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Investigate the Potential of Nutrient for Maize Grown as a Food Cum Fodder Purpose

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A B S T R A C T

A field study was conducted during *rabi* season, 2016-17 at the Instructional-Cum-Research Farm of Assam Agricultural University to investigate the potential of nutrient for maize grown as a food cum fodder purpose. The treatment consisted of eight crop management practices viz., Grain crop at 60 cm x 30cm (T_1), Fodder crop at 30 cm x15 cm (T_2), Fodder cum grain crop at 30 cm x 30 cm with removal of alternate rows at knee-high stage for fodder (T_3), Fodder cum grain crop at 30 cm x 30 cm with removal of alternate rows at tasseling stage for fodder (T_4), Fodder cum grain crop at 30 cm x 30 cm with removal of alternate rows at milking stage for fodder (T_5), Fodder cum grain crop at 30 cm x 15 cm with removal of alternate rows at knee-high stage for fodder (T_6), Fodder cum grain crop (30 cm x 15 cm) removal of alternate row at tasseling stage for fodder (T_7), Fodder cum grain crop at 30 cm x 15 cm with removal of alternate rows at milking stage for fodder (T_8) and two levels of fertilizer viz., F_1: 100% of RDF and F_2: 150% of RDF. Crop management practice T_1 recorded the highest values for all cob parameters, N, P and K uptake. The highest grain yield being 34.21 q ha^{-1} and was produced from T_1 which was *at par* with crop management practice T_6, T_7 and T_8. However, green fodder yield (164.04 q ha^{-1}) and crude protein yield (3.11 q ha^{-1}) was found to be highest in crop management practice T_2. Among the fertilizer levels F_2: 150% of RDF recorded the highest cob parameters, grain yield, green fodder yield, crude protein yield and nutrient (NPK) uptake of maize.

Introduction

Maize (*Zea mays* L.) is considered as one of the most important cereals in the world which served a staple food in wider range than any other cereal crops. Maize provides nutrients to both humans and animals. It is used as a source of raw materials for the production of oil, protein, starch, food sweeteners and alcoholic beverages and fuel source. It is grown across a wide range of climatic conditions of the world due to its wider adaptability (Amanullah *et al.,* 2007 and Chennankrishnan and Raja, 2012). It is popularly known as queen of cereals due to high genetic yield potentials than any other cereals (Kannan *et al.,* 2013).

There are many constraints for low production and productivity of maize. Maize being highly exhaustive crop and as such adequately supplied nutrients may have positive influence in increasing the yield of the crop. Among the essential nutrients, nitrogen is universally accepted as a key component to high yield and optimum economic return as it plays a very important part in crop productivity (Ahmad, 2000) and its deficiency is one of the major yield limiting factors for cereal production (Shah *et al.,* 2003). Phosphorus is also considered an essential nutrient to plant growth and development. It is an integral part of nucleic acid and is essential for cellular respiration and for metabolic activity. Therefore, the use of phosphorus along with nitrogen will help increase yield of maize (Safdar, 1997). Previous studies suggested that phosphorus influenced both maize's forage yield and quality (Patel *et al.,* 1997). Phosphorus application increased fodder yield and quality by increasing plant height, and the number of leaves plant^{-1} (Masood *et al.,*2011). Maize has high yield potential and responds greatly to potassium fertilizer. Therefore, proper management of potassium nutrient is essential to realize maximum potential of the crop because it plays an important role in activating various enzymes (Tisdale *et al.,* 1990). Hence, with these ideas in view, an attempt was, therefore, made to study the effect of different fertilizer levels on nutrient uptake and yield of dual purpose maize during *rabi* season.

