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Suvra Pattanaik
Department of Agronomy, Chandra Shekhar Azad University of Agriculture and Technology, Kanpur, Uttar Pradesh, India

Ram Pyare
Department of Agronomy, Chandra Shekhar Azad University of Agriculture and Technology, Kanpur, Uttar Pradesh, India

Uday Pratap Singh
Department of Agronomy, Chandra Shekhar Azad University of Agriculture and Technology, Kanpur, Uttar Pradesh, India

Corresponding Author:
Suvra Pattanaik
Department of Agronomy, Chandra Shekhar Azad University of Agriculture and Technology, Kanpur, Uttar Pradesh, India

Effect of in-situ green manuring and nitrogen levels on growth and yield of maize (*Zea mays* L.)

Suvra Pattanaik, Ram Pyare and Uday Pratap Singh

Abstract
An experiment was carried out at the Student's Instructional Farm (SIF) of Chandra Sekhar Azad University of Agriculture and Technology, Kanpur during kharif season of 2019 to find out "Effect of in-situ green manuring and nitrogen levels on growth and yield of maize (Zea mays L.)" The experiment comprises of twelve treatments i.e. control (No green manure and no nitrogen), no green manure+ 100kg N/ha, no green manure+ 150kg N/ha, no green manure+ 225kg N/ha, maize sown after in situ green manuring + 0 kg N/ha, maize sown after in situ green manuring + 100 kg N/ha, maize sown after in situ green manuring + 150 kg N/ha & maize sown after in situ green manuring + 225 kg N/ha, maize sown into standing dhaincha + 0kg N/ha, maize sown into standing dhaincha + 100kg N/ha, maize sown into standing dhaincha +150kg N/ha & maize sown into standing dhaincha + 225kg N/ha and laid out in a Randomized Block Design with three replications. The soil of the experimental plot was sandy loam in texture with Ph 7.7 & EC of 0.30 ds/m at 25°C. It contained 0.47% organic carbon. Result showed that the plots where maize was sown after incorporation of green manure and with the supply of 150 kg N/ha promoted significantly the growth and yield attributes of the maize crop compared to all remaining treatments. The treatment of maize sown after in-situ green manuring has done and at a dose of 150 kg N/ha observed significantly higher plant height (289.30 cm), accumulation of plant dry matter significantly higher at 150kg N/ha (17774.94kg/ha) and at 225kg/ha, an yield of 82.54 q/ha which is non significantly higher than 150kg N/ha (81.92q/ha) over other treatments.

Keywords: Green manure, nitrogen and maize

Introduction
Maize is one of the main and popular cereal crops due to its high value as stable food as well as its stover demand for animal feed and fuel and even for construction purposes. Maize is also the most important stable crop in terms of calorie intake in most of the British rural families. The total maize production in India accounts to 27.72 million tonnes in 2018-19. The production in 2019 accounts 28.08 million tonnes (source: ministry of agriculture). Approximately 88% of maize produced in Ethiopia is used as food, in both green cobs, and grain. Because of its multiple advantages, it ranks first in its productivity among major cereal crops. And it is therefore, one of the high priority crops to feed the ever increasing Ethiopian population.

Green manuring is one of the most effective and environmentally sound methods of sustaining soil productivity in agriculture. The effectiveness of green manure crop, however, is related to its ability to produce more biomass and to sequester large amount of plant nutrients in a short period of time. To improve the soil physical and chemical properties, to enhance the crop productivity and for better quality of produce, growing of green manuring crops is an inevitable practice in the years to come for sustainable agriculture. Under intensive farming situation, the main limitation is to get sufficient time gap to grow green manure crop. Though the practice of green manuring at the cost of main crop is rare, several attempts were made to introduce legumes as intercrop without affecting the main crop (Lakshmi *et al.* (2009) [2] and Rehman *et al.* (2010) [3].

