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Effect of different levels of seed rate, nitrogen and zinc on quality and nutrient uptake of fodder maize (*Zea mays* L.)

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Abstract
Field experiment was conducted at Zonal Agricultural Research Station, UAS, GKVK, Bengaluru during *kharif* 2017 to study the Effect of different levels of seed rate, nitrogen and zinc on yield and quality of fodder maize (*Zea mays* L.). There were 18 treatment combinations involving 3 levels of seed rate (50, 75 and 100 kg ha^{-1}), 3 nitrogen levels (100, 125 and 150 kg ha^{-1}) and 2 zinc levels (0 and 10 kg ha^{-1}). The experiment was laid out in a FRCBD, replicated thrice. The results revealed that, seed rate of 75 kg ha^{-1} recorded significantly higher green fodder yield (34.29 t ha^{-1}), Crude protein yield (0.89 t ha^{-1} and crude fiber yield (3.67 t ha^{-1}) over 50 kg ha^{-1} (29.58, 0.72 and 3.10 t ha^{-1}, respectively) and was on par with seed rate 100 kg ha^{-1} (32.50, 0.80 and 3.58 t ha^{-1}, respectively). Application of 150 kg nitrogen ha^{-1} resulted significantly higher green fodder yield (34.56 t ha^{-1}), crude protein content (8.95 %) and lower crude fiber content (32.05 %) over nitrogen at 100 kg ha^{-1} (29.14 t ha^{-1}, 7.52 and 35.46 %, respectively). 10 kg zinc ha^{-1} recorded significantly higher green fodder yield (33.07 t ha^{-1}), crude protein content (8.50 %) and lower crude fiber content (33.12 %) over no zinc.

Keywords: fodder maize, quality, nutrient uptake

Introduction
Fodder maize (*Zea mays* L.) is one of the most important crop grown throughout the year for fodder purpose with fodder productivity of 30-55 t ha^{-1}. Maize has wider adaptability, quick growing nature, succulent, palatability and free from toxicants has made excellent fodder and it can be safely fed to animals at any stage of the crop growth. Maize being exhaustive crop requires more nutrients to put forth more biomass in short period and plant population has direct role on higher yield of green fodder.

Among the essential nutrients, nitrogen is the most important limiting factor for plant growth. Nitrogen (N) plays a very important role in crop productivity (Ahmad, 2000) and its deficiency is one of the major yield limiting factor for cereal production (Shah *et al*. 2003). Among the micronutrients, zinc deficiency appears to be the most widespread and frequent micronutrient deficiency problem in crop and pasture in worldwide, resulting in severe losses in yield and nutritional quality. Its deficiency has severely plagued most of the Indian soils too, as a result many plant species are affected by zinc deficiency on a wide range of soil types in most agricultural regions of the world. Zinc (Zn) is an essential micronutrient and has particular physiological functions in all living systems, for maintenance of structural and functional integrity of biological membranes and facilitation of protein synthesis and gene expression. In plants, zinc plays a key role as a structural constituent or regulatory co-factor of a wide range of different enzymes and proteins in many important biochemical pathways which are mainly concerned with carbohydrate metabolism, both in photosynthesis and in the conversion of sugars to starch, protein and auxin metabolism.

Crude protein is the most important parameter to evaluate the quality of fodder maize. Higher crude protein per cent indicates good quality of fodder. Continuous supply of proteins to the animals is essential for maintaining their good health and Crude fibre content is the most important quality parameter influencing the digestibility of fodder. Crude fibre per cent was influenced by the age of the crop, nitrogen also has a significant influence on crude fibre content. The effect of nitrogen, seed rate and zinc on quality and nutrient uptake was very meagre therefore the above field experiment was conducted.

