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Response of FYM and Split Application of Nitrogen on Growth and Green Yield of Fodder Maize (*Zea mays* L.)

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

A field experiment was conducted at Main Forage Research Station, Anand Agriculture University, Anand (Gujarat) to study the effect of FYM and split application of nitrogen on the growth and yield of fodder maize in loamy sand soil during *rabi* season of 2021-22. The experiment was laid out in a randomized block design (factorial) with three replications. There ten treatment combinations comprising two levels of FYM *i.e.,* F_1 (No FYM) and F_2 (10 t FYM/ha) and five levels of nitrogen split *i.e.,* N_1 (Control: Common Practices, 50% Basal + 50% 30 DAS), N_2 (20% N at Basal + 80% N in three equal splits), N_3 (30% N at Basal + 70% N in three equal splits), N_4 (40% N at Basal + 60% N in three equal splits) and N_5 (50% N at Basal + 50% N in three equal splits). Application of 10 t FYM/ha were improved the growth, quality and yield attributes like periodical plant height, leaves/plant, leaf-stem ration, green and dry fodder yield, crude protein and dry matter content, NPK content and uptake, Acid Detergent Fiber (ADF) and Netural Detergent Fiber (NDF) as compared to control treatment of fodder maize. Response of FYM on soil EC, pH was found to be non-significant and soil available phosphorus potassium was found significant. Split application of nitrogen (50% N at Basal + 50% N in three equal splits) reported significant response on growth parameters like periodical plant height, number of leaves per plant, green fodder yield and quality parameters like dry matter content, crude protein content, dry fodder yield, crude protein yield,

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neutral detergent fiber and acid detergent fiber of fodder maize. Response of split application of nitrogen on post-harvest soil parameters like pH, EC, organic carbon, available phosphorus and potassium.

Keywords: Green fodder yield; dry fodder yield; split nitrogen; acid detergent fiber; netural detergent fiber.

1. INTRODUCTION

Maize is one of the important cereal crops in the world's agricultural economy and an important crop next to rice and wheat. Maize is a multifaceted crop used as a food, feed and industrial crop globally. It has a very predominant role to carry out in the Indian economy. About 85 per cent in consumed as human food. It has got a very high yield potential due to its genetic constituent in contrast to other crops hence it is called "queen of cereals" [1]. Green fodder is an important component of animal feed. Maize is one of the most prominent forage crops not only in India but throughout the world owing to its higher growth rate and yield, wider adaptability, higher digestibility, more palatability and lack of any potential anti-nutritional factor [2]. It is originated in Mexico [3] and second most important cereal fodder crop, after sorghum, because it is a dual-purpose crop. In world production, maize ranked as the third cereal crop after wheat and rice [4]. The fodder production in our country is insufficient to meet the requirement of livestock in India [5]. Precise management of feed and fodder crops is vital for improving the productivity of dairy and other livestock [6].

Water and nutrients are the most important elements influencing the growth of plants. Therefore, management of the factors in farming system is one of the most important components of Agriculture management [7]. Organic matter is known to improve soil health and the availability of plant nutrients [8-11]. Farmyard manure is one of the oldest manures used by the farmers to grow plants because of its easy availability [12]. It is most essential organic source since it provides all of the nutrients required for crop growth, including trace elements in modest quantities [13], it is not only supply macro and micronutrients to plants but also improves soil health from physical, chemical and biological point [14] of for increasing the production of quality fodder. Nutrient management through organic and inorganic plant nutrient source is very critical. Application of organic manure act a good source for fodder production as well as it accumulates higher carbon dioxide from the atmosphere [15].