Materials and Methods
A field experiment was conducted at student's Instructional Farm (SIF). Chandra Shekhar Azad University of Agriculture and Technology, Kanpur during Kharif season of 2019. The experimental field was situated in the central part of Uttar Pradesh at an elevation of 129.0 meters above mean sea level. The experimental field was well levelled and had assured irrigation facility through tube well. It is situated in alluvial belt of middle gangetic plain in Central part of Uttar Pradesh having class II of land capability.

The soil of the experimental field was clay loam in texture, low in nitrogen, medium in phosphorus and high in potassium with slightly alkaline in reaction.

The treatment was comprising of twelve treatments were laid out in Randomized Block Design with three replications. The details of treatments as farmer practice comprises of twelve treatments i.e. control (No green manure and no nitrogen), no green manure+ 100kg N/ha, no green manure+ 150kg N/ha, no green manure+ 225kg N/ha, maize sown after in situ green manuring + 0 kg N/ha, maize sown after in situ green manuring + 100 kg N/ha, maize sown after in situ green manuring + 150 kg N/ha & maize sown after in situ green manuring + 225 kg N/ha, maize sown into standing dhaincha + 0kg N/ha, maize sown into standing dhaincha + 100kg N/ha, maize sown into standing dhaincha +150kg N/ha & maize sown into standing dhaincha + 225kg N/ha. A popular maize hybrid DKC-7074 was used to study. The hybrid is yellow grained and matures in 110 to 120 days and has high yielding potential. Dhaincha is the fastest growing species of the genus and is very effective in smothering out weeds. Almost any well drained soil is suitable for kharif crop. It is grown during rainy season is mainly utilized as a green manure crop which can produce mass yield of approximately 4.5 to 6 t/ha.

Results and Discussion

Effect of treatments on growth and yield attributes of maize

The plant height was significantly improved from 150 kg N/ha to 225kg N/ha (260.46 cm to 261.03 cm). Increase in dry matter production from 150 kg N/ha to 225 kg N/ha was non significant at all the growth stages. Hence, this shows the best response of plants towards a nitrogen dose of 150kg N/ha (17,774.7 kg/ha). There is a significant response between plant responses between 100kg N/ha and 150kg N/ha (62.90 days to 62.67 days) were found in respect of days to 50% tasseling and a non significant response between 150 kg N/ha and 225kg N/ha (62.67 days to 62.72 days). Cob length shows that a significant increase in 150 kg N/ha from 100 kg N/ha (16.46 cm to 18.03 cm). In case of the green manuring treatments maize sown after incorporation of green manure gives a significant response (17.22 cm). The highest grain weight/cob obtained in the plots given 225kg N/ha and next to it, at 150kg N/ha (146.23g to 147.03g) and green manure shows significantly higher response (132.71 g) than both the other treatments where no green manure was taken. Test weight of grains obtained is highest in the plots given 225kg N/ha and next to it, at 150kg N/ha (30.63 g to 31.0 g) and green manure shows significantly higher response (30.4g) in respect of test weight. The lesser efficiency is because of the phenomenon of nutrient loss through leaching and also due to the side effects of burning effect of nitrogen on plants. These results suggest that an appropriate proportion of organic substitution not only provides enough nutrients but also improves the soil environment. The main benefit of using a legume as a green manure is that legumes fix nitrogen from the atmosphere and convert it into a form that is available to other plants. The incorporated legume residues are a biological source of nitrogen that reduces the amount of nitrogen required for the following crop. Green manuring incorporation helped in maintaining the soil organic matter, which in turn helped in improving the soil's structure, pore size and water-holding capacity.; whereas, in case of maize sown into standing green manure crop (G3), decrease in yield attributes might be due the competition for growth resources between maize and dhaincha. All the yield attributes increased with each increment of nitrogen application. The similar findings were reported by Nooli *et al*. (2001) [4], Perin *et al*. (2006) [5], Sujatha *et al.* (2008) [6], Rasool *et al.* (2015) [7] and Yang *et al.* (2017).

