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Effects of integrated nutrient management on symbiotic parameters and yield of fodder maize in Gujarat's heavy rainfall AES-III

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Abstract
Livestock is an essential aspect of Indian agriculture and plays a pivotal role in the rural economy. In India, maize is extensively cultivated for both grain and feed purposes. A field experiment titled "Effects of Integrated Nutrient Management on Symbiotic Parameters and Yield of Fodder Maize in Gujarat's Heavy Rainfall AES-III" was conducted on heavy black soil at the College Farm, N. M. College of Agriculture, Navsari Agricultural University, Navsari (Gujarat) during the summer season of 2019. This Field experiment consist Factorial Randomized block design total twelve treatments with three replication. The treatment consisted combinations of two organic manures *viz.* FYM @ 5.0 t/ha (O_1) and bio compost @ 5.0 t/ha (O_2), three levels of inorganic fertilizers *viz.*50% RDF (F_1), 75% RDF (F_2) and 100% RDF (F_3) and two levels of bio fertilizers *viz*. No biofertilizer (B_0) and *Azotobacter* + PSB @ Seed treatment 10 ml/kg seed each (B_1). The Nutrients of N, P, K were applied by using sources of Urea, SSP, respectively. Bio compost (5 t/ha), combination with 100% RDF (80:40:00 N: P: K Kg/ha), and Azotobacter + Phosphate Solubilizing Bacteria (10 ml/kg seed) resulted in greater plant height (178.80, 180.42 and 184.33 cm at harvest respectively) number of leaves (8.28, 8.17 and 8.44 at harvest respectively), dry matter accumulation per plant (28.56, 30.83 and 31.11at harvest respectively), leaf: stem ratio (0.27, 0.27 and 0.28 respectively) and length of internodes (15.39, 15.08 and 15.44 cm at harvest respectively) also higher green fodder yields (319.47, 318.29 and 320.86 q/ha, at harvest respectively) and dry fodder yields (126.20, 125.06 and 138.56 q/ha, at harvest respectively).

Keywords: Maize, bio compost, FYM, RDF, fodder, growth attributes, yield quality

Introduction
India's agriculture depends heavily on livestock, which has a big effect on rural economies. Good nutrition and feeding techniques improve sustainable animal production. Maize is the significant crop around the world as it is a versatile C4 plant that makes excellent use of solar radiation, earning it the title "queen of cereals."

Mexico is the original home of maize, which is grown in India for food and fodder. The most important organic source for crop growth is farmyard manure, or FYM. Nitrogen directly contributes to photosynthesis and improves the flavor and moisture content of fodder crops. It is phosphorus's responsibility to guarantee that crops mature on schedule. The term bio fertilizer denotes nutrient inputs of biological origin to the soil to favors plant growth. Biofertilizer are crucial elements in integrated nutrient management. Iqbal *et al*., (2015) [4] reported that there's no denying that managing plant nutrition well is essential to improving crop yields, and forage maize is not different. In the field of nutrition, nitrogen and phosphorus are important because they have a big impact on the quality and yield of green forage. Therefore, the current study aimed to investigate and harness the capabilities of *Azotobacter* as a biofertilizer to improve the development and productivity of maize- within the context of integrated fertilizer management. The nutritional status of plants is a fundamental factor that significantly influences crop production, ensuring the optimal performance of forage crops is essential. The present study formulated based on the above facts and the experiment was performed at college farm N.M.C.A. Navsari during summer season of 2019.

Materials and Methods

Experimental site

The details of the material used, methods and criteria incorporated for analysis of treatments during the study are shown here under fallowing different major heads as. The Experiment was taken at Navsari which comes under the south Gujarat heavy rainfall zone (AES -III). The average yearly rainfall received by this tract is regarding 1633 mm (mean of last ten years i.e. 2009 to 2018). South Gujarat soil is regionally called "Deep Black soils" and the soil of Navsari belongs to the category Ustochrepts with jalalpur series. The soils are clayey in texture comprised of predominant clay mineral is montmorillonite. The Exploratory field's soil was clayey in texture and showed moderate in available nitrogen (330.02 kg/ha), moderately increased amount of phosphorus (34.09 kg/ha) and increased potassium (339.29 kg/ha).