Materials and Methods

To see the agro-economic response of maize to added N, P_2O_5, K_2O and removal of extra plants at different stages of crop for fodder the experiment was conducted at the Instructional-Cum-Research Farm of Assam Agricultural University during 2016-17 on a sandy loam soil having 210.65 kg N ha^{-1}, 38.64 kg ha^{-1} of available phosphorous and 295.55 kg ha^{-1} available potassium. The pH of the soil was 5.15. The experiment was laid out in factorial RBD and replicated thrice. The treatment consisted of eight crop management practices *viz.,* Grain crop at 60 cm x 30cm (T_1), Fodder crop at 30 cm x15 cm (T_2), Fodder cum grain crop at 30 cm x 30 cm with removal of alternate rows at knee-high stage for fodder (T_3), Fodder cum grain crop at 30 cm x 30 cm with removal of alternate rows at tasseling stage for fodder (T_4), Fodder cum grain crop at 30 cm x 30 cm with removal of alternate rows at milking stage for fodder (T_5), Fodder cum grain crop at 30 cm x 15 cm with removal of alternate rows at knee-high stage for fodder (T_6), Fodder cum grain crop (30 cm x 15 cm) removal of alternate row at tasseling stage for fodder (T_7), Fodder cum grain crop at 30 cm x 15 cm with removal of alternate rows at milking stage for fodder (T_8) and two levels of fertilizer *viz.*, F_1: 100% of RDF and F_2: 150% of RDF. [NB: Recommended dose of fertilizer (RDF) = 60-40-40 N- P_2O_5- K_2O kg ha^{-1}]

The dual purpose maize hybrid variety PAC 751 was taken as test crop for assessing its performance. The seed was sown on a well prepared seedbed. Quantity of seeds required for different treatment was calculated according to the area of the individual plot and sowing was done in lines at spacing of 60 cm x 30 cm, 30 cm x 30 cm and 30 cm x 15 cm. At the time of final land preparation, well decomposed FYM @ 5 tones ha^{-1} was applied in the field and thoroughly incorporated before laying out the experiment. The total quantity of P and K and one-third (⅓) of nitrogen at sowing was applied and remaining two-third (⅔) of N in two equal doses at knee-high stage and at tasseling was applied as per treatment. Harvesting of fodder maize was done at different stage (knee-high stage, tasseling stage and milk stage) in alternate rows as per treatments. All other agronomic practices were kept normal and uniform for all the treatments. Data on agro-economic aspects of the crop were recorded and were analysed statistically and differences among treatment means were tested using -test at 5% level of significance.

Results and Discussion

The crop management practices and fertilizer levels affected significantly the crop characteristics namely green fodder yield (q ha^{-1}), crude protein content (%), crude protein yield (q ha^{-1}), length of cob (cm), diameter of cob (cm), weight of cob (g), number of rows per cob, number of kernels per row, number of kernels per cob, grain yield (q ha^{-1}),N, P and K content (%) in grain and stover and uptake (kg ha^{-1}) of N, P and K by grain and stover of dual purpose maize.

Significant variations in fodder parameter were recorded due to different crop management practices. Green fodder yield (164.04q ha^{-1}), crude protein content (8.781) and crude protein yield (3.11 q ha^{-1}) were significantly highest in fodder crop sown at spacing of 30cm x 15cm (T_2) over all other crop management practices (Table 1). In this practice all the maize plants were harvested for fodder purpose at tasseling stage. But other crop management practices only alternate rows were harvested for fodder purpose at different growth stages. The crop rectangularity (30cm × 15cm) and plant density (2,22,222 plants ha^{-1}) resulted from this spacing might be optimum to result in better light absorbance by more number of flag leaves which have higher photosynthesis efficiency and enhanced green fodder yield as described by Tetio-Kagho and Gardnar (1988).

Application of 50 per cent higher fertilizer over recommended level resulted in significantly higher green fodder yield (63.59 q ha^{-1}), crude protein content (8.645 %) and crude protein yield (1.13 q ha^{-1}) (Table 1). This might be due to the fact that the maize has the capacity to utilize all applied levels of fertilizer since maize crop is a heavy feeder of nutrients. This was in conformity with Aslam (2007), who observed maximum green fodder yield with 150kg N ha^{-1}. Sahoo and Panda (2001) reported that green fodder yield of maize increased with increasing levels of fertilizer.

