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Effect of integrated nutrient management on growth and yield of rabi forage maize (*Zea mays* L.)

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Abstract
A field experiment was conducted during *rabi* season of 2016 at Jorapura Farm of Livestock Research Station, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar to study the "Effect of integrated nutrient management on growth and yield of *rabi* forage maize (*Zea mays* L.)." Ten treatment combinations comprising of two factors *viz.*, farm yard manure levels (M_1: 10 t/ha, M_2: 15 t/ha) and fertilizers (F_1): RDF, (F_2): *Azotobacter* + PSB, (F_3): 50 % RDF + *Azotobacter* + PSB, (F_4): 75 % RDF + *Azotobacter* + PSB and (F_5): 100 % RDF + *Azotobacter* + PSB was laid out in randomised block design (factorial concept) with four replications. The results revealed that 15 t FYM/ha performed better by recording 5.67 and 5 per cent higher green forage (503 q/ha) and dry fodder (105 q/ha) yield, respectively over 10 t FYM/ha. Combined application of 100 % RDF + *Azotobacter* + PSB performed better by recording 58.23 and 52.63 per cent higher green forage (557 q/ha) and dry fodder (116 q/ha) yield over other treatments. The results revealed that application of 15 t FYM/ha performed better by recording higher plant height (165.9 cm), number of leaves per plant (12.6), stem girth of 3rd internode (7.96 cm), leaf area per plant (3624 cm^2), leaf: stem ratio (0.34) and length of internodes (12.1 cm) respectively over application of 10 t FYM/ha. Combined application of 100 % RDF + *Azotobacter* + PSB recorded higher values of plant height (175.8 cm), number of leaves per plant (13.5), stem girth of 3rd internode (9.28 cm), leaf area per plant (4000 cm^2), leaf: stem ratio (0.37) and length of internodes (12.7 cm) over other combinations. It is concluded that the application of 15 tonnes farm yard manure per hectare along with 100 % RDF + *Azotobacter* + PSB found superior followed by the application of 15 tonnes farm yard manure per hectare along with 75 % RDF + *Azotobacter* + PSB.

Keywords: INM, farm yard manure, RDF, biofertilizer, growth, yield, Rabi forage maize

Introduction
Maize (*Zea mays*) is one of the most important cereal crops in the world's agriculture economy both as food for human being and feed and fodder for cattle. There is no any other cereal on the earth, which has so immense potential as to maize and hence occupied a place as queen of cereals. In terms of world acreage, India stands next to U.S.A., Brazil, China and Mexico, while, it ranks eleventh in the respect of production. Maize cultivation in the India mostly confined to the states of Punjab, Haryana, Uttar Pradesh, Madhya Pradesh, Bihar, Maharashtra, Rajasthan, Karnataka, Gujarat, Andhra Pradesh, Tamil Nadu and, Jammu and Kashmir. In India, area and production of maize is about 9.19 million ha and 24.17 million tonnes, respectively with productivity of about 2632 kg/ha during the year 2014-15 (Anonymous, 2016) [1]. Indian livestock needs 1650 million tonnes fodder annually, but in contradictory to these requirements, 48 million tonnes of concentrates, 395 million tonnes of green fodder and 451 million tonnes of dry fodder are available which contributes about 62.8 and 23.5 per cent deficit of green and dry forage production, respectively. Thus, green forage supply has to grow at 3.2 per cent to meet the deficit of forage (Kumar and Faruqui, 2010) [17]. The high cost of chemical nitrogen fertilizer and low purchasing power of Indian farmers restricts its use on proper amounts, hampering crop production. Reliance on the increased use of chemical fertilizers and associated hazards put back attention on organic sources which are effective in promoting health and productivity of the soil. The basic concept of integrated nutrient management is the supply of required plant nutrients for sustaining the desired crop productivity with minimum deleterious effect on soil health environment Balasubramanian, 1999) [2]. With a view to reduce the losses and indiscriminate use of chemical fertilizers, substitution of part of the chemical fertilizer by locally available organic sources of nutrients

(Farmyard manure) and bio fertilizers (*Rhizobium* and PSB) is inevitable. Therefore, in the present context, a judicious combination of organic, inorganic fertilizers and biofertilizers helps to maintain soil and crop productivity. The present investigation was undertaken to study the effect of integrated nutrient management on growth and yield of *rabi* forage maize (*Zea mays* L.).