Experimental treatments

The Trial comprising twelve treatments arranged in factorial RBD and that repeated thrice. The treatment consisted combinations of two organic manures *viz.* FYM @ 5.0 t/ha (O_1) and bio compost @ 5.0 t/ha (O_2), three levels of inorganic fertilizers *viz.*50% RDF (F_1), 75% RDF (F_2) and 100% RDF (F_3) and two levels of bio fertilizers *viz*. No biofertilizer (B_0) and *Azotobacter* + PSB @ Seed treatment 10 ml/kg seed each (B_1). The Nutrients of N, P, K were applied by using sources of Urea, SSP, respectively. The fodder maize variety "African tall" was planted in First week of February with spacing of 30cm between two row FYM and bio compost were applied @ 5.0 t/ha on the experimental field five days prior to the sowing. Complete dose of phosphorous 40 (kg/ha) and nitrogen (80 kg/ha) was applied manually and uniformly as primary dose in SSP form and urea as per the treatment for all the plots. Seed treatment with *Azotobacter* and PSB was given to according to the treatment of plot. Plot wise quantity of seed was weighted, treated with *Azotobacter* + PSB (seed treatment @ 10 ml/kg seed each) before sowing and sown manually at the depth of 4-5 cm by line sowing required 60kg ha^{-1} seed. The crop was cultivated in adherence to all standard agricultural practices and received timely protection measures as required throughout its growth cycle. The crops were harvested at maturity on 25th April, 2019. The experimental data collected for growth parameters, yield attributes, and quality were put through to statistical analysis to determine the level of significance.

Results and Discussion

The statistical analysis to determine the growth, yield and quality parameters were performed and data are given in table. Additionally, relevant graphical representations are Included in this chapter when deemed essential. The outcomes regarding primary factors and noteworthy interactions are detailed in the following sections.

Growth, yield attributes and yields: Data obtained in Table 1 showed that plant height recorded numerically the maximum height of the plant at 30 DAS *i.e.* 53.52 cm, at 45 DAS *i.e.* 144.28 cm and at harvest *i.e.* 178.80 cm were observed with O_2 (Bio compost @ 5 t/ha) this was in accordance as concluded by Midha *et al*. (2014) [8] also, indicated that remarkably the maximum height of the plant at 30 DAS *i.e.* 58.73cm, 45 DAS *i.e.*148.17 cm and at harvest *i.e.* 194.44 cm was observed with 100% RDF (F_3) and numerically the highest plant height at harvest *i.e.184.33* cm was recorded with B_1 (Seed treatment *Azotobacter* + PSB) over treatments B_0 (No bio fertilizers) was in accordance with Jadav *et al.* (2017) [5], Ramesh *et al*. (2023) [11]. An examination of data Table 1 disclose that effect of arranged treatments did not influence number of leaves at 30, 45 DAS and at harvest which indicate that the treatments did not have any adverse influence on germination as well as on survival of the plants. The data showed in Table 1 represented that numerically the highest dry matter per plant (7.56 g and 28.56g at 30 and at harvest, respectively) was recorded with O_2 (bio compost @ 5/ha) However significantly highest dry matter at 45 DAS *i.e.*21.83 was recorded with O_2 (Biocompost @ 5/ha) also indicated that Significantly the highest dry matter per plant (7.93g, 19.68g, 31.33g at 30, 45 DAS and at harvest respectively) was observed with F_3 (100% RDF) these findings aliened perfectly with presented by Buriro *et al.* (2014) [2] and significantly the highest dry matter per plant (7.80g, 19.29g, 31.11g at 30 DAS, 45 DAS and at harvest respectively) was obtained with B_1(Seed Treatment with *Azotobacter* + PSB). The examination of data presented in Table 2 pointed that numerically higher leaf: stem ration (0.27) was recorded with O_2 (bio compost @ 5 t/ha) over O_1 (FYM 5 t/ha) also, indicated that significantly the maximum Leaf: stem ratio (0.29) was recorded with F_3 (100% RDF) these outcomes are also in support with result of (Midha *et al*. (2014) [8], chahal *et al.* (2020) [3] and indicated that leaf: stem ration was not affected significantly by the impact of bio fertilizers. Table 2 indicated that numerically higher length of internode (15.39) was recorded with O_2 (Bio compost @ 5 t/ha) also, indicated that significantly the highest length of internode (16.42) was recorded with F_3 (100% RDF) and indicated that length of internode was influenced none significantly by the impact of bio-fertilizers. The perusal of data obtained in Fig 1 indicated that numerically the maximum green fodder yield (319.47 q/ha) was reported with O_2 (bio compost @ 5 t/ha), (344.00 q/ha) was listed with F_3 (100% RDF) were reported by Rangasami *et al*. (2024) [12], Ananthi, and Shilpa (2024) [1] and (320.86 q/ha) was achieved with B_1 (Seed treatment with *Azotobacter* + PSB). An appraisal of data in Table 1 and 1.2 revealed that the application of organic manure (FYM @ 5t/ha and bio compost @ 5t/ha) were not significantly increased plant height, number of leaves, dry matter accumulation (at 30 DAS and at harvest), leaf: stem ratio, number of internodes, length of internodes, green and dry fodder yield Fig 1. However, an application of bio compost produced has considerable impact on dry matter accumulation at 45 DAS over FYM (Table 1). The lack of significant response on most parameters could be attributed to the similar effects exerted by organic sources, FYM and bio compost.