Nitrogen is a fundamental key component in crop growth and development and furthermore most restricting supplements in the soil [1]. Nitrogen plays a key role in the vegetative growth and grain productions of maize [16]. Among the nutrients, nitrogen is vital for plant growth and is the most limiting nutrient in Indian soils [17]. Split application of nitrogen is one of the methods to improve nitrogen use by the crop while reducing the nutrients loss through leaching and volatilization (Lalita et al, 2017). Nitrogen has numerous functions in the plants. It is an essential elements of amino acids DNA and RNA [18]. Nitrogen is a constituent of plant compounds including nucleotides, amines, and amines. Many enzymes are proteinaceous; hence N plays a key role in many metabolic reactions. Nitrogen is a structural constituent of cell walls [19]. Because N is contained in the chlorophyll molecules, a deficiency of N will result in a chlorotic condition in the plant. Supply of nutrients at an appropriate time and amount is always imperative for better growth and development of a crop. However, yield and quality parameters are very much affected by inadequate availability of plant nutrients. Low yield of fodder maize is due to many constraints but NPK fertilizer application is one of the major factors [20]. Different fertilizer applications and splitting of nitrogen can reduce nutrient losses, therefore more amount of nutrients may become available which may be used efficiently by crops plants and thus, may result in nutrient economy [21].

Keeping in view the importance of farmyard manure as an organic manure and nitrogen as a key nutrient for plant growth and development, a field trial was undertaken to study the effect of FYM and split application of nitrogen on the yield and quality of fodder maize.

2. MATERIALS AND METHODS

A present field experiment study was conducted at Main Forage Research Station, Anand

Agriculture University, Anand (Gujarat) to study the effect of FYM and split application of nitrogen on the growth and yield of fodder maize during *rabi* season of 2021-22. The soil of experimental site was loamy sand in texture commonly referred to as "*Goradu*" soil. The soil of the experimental plot was low in organic carbon (0.34%), medium in available phosphorus (35.86 kg/ha) and medium in available potash (267.80 kg/ha), soil pH (7.92) and EC (0.24 dSm^{-1}). The experiment was laid out in a randomized block design (factorial) with three replications. There were ten treatment combinations comprising two levels of FYM *i.e.,* $\mathbf{F_1}$ (No FYM) and $\mathbf{F_2}$ (10 t FYM/ha) and five levels of nitrogen split *i.e.,* $\mathbf{N_1}$ (Control: Common Practices, 50% Basal + 50% 30 DAS), $\mathbf{N_2}$ (20% N at Basal + 80% N in three equal splits), $\mathbf{N_3}$ (30% N at Basal + 70% N in three equal splits), $\mathbf{N_4}$ (40% N at Basal + 60% N in three equal splits) and $\mathbf{N_5}$ (50% N at Basal + 50% N in three equal splits). Calculated dose of FYM (contained 1.22 % N, 0.42 % P_2O_5 and 0.45 % K_2O) was applied in the respective plot 15 days before sowing. Recommended dose of fertilizer (80-40-00 kg NPK/ha) was supplied through Urea and SSP. Basal dose of nitrogen was applied according to the treatment (Split application of nitrogen) and the remaining nitrogen (according to treatments) was applied in three equal splits at 15, 30 and 45 DAS in treatment N_2 to N_5. Maize variety African tall was sown by drilling method using 80 kg seed per hectare at a row spacing of 30 cm. Crop production management practices were adopted as per recommendation of the. In maize, 5 plants were selected randomly from the net plot area for the measurements of growth and yield of maize. The field was kept free from weeds by manually hoeing and chemically. Plant protection measure and irrigations whenever required were provided. A fresh sample of 500 g fodder maize was collected from each net plot and chopped into small pieces and it was air dried for three to four days. The forage quality was assessed in terms of crude protein, dry matter, dry matter yield, crude protein yield analysis protocol was followed by described by the association of official Analytical Chemistry [22]. The dry matter content multiply with total green fodder yield for calculation of dry matter yield and CP content was multiplied with total dry matter to calculate the Crude Protein Yield (CPY) These air-dried samples were oven dried in the oven at 70 ℃ temperature till constant weight obtained and the dried samples were powdered to pass through 6 mm sieve. Take replicated observations for statistical analysis. Replicated data statistical analysis was carried out by the Department of Agricultural Statistics, B.A. College of Agriculture, Anand Agricultural University, Anand, as per the procedure described by Cochran and Cox [23]. The variances of different sources of variation in ANOVA were tested by "F - test" and compared with the value of Table F at 5% level of significance.

