4th as far as maize area in the world. In Uttar Pradesh maize was grown in terms of area 62374 ha. And 110903 metric ton production, 1176 kg ha^{-1}. Production in Uttar Pradesh during 2014. Tillage practice is one of the factors along with crop sequence, planting direction, and the amount, distribution and intensity of rainfall (Boardman and Poesen 2006) that having a strong influence on water-induced soil erosion. Numerous studies on different soils conducted around the world. Have proven that ploughing up/down the slope is the least favourable tillage method, since it leads to the highest soil loss, whereas no-tillage and perpendicular ploughing are much more efficient for erosion mitigation. Furthermore, crops and their residues on surface can have a strong influence on mitigation of water erosion, even if soil was under heavy rainfall (Cerda *et al*., 2016) [3].

Conventional tillage generally, aims at reversing and stirring a deep layer of soil, incorporating and destroying plant debris, exposing soil pests to sunshine for control, lump breaking and ground levelling. This preparation is composed primarily of harrowing for removing the residues of previous crop. It is done still in the dry season, after sub soiling, to break up the compacted layer and could be replaced by chiselling when the compacted layer is shallower. With a harrow or a mouldboard plough, ground is turned over, burying the vegetable remains to an average depth of 15–30 cm. Together with the first ploughing and harrowing, we apply fertilizers such as lime and phosphate, and pesticides. After these steps, we promote lump breaking and ground levelling with harrows.

Summer ploughing in the month of May - June farmers plough land with the help of desi plough or MB plough. Depth of ploughing is kept around 30 cm. This ploughing is considered very important by farmers as by this ploughing. Farmyard manure and left over of previous crop is mixed in soil. After deep ploughing land is left fallow so that sunlight can reach at the deepest layer possible. Plant protection scientist considered is a rational practice as a majority of damaging insect pest pathogen harbour in soil. When soil is turned up in the month of May- June and left opens for 10-15 days, these pest are killed due to rupture of their cell wall and overheating as then temperature is around 30ºC or more. Turning the soil also promotes parasitic predation in soil thereby reduces the population of soil borne insect pest and pathogen (Chandola, 2011) [4].

In India, dry lands constitute 65 per cent of the total cultivable area of 143 m ha and contribute about 45 per cent to the India's total food production. In India, the dry land areas face twin problems of poor fertility and deficit moisture supply for successful crop production. The partial or total crop failures due to mild and severe droughts are more common involving high element of risk. Farming in dry land is said to be a gamble with nature. Extreme variability of rainfall between seasons and within seasons impose severe restriction on crop production. The vagaries of monsoons in these areas make the life of the farmer more miserable. The major reasons for lower productivity of dry lands include lack of adoption of appropriate conservation measures, lack of availability of moisture during post rainy season (Rabi/winter) and poor management practices to exploit the conserved moisture and inadequate supply of plant nutrients required for better crop growth. Low annual rainfall (500-750mm), high runoff (10 to 20%), low infiltration rate (< 10 mm hr^{-1}), removal of fertile top soil and absence of conservation measures reduced moisture storage, decline in soil fertility and productivity are some of the production constraints in most of the crops. Annual rainfall in several parts of dry lands is sufficient for one or more crops per year. Erratic and high intensity storms lead to runoff and erosion. The effective rainfall may be 65% or sometimes less than 50%. Hence, soil management practices have to be tailored to store and conserve as much rainfall as possible by reducing the runoff and increasing storage capacity of soil profile. The simple in situ moisture conservation technology developed to prevent or reduce water losses and to increase water intake is the Broad Bed and Furrow (BBF) method.