Objective of the study

To study the effect of different treatments on growth and forage yield of *rabi* forage maize.

Materials and Method

The field experiment was conducted during *rabi* season of 2016 at the Jorapura Farm of the Livestock Research Station, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar, District: Banaskantha (North Gujarat), India to study the "Effect of integrated nutrient management on growth and yield of *rabi* forage maize (*Zea mays* L.)." The soil of experimental field was loamy sand in texture with low in organic carbon (0.15 %) and available nitrogen (172.48 kg/ha), medium in available phosphorus (33.42 kg/ha) and high in available potash (325.72 kg/ha) having pH value of 7.6. Ten treatments combination comprising of two factors *viz.*, farm yard manure levels (M_1: 10 t/ha, M_2: 15 t/ha) and fertilizers (F_1): RDF, (F_2): *Azotobacter* + PSB, (F_3): 50 % RDF + *Azotobacter* + PSB, (F_4): 75 % RDF + *Azotobacter* + PSB and (F_5): 100 % RDF + *Azotobacter* + PSB was laid out in randomized block design and replicates four times. Recommended dose of phosphorus @ 40 kg P_2O_5/ha was supplemented through single supper phosphate and applied at the time of sowing. All other cultural practices were performed uniformly for all treatments. Forage maize cv. African tall was sown in 10th October, 2016 using recommended seed rate of 80 kg/ha and keeping 45 cm distance between two rows at the depth of about 4-5 cm. Weeding and plant protection measures were undertaken as per the need and the required plant population was maintained. The irrigation was applied by sprinkler irrigation system.

The observations were recorded during course of study including plant height, number of leaves per plant, stem girth of 3rd internode, leaf area per plant, leaf: stem ratio, length of internodes, green forage yield and dry fodder yield. The collected data for various parameters were statistically analysed using Fishers' analysis of variance (ANOVA) technique and the treatments were compared at 5 per cent level of significance.

Result and Discussion

Effect of FYM

Growth and yield of *rabi* forage maize were significantly influenced due to increasing levels of farm yard manure. 15 t FYM/ha recorded significantly higher plant height (165.9 cm), number of leaves per plant (12.6), leaf area per plant (3624 cm^2) and length of internode (12.1 cm) of forage maize as compared to application of 10 t FYM/ha (Table 1).

Table 1: Growth parameters of *rabi* forage maize as influenced by different treatments

Treatments		Plant height (cm) at harvest	No. of leaves per plant	stem girth of 3rd inter-node (cm)	Leaf area per plant (cm^2)	Leaf: stem ratio	Length of inter-node (cm)
[A]	Farm yard manure (M):						
	M_1: 10 t FYM/ha	146.6	11.9	7.73	3312	0.33	11.5
	M_2: 15 t FYM/ha	165.9	12.6	7.96	3624	0.34	12.1
S.Em. ±		2.81	0.20	0.10	54.76	0.005	0.20
C.D. (P = 0.05)		8.16	0.60	NS	159	NS	0.6
[B]	Fertilizer (F):						
	F_1: RDF	158.8	11.5	7.73	3369	0.32	11.2
	F_2: *Azotobacter* + PSB	117.5	11.2	5.84	2952	0.31	10.8
	F_3: 50 % RDF + *Azotobacter* + PSB	156.6	12.1	7.73	3328	0.33	12.2
	F_4: 75 % RDF + *Azotobacter* + PSB	172.6	13.0	8.64	3691	0.34	12.2
	F_5: 100 % RDF + *Azotobacter* + PSB	175.8	13.5	9.28	4000	0.37	12.7
S.Em. ±		4.44	0.31	0.17	86.59	0.008	0.32
C.D. (P = 0.05)		12.9	0.90	0.49	251	0.02	0.9
Interaction (M x F):							
S.Em. ±		6.29	0.44	0.24	122.45	0.012	0.45
C.D. (P = 0.05)		NS	NS	NS	NS	NS	NS
S.Em. ±		8.04	7.21	6.08	7.06	7.03	7.67

This might be due to additional amount of nutrient supplied as well as beneficial effects of decomposed organic matter that derived in connection with physicochemical properties of the soil. These findings are conformity with the findings of Nanjappa *et al.* (2001) [23], Vadivel *et al.* (2001) [29], Mahesh *et al.* (2010) [18], Mukherjee (2014) [21] and Kumar *et al.* (2015) [16].