3. RESULTS AND DISCUSSION

3.1 Effect of FYM

Response of FYM on plant population at 15 DAS was found to be non-significant, it means uniform germination of seed and no response of FYM on fodder maize.

Application of FYM 10 t/ha (F_2) recorded significantly higher plant height (86.63 and 192.30 cm at 40 DAS and at harvest, respectively), leaves/plant (9.43 and 14.24 at 40 DAS and at harvest, respectively) and leaf-stem ratio (0.62 %) as compared to no application of FYM (F_1). Enhancement in growth parameters with the application of FYM might be attributed to the fact that FYM supplied macro and micronutrient particularly nitrogen which favours rapid cell division and cell elongation [24]. Response of FYM was found non- significant on number of leaves per plant and plant height at 20 DAS.

Data presented in Table 1, application of 10 t FYM/ha (F_2) reported high leaf stem ratio (0.62) compared to no application of FYM (F_1). Increased in the leaf stem ratio might be due to the supply of all essential plant nutrients, growth hormones and enzymes by FYM to plant which resulted in higher plant height and numerically a greater number of leaves [6].

Application of FYM 10 t/ha (F_2) reported higher green fodder yield (434 q/ha) compared to no application of FYM (F_1). The magnitude of mean increase in green fodder yield with F_2 (10 t FYM /ha) was 13.02% over F_1 (No FYM: control). This might be due to the availability of the available forms of nutrients through of growth period as well as increased availability of soil nitrogen and other macro and micronutrients that might have enhanced meristematic growth and resulted in higher fodder yield. Other reason might be due to the increase in green fodder yield with the application of FYM could be attributed to conductive effect of FYM on root and shoot growth of plant which in turn accrued from increased morphological parameters viz., plant height and number of leaves per plant [6,24].

The data revealed (Table 2) farmyard manure produced more dry matter yield (67.44q/ha) and crude protein yield (4.32 q/ha) than no application of FYM. The higher dry matter content in the FYM-treated plot might be attributed to a higher assimilation rate and better assimilate partitioning. Plant's metabolic processes were affected by nutrients such as N, K, and Zn owing to hormonal influences. Nutrient elements are important in plants because they provide a high plant height, number of leave and leaf area index, which increases light interception on the crop canopy and, as a result, increases the amount of dry matter content of plant [25] while crude protein content might be due to more availability of nitrogen, which ultimately led to more nitrogen uptake and nitrogen content accumulated in plants and extended benefit with congenial biochemical reactions at higher FYM levels as reported by Kamalakumari and Singaram [26].

Application of FYM significantly affected the dry matter content and crude protein content of fodder maize. Dry matter (15.52 %) and crude protein content (6.38 %) were observed higher by application of 10 t FYM/ha (F_2) compared to no application of FYM (F_1). Higher crude protein content might be due to more availability of nitrogen, which ultimately led to more nitrogen uptake and nitrogen content accumulated in plant and extended benefit with congenial biochemical reactions by FYM [26]. More uptake of nitrogen which is a constituent of protein, amino acids, and amides [27,28]. It is application of nitrogen through organic manures continuously supply essential macro and micronutrients. Increasing crude protein content with application of nitrogen is associated with cell division and cell elongation. Nitrogen supply also increased the formation of nucleotide and coenzyme of nitrogen constituent, therefore, facilitate cell elongation [29].

Application of 10 t FYM/ha reported higher dry fodder yield (67.44 q/ha) and crude protein yield (4.32 q/ha) compared to no application of FYM (F_1). Higher dry fodder yield might be due to nitrogen enhancing the meristematic and photosynthetic activity by regulating up the cell elongation and division and chlorophyll contents of leaves and it reflects the higher DMY. In general, organic manures like FYM and other known to have a synergistic effect. Sometimes the organic manures have supplementary and complimentary effect with inorganic fertilizers. FYM in combination with inorganic fertilizer increase the availability of macro and micronutrients, hence increasing the quality of plants [30,31].

Studies on FYM application indicated that, lower Neutral detergent fiber content (65.66%) and Acid detergent fiber content (42.68 %) by application of 10 t FYM/ha over no application of FYM (F_1).