Method and Material

A field experiment was conducted at agricultural research farm Institute of agricultural science Banaras Hindu University during kharif season during 2017-2018. The perusal of data revealed that the soil was sandy clay in texture and moderately fertile condition, soil reaction 7.87, low in organic matter 0.375, low (194 kg ha^{-1}) in available nitrogen, low in available phosphorus (18.5 kg ha^{-1}), and low in potassium content (225.56), and bulk density of 0-15 depth cm was 1.41 g cc^{-1}, and the soil moisture content in 0-15 cm depth 18.59%, the total rainfall received during the growth period was 462 and 724.8 mm during both the year.

The experiment was laid out in factorial randomized block design with two tillage practices as a factor one and five land surface modification in a factor two. The factor one includes were M_1 - Conventional tillage (2 disking + 1 criss cross cultivation), M_2- Summer ploughing + Conventional tillage. The factor two treatment were S_1- Line sowing, S_2- Ridge furrow planting, S_3- Raised bed planting (two row), S_4- Ridge furrow planting + Straw Mulch, S_5- Raised bed planting (two row) + straw mulch. The net plot area was 12.60 X 7.40 m^2. Used as mulch @ 6 t ha^{-1} was spread between the crop row in uniform thickness at 20 DAS. Five randomly selected plant from the net plot area were used to record the plant height and dry-matter production at 30, 60, and at harvesting. The height was measured from base of the plant to fully opened top leaf. For determine the dry matter, sampled plant were first air dried than air dried sampled plants were dried in an oven at 70^0C till they attained a constant dry weight. Total dry matter accumulation was expressed in g m^{-2}. Leaf area index was calculated by LP-80 Accu PAR. Number of leaves was noted randomly selected 10 plants in each plot at 30, 60, and at harvest. Chlorophyll content was calculated by SPAD value. Crop growth rate and relative growth rate was determine by the formula of Radford, 1967 in g m^{-2} day^{-1} and g g^{-1} day^{-1}. Data were subjected to analysis of variance appropriate for a factorial RBD. Treatment difference was considered significant based on result of critical difference (CD) were calculated at 5% level of probability.

Result and Discussion

Tillage and land surface modification practices showed significant variation on plant height during both the years of experimentation. A perusal of data showed that comparatively taller plant in 2018 than 2017. Maximum plant height was recorded under summer ploughing + conventional tillage (196.10 and 200.74), which was significantly superior over conventional tillage (2 disking + 1 criss-cross cultivation) (179.88 and 181.05), respectively at all stages of crop growth except 30 DAS, during both the year of experimentation (Arya *et al*., 2020) [1]. Among land surface modifications, raised bed planting (two row) + straw mulch (195.55 and 197.65) was recorded significantly tallest plant over line sowing (181.54 and 183.80), ridge furrow planting (183.30 and 188.15), raised bed planting (two row) (185.11 and 189.33) and it were statistically at par with ridge furrow planting + straw mulch (194.43 and 195.53), respectively at all the stages of crop growth except 30 DAS, during both the year of experimentation. The interaction effect of tillage and land surface modification practices on plant height was found to be non- significant during both the years of study (Yadav *et al*., 2018) [12]. Data further observed that maximum number of leaf was recorded under summer ploughing + conventional tillage (10.34 and 11.38), which was statistically superior over conventional tillage (2 disking + 1 criss-cross cultivation) (8.21 and 8.72), respectively at all stages of crop growth except 30 DAS, during both the years.

Raised bed planting (two row) + straw mulch (10.48 and 11.49) was recorded significantly higher number of leaf over line sowing (8.20 and 8.46), ridge furrow planting (8.87 and 9.56), raised bed planting (two row) (8.97 and 9.89) and it were statistically at par with ridge furrow planting + straw mulch (9.85 and 10.83), respectively at all the stages of crop growth except 30 DAS, during both the year of experimentation (Harish *et al*., 2021) [5].

Significantly maximum dry mater accumulation was recorded under summer ploughing + conventional tillage (1182.30 and 1204.71), over conventional tillage (2 disking + 1 criss-cross cultivation) (971.66 and 972.20), respectively at all stages of crop growth except 30 DAS, during both the year of experimentation.