Quality: Applying manures like FYM and bio compost to fodder maize demonstrated a significant impact on increasing the crude protein content, while it had no is considerable impact on the crude fiber composition in the maize. Table 2. the utilization of organic manures caused a notable increase in the crude protein content of fodder maize. Table 2. Significantly the highest protein content (10.16%) was recorded with O_2 (bio compost @ 5 t/ha) which was found significantly higher also, indicated that Significantly the maximum Crude protein content (10.67%) was obtained with F_3 (100% RDF) were also reported by Yadahalli *et al*. (2022) [15], Patel and Thanki, (2022) [10] and Significantly the highest protein content (10.13%) was recorded with B_1 (*Azotobacter* + PSB) were also reported by Yadav *et al*. (2022) [16],whereas numerically higher crude fiber (29.27%) was recorded with O_1 (FYM @ 5 t/ha) which was also reported by Kumar *et al*. (2022) [6, 7], Shekara *et al*. (2020) [13] and Naveen *et al*. (2021) [9], also that crude fiber was not considerably impacted by the effect of inorganic fertilizers and that crude fiber was not impacted importantly by the effect of bio fertilizers. An

application of bio compost @ 5 t/ha significantly influenced on crude protein content Table 2. Application of the bio compost @ 5 t/ha gave the highest crude protein content (10.16%). The superior crude protein content observed can be attributed to the beneficial impacts of organic fertilizers on both growth and yield characteristics. The results are in related with Verma *et al.* (2012) [14] and Buriro *et al.* (2014) [2].

Table 1: Effect of Integrated Nutrient management on Plant height, Number of leaves and dry matter accumulation of fodder maize

Treatments	Plant height (cm)			Number of leaves			Dry matter accumulation (g/plant)		
	30 DAS	45 DAS	At harvest	30 DAS	45 DAS	At harvest	30 DAS	45 DAS	At harvest
(A) Levels of organic manure									
O_1:FYM @ 5t/ha	52.97	135.53	186.50	7.89	8.39	7.94	7.40	14.87	28.44
O_2:Bio compost @ 5t/ha	53.52	144.28	178.80	8.44	8.94	8.28	7.56	21.83	28.56
S.Em±	1.315	3.303	4.66	0.195	0.227	0.231	0.20	0.45	0.73
CD at 5%	NS	NS	NS	NS	NS	NS	NS	1.34	NS
(B) Levels of inorganic fertilizer (80-40-00) NPK kg/ha									
F_1: 50%RDF	47.46	132.17	173.08	8.33	8.17	7.67	6.97	17.41	23.33
F_2: 75%RDF	53.54	139.37	180.42	7.92	8.92	8.17	7.53	17.95	30.83
F_3: 100%RDF	58.73	148.17	194.44	8.25	8.92	8.50	7.93	19.68	31.33
S.Em±	1.610	4.04	5.71	0.239	0.278	0.283	0.25	0.56	0.90
CD at 5%	4.72	11.86	16.75	NS	NS	NS	0.73	1.65	2.64
(C) Bio fertilizer (10 ml /kg seed each)									
B_0:No bio fertilizer	51.55	143.72	180.96	8.06	8.50	7.78	7.16	17.41	25.89
B_1:*Azotobacter*+ PSB	54.95	136.08	184.33	8.28	8.83	8.44	7.80	19.29	31.11
S.Em±	1.315	3.303	4.66	0.195	0.227	0.231	0.20	0.45	0.73
CD ($P \leq 0.05$)	NS	NS	NS	NS	NS	NS	0.60	1.34	2.16