The statistically analysed data presented in Table 3 indicates that application of 10-ton FYM/ha (F_2) registered significantly higher nitrogen content (1.02%) compared to control treatment (0.86%) in fodder maize. An increase in nitrogen content might be due to continuous and steadily supply of nitrogen through FYM. This might have led to better assimilation of nitrogen [32]. Application of FYM @10t/ha (F_2) reported higher phosphorus content (0.19%) and Potassium content (1.15%) than no application of FYM (F_1). Significantly higher phosphorus content might be due to an increase in phosphorus content might be due to the increased absorption of nutrients and efficient translocation toward the plant system during vegetative growth, higher potassium content might be due to Application of organic manure to the crop potassium content increases might be due to the increased absorption of nutrients and efficient translocation toward the plant system during vegetative growth [32].

It was reported that application of 10 t FYM/ha (Table 3) recorded higher nutrient uptake by fodder maize. Higher nitrogen (69.12 kg/ha), phosphorus (12.70 kg/ha) and potassium (77.36 kg/ha) uptake were noted by application of 10 t FYM/ha (F_2) compared to no application of FYM (F_1). On the mean basis, FYM application significantly enhanced nitrogen, phosphorus and potassium uptake by dry fodder to the tune of 59.45, 71.62 and 45.00 per cent over no manure application of FYM. This could also be explained on the basis of better availability of desired and required nutrients in crop root zone and from the solubilization caused by the organic acid produced from the decaying of organic matter and also increased uptake by plant and enhanced photosynthetic and metabolic activities result in in better partitioning of photosynthates to sinks [33].

Perusal of data presented in Table 4 revealed that application of 10 t FYM/ha (F_2) reported higher organic carbon (0.37 %), available P (41.20 kg/ha) and available K (261.44 kg/ha) than no application of FYM (F_1). Response of FYM on pH and EC were found to be non-significant. An increase in soil organic carbon content may be attributed to the addition of more organic material through FYM [34] and increase in phosphorus content in soil might be due to the high concentration of nutrients in FYM Kumar et al*.* [32].

3.2 Split Application of Nitrogen

Time of nitrogen application significantly affected plant height, number of leaves per plant and leaf stem ratio (Table 1). Higher plant height (87.17 and 192.12 cm at 40 DAS and at harvest) was obtained with the N_5 (50% N at Basal + 50% N in three equal splits) treatment. The plant height increased with more nitrogen splits application. It might be due to supply of proper amount of N at different growth stages of maize. The nitrogen promotes plant growth, increased the number and length of internodes which resulted taller plants of maize [35]. Increased cell division, cell elongation, nucleus formation as well as green foliage. Increase in plant height may also be due to prolonged vegetative growth which increased the plant height [36]. It also may be due to fact that split application makes better utilization of nitrogen by reducing its loss and matching the nitrogen supply with crop demand [37].

It can be inferred from the data showed that split applications of nitrogen had significant effect on the number of leaves per plant at 40 DAS (9.83) and at harvest (15.31). However, split application of nitrogen found non-significant with number of leaves per plant at 20 DAS. Higher number of leaves per plant (9.83 and 15.31, at 40 DAS and at harvest) was recorded from treatment N_5 (50% N at Basal + 50% N in three equal splits) which was statistically at par with N_3 (30% N at Basal + 70% N in three equal splits) and N_4 (40% N at Basal + 60% N in three equal splits). The increase in the number of leaves per plant could possibly be ascribed to fact that nitrogen often increase plant growth and plant height and this results in more noder and internodes and subsequently more production of leaves [38].

It was ascertained from data (Table 4) that treatment N_5 (50% N at Basal + 50% N in three equal splits) reported significantly higher leaf stem ratio (0.61) at harvest of fodder maize. Optimum supply of plant nutrients is always imperative for better growth and development of a crop. By split application of nitrogen leaf stem ratio increases, it might be due to the fact that split application of nitrogen tends to increase nitrogen use efficiency leading to better growth like plant height and number of leaves per plant as well as development phase [39].

Plant population per meter row length recorded at 15 DAS in fodder maize did not show significant influence of FYM and split application of nitrogen [40-42].

