Int.J.Curr.Microbiol.App.Sci (2018) Special Issue-7: 4185-4191

International Journal of Current Microbiology and Applied Sciences
ISSN: 2319-7706 **Special Issue-7 pp. 4185-4191**
Journal homepage: http://www.ijcmas.com

Original Research Article

Effect of Tillage and Nutrient Management on Growth, Yield and Harvest Index of Corn (*Zea mays* L.) in Indo-Gangetic Plains of India

Amrendra Kumar*, Mahendra Singh Pal, Amit Bhatnagar and A. Qureshi

Department of Agronomy: College of Agriculture, G B Pant University of Agriculture & Technology, Pantnagar-263145, Uttarakhand, India
**Corresponding author*

A B S T R A C T

The present experiment was carried out during 2013-14 and 2014-15 at Norman E. Borlaug Crop Research Centre, G. B. Pant University of Agriculture and Technology, Pantnagar, district Udham Singh Nagar, Uttarakhand representing the *Tarai* belt of Uttarakhand to study the effect of tillage options and nutrient levels on growth, yield and harvest index of grain maize in Indo- Gangetic plains of India. Geographically Pantnagar is situated at 29˚N latitude, 79.5˚ E longitude and at an altitude of 243.84 m above mean sea level in the foot hills of Himalayas. The experimental site was silty clay loam having soil pH 7.21, organic carbon 0.684% and 242.42, 22.56 and 240.32 kg available N, P_2O_5 and K_2O/ha, respectively. The experiment was laid out in a split plot design with 18 treatments with 06 tillage options i.e. FIRBS, conventional tillage (CT), sub soiling (SS), zero tillage (ZT), minimum tillage with two pass of rotavator (MT) and permanent raised bed system (PRBS) in main plot and 03 nutrient levels i.e. 50% of recommended dose of fertilizers (50% RDF), site specific nutrient management (SSNM) and 100% recommended dose of fertilizer (RDF) in sub plot with three replications. Treatments were replicated thrice. The crop was grown as per recommended practices. The fertilizer dose was N:P_2O_5:,K_2O:: 120:60:40 (100% RDF),120:10:37(SSNM) and 60:30:20 (50% RDF), kg/ha, respectively. One third of nitrogen and full dose of P_2O_5 and K_2O were applied as basal and remaining nitrogen was top dressed in two equal split at knee high and tasseling stage. The results revealed that tillage options and nutrient levels had significant effect on growth and yield attributes, grain yield and harvest index during both years. The grain yield was recorded highest under FIRBS with 18.3, 17.2 and 14.2% higher than CT, SS and ZT, respectively. However it remained significantly at par with PRBS. Similarly, the RDF produced significantly higher corn yield with 9% and 37.2% greater than SSNM and 50% RDF. The SSNM also had 25.8% greater corn yields than 50% RDF.

Keywords

Tillage options, corn, nutrient management, rotavator, SPAD, SSNM

Introduction

Corn (*Zea mays* L.) is an important cereal crop for food, feed and fodder. It is a miracle crop and also known as 'Queen of cereals. In term of area, maize is the third most important staple food crop in the world after wheat and rice but in term of productivity, it ranks first followed by rice, wheat and other millets. Due to revolution in tillage options like minimum tillage, zero tillage, FIRBS, raised bed planting, the paradigm shift in tillage has been observed in world over. Due to the availability of herbicides, insecticides and fungicides and also more mechanization, the farmers prefer

new tillage options compared to conventional tillage that is required mainly for seedbed preparation and weed control (Mohante *et al.*, 2006). Similarly zero tillage promotes high aggregate stability, decreases soil temperature and maintains high carbon and nitrogen (Irizar *et al.*, 2013). FIRBS and raised bed planting reduces cost of cultivation and water and nutrient requirement in rice-wheat system and increased soil quality (Goverts *et al.*, 1999). The sub soiling is an urgent need to break the hard pan and also improve the soil porosity and percolation. Therefore, some of the research findings have already indicated that the sub soiling may be beneficial to improve the productivity and profitability of the system, compared to adopting conventional tillage system. Corn is a C_4 plant and required high amount of nutrients and water, hence nutrient management plays significant role to modify the growth and development of corn. The knowledge on interaction of tillage and nutrient management on growth and yield of corn is scanty in Tarai region of Uttarakhand. Therefore, the present study was carried out in *Tari* region of Indo-Gangetic plains of India to study the effect of tillage and nutrient levels on growth and productivity of corn.

