International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
IJCS 2018; 6(3): 107-110

Received: 16-03-2018
Accepted: 21-04-2018

Prabhat Kumar
M.sc. Scholar, Department of Agronomy, Dr. Rajendra Prasad Central Agriculture University Pusa, Samastipur, Bihar, India

M Kumar
Uni. Professor- cum- Chief Scientist, Department of Agronomy, Tirhut College of Agriculture, Dr. Rajendra Prasad Central Agriculture University, Pusa, Samastipur, Bihar, India

Randhir Kumar
M.sc. Scholar, Department of Agronomy, Dr. Rajendra Prasad Central Agriculture University Pusa, Samastipur, Bihar, India

Kaushal Kishor
PhD. Scholar, Department of Agronomy, Dr. Rajendra Prasad Central Agriculture University Pusa, Samastipur, Bihar, India

Shashidhar Yadav
PhD. Scholar, Department of Agronomy, Dr. Rajendra Prasad Central Agriculture University, Pusa, Samastipur, Bihar, India

Rakesh Kumar Raj
M.sc. Scholar, Department of Agronomy, Dr. Rajendra Prasad Central Agriculture University Pusa, Samastipur, Bihar, India

Correspondence
Prabhat Kumar
M.sc. Scholar, Department of Agronomy, Dr. Rajendra Prasad Central Agriculture University Pusa, Samastipur, Bihar, India

Effect of nutrient management on growth of maize (*Zea mays* L.) under different tillage practices

Prabhat Kumar, M Kumar, Randhir Kumar, Kaushal Kishor, Shashidhar Yadav and Rakesh Kumar Raj

Abstract
A field experiment was carried out during *kharif* season of 2016 at Crop research farm TCA Dholi, Dr. Rajendra Prasad Central Agricultural University, Pusa, Samastipur, (Bihar) to study the "Effect of nutrient management on growth of maize (*Zea mays* L.) Under different tillage practices". The experiment was laid out in a split plot design with three replication. Main plot consist of three different tillage practices *viz.,* a) Zero tillage (ZT), b) Conventional tillage (CT) and c) Bed planting (BT) and sub plot comprised of four different level of nutrient management *viz.,* a) Recommended dose of fertilizer (RDF) (120, 60 and 50 kg/ha N, P_2O_5 and K_2O), b) Site Specific Nutrient Management (SSNM) based on nutrient expert and c) Farmers practice (FP) (150% of RDF + 10 ton FYM). Growth attributes *i.e.,* plant height, leaf area, days to 50% tasseling, days to 50% silking, plant population at maturity and dry matter accumulation were found significantly higher under bed planting tillage practices over zero tillage and conventional tillage practices. Among the different nutrient management practices, farmers practices was reported significantly higher growth attributes than recommended dose of fertilizer but statistically at par with site specific nutrient management practices.

Keywords: Maize, growth, tillage practices, nutrient level

Introduction
Maize (*Zea mays* L.) is the third most important cereal crop of India after rice and wheat. It is cultivated in an area of 92.58 lakh ha with a production of 236.73 lakh tonnes and productivity of 25.57 q/ha (Directorate of Economics and Statistics, 2016) [3]. There is no other cereal crop which has such immense productivity potential as maize and therefore, maize occupies a unique place as "Queen of Cereals". It can be grown across a wide range of climatic conditions of the world due its wider adaptability. It is mainly a rainfed *kharif* season crop. Production is limited by low fertilizer use efficiency, inadequate existing fertilizer recommendations and the ignorance of nutrients balance that are posing serious threat in maize production. Many beneficial effects of no-till/zero-till and minimum tillage have also been reported like increased porosity, organic carbon, water holding capacity and decreases bulk density. Similarly, bed planting system have also been reported very beneficial for improving soil environment for better plant growth development with minimum requirement of irrigation water. The response of N, P and K, separately on different crops has been explored widely but the research work on the combined effect of balanced fertilization particularly on maize is needed. Similarly, the response of balanced fertilizers on different crops under different tillage operation like zero tillage, minimum tillage, sub soiling, furrow irrigated raised based system and raised bed planting system is limited and needs attention of the researchers on different crops mainly for increased input use efficiency, system productivity, and its profitability under different tillage practices specially in maize.