Split application of nitrogen is one of the methods to improve nitrogen use by the crop while reducing nutrient loss through leaching and volatilization (Lalita el al, 2018). The attained results showed that, split applications of nitrogen N_5 (50% N at Basal + 50% N in three equal splits) recorded higher green fodder yield (447 q/ha) than the rest of treatment except treatment N_3 (30% N at Basal + 70% N in three equal splits) and N_4 (40% N at Basal + 60% N in three equal splits). Treatment N_5 reported 20 and 13 per cent higher green fodder yield than treatment N_1 and N_2, respectively.

Split applications of nitrogen N_5 (50% N at Basal + 50% N in three equal splits) reported higher dry matter content (15.20%), dry matter production is basically a measure of photosynthetic efficiency of the assimilatory system in plants and crude protein content (6.31%) Crude protein contents have a major role in increasing the quality of fodder crops. Dry matter content, treatment N_5 statically at par with treatment N_3 and N_4 and crude protein content was at par with N_4. Increase in dry matter content may be due to better utilization of nitrogen at proper time and growth stage through split application, which in turn produced more assimilates by maize crop [37].

Treatment N_5 (50% N at Basal + 50% N in three equal splits**)** reported significantly lower Neutral detergent fiber (65.29%) and Acid detergent fiber (44.10%).

The use of nitrogen by plants involves several steps, including uptake, assimilation, translocation and, when the plant is ageing, recycling and remobilization. Data presented in Table 3 reported that split application 50% N at Basal + 50% N in three equal splits treatments (N_5) reported higher nitrogen content (1.01%) in fodder maize. Response of split application of nitrogen on green fodder phosphorus and potassium content was found to be non-significant. Nutrient uptake by fodder maize is influenced by split application of nitrogen. Significantly higher nitrogen uptake 69.60 kg/ha), phosphorus uptake (12.42 kg/ha) and potassium uptake (78.17 kg/ha) were reported in treatment N_5 (N_5 (50% N at Basal + 50% N in three equal splits**).** As compared to treatment N_1 (50 % Basal + 50 % at 30 DAS) treatment N_5 (50% N at Basal + 50% N in three equal splits**)** reported 55, 57.01 and 50.03 % higher N, P and K uptake by fodder maize, respectively.

Response of split application of nitrogen on soil parameters like pH, EC, OC, available Phosphorus and potassium were found to be non-significant.

Table 1. Effect of FYM and split application of nitrogen on growth attributes of fodder maize

Treatment	Plant stand (15 DAS)	No. of leaves			Plant height (cm)			Leaf-stem ratio
		20 DAS	40 DAS	Harvest	20 DAS	40 DAS	Harvest	
Level of FYM								
F_1	7.27	6.12	8.73	13.02	31.44	76.62	173.39	0.52
F_2	7.57	6.28	9.43	14.24	32.51	86.63	192.30	0.62
SEm±	0.21	0.16	0.22	0.35	0.84	1.64	2.66	0.02
CD at 5%	NS	NS	0.65	1.04	NS	4.86	7.92	0.05
Split of Nitrogen (kg/ha)								
N_1	6.77	6.27	8.47	11.85	32.15	80.05	175.00	0.49
N_2	7.77	6.07	8.48	12.96	31.02	76.10	176.25	0.56
N_3	7.57	6.27	9.32	13.68	31.13	79.15	183.67	0.57
N_4	7.70	6.17	9.30	14.35	32.22	85.67	187.21	0.60
N_5	7.30	6.23	9.83	15.31	33.37	87.17	192.12	0.61
SEm±	0.32	0.26	0.34	0.55	1.32	2.59	4.21	0.03
CD at 5%	NS	NS	1.02	1.66	NS	7.69	12.52	0.07
Interaction effect (F× N)								
SEm±	0.46	0.37	0.49	0.78	1.87	3.66	5.96	0.04
CD at 5%	NS	NS	NS	NS	NS	NS	NS	NS

Table 2. Effect of FYM and split application of nitrogen on yield and quality traits of fodder maize