Effect of treatments on yields

The highest biological yield was obtained from the plot given a nitrogen dose of 225kg N/ha. The effect of green manure in situ shows a significant result where maize was sown after one week when incorporation of green manure was over than the other treatments. The best response hence was observed in the second treatment (77.82q/ha). The 150kg N/ha shows a significant increase than 100kg N/ha and the highest yield (82.54q/ha) was obtained from the plot given a nitrogen dose of 225kg N/h and The effect of green manure in situ shows a significant result where maize was sown after one week when incorporation of green manure was over than the other treatments where no green manure crop was taken. There was a significant result of stover yield in the treatment of 150 kg N/ha than 100kg N/ha (81.83q/ha to 86.46q/ha) and The best response hence was observed in the second treatment where maize was sown after in-situ green manuring (84.56 q/ha). highest harvest index was found in 150 kg N/ha i.e. 48.6 and also the response was significantly higher than the plots given 100kg N/ha. There was a significant increase in this observation from 100 kg N/ha to 225 kg N/ha (48.23 to 48.53). In case of the green manuring treatments maize sown after incorporation of green manure gives a significant response in respect of harvest index (47.55). The Consumption of synthetic N fertilizers has eliminated the practice of enriching soils with organic C and N by adding organic manures and green manuring. However, it was observed in the current experiment that yield obtained was highest at G2 system of green manuring in-situ at the same level of nitrogen. Similar results have also been reported earlier by Tripathi and Hazra (2002) [8], Balkcom and Reeves (2005) [9], Sharma and Behera (2009) [10] and Karyot *et al*. (2018) [11].

Table 1: Effect of in-situ green manuring and nitrogen levels on growth and yield attributes of maize (*Zea mays* L.) during kharif season of 2019

Treatment	Plant height (cm)	Dry matter accumulatioin (kg/ha)	Days to 50% tasseling	Days to 50% silking	Cob length (cm)	Grain weight/cob (g)	Test weight (g)
Green manure							
No GM	254.10	14944.65	62.08	69.10	16.37	123.5	29.45
Maize sown after in situ GM	275.20	18178.90	61.30	67.51	17.22	132.71	30.43
Maize sown into standing dhaincha	214.32	13071.25	65.48	72.69	15.80	124.97	26.47
SE (d) ±	0.34	45.51	0.016	0.031	0.024	0.283	0.229
CD at 5%	0.99	134.36	0.048	0.092	0.071	0.837	0.676
Nitrogen levels (kg/ha)							
Control	221.70	9878.06	63.53	72.33	13.27	84.33	25.27
100 kg/ha	246.93	15550.80	62.90	71.33	16.47	126.47	28.23
150 kg/ha	260.46	17774.94	62.67	67.67	18.03	146.23	30.63

225 kg/ha	261.03	17928.94	62.72	67.76	18.10	147.03	31.00
SE (d) ±	0.38	52.55	0.019	0.036	0.028	0.327	0.264
CD at 5%	1.14	155.14	0.055	0.106	0.081	0.966	0.780

Table 2: Effect of in-situ green manuring and nitrogen levels on yields and harvest index of maize (*Zea mays* L.) during *kharif* season of 2019

Treatment	Biological yield (q/ha)	Grain yield (q/ha)	Stover yield (q/ha)	Harvest index (%)
Green manure				
No GM	143.41	67.89	75.52	46.92
Maize sown after in situ GM	162.39	77.82	84.56	47.55
Maize sown into standing dhaincha	141.48	66.54	74.93	46.45
SE (d) ±	0.356	0.197	0.164	0.026
CD at 5%	1.05	0.582	0.484	0.076
Nitrogen levels (kg/ha)				
Control	99.69	42.44	57.33	42.57
100 kg/ha	156.60	75.41	81.83	48.23
150 kg/ha	168.39	81.92	86.46	48.63
225 kg/ha	169.5	82.54	86.86	48.53
SE (d) ±	0.41	0.23	0.19	0.030
CD at 5%	1.21	0.67	0.56	0.088

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