Green forage and dry fodder yield were affected due to increasing levels of farm yard manure 15 t FYM/ha recorded significantly higher green forage (503 q/ha) and dry fodder (105 q/ha) yield mention in Table 2.

Table 2: Green forage yield and dry fodder yield of *rabi* forage maize as influenced by different treatments

Treatments		Green forage yield (q/ha)	Dry fodder yield (q/ha)
[A]	Farm yard manure (M):		
	M_1: 10 t FYM/ha	476	100
	M_2: 15 t FYM/ha	503	105
S.Em. ±		9.05	1.83
C.D. (P = 0.05)		26	5

[B]	Fertilizer (F):		
	F_1: RDF	499	104
	F_2: *Azotobacter* + PSB	352	76
	F_3: 50 % RDF + *Azotobacter* + PSB	510	108
	F_4: 75 % RDF + *Azotobacter* + PSB	528	109
	F_5: 100 % RDF + *Azotobacter* + PSB	557	116
S.Em. ±		14.30	2.89
C.D. (P = 0.05)		42	8
Interaction (M x F):			
S.Em. ±		20.23	4.09
C.D. (P = 0.05)		NS	NS
C.V. %		8.27	7.98

This might be due to improve in all growth parameter *viz.*, plant height, number of leaves, stem girth of 3rd internode, leaf area per plant, leaf: stem ratio, length of internode and availability of nutrients at every crop growth stage in adequate amount and slow release of primary and secondary nutrients which increase green forage yield and increase in green forage yield with application of farm yard manure similarly increase in dry forage yield. These findings are conformity with the findings of Nanjappa *et al.* (2001) [23], Vadivel *et al.* (2001) [29], Pathak *et al.* (2005) [24], Golada *et al.* (2012) [7], Kumar *et al.* (2015) [16] and Verma *et al.* (2016) [30].

Effect of fertilizer

Maximum plant height (175.8 cm), number of leaves per plant (13.5), and length of internodes (12.7 cm) were recorded from plot fertilized with treatment combination of 100 % RDF + *Azotobacter* + PSB followed by 75 % RDF + *Azotobacter* + PSB (Table 1). Application of 100 % RDF + *Azotobacter* + PSB registered maximum stem girth of 3rd internode (9.28 cm), leaf area per plant (4000 cm^2), leaf: stem ratio (0.37) over other treatment (Table 1). Both the treatments were found significantly superior over the rest of all treatment for growth attributing parameters. This might be due to superiority of combined treatment of inorganic, organic sources and use of *Azotobacter* as seed inoculation resulted in better growth and PSB containing phosphate solubilising ability due to secretion of phosphate enzyme to dissolve P present in the organic matter applied in the form of farm yard manure for increasing growth of maize by simultaneous exudation of organic acids (by decreasing pH) and releasing phosphatases which increase plants vegetative growth. The results obtained during the investigation are in close accordance with the finding of Gawai *et al.* (2006) [6], Munda *et al.* (2007) [22]. Mahesh *et al.* (2010) [18], Tetarval *et al.* (2011) [28], Haque *et al.* (2012) [29], Karforma *et al.* (2012) [15], Pathan *et al.* (2012) [25], Channabasamma *et al.* (2013) [23], Hussain *et al.* (2013) [10], Joshi *et al.* (2013) [12], Kalhapure *et al.* (2013) [13], Masih *et al.* (2016) [19], Pathan *et al.* (2014) [26], Kumar *et al.* (2015) [16] and Yadav *et al.* (2013) [31].