Among land surface modifications, raised bed planting (two row) + straw mulch (1186.63 and 1201.34) was recorded significantly higher dry mater accumulation (g plant^{-1}) plant over line sowing (948.83 and 975.63), ridge furrow planting (1039.80 and 1040.85), raised bed planting (two row) (1054.13 and 1067.19) and it were statistically at par with ridge furrow planting + straw mulch (1155.53 and 1157.26), respectively at all the stages of crop growth except 30 DAS, during both the year of experimentation. Maximum leaf area index was recorded under summer ploughing + conventional tillage (3.31 and 3.65), which was significantly superior over conventional tillage (2 disking + 1 criss-cross cultivation) (2.52 and 2.71), respectively at all stages of crop growth except 30 DAS, during both the years (Khan *et al*., 2021) [8].

Maximum leaf area index was recorded under summer ploughing + conventional tillage (3.31 and 3.65), which was significantly superior over conventional tillage (2 disking + 1 criss-cross cultivation) (2.52 and 2.71), respectively at all stages of crop growth except 30 DAS, during both the years.

A perusal of data revealed that, raised bed planting (two row) + straw mulch (3.36 and 3.81) was recorded leaf area index plant over line sowing (2.49 and 2.79), ridge furrow planting (2.66 and 2.96), raised bed planting (two row) (2.87 and 2.91) and it were statistically at par with ridge furrow planting + straw mulch (3.19 and 3.45), respectively at all the stages of crop growth except 30 DAS. The interaction effect of tillage and land surface modification practices on leaf area index was found to be non- significant during both the years of study. (Parihar *et al*., 2018) [10]. Significantly the highest chlorophyll content at 60 DAS but at harvested stage found no significant under summer ploughing + conventional tillage (48.26 and 48.91), and conventional tillage (2 disking + 1 criss-cross cultivation) (43.21 and 43.51), respectively e, during both the year of experimentation.

A perusal of data indicated that raised bed planting (two row) + straw mulch (48.74 and 49.00) recorded highest chlorophyll content was found as surface modification practices over line sowing (42.72 and 43.33), ridge furrow planting (44.19 and 44.77), raised bed planting (two row) (45.71 and 46.50) and it were at par with ridge furrow planting + straw mulch (47.31 and 47.45). Data further reveals that summer ploughing + conventional tillage (11.95 and 12.14), was recorded significantly crop growth rate (g m^{-2} day^{-1}) recorded under over conventional tillage (2 disking + 1 criss-cross cultivation) (8.07 and 8.50), at all the stages of crop growth except 30 DAS, during both the years.

Raised bed planting (two row) + straw mulch (11.98 and 12.43) was recorded significantly highest crop growth rate (g m-^{2} day-^{1}) over line sowing (7.70 and 8.13), ridge furrow planting (9.22 and 9.50), raised bed planting (two row) (9.63 and 9.76) and it were statistically at par with ridge furrow planting + straw mulch (11.52 and 11.78), respectively during both the year of experimentation (Naeem *et al*., 2021) [9].

An estimation of data revealed that tillage and land surface modifications caused non-significant variation on relative growth rate during both the years of study. Maximum relative growth rate was recorded under summer ploughing + conventional tillage (0.0109 and 0.0113), followed by conventional tillage (2 disking + 1 criss-cross cultivation) (0.0094 and 0.0099), respectively at all stages of crop growth during both the year of experimentation.

Among the land surface modification raised bed planting (two row) + straw mulch (0.0120 and 0.0123) was recorded higher relative growth rate followed by over line sowing (0.0081 and 0.0092), ridge furrow planting (0.0096 and 0.0097), raised bed planting (two row) (0.0097 and 0.0101) and ridge furrow planting + straw mulch (0.0115 and 0.0117), respectively at all the stages of crop growth during both the year of experimentation (Naeem *et al*., 2021) [9].

