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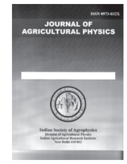

Research Article

Influence of Farmyard Manure and Nitrogen on Growth and Fodder Yield of Summer Maize

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ABSTRACT

A field experiment was conducted at the Research Farm of Department of Agronomy, Punjab Agricultural University, Ludhiana during *rabi* season of 2011. The field trial comprising of twelve treatments *viz,* three main plots [farm yard manure (FYM) at 0 (control), 12.5 ($F_{12.5}$) and 25 t ha^{-1} (F_{25})] and four fertilizer nitrogen (N) levels in sub plots (0, 40, 80 and 120 kg ha^{-1}) in a split plot design with four replications. Green fodder yield of 3.69 t ha^{-1} was obtained with application of FYM @ 25 t ha^{-1} which was significantly higher than that in $F_{12.5}$ and control. Dry matter yield, plant height, leaf area index, leaf stem ratio and moisture content recorded at F_{25} and $F_{12.5}$ were significantly higher than the control, but similar with one another. Nitrogen at 120 kg ha^{-1} resulted higher green fodder yield (4.06 t ha^{-1}) over lower N levels. Application of FYM and synthetic fertilizer N alone or in combination induced the crop to attain tasseling, silking and harvestable stage earlier than the control.

Key words: Summer maize, Nitrogen, FYM, Growth parameters, Fodder yield

Introduction

Livestock is an integral component of farming system in India Punjab but the area under fodder crops and/or grassland has been consistently disproportionate to the bovine population in the country. Consequently, limited and poor quality fodder is constraint of dairy industry and rural farming. Therefore, to improve the productivity of dairy and other livestock precise, management of feed and fodder crops are vital. For increasing the production of quality fodder, balanced nutrient management with organic and inorganic plant nutrient sources is crucial. It is crucial to maintain soil organic carbon for efficient utilization of synthetic fertilizer inputs and to improve physical conditions of the soil (Manna and Ganguly, 2003). Maize is one of the most important dual purpose crop grown widely for grain and fodder. The maize fodder is succulent, sweet, palatable, nutritious and free from toxicants. It can be safely fed to animals at any stage of crop growth. Nitrogen is the most important and limiting nutrient for plant growth in soils of Punjab. Nitrogen application increases the crude protein and metabolic energy besides making the plant more succulent and palatable (Almodares *et al.*, 2009). Nitrogen is known for growth pattern of maize crop (Aslam *et al.,* 2011 and Zhang *et al.,* 2014). Farmyard manure plays important role in cycling of N and availability of nutrient in soil (Kumar *et al.,* 2005). The present study was conducted to study the effect of FYM and N on growth pattern, development behavior and fodder yield of summer maize.

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Materials and Methods

A field experiment was conducted at the Research farm of Department of Agronomy, Punjab Agricultural University, Ludhiana during *rabi* season of 2011. The soil was loamy sand in texture, has pH of 8.0, is low in organic C (0.33%) and available N (130 kg ha^{-1}), high in available P (28.5 kg ha^{-1}) and medium in available K (240 kg ha^{-1}). The field experiment included twelve treatment combinations with three main plots (FYM @ 0, 12.5 and 25 t ha^{-1}) and four synthetic N levels in sub-plots (0, 40, 80 and 120 kg ha^{-1}).The experiment was laid out in split plot design with four replications. FYM was mixed in the main plots during previous crop cultivation. Half of N in the form of urea and full dose of P (60 kg P_2O_5 ha^{-1}) as single super phosphate and K (30 kg K_2O ha^{-1}) as muriate of potash were applied at the time of sowing by drilling in the furrows. Maize composite variety J-1006 was sown by *kera* (dropping the seed in furrows) method, on April 11, 2011 by using 75 kg seed ha^{-1} at row spacing of 30 cm. Seed treatment was done with bavistin @ 3 g kg^{-1} of seed before sowing. Half of N was applied by top dressing at 30 days after sowing. FYM used in the study contained 1.1% N, 0.49% P and 2.17% K. Observations were taken at attaining 50% tasseling and silking and harvestable stage. Plant heights, leaf area index, leaf to stem ratio and biomass accumulation were measured at 30, 45 and 60 days after sowing (DAS) and at harvest.

Results and Discussion

Growth attributes

Plant heights significantly increased due to application of FYM (Table 1). The FYM improves soil nutrient status and their availability, which is essential for plant growth and development. It also improves the physical, chemical and biological conditions of the soil and ultimately results in better growth (Singh and Nepalia, 2009). Each incremental level of N enhanced plant heights. Nitrogen increases photosynthetic activity and helps in maintaining higher auxin level which might have resulted in better plant height (Thind and Sandhu, 1984).