Materials and Methods
The field experiment was conducted to study the "Effect of nutrient management on growth of maize (*Zea mays* L.) Under different tillage practices" during *kharif* season of 2016 at Crop research farm of TCA Dholi, Dr. Rajendra Prasad Central Agricultural University, Pusa, Samastipur (Bihar). The experimental area, Dholi falls in humid sub-tropical climatic zone, which is influenced greatly by monsoon.

It is situated at 25.98ºN latitude, 85ºE longitude and 52.3 meters above mean sea level. The experiment was laid out in a split plot design with thrice replication. Main plot consist of three different tillage practices *viz.,* a) Zero tillage (ZT), b) Conventional tillage (CT) and c) Bed planting (BP) and sub plot comprised of four different level of nutrient management *viz.,* a) Recommended dose of fertilizer (RDF) (120, 60 and 50 kg/ha N, P_2O_5 and K_2O), b) Site Specific Nutrient Management (SSNM) based on nutrient expert and c) Farmers practice (FP) (150% of RDF + 10 ton FYM). A plot having uniform fertility and even topography was selected for experimental trial.

The experimental area was ploughed except zero tillage with a tractor driven plough and cross harrowing was done thrice with help of disc harrow. Pre-sowing irrigation was given 7 days before land preparation to ensure adequate moisture content in the soil for better germination.

Seed rate of 20 kg/ha was used for sowing of maize. Furrows were opened at 67 cm apart by narrow spade (kudali) and seeds were sown in furrows at a depth of 3-4 cm maintaining plant to plant distance of 20 cm. Thinning and gap filling were done at 20 days after sowing, whereever required. One pre-emergence spray of atrazine @ 2.0 kg/ha was done after sowing followed by two manual weeding at 25 and 56 days after sowing for effective weed control in maize. One pre-sowing irrigation was given before land preparation especially to provide sufficient moisture for better germination of seed and other irrigations were scheduled at critical growth stages viz., six leaf stage, knee height stage, tassel emergence, 50 per cent silking and at dough stage. Usual plant protection measures were adopted to protect the crop from insect pests and diseases and when required. The crop was harvested when the cobs become nearly dry and plants showed physiological maturity (yellowing). First, the cobs were removed from the standing crop and the stover was harvested latter. The harvested cobs were kept in separate gunny bags for each plot and dried under the sun before shelling. After shelling, moisture per cent in grain and yield kg/plot were recorded each plot and then converted into q/ha at 15 per cent moisture level. Five plants from net plot were randomly taken and tagged from second row of each plot for recording the observations at different stages of growth at 30 days interval i.e. 30, 60, 90 and 150 days after sowing.

Height of marked five plants were measured at 30, 60 and 90 days after sowing. The plant height was measured from the base of the plant to the tip of the upper most leaf.

The plant collected for dry weight were utilized to record the leaf area. All the green leaves were classified into three groups as large, medium, and small. Three leaves of each class were randomly chosen and their range was measured with the assistance of a leaf area meter. After emergence of first tassel, the periodic counts on the no. of plant bearing a tassel was made. The day by which 50% of the plants in the each plot area bearing tassel was recorded. The days taken for 50% tasseling were calculated by taking difference in days between the date of sowing and date at which 50% tasseling. After emergence of first silk, the periodic counts on the no. of plant bearing a silk was made. The day by which 50 per cent of the plants in the each plot area bearing silk was recorded. The days taken for 50 per cent silking were calculated by taking difference in days between the date of sowing and date at which 50% silking. For plant population at maturity, the plant excluding the border row was counted at maturity and dry matter accumulation (g/plant) was recorded at 30, 60 and 90 DAS. Randomly three plants were chosen from observation rows of every plot and cut simply over the ground level with the assistance of a sickle. These plants were sun dried for 48 hours. After sun drying, these plants there dried in the oven at 65±5ºC temperature for 48-72 hours till the sampled accomplished a constant weight and weighed. The dry matter was expressed in gram per plant.