Table 1: Response of tillage and land surface modification on plant height at different growth stages of *kharif* maize under dryland condition

Treatment	30 DAS		60DAS		At harvest	
	2017	2018	2017	2018	2017	2018
Tillage						
M_1: Conventional tillage (2 disking + 1 criss-cross cultivation)	50.53	53.48	161.73	163.45	179.88	181.05
M_2: Summer ploughing + conventional tillage	53.00	54.56	177.88	181.21	196.10	200.74
S.Em+	0.94	0.97	1.56	1.77	2.31	1.97

CD (P=0.05)	NS	NS	4.52	5.13	6.70	5.72
Land surface modification						
S_1: Line sowing	49.93	52.16	163.02	163.73	181.54	183.80
S_2: Ridge furrow planting	51.35	52.54	166.25	169.59	183.30	188.15
S_3: Raised bed planting (two row)	51.73	53.70	168.45	171.09	185.11	189.33
S_4: Ridge furrow planting + straw mulch	52.35	54.69	175.21	177.29	194.43	195.53
S_5: Raised bed planting (two row) + straw mulch	53.45	56.99	176.09	179.95	195.55	197.65
S.Em+	1.49	1.54	2.46	2.80	3.65	3.11
CD (P=0.05)	NS	NS	7.15	8.11	10.59	9.04

Table 2: Response of tillage and land surface modification on number of leaves at different growth stages of *kharif* maize under dryland condition

Treatment	30 DAS		60DAS		At harvest	
	2017	2018	2017	2018	2017	2018
Tillage						
M_1: Conventional tillage (2 disking + 1 criss-cross cultivation)	6.27	7.14	9.80	11.32	8.21	8.72
M_2: Summer ploughing + conventional tillage	7.37	8.42	13.30	14.57	10.34	11.38
S.Em+	0.39	0.54	0.30	0.39	0.32	0.30
CD (P=0.05)	NS	NS	0.86	1.14	0.93	0.88
Land surface modification						
S_1: Line sowing	5.78	6.60	9.88	11.05	8.20	8.46
S_2: Ridge furrow planting	6.53	7.20	10.75	12.51	8.87	9.56
S_3: Raised bed planting (two row)	6.89	7.30	10.88	12.80	8.97	9.89
S_4: Ridge furrow planting + straw mulch	7.24	8.55	12.88	13.89	9.85	10.83
S_5: Raised bed planting (two row) + straw mulch	7.65	9.23	13.38	14.45	10.48	11.49
S.Em+	0.61	0.86	0.47	0.62	0.51	0.48
CD (P=0.05)	NS	NS	1.37	1.80	1.47	1.40

Table 3: Response of tillage and land surface modification on dry matter accumulation (gm^{-2}) at different growth stages of *kharif* maize under dryland condition

Treatment	30 DAS		60DAS		At harvest	
	2017	2018	2017	2018	2017	2018
Tillage						
M_1: Conventional tillage (2 disking + 1 criss-cross cultivation)	314.30	318.66	727.72	730.65	971.66	972.20
M_2: Summer ploughing + conventional tillage	328.79	328.83	862.45	862.90	1182.30	1204.71
S.Em+	5.12	4.39	13.25	13.12	23.46	22.70
CD (P=0.05)	NS	NS	38.45	38.08	68.07	65.87
Land surface modification						
S_1: Line sowing	305.33	308.90	736.22	736.97	948.83	975.63
S_2: Ridge furrow planting	322.23	324.50	777.70	778.35	1039.80	1040.85
S_3: Raised bed planting (two row)	323.83	324.75	787.40	788.11	1054.13	1067.19
S_4: Ridge furrow planting + straw mulch	328.00	329.29	815.90	821.26	1155.53	1157.26
S_5: Raised bed planting (two row) + straw mulch	328.35	331.28	858.20	859.18	1186.63	1201.34
S.Em+	8.09	6.94	20.95	20.75	37.09	35.89
CD (P=0.05)	NS	NS	60.80	60.22	107.63	104.14

Table 4: Response of tillage and land surface modification on leaf area index at different growth stages of *kharif* maize under dryland condition.