Green forage and dry fodder yield were affected significantly due to different fertilizer treatment. Maximum green forage (557 q/ha) and dry fodder (116 q/ha) yield of crop were registered when crop fertilized with 100 % RDF + *Azotobacter* + PSB followed by 75 % RDF + *Azotobacter* + PSB (Table 2). Both the treatments were found significantly superior over the rest of all other treatment combination for green forage and dry fodder yield. This might be due to the application of the integrated sources of nutrients including 100 % RDF along with biofertilizers (*Azotobacter* + PSB) provided balanced nutrients to the crop which resulted into significantly increase in green forage yield. The results are supported by the findings of Singh *et al.* (2005) [27], Karforma *et al.* (2012) [15], Husain *et al.* (2013) [10], Meena *et al.* (2013) [20], Jat *et al.* (2014) [11], Kalhapure *et al.* (2014) [14], Deva (2015) [4, 5], Deva (2015) [4, 5] Gundlur *et al.* (2015) [8] and Verma (2016) [30].

Conclusion

Based on the results from one year experimentation, it is concluded that higher production of *rabi* forage maize in loamy sand soil can be secured by fertilizing the *rabi* forage maize variety African tall with 15 tonnes farm yard manure per hectare along with 75 % RDF + *Azotobacter* + PSB treatment combinations.

References

1. Anonymous, 2016. www. indistat.com
2. Balasubramanian V. Managing soil quality for sustainable rice production. Tamil Nadu Rice Research Institute, Anuthrai, 1999, 11-24.
3. Channabasamma A, Habsur NS, Bangaremma SW, Akshaya MC. Effect of nitrogen and sulphur levels and ratios on growth and yield of maize. Molecular Plant Breeding. 2013; 43(7):292-296.
4. Deva S. Effect of tillage practices and nutrient management on fodder yield of oat, soil fertility and microbial population. The Bioscan. An International Quarterly Journal of Life Sciences. 2015; 10(1):173-176.
5. Deva S. Yield of fodder oat and balance sheet of nutrients influenced by tillage practices and nutrient management. International Journal of Agricultural Sciences. 2015; 11(1):112-115.
6. Gawai PP, Pawar VS. Integrated nutrient management in sorghum [*Sorghum bicolor* (L.) Moench] - chickpea (*Cicer arietinum*) cropping sequence under irrigated conditions. Indian Journal of Agronomy. 2006; 51(1):17-20.
7. Golada SL, Patel BJ, Sharma GL. Effect of FYM, nitrogen and *Azospirillum* inoculation on yield and quality of forage pearlmillet. Agricultural Science Digest. 2012; 32(3):237-240.
8. Gundlur SS, Patil PL, Rajkumara S, Ashoka P, Neelakanth JK. Influence of integrated nutrient management on yield and uptake of nutrients by maize and soil fertility under irrigated conditions in Vertisol. Karnataka Journals of Agricultural Science. 2015; 28(2):172-175.
9. Haque S, Sarthi PP, Saha A. Growth attitudes, cob yield and economics of maize (*Zea mays* L.) cultivar as affect by integrated nutrient management under tarai region of West Bengal. Indian Journal of Agricultural Research. 2012; 46(1):42-47.
10. Hussain, Iqbal, Muhmmad, Asghar, Hafiz, Naeem, *et al*. Impact of phosphate solubilising bacteria on growth and