Among the crop management practices grain crop at a spacing of 60 cm x 30cm (T_1) produced significantly the highest cob length with husk (22.32 cm), cob length without husk (13.48 cm), cob diameter with husk (6.55 cm), cob diameter without husk (5.27), weight of cob with husk (237.02 g) and without husk (209.53), number of rows per cob (16.33), number of kernels per row(40.17), number of kernels per cob (655.67) and grain yield (34.21 q ha^{-1}) (Table 2). The present results were supported by the findings of Biswas and Quayuum (1991) and Johnson and Wilman (1997) for size of cobs. Biswas and Quayuum (1991) and Johnson and Wilman (1997) found that decreasing spacing increased the cob diameter of maize. The number of kernels per row is an important yield parameter. Number of kernels per row was significantly influenced by spacing. Number of grains per row increased with increasing spacing. Abuzar *et al.*, (2011) and Andrade *et al.*, (1993) observed that an increase in plant density decrease the number of kernels per row and grains per cob in maize. The increase in all these characters in T_1 might be due to the availability of all the resource at adequate amount at T_1 crop management practice, which helped in higher photosynthetic and metabolic activities of plant, resulting increase in cob parameter, which directly helps in increasing yield. The findings can be corroborated with the findings of Asghar *et al.*, (2010), Thavaprakaash *et al.*, (2008), Randhawa and Khan (2007) and Thakur *et al.*, (1997). Plant spacing significantly influenced the grain yield of maize**.** Moriri *et al.*, (2010) reported that grain yield increased with increase plant density. These finding are in conformity with Ahmed (2010) and Agasibagil (2006).

Table.1 Effect of crop management practices and levels of fertilizer on yield and quality of fodder of dual purpose maize

Treatment	Green fodder yield (q ha^{-1})	Crude protein content (%)	Crude protein yield (q ha^{-1})
Crop management (T)			
T_1: Grain (G)	-	-	-
T_2: Fodder (F)	164.04	8.781	3.11
T_3: F at KHS* with S_1+G	12.13	8.606	0.18
T_4: F at TS with S_1+G	63.90	8.609	1.02
T_5: F at MS with S_1+G	74.18	8.644	1.40
T_6: F at KHS with S_2+G	21.76	8.675	0.34
T_7: F at TS with S_2+G	78.31	8.738	1.39
T_8: F at MS with S_2+G	87.15	8.758	1.57
S. Em ±	3.72	0.23	0.09
CD (P = 0.05)	10.80	NS	0.26
Levels of fertilizer (F)			
F_1 (100% of RDF)	63.59	8.645	1.13
F_2 (150% of RDF)	79.68	8.730	1.45
S. Em ±	1.99	0.12	0.05
CD (P=0.05)	5.79	NS	0.14
Interaction (T × F)			
S. Em ±	3.72	0.23	0.09
CD (P = 0.05)	NS	NS	NS
*KHS**: Knee-high Stage,** TS**: Tasseling Stage,** MS**: Milking Stage,** S_1**: 30 cm x 30 cm spacing and** S_2: **30 cm x 15 cm**			

Table.2 Effect of crop management practices and levels of fertilizer on cob parameter of dual purpose maize