Treatment	25 Days		50 Days	
	2017	2018	2017	2018
Tillage				
M_1: Conventional tillage (2 disking + 1 criss-cross cultivation)	1.48	1.49	2.52	2.71
M_2: Summer ploughing + conventional tillage	1.59	1.65	3.31	3.65
S.Em+	0.06	0.07	0.11	0.16
CD (P=0.05)	NS	NS	0.31	0.46
Land surface modification				
S_1: Line sowing	1.48	1.50	2.49	2.79
S_2: Ridge furrow planting	1.51	1.52	2.66	2.96
S_3: Raised bed planting (two row)	1.50	1.54	2.87	2.91
S_4: Ridge furrow planting + straw mulch	1.57	1.58	3.19	3.45
S_5: Raised bed planting (two row) + straw mulch	1.62	1.71	3.36	3.81
S.Em+	0.10	0.11	0.17	0.25
CD (P=0.05)	NS	NS	0.49	0.73

Table 5: Response of tillage and land surface modification on chlorophyll content (SPAD Value) at different growth stages of *kharif* maize under dryland condition

Treatment	30 DAS		60DAS		At harvest	
	2017	2018	2017	2018	2017	2018
Tillage						
M_1: Conventional tillage (2 disking + 1 criss-cross cultivation)	29.45	31.88	43.21	43.51	25.42	25.70
M_2: Summer ploughing + conventional tillage	31.32	32.41	48.26	48.91	27.42	28.31
S.Em+	0.65	0.46	0.61	0.57	0.70	0.93
CD (P=0.05)	NS	NS	1.77	1.64	NS	NS
Land surface modification						
S_1: Line sowing	28.05	30.99	42.74	43.33	24.50	24.75
S_2: Ridge furrow planting	29.53	31.34	44.19	44.77	25.85	26.15
S_3: Raised bed planting (two row)	30.78	32.13	45.71	46.50	26.67	27.13
S_4: Ridge furrow planting + straw mulch	31.53	32.97	47.31	47.45	27.24	28.40
S_5: Raised bed planting (two row) + straw mulch	32.03	33.30	48.74	49.00	27.85	28.59
S.Em+	1.03	0.73	0.96	0.89	1.10	1.47
CD (P=0.05)	NS	NS	2.80	2.60	NS	NS

Table 6: Response of tillage and land surface modification on crop growth rate (g m^{-2} day^{-1}) at different growth stages of *kharif* maize under dryland condition

Treatment	30 DAS		60DAS		At harvest	
	2017	2018	2017	2018	2017	2018
Tillage						
M_1: Conventional tillage (2 disking + 1 criss-cross cultivation)	10.58	11.02	12.69	13.78	8.07	8.50
M_2: Summer ploughing + conventional tillage	10.85	10.89	16.81	17.52	11.95	12.14
S.Em+	0.09	0.18	0.48	0.50	0.61	0.67
CD (P=0.05)	NS	NS	1.39	1.44	1.78	1.95
Land surface modification						
S_1: Line sowing	10.38	10.84	13.08	13.85	7.70	8.13
S_2: Ridge furrow planting	10.58	10.78	14.25	15.22	9.22	9.50
S_3: Raised bed planting (two row)	10.73	10.97	14.51	15.36	9.63	9.76
S_4: Ridge furrow planting + straw mulch	10.93	11.08	15.26	16.29	11.52	11.78
S_5: Raised bed planting (two row) + straw mulch	10.95	11.10	16.66	17.52	11.98	12.43
S.Em+	0.15	0.28	0.76	0.78	0.97	1.06
CD (P=0.05)	NS	NS	2.20	2.28	2.81	3.08

Table 7: Response of tillage and land surface modification on relative growth rate (g g^{-1} day^{-1}) at different growth stages of *kharif* maize under dryland condition.