Materials and Methods

The present experiment was carried out during 2013-14 and 2014-15 at Norman E. Borlaug Crop Research Centre, G. B. Pant University of Agriculture and Technology, Pantnagar district Udham Singh Nagar, Uttarakhand representing the *Tarai* belt of Uttarakhand to study the effect of tillage options and nutirnet levels on growth, yield and hravets index of grain maize in Indo-Gangetic plains of India. Geographically Pantnagar is situated at 29˚N latitude, 79.5˚ E longitude and at an altitude of 243.84 m above mean sea level in the foot hills of Himalayas. The experimental site was silty clay loam having soil pH 7.21, organic carbon 0.684% and 242.42, 22.56 and 240.32 kg available N, P_2O5 and K_2O/ha, respectively. The experiment was laid out in a split plot design with 18 treatments with 06 tillage options i.e. FIRBS, conventional tillage (CT), sub soiling (SS), zero tillage (ZT), minimum tillage with two pass of rotavator (MT) and permanent raised bed system (PRBS) in main plot and 03 nutrient levels i.e. 50% of recommended dose of fertilizers (50% RDF), site specific nutrient management (SSNM) and 100% recommended dose of fertilizer (RDF) in sub plot with three replications. Treatments were replicated thrice. The crop was grown as per recommended practices. The corn varieties i.e.31Y45 and 4212 was planted on 2013 and 2014 respectively. The fertilizer dose was N:P_2O_5:,K_2O; 120:60:40 (100% RDF), 120:10:37(SSNM) and 60:30:20 (50% RDF), kg/ha, respectively. One third of nitrogen and full dose of P_2O_5 and K_2O were applied as basal and remaining nitrogen was top dressed in two equal splits at knee high and tasseling stage. The growth parameters like plant height, number of green leaves/plant and SPAD values; yield attributes like cob length, cob girth, grain weight/cob, 1000 grain weight, grain yield and harvest index were measured as per the standard methods. The fertilizer dose under SSNM was estimated based on decision support system on nutrient management of maize developed by IPNM.

Results and Discussion

Effect of tillage options

Growth attributes

The growth attributes of corn i.e. plant height, number of green leaves/plant and

leaf greenness (SPAD values) differed greatly by tillage options during both the years (Table.1). The plant height did not affect significantly during both years, however the tallest plants were recorded in PRBS in 2013 and MT in 2014. The pooled values revealed that PRBS produced the tallest plant of Maize followed by SS, CT and FIRBS, mainly because of better root development and greater availability of nutrient and water. The number of green leaves/plant affected significantly in 2013 as well as pooled data. However, the maximum numbers of green leaves were recorded under PRBS in both years. The pooled values showed that PRBS produced the maximum number of green leaves that remained significantly at par with FIRBS, ZT and MT. The results are close conformity with the results obtained by Bakht *et al.,* (2004) as they also reported taller plants and more leaves/plants under Ridge planting. The greenness of leaves in form of SPAD values was affected by tillage during both the years. The highest SPAD values was observed under ZT in 2013 and remained significantly at par with MT,PRBS and SS, while in 2014,the highest SPAD values was noticed in MT that was significantly equal to FIRBS and ZT. The pooled value also indicated that MT had the highest SPAD values that were significantly equal to ZT and PRBS. The higher SPAD values are an index of greenness or chlorophyll content that is essential for photosynthesis.

Yield attributes

The tillage had significant effect on yield attributes of corn i.e. cob length, cob girth, grain weight/cob and 1000 grain weight during both years. (Table.2). The tillage had significant effect on cob length during both years and also pooled values. The highest cob length was recorded under ZT in 2013 that remained significant with PRBD and FIRBS and in 2014, FIRBS had produced the longest cob that were significantly at par with CT, ZT and SS. The pooled values indicated that FIRBS had higher cob length that remained non-significant with ZT. The lowest values of cob length were recorded at CT. The cob girth was also affected significantly only during 2013. The highest cob girths were found under PRBS that remained significant at par with FIRBS, SS and ZT in 2013 but in 2014, the FIRBS had highest cob girth. The pooled data revealed that ZT gave the highest cob girth followed by PRBS and FIRBS. Significantly highest grain weight was recorded under PRBS that remained significantly equal to FIRBS and MT during 2013, while CT had significantly highest value during 2014. The pooled data revealed that FIRBS had significantly highest grain weight/cob that is significantly at par with CT, ZT, MT and PRBS. Tillage also had significant effect on 1000 grain weight during both years. Significantly higher 1000 grain weight was recorded under MT that remained significantly equal to FIRBS and PRBS during 2013. The FIRBS had maximum 1000 grain weight during 2014 followed by SS and CT. The pooled data were also affected significantly with the highest value under FIRBS that remained significantly at par with CT, MT and PRBS. In general, ZT and FIRBS had the lowest and the highest 1000 grain weight, respectively. This might be due to more translocation of photosynthesis into the sink and produced bold grains in the cobs. Wider inter plant spacing reduced inter plant competition that resulted into adequate availability of moisture and nutrient and also increased light interception. The factors positively reflected on higher photosynthesis rate and accumulation of more assimilates during the reproductive phase which in turn increased the sink size, therefore the higher availability of source under given spacing