Treatment	Length of cob (cm)		Diameter of cob (cm)		Weight of cob (g)		No. of rows per cob	No. of kernels per row	No. of kernels per cob	Grain yield (q ha^{-1})
	with husk	**without husk**	**with husk**	**without husk**	**with husk**	**without husk**				
Crop management (T)										
$T_{1:}$ Grain (G)	22.32	13.48	6.55	5.27	237.02	209.53	16.33	40.17	655.67	34.21
$T_{2:}$ Fodder (F)	-	-	-	-	-	-	-	-	-	-
$T_{3:}$ F at KHS* with S_1+G	20.19	12.52	6.12	4.88	211.78	192.69	15.33	37.00	558.74	25.76
T_4: F at TS with S_1+G	20.00	11.54	6.06	4.86	210.83	190.70	15.00	36.50	556.35	23.67
T_5: F at MS with S_1+G	19.55	11.36	6.00	4.71	206.91	189.13	15.00	35.83	549.33	23.15
T_6:F at KHS with S_2+G	17.67	10.45	5.30	4.27	188.00	178.43	14.67	33.17	478.67	32.19
T_7: F at TS with S_2+G	17.32	10.03	5.23	4.26	187.04	177.28	14.33	33.00	473.67	31.10
T_8: F at MS with S_2+G	17.02	9.96	5.20	4.30	186.90	177.21	14.33	32.50	466.00	30.62
S. Em ±	0.44	0.38	0.15	0.10	4.83	5.21	0.48	0.55	19.19	1.33
CD (P = 0.05)	1.27	1.11	0.43	0.30	14.04	15.16	NS	1.61	55.79	3.86
Levels of fertilizer (F)										
F_1 (100% of RDF)	17.87	10.45	5.54	4.40	194.54	181.58	14.67	34.81	510.31	25.36
F_2 (150% of RDF)	20.43	12.22	6.02	4.89	213.60	194.13	15.33	36.10	557.81	31.98
S. Em ±	0.23	0.2	0.08	0.05	2.58	2.79	0.26	0.3	10.25	0.71
CD (P=0.05)	0.68	0.59	0.23	0.15	7.52	8.12	NS	0.86	29.88	2.07
Interaction (T × F)										
S. Em ±	0.44	0.38	0.15	0.10	4.83	5.21	0.48	0.55	19.19	1.33
CD (P = 0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	3.86

*KHS**: Knee-high Stage,** TS**: Tasseling Stage,** MS**: Milking Stage,** S_1**: 30 cm x 30 cm spacing and** S_2**: 30 cm x 15 cm**

Table.2a Interaction effect of crop management practices and levels of fertilizer on grain yield ($q\ ha^{-1}$) of dual purpose maize

Crop management (T)	Grain yield ($q\ ha^{-1}$)	
	Levels of fertilizer	
	F_1 (100% of RDF)	**F_2 (150% of RDF)**
T_1: Grain (G)	31.86	36.55
T_2: Fodder (F)	-	-
T_3: F at KHS* with S_1+G	16.74	34.78
T_4: F at TS with S_1+G	21.62	25.71
T_5: F at MS with S_1+G	22.88	23.41
T_6: F at KHS with S_2+G	29.51	34.87
T_7: F at TS with S_2+G	27.72	34.49
T_8: F at MS with S_2+G	27.17	34.06
S. Em ±	1.33	
CD (P= 0.05)	3.86	

*KHS**: Knee-high Stage,** TS**: Tasseling Stage,** MS**: Milking Stage,**
S_1**: 30 cm x 30 cm spacing and** S_2: **30 cm x 15 cm**

Table.3 Effect of crop management practices and levels of fertilizer on uptake (kg ha^{-1}) of N, P and K by grain and stover of dual purpose maize