Treatment	30-60 DAS		60-90 DAS	
	2017	2018	2017	2018
Tillage				
M_1: Conventional tillage (2 disking + 1 criss-cross cultivation)	0.0293	0.0295	0.0094	0.0099
M_2: Summer ploughing + conventional tillage	0.0307	0.0318	0.0109	0.0113
S.Em+	0.0007	0.0009	0.0008	0.0007
CD (P=0.05)	NS	NS	NS	NS
Land surface modification				
S_1: Line sowing	0.0286	0.0287	0.0081	0.0092
S_2: Ridge furrow planting	0.0287	0.0304	0.0096	0.0097
S_3: Raised bed planting (two row)	0.0308	0.0304	0.0097	0.0101
S_4: Ridge furrow planting + straw mulch	0.0308	0.0313	0.0115	0.0117
S_5: Raised bed planting (two row) + straw mulch	0.0310	0.0324	0.0120	0.0123
S.Em+	0.0011	0.0014	0.0012	0.0010
CD (P=0.05)	NS	NS	NS	NS

Conclusion

Based on the two year experimentation, it can be concluded that summer ploughing + conventional tillage and under land surface modification raise bed planting (two row + straw mulch) had pronounced effect on higher growth indices than other given treatments.

Reference

1. Arya CK, Singh B, Sharma MK. Effect of different tillage practices and cropping systems on crop productivity. International Journal of Current Microbiology Applied. Sciences. 2020;9(10):11-16.
2. Boardman J, Poesen J. (Eds) Soil erosion in Europe John Wiley and Sons. 2007.
3. Cerda Artemi O, Gonzalez-Pelayo, Gimenez-Morera A. Use of barley straw residues to avoid high erosion and runoff rates on persimmon plantations in Eastern Spain under low frequency–high magnitude simulated rainfall events, Soil Research. 2016;54:154-165.
4. Chandola Manish, Rathore S, Kumar B. Indigenous pest management practices prevalent among hill farmers of Uttarakhand. 2011.

5. Harish MN, Choudhary AK, Dass A, Singh VK, Pooniya V, Varatharajan T. Tillage and phosphorus management in maize (*Zea mays* L.) under maize–wheat cropping system. Indian Journal of Agricultural Sciences. 2021;91:117-122.
6. ICAR-IIMR annual report 2015-16, ICAR-Indian Institute of maize research, pusa campus, New Delhi – 110012. 2015, 78.
7. Kaur R, Arora VK. Deep tillage and residue mulch effects on productivity and water and nitrogen economy of spring maize in north-west India, Agricultural Water Management. 2019;213:724-731.
8. Khan AG, Imran M, Khan A, Fares A, Simunek J, Ul-Haq T, *et al*. Performance of spring and summer sown maize under different irrigation strategies in Pakistan. Sustainability. 2021;13(5):2757.
9. Naeem M, Mehboob N, Farooq M, Farooq S, Hussain S, Ali H, *et al*. Impact of different barley-based cropping systems on soil physicochemical properties and barley growth under conventional and conservation tillage systems. Agronomy. 2021;11(1):8.
10. Parihar CM, Yadav MR, Singh AK, Kumar B, Pooniya V, Pradhan S, Saharawat YS. Long-term conservation agriculture and intensified cropping systems: Effects on growth, yield, water, and energy-use efficiency of maize in north western India. Pedosphere. 2018;28(6):952-963.
11. Radford PJ, Groth analysis formulae, their use and abuse. Crop Science. 1967;7:171-175.
12. Yadav GS, Saha P, Babu S, Das A, Layek J, Debnath C. Effect of no-till and raised-bed planting on soil moisture conservation and productivity of summer maize (*Zea mays*) in Eastern Himalayas. Agricultural Research. 2018;7(3):300-310.