DAS: Days after sowing, FYM: Farm yard manure, RDF: Recommended dose of fertilizer, SEM: Standard error of mean *Significant ≤at P 0.05; NS- Non Significant at $p > 0.05$

Table 2: Effect of Integrated Nutrient management on Number of internode, length of internode, leaf: stem ratio, crude protein content and crude fiber content of fodder maize

Treatments	At harvest		Leaf: stem ratio	Crude protein content	Crude fiber Content
	Number of internode	Length of internode			
(A) Levels of organic manure					
O_1: FYM @ 5.0 t/ha	8.33	14.72	0.26	9.45	29.27
O_2: Biocompost@5.0	9.11	15.39	0.27	10.16	28.91
S.Em±	0.268	0.279	0.0064	0.192	0.534
CD at 5%	NS	NS	NS	0.56	NS
(B) Levels of inorganic fertilizer (80-40-00) NPK kg/ha					
F_1: 50% RDF	8.42	13.67	0.24	9.08	28.55
F_2: 75%RDF	8.42	15.08	0.27	9.67	28.37
F_3: 100%RDF	9.33	16.42	0.29	10.67	30.35
S.Em±	0.329	0.342	0.0079	0.236	0.654
CD at 5%	NS	1.00	0.023	0.692	NS
(C) Bio fertilizer (10 ml /kg seed each)					
B_0: No bio fertilizer	8.50	14.67	0.26	9.49	29.04
B_1:*Azotobacter*+PSB	8.94	15.44	0.28	10.13	29.14
S.Em±	0.268	0.279	0.0064	0.192	0.534
CD ($P \leq 0.05$)	NS	NS	NS	0.565	NS

FYM: Farm yard manure, RDF: Recommended dose of fertilizer, S.Em: Standard error of mean *Significant ≤at P 0.05; NS- Non Significant at P > 0.05

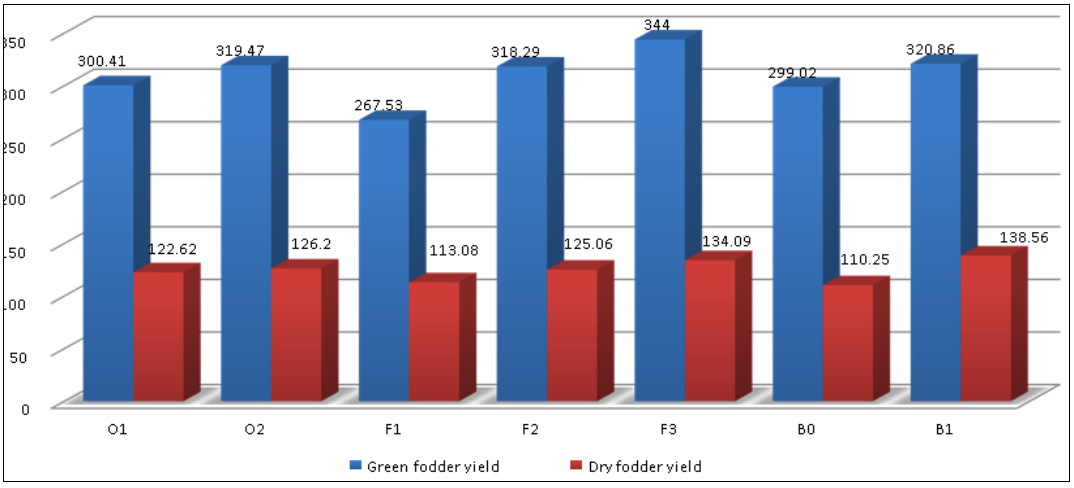

Fig 1: Yield of green and dry forage maize influenced by different treatments

Conclusion

According to the results obtained, it can be deduced that achieving an increased yield in terms of both green and dry fodder, as well as improved quality of fodder maize in terms of crude protein content and crude fiber, is possible through the application of specific agricultural practices. These practices include the application of 5.0 tons per hectare of bio compost and the use of 100% RDF, which corresponds to 80-40-00, N: P: K kg/ha. Additionally, seed inoculation with Azotobacter and PSB at a rate of 10 ml/kg of seed each plays a crucial role. This combination of practices has shown to be particularly effective in the agro-ecological sub-region (AES-III) characterized by heavy rainfall in South Gujarat. The comprehensive approach not only boosts the yield but also enhances the nutritional quality of the fodder maize, making it a viable strategy for farmers in this region to optimize their crop production sustainably.

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