Treatment	GFY (q/ha)	DM%	DFY (q/ha)	CP%	CPY (q/ha)	NDF (%)	ADF (%)
Levels of FYM							
F_1	384	13.02	50.06	5.39	2.71	72.86	49.81
F_2	434	15.52	67.44	6.38	4.32	65.66	42.68
SEm±	10.50	0.23	1.61	0.09	0.11	1.07	0.66
CD at 5%	31.21	0.70	4.79	0.28	0.32	3.19	1.95
Levels of N split							
N_1	374	13.13	48.97	5.66	2.80	73.54	48.14
N_2	396	13.75	54.60	5.69	3.15	70.49	47.73
N_3	399	14.47	58.17	5.81	3.42	69.04	46.62
N_4	428	14.80	63.76	5.94	3.85	67.94	44.63
N_5	447	15.20	68.25	6.31	4.35	65.29	44.10
SEm±	16.61	0.37	2.55	0.15	0.17	1.70	1.04
CD at 5%	49.35	1.10	7.57	0.44	0.50	5.04	3.08
Interaction effect (F× N)							
SEm±	23.49	0.52	3.60	0.21	0.24	2.40	1.47
CD at 5%	NS	NS	NS	NS	NS	NS	NS

Where GFY= green fodder yield, DM%= Dry matter content, DFY= Dry fodder yield, CP%= Crude protein content, CPY= Crude protein yield, NDF= Neutral detergent fiber, ADF= Acid detergent fiber

Table 3. Effect of FYM and split application of nitrogen on NPK content and uptake by fodder maize

Treatment	N Content (%)	N Uptake (kg/ha)	P Content (%)	P Uptake (kg/ha)	K Content (%)	K Uptake (kg/ha)
Levels of FYM						
F_1	0.86	43.35	0.15	7.40	1.07	53.50
F_2	1.02	69.12	0.19	12.70	1.15	77.36
SEm±	0.02	1.72	0.00	0.37	0.01	1.77
CD at 5%	0.04	5.11	0.01	1.11	0.04	5.24
Levels of N split						
N_1	0.91	44.87	0.16	7.91	1.06	52.10
N_2	0.91	50.32	0.16	9.12	1.10	60.30
N_3	0.93	54.76	0.17	9.76	1.10	64.59
N_4	0.95	61.60	0.17	11.03	1.13	71.99
N_5	1.01	69.60	0.18	12.42	1.14	78.17
SEm±	0.02	2.72	0.01	0.59	0.02	2.79
CD at 5%	0.07	8.08	NS	1.75	NS	8.29
Interaction effect (F× N)						
SEm±	0.03	3.84	0.01	0.79	0.03	3.95
CD at 5%	NS	NS	NS	NS	NS	NS

Table 4. Effect of FYM and split application of nitrogen on soil parameters after harvest of crop

Treatment	pH (1:2.5)	EC (dS/m)	OC (%)	Available P (kg/ha)	Available K (kg/ha)
Initial	7.92	0.24	0.342	35.86	267.8
Levels of FYM					
F_1	7.93	0.24	0.32	37.50	250.55
F_2	7.83	0.23	0.37	41.20	261.44
SEm±	0.05	0.005	0.007	0.83	3.31
CD at 5%	NS	NS	0.019	2.45	9.85
Levels of N split					
N_1	7.88	0.25	0.35	39.35	259.49
N_2	7.89	0.23	0.35	38.62	257.45
N_3	7.87	0.24	0.34	39.71	255.51
N_4	7.87	0.24	0.34	39.46	254.31
N_5	7.92	0.24	0.34	39.63	253.23
SEm±	0.07	0.008	0.010	1.30	5.24
CD at 5%	NS	NS	NS	NS	NS
Interaction effect (F× N)					
SEm±	0.10	0.012	0.015	1.85	7.41
CD at 5%	NS	NS	NS	NS	NS