Materials and Methods

The material used and methods adopted during the course of this investigation are described in this chapter. The experiment was conducted at Zonal Agricultural Research Station (ZARS), Gandhi Krishi Vignana Kendra, University of Agricultural Sciences, and Bengaluru which is situated at 13 º 05' North latitude and 77 º 34' East longitude and at an altitude of 924 m above mean sea level which comes under eastern dry zone (ACZ-V) of Karnataka. The soil of the experimental plot was red sandy clay loam in nature. Composite soil samples to a depth of 0-30 cm was collected from the experimental plots before sowing and analysed for physico-chemical properties. The soil reaction was neutral, medium in available nitrogen, available phosphorus and available potassium (6.46, 258.8 kg ha^{-1}, 22.9 kg P_2O_5 ha^{-1} and 165.2 kg K_2O ha^{-1} of soil reaction available nitrogen, available phosphorus and available potassium respectively). The experiment was laid out in RCBD with Factorial concept replicated thrice. The experiment consists of 18 treatments combination *viz.*, 3 levels of seed rate (50, 75 and 100 kg ha^{-1}), 3 nitrogen levels (100, 125 and 150 kg ha^{-1}) and 2 zinc levels (0 and 10 kg ha^{-1}). Furrows were opened at 30 cm apart and 75 P_2O_5 and 40 kg K_2O kg ha^{-1} applied through single super phosphate and muriate of potash respectively. Nitrogen 50 per cent basal and 50% as top dressing 30 DAS was applied as per the treatments. Crop was sown on 2nd August, 2017 and harvested at 50 per cent flowering to milking stage. Five plant randomly selected in net plot area to take growth observation at different stage of crop growth. While harvesting crop from net plot area harvested separately as per treatments and values were converted into hectare basis and expressed in tones. The samples were first dried under shade and then in over at 60^0C till attaining constant weight, the green fodder yield was converted into dry matter yield (t/ha). The crude protein content of forage was worked out by multiplying crude protein percentage with factor 6.25 (Doubetz and Wells, 1968) [5]. The crude protein yield was calculated by multiplying crude protein percentage with dry matter yield and expressed in tones per hectare. Crude fibre content in plant was estimated by acid-alkali digestion methods (Mahadeva, 1965) [8] and was expressed in percentage. Crude fibre yield was worked out by multiplying crude fibre percentage with dry matter yield and expressed in tones per hectare.

After the harvest soil samples were collected from all the treatments and analyzed for available nitrogen, available phosphorus, available potassium and available zinc. Nutrient uptake from crop was estimated using different method for nitrogen, phosphorus, potassium and zinc. Data on crude protein content (%) and yield (t/ha), crude fibre content (%) and crude fibre yield (t/ha), uptake of nitrogen, phosphorus, potassium and zinc were analyzed statistically as mentioned by Gomez and Gomez, 1984) [7].

Results

Crude protein content

The results revealed that different seed rate did not increase crude protein content of fodder maize significantly. Crude protein content of fodder maize recorded significantly higher with the application of nitrogen at 150 kg per ha (8.95 %) as compared to nitrogen at 100 kg per ha (7.52 %). The application of zinc at 10 kg per ha significantly increased crude protein content (8.50 %) over no zinc application (8.00 %).

Crude fiber content

Crude fiber content of fodder maize did not differ significantly with the seed rates. However higher crude fiber content was recorded with seed rate of 75 kg per ha (34.76 %) and lower with 50 kg per ha (34.11 %). Application of 100 kg nitrogen per ha recorded significantly higher crude fiber content (35.46 %) over 150 kg nitrogen per ha (32.05 %). Zinc application at 10 kg per ha significantly decreased crude fiber content (33.12 %) of fodder maize over no zinc application (34.42 %).

The data pertaining to quality parameters of fodder maize as influenced by different levels of seed rate, nitrogen and zinc are presented in table 1 & 2.

Crude protein yield

Seed rate of 75 kg per ha recorded significantly higher total crude protein yield (0.89t ha^{-1}) as compared to that with seed rate of 50 kg per ha (0.72 t ha^{-1}) and it was on par with seed rate of 100 kg per ha (0.80 t ha^{-1}). Application of 150 kg nitrogen ha^{-1}recorded significantly higher total crude protein yield (0.95 t ha^{-1}) than 100 kg nitrogen per ha (0.67 t ha^{-1}) and the application of zinc at 10 kg per ha significantly increased crude protein yield (0.86 t ha^{-1}) over no zinc application (0.75 t ha^{-1}). Interaction between seed rate, nitrogen and zinc was found to be non-significant on crude protein yield of fodder maize.

Crude fiber yield

Seed rate of 75 kg per ha recorded significantly higher total crude fiber yield (3.67 t ha^{-1}) as compared to that with seed rate of 50 kg per ha (3.10 t ha^{-1}) and it was on par with seed rate of 100 kg per ha (3.58 t ha^{-1}).Among nitrogen levels, application of 150 kg nitrogen per hare corded significantly higher total crude fiber yield (3.89 t ha^{-1}) compared to 100 kg nitrogen ha^{-1} (3.11 t ha^{-1}).Zinc application at 10 kg per ha significantly increased crude fiber yield (3.60 t ha^{-1}) of fodder maize over no zinc application (3.25 t ha^{-1}).