record significantly higher values of the sink in terms of length, girth and weight of cob. The result is close to Pinjari *et al.,* (2008) in baby corn.

Grain yield and harvest index

Grain yield and Harvest index differed greatly with tillage options during both years. (Table.2). Grain yield was affected significantly during both years as well as pooled values. Significantly higher grain yield was recorded under FIRBS that remained significantly at par with PRBS during both years. The lowest grain yield of maize was recorded in CT that was significantly equal to SS, ZT and MT during both years. The pooled values also followed the above trend. The corn grain yield was recorded 18.3, 17.2 and 14.2% higher under FIRBS than CT, SS and ZT, respectively. However, the FIRBS and PRBS had significantly similar values. The higher grain yield is cumulative result of greater values of cob length, cob girth, grain weight/cob and also 1000 grain weight. The harvest index was affected significantly only during 2014; however it greatly differed with tillage options. The highest Harvest index was recorded in PRBS followed by MT and FIRBS IN 2013 but in 2014, significantly highest values was recorded in SS. On the basis of pooled data, PRBS give the highest harvest index followed by SS, FIRBS and MT. The higher H.I. was attributed to higher grain yield than straw yield.

Effect of nutrient management

Growth attributes

The Nutrient management had significant effect on growth attributes of corn i.e. plant height, number of green leaves/plant and SPAD values during both the years. (Table.1). The tallest plants were recorded at application of RDF that remained significantly at par with SSNM during both the years. The pooled values also followed above trend. Higher nutrient level extended vegetative growth period that increased photosynthesis and it's more partitioning to stem that had favorable impacts on plant height as supported by Akbar *et al.,* (2002) who reported taller plants at higher dose of nutrients. Higher plants height at harvest under 100% recommended nitrogen dose was also reported by Layek *et al.,* (2012). The maximum number of green leaves was recorded at RDF that remained significantly at par with SSNM during both years. Significantly lower number of green leaves was recorded in 50% of RDF. The pooled data also followed above trend. Significantly higher leaf area under 100% of RDF might be ascribed to better root growth of corn shoots due to more supply of nitrogen being vital part of protoplasm that helped in cell division and thus favored more production of leaves. Layek *et al.,* (2012) also reported significantly higher leaf area under 100% nitrogen application treatments. SPAD values differed significantly by nutrient management levels during both years with significantly highest value at RDF followed by SSNM and significantly lowest value at 50% RDF. The pooled SPAD value was also affected significantly by nutrient levels and also had similar trend.

Yield attributes

The yield attributes of corn i.e. cob length, cob girth, grain weight/cob and 1000 grain weight differed significantly among different nutrient doses during both years except cob girth in 2013 (Table.2). The cob length was recorded significantly highest at RDF during both the years. However it remained significantly at par with the SSNM during 2014. The pooled data revealed that RDF had significantly higher cob length.

Table.2 Effect of tillage and nutrients management on cob length, cob girth, grain wt/cob, grain yield and harvest index