yield of maize. Soil and Environmental Science of Pakistan. 2013; 32(1):71-78.
11. Jat PC, Rathore SS, Sharma RK. Effect of integrated nutrient management and intercropping systems on yield attributes and yield of maize. 2014; 27(1):52-56.
12. Joshi Ekta, Nepalia V, Verma, Arvind, Singh Dilip. Effect of integrated nutrient management on growth, productivity, and economics of maize (*Zea mays* L.). Indian Journal of Agronomy. 2013; 58(3):434-436.
13. Kalhapure AH, Shete BT, Dhonde MB. Integrated nutrient management in Maize (*Zea mays* L.) for increasing production with sustainability. International Journal of Agriculture and Food Science Technology. 2013; 4(3):195-206.
14. Kalhapure, Aniket, Shete, Balasaheb, Dhonde, Madhukar, *et al*. Influence of organic and inorganic sources of nutrients on maize. Indian Journal of Agronomy. 2014; 59(2):295-300.
15. Karforma J, Ghosh M, Ghosh DC, Mandal S. Effect of integrated nutrient management on growth, productivity, quality and economics of fodder maize in rainfed upland of tarai region of West Bengal. International Journal of Agriculture Environment Biotechnology. 2012; 5(4):419-427.
16. Kumar, Rakesh. productivity, profitability and nutrient uptake of maize (*Zea mays* L.) as influenced by management practices in North-East India. Indian Journal of Agronomy. 2015; 60(2):273-278.
17. Kumar S, Faruqui SA. Forage production technologies for different agro-ecological regions, 2010, 1.
18. Mahesh LC, Kalyanamurthy KN, Ramesha YM, Yogeseshappa H, Shivakumar KM, Prakash H. Effect of integrated nutrient management on growth and yield of maize (*Zea mays* L.). International Journal of Agricultural Sciences. 2010; 6(1):275-277.
19. Masih, Ashish, Swaroop, Narendra. Effect of integrated nutrient management on growth and yield attributes of maize (*Zea mays* L.). *var*. Kirtiman Saurabh. International Journal of Multidisciplinary Research and Development. 2016; 3(5):250-253.
20. Meena RM, Dashora LN, Dhaker RC, Meena BP. Effect of integrated nutrient management on quality parameters of fodder yield in sorghum [*Sorghum bicolor* (L.) Moench]. Annals of Agribio Research. 2013; 18(3):325-327.
21. Mukherjee, Dhiman. Influence of integrated nutrient management on productivity, nutrient uptake and economics of maize (*Zea mays* L.) - yellow sarson (*Brassica rapa*) cropping system under rainfed mid hill condition. Indian Journal of Agronomy. 2014; 59(2):221-228.
22. Munda GC, Mokidul, Islam, Patel DP. Effect of IPNS on productivity, profitability and economic feasibility of maize based cropping system on farmers field. Indian Journal of Agricultural Research. 2007; 41(3):200-204.
23. Nanjappa HV, Ramachandrappa BK, Mallikarjuna BO. Effect of integrated nutrient management on yield and nutrient balance in maize (*Zea mays* L.). Indian Journal of Agronomy. 2001; 46(4):698-701.
24. Pathak SK, Singh SB, Jha RN, Sharma RP. Effect of nutrient management on nutrient uptake and changes in soil fertility in maize (*Zea mays* L.) - wheat (*Triticum aestivum*) cropping system. Indian Journal of Agronomy. 2005; 50(4):269-273.
25. Pathan SH, Kamble AB. Effect of integrated nutrient management on yield sustainability and soil fertility of forage cropping system. Range Management and Agroforestry. 2012; 33(2):151-156.
26. Pathan SH, Kamble AB. Effect of integrated nutrient management on forage yield and quality of lucerne (*Medicago sativa* L.). Range Management and Agroforestry. 2014; 35(1):56-60.
27. Singh MM, Maurya ML, Singh SP, Mishra CH. Effect of nitrogen level and biofertilizer inoculation on productivity of forage sorghum [*Sorghum bicolor* (L.) Moench]. Indian Journal of Agricultural Sciences. 2005; 75(3):167-168.
28. Tetarval JP, Baldev, Ram, Meena DS. Effect of integrated nutrient management on productivity, profitability, nutrient uptake and soil fertility in rainfed maize (*Zea mays* L.). Indian Journal of Agronomy. 2011; 56(4):373-376.
29. Vadivel N, Subbian P, Velayutham A. Effect of integrated nitrogen - management practices on the growth and yield of rainfed winter maize (*Zea mays* L.). Indian Journal of Agronomy. 2001; 46(2):250-254.
30. Verma, Chanchal, Thanki JD, Singh, Deshraj, Chaudhari SN. Effect of nitrogen, biofertilizer and farm yard manure on yield and nutrient uptake in oat (*Avena sativa* L.). The Bioscan. An International Quarterly Journal of Life Sciences. 2016; 11(1):499-501.
31. Yadav, Arvind Kumar, Singh P, Singh Kuldeep. Productivity, Nutrient Uptake and Quality of Sorghum [*Sorghum bicolor* (L.) Moench] as affected by Tillage and Integrated Nutrient Management. Annals of Agribio Research. 2013; 18(2):146-150.