4. CONCLUSION

In view of the results obtained from the present investigation it can be concluded that application of 10 t/ha FYM obtained higher maize green fodder yield and fodder quality and split application of nitrogen as 50% N at basal + 50% N in three equal splits or 40% N at basal + 60% N in three equal splits or 30% N at basal + 70% N in three equal splits obtained higher maize green fodder yield and quality.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Suraj M, Somangouda G, Salakinkop SR. Yield of yield attributes of (*Zea mays* L. Saccharate) as influenced by split application of nitrogen and potassium during kharif under protective irrigation. J Entomol Zool Stud. 2020;8(4):361-4.
2. Hedayetullah M, Zaman P, editors. Forage crops of the world, Volume I: Major forage crops. CRC Press; 2018.
3. Mangelsdorf PC, Macneish RS, Galinat WC. Domestication of corn. Science. 1964;143(3606):538-45.
4. Purseglove JW. Tropical crop. Monocotyledons. London: Longmans; 1972. p. 300-33.
5. Ananthi T, Vennila C. Influence of organic manure and inorganic fertilizers on growth and yield of fodder maize (*Zea mays* L.) grown in North Eastern zone of Tamil Nadu. Curr J Appl Sci Technol. 2021;40(8):70-8.
6. Sharma PK, Kalra VP, Tiwana US. Effect of farmyard manure and nitrogen levels on growth, quality and fodder yield of summer maize (Zea mays L.). Agric Res J. 2016;53(3):355-59.
7. Liebman M, Davis AS. Integrated of soil, crop and weed management in low external input farming system. Weed Res. 2000;40(1):27-47.
8. Atagana HI. Co-composting of PAH-contaminated soil with poultry manure [letter]. Lett Appl Microbiol. 2004;39(2):163-8.
9. Montemurro F, Maiorana M, Convertini G, Fornaro F. Improvement of soil properties and nitrogen utilization of sunflower by amending municipal solid waste compost. Agron Sustain Dev. 2005;25(3):369-75.
10. Guillaumer E, Villar JM. Response of wheat to additional nitrogen fertilizer application after pig slurry on over fertilized soils. Agron Sustain Dev. 2006:127-33.
11. Ahmad R, Khalid A, Arshad M, Zahir ZA, Mahmood T. Effect of compost enriched with N and L-tryptophan on soil and maize. Agron Sustain Dev. 2008;28(2):299-305.
12. Singh L, Sukul P. Impact of vermicompost and farm yard manure, fly ash and inorganic fertilizers on growth and yield attributing characters of maize (*Zea mays* L.). Plant Arch. 2019;19(2):2193-200.
13. Singh S, Dayal G, Shukla AK, Sahu AK, Singh SK. Response of farm yard manure and zinc application of growth parameters and yield of winter maize (*Zea mays* L.). Flora Fauna. 2021;27(2):284-8.
14. Reddy YR, Reddy GH. Principle of agronomy. 3rd ed. Kalyani Pulishers. Ludhiana, India; 2003. p. 203-53.
15. Thennarasu A, Sivakumar T, Sundaram SM, Sankaran VM, Vanan TT. Influence of organic manure on fodder yield and carbon sequestration potential of fodder maize (*Zea mays* L.). Rev Bras Zootec. 2016;37:1265-0.
16. Khan F, Khan S, Fahad S, Faisal S, Hussain S, Ali S et al. Effect of different levels of nitrogen and phosphorus on the phenology and yield of maize varieties. Am J Plant Sci. 2014;05(17):2582-90.
17. Karthika, N, Kalpana R. HCN content and forage yield of multi-cut forage sorghum under different organic manures and nitrogen levels. Chem Sci Rev Lett. 2017;6(23):1659-63.
18. Bould C, Hewitt EJ, Needham P 1984. Diagnosis of Mineral Disorders in plants. Principles. New York: Chemical publishing.
19. Schrader LE. Functions and transformation of nitrogen in higher plants. ASA, CSSA, and SSSA Books. 1984;1:55-65.
20. Witt C, Pasuquin JMCA, Dbermann A. Site-specific nutrients management for maize in favorable tropical environments of Saia. Proceedings of the 5th inter. Crop Sci Cong. 2008;1-4.
21. Mandal S, Thakor TC. Effect of subsoiling, deep and different rate of placement of fertilizer on sugarcane crop response. J Agric Eng. 2010;47(1):9-13.
22. Association of cofficila Analytical chemist. Official methods of analysis. 14th Ed. Arlington, Virginia; 1984.
23. Cochran WG, Cox GM. Experimental designs. Jhon willy and sons Inc., New York; 1967.
24. Bhat RA, Ahmad F, Ahngar TA, Shiekh TA, Rashid Z, Raja W et al. Evaluation of fodder maize (*Zea mays* L.) cv. African tall and its response to different rates of FYM and biofertilizers under cold arid conditions of Kargil. Int J Plant Soil Sci. 2021;33(24):458-65.
25. Kumar S, Singh M, Meena BL, Meena VK, Onte S, Bhattchargee S. Baljeet. Yield and qualitative evaluation of fodder maize (*Zea mays* L.) under potassium and zinc based integrated nutrient management. Indian J Anim Nutr. 2020;37(3):235-41.
26. Kamalkumari K, Singaram P. Quality parameters of maize as influenced by