Treatments	Cob length(cm)			Cob girth(cm)			Grain wt/cob (g)			Grain yield (q/ha)			Harvest index		
	2013	2014	Pool	2013	2014	Pool	2013	2014	Pool	2013	2014	Pool	2013	2014	Pool
Tillage options															
FIRBS	16.9	16.0	16.4	14.4	13.5	14.0	146.1	99.1	122.6	66.52	67.52	67.02	45.0	45.3	45.2
CT	15.0	15.4	15.2	13.3	13.3	13.2	117.8	116.3	117.1	56.02	57.32	56.66	44.6	44.3	44.4
SS	15.9	15.0	15.3	14.2	13.4	13.8	85.5	86.5	86.0	58.16	59.11	58.63	44.9	47.4	46.2
ZT	17.9	14.9	16.4	14.9	13.2	14.1	142.9	92.4	117.7	56.75	57.72	57.2	44.6	45.0	44.8
MT	17.2	13.2	15.2	13.6	13.4	13.5	146.4	88.8	117.6	58.32	59.06	58.69	45.2	45.0	45.2
PRBS	17.4	13.5	15.5	14.9	13.2	14.0	156.2	79.1	117.7	65.94	66.50	66.22	46.2	46.1	46.2
SEm±	0.34	0.62	0.28	0.25	0.29	0.23	4.16	3.91	2.23	1.36	0.92	0.84	1.04	0.36	0.59
CD at 5%	1.08	1.96	0.88	0.8	NS	NS	13.13	12.32	7.03	4.3	2.89	2.64	NS	1.13	NS
Nutrients level															
50% RDF	15.8	13.3	14.6	13.9	12.9	13.42	121.4	78.4	99.9	49.8	50.61	50.21	43.07	43.28	43.18
SSNM	16.8	14.5	15.7	14.2	13.3	13.8	125.8	92.4	109.1	62.6	63.81	63.18	45.83	46.71	46.27
RDF	17.5	16.0	16.8	14.5	13.7	14.1	150.2	110.4	130.1	68.5	69.19	68.85	46.64	45.59	46.5
SEm±	0.3	0.4	0.27	0.19	0.16	0.14	2.96	1.91	1.83	0.88	0.72	0.65	0.51	0.4	0.38
CD at 5%	0.89	1.22	0.81	0.56	0.49	0.42	8.64	5.59	5.36	2.58	2.12	1.91	1.51	1.75	1.12
Interaction (T×N)	NS	NS	NS	NS	NS	NS	S	S	S	NS	NS	NS	NS	NS	NS

**FIRBS-Furrow irrigated raised bed system; CT-Conventional tillage; SS-Sub soiling; ZT-Zero tillage; MT-Minimum tillage and PRBS-Permanent raised bed system

Table.1 Effect of tillage and nutrient management on growth attributes of corn

Treatments	Plant height(cm) at harvest			No. of green leaves/plants			SPAD value at Tasseling stage.		
	2013	2014	pool	2013	2014	pool	2013	2014	pool
Tillage options									
FIRBS	200.0	178.1	189.0	11.4	11.2	11.3	37.4	47.1	42.3
CT	199.3	180.5	189.8	10.6	11.4	11.0	38.1	43.2	40.7
SS	201.7	179.1	190.1	10.0	10.9	10.5	40.5	45.4	43.0
ZT	200.2	169.4	184.8	11.3	11.1	11.2	42.9	47.4	45.1
MT	192.4	182.0	187.2	11.1	11.2	11.2	42.5	48.8	45.6
PRBS	205.7	176.8	191.3	11.5	11.5	11.5	41.7	46.1	43.9
SEm±	4.17	4.17	3.66	0.25	0.14	0.14	0.73	0.7	0.54
CD at 5%	NS	NS	NS	0.8	NS	0.45	2.3	2.2	1.72
Nutrients level									
50% RDF	194.7	172.7	183.7	10.5	11.0	10.7	38.5	43.1	40.8
SSNM	201.0	177.4	189.2	11.1	11.2	11.2	39.6	46.5	43.1
RDF	203.8	182.8	193.3	11.4	11.4	11.4	43.5	49.4	46.5
SEm±	2.69	2.171	1.20	0.8	0.1	0.07	0.47	0.76	0.42
CD at 5%	3.70	6.35	3.52	0.8	0.3	0.21	1.38	2.23	1.23
Interaction (T×N)	NS	NS	NS	S	NS	S	S	S	S

**FIRBS-Furrow irrigated raised bed system; CT-Conventional tillage; SS-Sub soiling; ZT-Zero tillage; MT-Minimum tillage and PRBS-Permanent raised bed system

The lowest cob length was recorded at 50% RDF. Similarly the cob girth was recorded significantly maximum at RDF followed by SSNM and the minimum at 50% RDF.

But the cob length remained significantly equal at both 50% RDF and SSNM as well as SSNM and RDF. The grain weight varied significantly among nutrient levels and the highest value was recorded at RDF and the lowest at 50% RDF during the both the years. On the basis of pooled data, RDF had significantly highest and 50% RDF the lowest grain weight per cob. The nutrient level had significant effect on 1000 grain weight and significantly higher 1000 grain weight was recorded at RDF and the lowest at 50% RDF. The pooled data also indicated that RDF had significantly highest and 50% RDF, the lowest value. The RDF had 4.5 and 11.5% higher 1000 grain weight than SSNM and 50% RDF, respectively.