Application of 25 t of FYM enhanced LAI significantly compared to no (F_0) or lower levels of FYM ($F_{12.5}$), difference between F_0 and $F_{12.5}$ were non-significant at 45 and 60 DAS (Table 1). Lower values of LAI at early stage were also reported by Singh and Nepalia (2009), Kumar (2009) and Vadivel *et al.* (2001). Nitrogen application has strong impact on the LAI at 45 and 60 DAS. At 45 DAS, significantly higher LAI was produced in N_{80} than N_{40}, but was at par with N_{120}. Increase in LAI with increase in N level was due to higher number of leaves $plant^{-1}$ which may be due to lesser senescence and leaf retention for longer period with higher nitrogen application, maize being a nitro-positive plant.

Table 1. Effect of farm yard manure and N on plant height, leaf area index and leaf-stem-ratio of maize fodder

Treatments	Plant height (cm)			Leaf area index			Leaf-stem-ratio		
	Days after sowing			Days after sowing			Days after sowing		
	30	45	60	30	45	60	30	45	60
FYM (t ha^{-1})									
0	20.58	63.59	114.74	0.12	2.00	3.10	1.23	0.78	0.47
12.5	22.16	68.79	129.54	0.13	2.33	3.50	1.30	0.84	0.56
25	22.41	71.59	135.81	0.18	2.54	3.51	1.34	0.91	0.64
CD (p=0.05)	*0.20*	*3.62*	*8.19*	0.02	0.30	0.36	NS	0.06	0.03
Nitrogen levels (kg ha^{-1})									
0	19.40	63.80	112.18	0.13	1.81	3.00	1.22	0.77	0.51
40	20.74	67.25	123.70	0.14	2.21	3.31	1.27	0.83	0.54
80	21.76	68.75	131.97	0.15	2.50	3.48	1.31	0.87	0.57
120	24.98	72.16	138.93	0.15	2.64	3.71	1.35	0.91	0.60
CD (p=0.05)	*0.37*	*2.06*	*2.52*	NS	0.23	0.21	NS	0.10	0.06

Farm Yard Manure significantly increased higher leaf-to-stem ratio at 45 and 60 DAS (Table 1). Leaf-to-stem ratio at 30 DAS was indifferent, due to less N applied, while requirement for nutrients increases at later stages. Increase in higher leaf-stem ratio with application of FYM is indicative of better plant growth and development under FYM (Singh and Nepalia, 2009). At 45 DAS, N_{80} produced higher leaf-stem ratio than N_0, but at par with N_{40}. At 60 days, N_{120} produced higher leaf-stem ratio than N_0 and N_{40}, was at par with N_{80}. Higher dose of N induced photosynthesis and triggered growth and development, as indicated by higher plant height and LAI. Therefore, leaf-to-stem ratio with increase in N levels was higher and leaf growth was better with higher N availability during the later growth stages. These findings are in close agreement with the findings of Bakht *et al.* (2006).

Biomass production

Dry biomass production was significantly affected by both FYM and N levels at 30, 45 and 60 DAS (Table 2). Effect of lower N either through FYM or synthetic fertilizer on green matter accumulation was not was so evident at 30 DAS, but was obvious as the crop growth advanced. Response of maize fodder to higher dose of FYM may be attributed to nutrients other than N, and explain the benefit of balanced fertilization. Higher green fodder yield was the cumulative effect of plant height and leaf area index at later stages of crop growth. Similar results were reported by Venkatesh *et al.* (2002) and Surendra and Sharanappa (2000). Higher yield of maize fodder obtained due to addition of N may be attributed to the fact that N is an important constituent of amino acids and chloroplasts which directly influenced plant growth and development through greater photosynthates. Higher leaf area captures more photosynthetically active radiation with higher photosynthesis (Singh and Dubey, 2007). Similar findings were also reported by Kumar and Sharma (1997) and Singh *et al*. (2000).

Application of either FYM or synthetic fertilizer N or both induced crop to reach to tasseling, silking and harvest stage earlier than that in the non-manure or non-fertilized plot. Combined use of FYM and N had synergistic effect on advancing the date of maturity. Nutritional status of a crop is known to influence floral induction in crop. Certain crop such as maize attains reproductive stage only when N content in the plant is above the threshold level. Eltelib *et al.* (2006) also observed that increase in N level advanced the tasseling and silking stage in maize.

Table 2. Effect of farm yard manure and N on the green and dry matter accumulation of maize fodder during growth

Treatments	Green fodder yield (q ha^{-1})			Dry matter yield (q ha^{-1})		
	Days after sowing			Days after sowing		
	30	45	60	30	45	60
FYM (t ha^{-1})						
0	50.2	130.9	285.8	17.0	28.7	78.4
12.5	58.9	165.2	294.7	17.3	31.7	77.7
25	64.5	195.8	308.7	19.5	37.5	82.5
CD (p=0.05)	*1.4*	*9.0*	*4.9*	*0.9*	*1.9*	*3.8*
Nitrogen levels (kg ha^{-1})						
0	51.3	107.0	244.4	17.1	28.0	70.3
40	54.7	139.4	289.0	17.4	29.7	77.4
80	59.6	190.8	299.5	18.2	34.0	81.1
120	65.8	218.5	352.7	19.0	38.7	89.4
CD (p=0.05)	*1.1*	*6.4*	*7.3*	*0.8*	*1.9*	*3.2*