fertilizers and manures. Madras. Agric J. 1996;83:(32-3).
27. Keshwa GL, Yadav ML. Effect of nitrogen and cutting management on quality components of forage pearl millet. Indian J Agric Sci. 1989;59:734-6.
28. Bhillar RL. Effect of cutting management and nitrogen levels on growth, yield and quality of oat (*Avena sativa* L.) [Ph.D. thesis]. G. B. Pant University of Agriculturae and Technology, Pantnagar; 2007,
29. Verma SS, Singh V. Quality of forage oat in relation to nitrogen fertilization. Forage Res. 1987;13:77-83.
30. Manohar SS, Singh GD, Rathore PS. Influence of sulphur, phosphorus and farm yard manure on yield attributes and yield of maize (*Zea mays* L.) in southern Rajasthan conditions. Indian J Agron. 1992;36:448-50.
31. Patel RH, Vihol PP 1992. Residual effect of P and FYM on growth, yield and quality of rabi maize. Farming system.
32. Kumar S, Kumar A, Singh J, Kumar P. Growth indices and nutrient uptake of fodder maize (*Zea mays* L.) as influenced by integrated nutrient management. Forage Res. 2016;42(2):119-23.
33. Jinjala VR, Viradia HM, Sarvaiya NN, Raj AD. Effect of integrated nutrient management on baby corn (*Zea mays* L.). Agric Sci Dig. 2016;1-4:D-4379.
34. Babu S, Singh R, Avasthe RK, Yadav GS, Das A, Singh VK et al. Impact of land configuration and organic nutrient management on productivity, quality and soil properties under baby corn in Estern Himalayas. www. Sci Rep. 2020;10(1): 16129.
35. Adhikari P, Baral BR, Shrestha J. Maize response to time of nitrogen application and planting seasons. J Maize Res Dev. 2016;2(1):83-93.
36. Castro PRC, Kluge RA, Sestari I. Manual of plant physiology: crop physiology (in portugues Agronômica ceres. São Paulo, Brazil. 2008;864.
37. Muthukumar VB, Velayudham K, Thavaprakaash N. Growth and yield of baby corn (*Zea mays* L.) as influenced by plant growth regulators and different time of nitrogen application. Res J Agric Biol Sci. 2005;1(4):303-7.
38. Pv G, Ah K, Pr P. Effect of split nitrogen application on growth parameters of maize. Int J Chem Stud. 2020;8(3):1030-3.
39. Alipatra A, Kundu CK, Bandopadhyay P, Bera PS, Banerjee H. Growth, yield and quality of fodder oat (*Avena sativa* L.) as affected by split application of fertilizer and cutting management. Crop Res 43. 2012;1(2 & 3):234-7.
40. Amanullah HR, Shah Z. Effects of plant density and N on growth dynamics and light interception in maize. Arch Agron Soil Sci. 2008;54:401-11.
41. Kalra VP, Sharma P. Influence of farmyard manure and nitrogen on growth and fodder yield of summer maize. J Agric Phys. 2015;15(2):175-80.
42. Verma L, Kumar V, Shindhe SS, Asewar BV. Effect of split application of nitrogen on growth and yield of kharif maize (*Zea mays* L.). J Pharmacogn Phytochem. 2017;7(2): 1129-31.

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