Grain yield and harvest index

Grain yield and harvest index differed greatly with nutrient levels during both years (Table.2). The grain yield of corn differed significantly among nutrient levels during both years. Significantly highest and lowest grain yield was obtained at RDF and 50% RDF, respectively. The SSNM gave significantly highest value compare to 50% RDF and the lowest compare to RDF during both years. The pooled data also followed above trend and produced 9% and 37.2% greater grain yield under RDF than SSNM and 50% RDF, respectively. SSNM also produced 25.8% higher grain yield than 50% RDF. The higher grain yield is the cumulative effect of higher values of yield attributes. These results are in conformity with Mashingaidge *et al.*, (2010) who also reported significantly higher grain yield of corn at 100% of recommended dose of nitrogen. The higher harvest index was recorded at RDF and SSNM during 2013 and

2014, respectively; however the harvest index value at both RDF and SSNM remained significantly equal during both the years. The pooled data also had significantly higher value at RDF followed by SSNM and significantly lowest at 50% RDF. The highest value at higher levels of nutrient might be due to better growth, higher photosynthesis and its greater partioning from source to sink.

The interaction between tillage options and nutrient levels remained non-significant for all growth and yield attributes, grain yield and harvest index during both the years as well as the pooled values except number of green leaves in 2013, SPAD values and pooled values and grain weight/cob.

The experimental results indicated that furrow irrigated raised bed system (FIRBS) and permanent raised bed system (PRBS) produced almost significantly grain yield but higher than CT, SS, ZT and MT.

Similarly the RDF produced significantly higher grain yield than SSNM and 50% RDF. Therefore corn may be grown either on FIRBS and PRBS with application 120:60:40 (N: P: K) kg/hectare for better grain yield and harvest index in *Tarai* region of Indo-Gangetic plains of India.

References

Akbar, F., Wahid, A., Akhtar, S., Ahmad, A.N and Chaudhary, F. M. (2002). Optimization of method and time of nitrogen application for increased nitrogen use efficiency and yield in maize. *Pak. J. Bot.* 3(1): 337-341.

Bakht, J., Ahmad, S., Tariq, M., Akber, H. and Shafi, M. 2004. Response of maize to planting methods and fertilizer. *J. of Agric. and Bio Sci.* 1(3):8-14.

Govarts, B., Sayre, K. D. and Lichter, K. (1999). Influence of permanent raised bed planting and residue management on physical and chemical soil quality in rainfed maize-wheat system. *Plant and Soil* 291(1-2): 39-54.

Irizar, A., Andriuo, A. and Mary, B. (2013). Long-term impact of no tillage in two intensified crop rotations on different soil organic matter fractions in Argentine Rolling Pampa. *The Open Agric. J.* 7: 22-31.

Layek, J., Shivakumar, B. G., Rana, D. S., Munda, S. and Lakshman, K. (2012). Growth pattern, physiological indices and productivity of different soybean (*Glycine max*) based intercrops as influenced by nitrogen nutrition. *Indian J. Agron.* 57(4): 349-356.

Mashingaidze, A. B., Lotz, L. A., Werf, W. V., Chipomho, J., Kropff, M. J. and Nabwami, J. (2010). The influence of fertilizer placement on maize yield and growth of weeds. *Scientific Conference Proceedings*. pp. 786-800.

Mohanty, M., Painuli, D. K., Misra A. K., Bandyopadhyaya K. K. and Ghosh P. K. (2006). Estimating impact of puddling, tillage and residue management on wheat (*Triticum aestivum* L.) seedling emergence and growth in a rice-wheat system using nonlinear regression models. *Soil and Tillage Res.* 87: 119-130.

Najafinezhadi, H., Javaheri, M. A., Gheibi, M. and Rostami, M.A. (2007). Influence of tillage Practices on the grain Yield of maize and some soil properties in maize wheat cropping system. *J. of Agric. and Soc. Sci.* 3: 87-90.

Pinjari, S.S., Zarapkar, D.S., Bhondve, T.S. and Suryawanshi, J.S. 2008. Effect of level of Nitrogen and Spacing on quality parameters, nutrient uptake of baby corn (*Zea mays* L.) and soil health. *J. Advances in Sci. Tech.* 11(1-2): 58-63.