Result and Discussion

The results obtained from the present investigation are presented in Table 1 & 2.

Table 1: Effect of nutrient management and different tillage practices on plant height and Dry matter accumulation.

Treatments	Plant height(cm)			Dry matter accumulation (g/plant)		
	30 DAS	60 DAS	90 DAS	30DAS	60DAS	90DAS
Tillage Practices						
ZT	86.17	178.07	186.87	25.61	120.39	239.80
CT	79.81	176.34	180.94	24.15	113.79	217.99
BP	92.47	189.33	194.38	27.75	144.76	257.28
S.E m ±	0.85	1.21	0.80	0.12	0.58	1.26
C.D. (P=0.05)	3.45	4.86	3.22	0.49	2.34	5.08
Nutrient Management						
RDF	84.30	178.00	179.53	25.45	122.47	13.46
SSNM	86.17	181.03	182.68	25.91	124.72	13.67
FP	87.97	184.70	187.38	26.15	131.75	13.76
S.E m ±	0.65	1.56	0.40	0.15	0.68	0.004
CD (P=0.05)	2.04	4.87	1.23	0.48	2.13	0.012

Table 2: Effect of nutrient management and different tillage practices on days to 50% tasseling, 50% silking and Leaf area cm^2/plant and plant population

Treatments	50% tasseling	50% Silking	Leaf area cm^2/plant	Plant Population
Tillage Practices				
ZT	54.66	57.11	4349	71956
CT	54.89	57.67	3948	71683
BP	53.67	55.85	4978	72594
S.E m ±	0.26	0.23	50	152
C.D. (P=0.05)	0.87	0.93	204	518
Nutrient Management				
RDF	55.67	57.66	4290	65619

SSNM	54.33	56.11	4373	67042
FP	53.22	56.00	4612	68686
S.E m ±	0.28	0.20	60	376
CD (P=0.05)	0.87	0.63	186	1171

Plant height

Significant effects were recorded for different growth stages at 30, 60 and 90 DAS. The maximum plant height (194.38 cm) recorded under bed planting tillage which was found significantly superior over (180.94 cm) conventional tillage but found at par with plant height (186.87 cm) recorded under zero tillage practices. Similar trends of plants height were observed at 30 and 60 DAS. The higher plant height under bed planting might be caused by higher availability of nutrients and moisture. Similar findings were also reported by Singh *et al.* (2012) [8]. Significantly effect of nutrient management were recorded at different growth stages. At 30 DAS the maximum plant height (87.97 cm) was recorded with farmers practices nutrient management which was statistically superior over (84.30 cm) RDF but found at par with (86.17 cm) SSNM. At 60 DAS maximum plant height of 184.70 cm recorded with farmer practices nutrient management which was statistically at par (181.03 cm) with SSNM nutrient management. At 90 DAS the maximum plant height was recorded in (187.38 cm) with farmer practices nutrient management. The lowest plant height was recorded (179.53cm) with recommended dose fertilizer (RDF) nutrient management.

Higher plant height recorded at farmer practices might be due to higher availability of essential nutrients that extended vegetative growth period which increased photosynthetic formation and also portioning to stem that had favourable impact on plant height. These results were close conformity with the results observed by Meena (2012) [5], who found that plant height in maize increased with increasing fertilizer.