Treatment	Grain			Stover			Total uptake (grain+stover)		
	N	**P**	**K**	**N**	**P**	**K**	**N**	**P**	**K**
Crop management (T)									
$T_{1:}$ Grain (G)	76.08	12.93	26.35	49.36	16.36	45.35	125.44	29.27	71.70
$T_{2:}$ Fodder (F)	-	-	-		-		-	-	-
T_3: F at KHS* with S_1+G	59.52	10.48	20.16	30.02	12.50	27.71	89.54	22.98	47.87
T_4: F at TS with S_1+G	58.34	9.24	18.65	23.49	11.62	25.87	81.83	20.86	44.53
T_5: F at MS with S_1+G	51.14	7.95	16.61	17.39	10.75	20.54	68.53	18.70	37.14
T_6: F at KHS with S_2+G	74.01	12.07	25.73	46.11	16.35	45.01	120.12	28.42	70.74
T_7: F at TS with S_2+G	71.55	11.32	23.43	42.33	15.13	33.51	113.88	26.45	56.94
T_8: F at MS with S_2+G	70.58	11.08	22.98	37.58	14.14	27.52	108.16	25.23	50.50
S. Em ±	3.38	0.78	1.29	2.32	0.64	2.44	2.10	0.96	3.19
CD (P = 0.05)	9.81	2.28	3.74	6.75	1.85	7.10	6.10	2.78	9.26
Levels of fertilizer (F)									
F_1 (100% of RDF)	57.09	9.47	19.61	30.45	12.72	26.23	87.55	22.19	45.83
F_2 (150% of RDF)	74.68	11.98	24.37	39.92	14.95	38.21	114.60	26.93	62.57
S. Em ±	1.80	0.42	0.69	1.24	0.34	1.30	3.91	0.51	1.70
CD (P=0.05)	5.26	1.22	2.00	3.62	0.99	3.80	11.37	1.49	4.96
Interaction (T × F)									
S. Em ±	3.38	0.78	1.29	2.32	0.64	2.44	3.91	0.96	3.19
CD (P = 0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS

*KHS**: Knee-high Stage,** TS**: Tasseling Stage,** MS**: Milking Stage,** S_1**: 30 cm x 30 cm spacing and** S_2**: 30 cm x 15 cm**

The highest cob length with husk (20.43 cm), cob length without husk (12.22 cm), cob diameter with husk (6.02 cm), cob diameter without husk (4.89), weight of cob with husk (213.60 g) and without husk (194.13), number of rows per cob (15.33), number of kernels per row (36.10), number of kernels per cob (557.81) and grain yield (31.98 q ha^{-1}) showed a positive response to the increasing levels of fertilizer (Table 2 and 2a). Increase in nitrogen level, increased the yield attributes by better uptake of all the nutrients and increased translocation of photosynthates from source to sink in hybrid maize (Srikanth *et al.*, 2009). The same trend was observed up to 200 kg nitrogen by Parthipan (2000) and 225 kg nitrogen by Singh *et al.*, (1997). The findings were in conformity with Hanif (2007) who had concluded that yield and quality parameters were improved with increased nitrogen and phosphorous levels. Similar results were observed by Hanif (2007) who concluded that increase in yield was mainly due to increase in growth parameters with respect to the increased in levels of nitrogen and phosphorous up to 150-100 kg ha^{-1}. This result was in conformity with Jogdand *et al.*, (2008). Similar results were also reported by Rasheed *et al.*, (2004). Significantly higher crude protein yield due to application of higher fertilizer level might be due to the higher availability of sources under higher nitrogen levels and higher photosynthetic activities. Similar results were obtained by Ramchandrappa *et al.*, (2004).

Application of crop management practice resulted in significantly higher N, P and K uptake by grain and stover (Table 3). The higher yield of the crop was also evident from the fact that significantly highest values of uptake of nutrients N, P, K by the crop. Significantly the highest uptakes of all the three major nutrients through grain were noted in the grain crop sown at a spacing of 60 cm x 30 cm (T_1) and remained *at par* with that of all the three high population density (30 cm x 15 cm) of dual purpose maize with removal of alternate rows at knee-high, tasseling and milking stages (T_6, T_7 and T_8), respectively. Closer spacing of 30 × 15 cm which accommodated the highest plant density (2,22,222 plants ha^{-1}) enhanced the dry matter production and elicited a significant absorption of N, P and K by dual purpose maize. The percent recovery also might have increased with increase in population level due to exploration of soil with stimulated root system to absorb more N, P and K. Bhatt (2012) also reported significant increase in uptake of nitrogen with closer crop geometry of maize at higher plant density. Levels of fertilizer brought significant difference in total uptake of N, P and K nutrients (Table 3). Significantly higher uptake of all these elements were recorded when the dual purpose maize was fertilized with 150 per cent of recommended level of fertilizer. Kostandi and Soliman (1991) reported that balanced application of NPK is required for proper uptake of NPK.

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