Table 3. Effect of FYM and synthetic N on green and dry fodder yield and moisture content of maize fodder

Treatments	Moisture content (%)	Green fodder yield (q ha^{-1})	Dry fodder yield (q ha^{-1})
FYM (t ha^{-1})			
F_0	74.07	292.9	81.5
$F_{12.5}$	79.23	344.1	87.4
F_{25}	80.95	368.8	92.1
CD (p=0.05)	*1.31*	*9.1*	*7.6*
Nitrogen levels (kg ha^{-1})			
N_0	74.79	267.2	79.4
N_{40}	77.21	318.1	84.3
N_{80}	79.08	349.3	89.0
N_{120}	81.26	406.3	94.6
CD (p=0.05)	*2.01*	*7.5*	*10.1*

Table 4. Interaction effects of FYM and synthetic N on green fodder yield (q ha^{-1}) of maize at harvest

Treatment	Farm yard manure (t ha^{-1})			Mean
	F_0	$F_{12.5}$	F_{25}	
Nitrogen (kg ha^{-1})				
N_0	255.22	255.97	291.35	267.18
N_{40}	281.96	336.49	335.97	318.14
N_{80}	289.64	354.61	403.76	349.34
N_{120}	345.61	429.31	443.92	406.28
Mean	292.86	344.10	368.75	

*CD (5%) FYM = 9.1 Nitrogen =7.5 FYM * N =13.0*

Green and dry fodder yield and moisture content at harvest

Each level of FYM and N improved green fodder yield significantly over the lower levels (Table 3). Green fodder yield of 292.9 q ha^{-1} was obtained at harvest in F_0 treatment, which was 17.5 and 25.9% less than that obtained in two higher FYM levels, respectively. Application of 120 kg N produced 406.3 q ha^{-1} green fodder, which was significantly higher over the lower levels. This increase in the green fodder yield could be attributed to increase in plant height and leaf area index (Devi, 2002; Karki *et al*., 2005). The FYM used in this study contained 1.1% N, 0.49% P_2O_5 and 2.17% K_2O, which supplied additional nutrients to the crop and thus modified the crop response to N. The response of maize fodder to higher dose of N in the presence of FYM may be attributed to the role of FYM in providing nutrients other than the synthetic fertilizer N (balanced fertilization). Higher green fodder yield was the results of cumulative effect of increase in plant height, leaf-stem-ratio and leaf area index (Venkatesh *et al.,* 2002). Higher values of LAI due to application of FYM and synthetic N helped in effectively capturing the photosynthetically active radiation (Singh and Dubey, 2007). Interaction between FYM and synthetic N clearly indicates application of FYM with lower N dose could be effective in improving green fodder yield than application of synthetic N at higher dose (Table 4). The highest yield although was obtained with 120 N kg ha^{-1} along with FYM @25 t ha^{-1}.

Application of F_{25} produced significantly higher dry matter yield over $F_{12.5}$ and control (F_0) (Table 3). At harvest, F_{25} had higher dry matter yield than the control (F_0) however at par with $F_{12.5}$. Higher plant height and LAI under F_{25} compared to $F_{12.5}$ and control resulted in more dry matter at harvest. Our results are in agreement with Karki *et al.* (2005). Application of 120 kg N ha^{-1} resulted in significantly higher dry matter accumulation at 30, 45 and 60 DAS. Application of N_{120} produced significantly higher dry matter yield than control (N_0) and N_{40} at harvest, but was at par with N_{80}. Improvement in dry matter yields at higher nitrogen levels was due to improved growth parameters namely plant height, and LAI (Kakol *et al.,* 2003).

Data revealed that FYM produced more succulent fodder than the control (F_0). The fodder had 1.7 and 1.9% moisture content in FYM @ 25 t ha^{-1}, which was significantly higher than that that from $F_{12.5}$ plots (Table 3). The moisture content of maize tended to increase with increasing N levels. Each level of N produced fodder with significantly higher moisture content. Nitrogen application tends to produce succulence, which is an index of quality in fodder crops. Adequate nitrogen supply favors crop growth, which increases the protein formation from manufactured carbohydrates. Consequently less carbohydrate is deposited in the vegetative cells and more protoplasm is formed. Protoplasm is highly hydrated so it leads to more succulence (Tisdale and Nelson 2011).

Conclusion

Application of FYM and synthetic N significantly influenced the plant height, LAI, leaf-stem-ratio of summer maize fodder. Similarly, owing to increase in growth of maize with application of FYM and nitrogen significant increase in green and dry fodder yield over control was recorded at all crop growth stages. At harvest stage, FYM @ 25 t ha^{-1} produced green fodder which was equivalent to 80 kg N per hectare alone. The extent of substitution of inorganic fertilizer with FYM however depends on duration of the crop, season and its rate of application.

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