Leaf area/plant (60 DAS)

The leaf area varied among different tillage practises and significantly higher leaf area was recorded (4978 cm^2plant^{-1}) under bed planting tillage practice over (3948 cm^2plant^{-1}) conventional tillage and (4349 cm^2plant^{-1}) zero tillage practices. He leaf area varied among different nutrient management but significantly highest leaf area was recorded (4612 cm^2plant^{-1}) under farmer practices nutrient management over (4290 cm^2plant^{-1}) RDF and (4373 cm^2plant^{-1}) SSNM nutrient management practices. The lowest leaf area was recorded (4290.00 cm^2plant^{-1}) under RDF nutrient management. Significantly higher leaf area under farmer practices might be ascribed to better growth of maize shoots due to more supply of nitrogen. Nitrogen being vital part of protoplasm helped in cell-division and favoured more production of leaves. The higher value of leaf area was again the result of number leaf and its expansion. Ammanualh *et al.* (2009) [2] also reported higher leaf area of maize at 180 kg N/ha compared to 120 kg N/ha. Pandey (2015) [7] and Layek *et al.* (2012) also noticed significantly higher leaf area at 100% nitrogen application.

Days to 50% tasseling

The minimum days to 50% tasseling was observed in (53.67 days) bed planting tillage practice which was found statistically lowered as compared to (54.66 days) zero tillage practices and (54.89 days) conventional tillage practices. The minimum days to 50% tasseling was found in (53.22 days) under farmer practices which was found statistically lowered over (55.67 days) RDF and (54.33 days) SSNM.

Days to 50% Silking

The minimum days to 50% silking was observed in (55.85 days) under bed planting tillage practice which was found statistically lowered as compared to (57.11 days) zero tillage practices and (57.67 days) conventional tillage practices.

The minimum days to 50% silking was observed in (56.00 days) under farmer practices nutrient management which was found statistically lowered over (57.66 days) RDF but found at par with (54.33 days) SSNM.

Plant population at maturity

Significant effect of plant population was recorded at all growth stages. The maximum plant population (72594 plant/ha) was recorded under bed plating tillage practices which was significantly superior over rest of the treatment. The minimum plant population at maturity was found (71683 plant/ha) under conventional tillage practices. Plant population significantly affected by nutrient management was recorded at maturity stage. At the maturity stage, the maximum plant population was observed under (68686 plant/ha) farmers practices nutrient level which was significantly superior over (65619 plant/ha) RDF and (67042 plant/ha) SSNM. The lowest plant population was recorded (65730 plant/ha) with RDF nutrient level.

Dry matter accumulation at 30, 60 and 90 DAS

Significant effect of dry matter accumulation was recorded at 30, 60 and 90 days. The maximum dry matter accumulation was recorded at 30 DAS (27.75 gm), 60 DAS (144.76 gm) and 90 DAS (257.28 gm) in bed planting tillage practice. The lowest dry matter accumulation was recorded at 30 DAS (24.15 gm), 60 DAS (113.79 gm) and 90 DAS (217.99 gm) with conventional tillage practice. Significant effect of dry matter accumulation was recorded at all the stages 30, 60 and 90 DAS. The maximum dry matter accumulation (26.15 gm) was recorded at 30 DAS which was statistically at par with (25.91 gm) SSNM nutrient management. At 60 DAS the maximum dry matter accumulation was found (131.75 gm) under farmer practices nutrient level. At 90 DAS highest dry matter accumulation was observed at (265.83 gm) farmer practices. The lowest dry matter accumulation was found (209.37 gm) at 90 DAS in RDF level. The higher dry matter accumulation was the results of higher plant height and more number of leaves per plant. Singh *et al.* (2012) [8] also recorded more dry matter accumulation at higher dose of nitrogen application. Similar findings were also confirmed by Akbar *et al.* (2002) [1].

Conclusion

The experimental evidences warrant the following specific conclusion which may be adopted for better crop yield in maize during *kharif* season**.** Growth attributes of maize in bed planting was found significantly superior over rest of the tillage practices. Growth of maize under nutrient management practices, farmer practices was found significantly superior over RDF but statistically at par with SSNM.

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