Table 1: Crude protein content and crude fiber content of fodder maize as influenced by different levels of seed rate, nitrogen and zinc

Treatments	Crude protein (%)	Crude fiber (%)	Treatments	Crude protein (%)	Crude fiber (%)
Seed rate (S)			**Interaction (NxZn)**		
S_1	8.02	34.11	N_1Zn_0	7.47	36.10
S_2	8.46	34.76	N_1Zn_1	7.78	34.83
S_3	8.29	34.44	N_2Zn_0	8.01	34.42
S.Em$\pm$	0.20	0.50	N_2Zn_1	8.41	33.20
CD at 5%	NS	NS	N_3Zn_0	8.59	32.76
Nitrogen level (N)			N_3Zn_1	9.31	31.35
N_1	7.52	35.46	S.Em$\pm$	0.287	0.718
N_2	8.20	33.80	CD at 5%	NS	NS
N_3	8.95	32.05	Interaction (SxNxZn)		
S.Em$\pm$	0.20	0.50	$S_1N_1Zn_0$	7.33	36.08

CD at 5%	0.58	1.46	$S_1N_1Zn_1$	7.55	35.71
Zinc level (Zn)			$S_1N_2Zn_0$	7.76	34.89
Zn_0	8.00	34.42	$S_1N_2Zn_1$	8.31	33.90
Zn_1	8.50	33.12	$S_1N_3Zn_0$	8.41	33.43
S.Em±	0.16	0.41	$S_1N_3Zn_1$	8.76	32.68
CD at 5%	0.47	1.19	$S_2N_1Zn_0$	7.52	35.24
Interaction (SxN)			$S_2N_1Zn_1$	7.85	33.64
S_1N_1	7.44	35.90	$S_2N_2Zn_0$	8.15	33.49
S_1N_2	8.04	34.39	$S_2N_2Zn_1$	8.55	32.54
S_1N_3	8.58	33.05	$S_2N_3Zn_0$	8.85	32.00
S_2N_1	7.69	34.44	$S_2N_3Zn_1$	9.89	29.70
S_2N_2	8.35	33.01	$S_3N_1Zn_0$	7.55	36.00
S_2N_3	9.37	30.85	$S_3N_1Zn_1$	7.92	35.14
S_3N_1	7.74	36.05	$S_3N_2Zn_0$	8.10	34.88
S_3N_2	8.24	34.02	$S_3N_2Zn_1$	8.37	33.16
S_3N_3	8.90	32.26	$S_3N_3Zn_0$	8.51	32.85
S.Em±	0.351	0.880	$S_3N_3Zn_1$	9.30	31.67
CD at 5%	NS	NS	S.Em±	0.49	1.24
Interaction (SxZn)			CD at 5%	NS	NS
S_1Zn_0	7.84	34.80	S_1: 50 kg seeds ha^{-1}		
S_1Zn_1	8.21	34.10	S_2: 75 kg seeds ha^{-1}		
S_2Zn_0	8.17	33.58	S_3: 100 kg seeds ha^{-1}		
S_2Zn_1	8.76	31.96	N_1: 100 kg nitrogen ha^{-1}		
S_3Zn_0	8.05	34.90	N_2: 125 kg nitrogen ha^{-1}		
S_3Zn_1	8.53	33.32	N_3: 150 kg nitrogen ha^{-1}		
S.Em±	0.287	0.718	Zn_0: 0 kg zinc ha^{-1}		
CD at 5%	NS	NS	Zn_1: 10 kg zinc ha^{-1}		

Table 2: Crude protein yield and crude fiber yield of fodder maize as influenced by different levels of seed rate, nitrogen and zinc

Treatments	Crude protein yield (t/ha)	Crude fiber yield (t/ha)	Treatments	Crude protein yield (t/ha)	Crude fiber yield (t/ha)
Seed rate (S)			**Interaction (NxZn)**		
S_1	0.72	3.10	N_1Zn_0	0.63	3.01
S_2	0.89	3.67	N_1Zn_1	0.70	3.23
S_3	0.80	3.58	N_2Zn_0	0.74	3.43
S.Em±	0.035	0.123	N_2Zn_1	0.84	3.60
CD at 5%	0.101	0.353	N_3Zn_0	0.87	3.67
Nitrogen level (N)			N_3Zn_0	1.04	3.86
N_1	0.67	3.11	S.Em±	0.050	0.174
N_2	0.79	3.50	CD at 5%	NS	NS
N_3	0.95	3.89	Interaction (SxNxZn)		
S.Em±	0.035	0.123	$S_1N_1Zn_0$	0.56	2.75
CD at 5%	0.101	0.353	$S_1N_1Zn_1$	0.65	3.08
Zinc level (Zn)			$S_1N_2Zn_0$	0.68	3.05
Zn_0	0.75	3.25	$S_1N_2Zn_1$	0.77	3.22
Zn_1	0.86	3.60	$S_1N_3Zn_0$	0.80	3.14
S.Em±	0.03	0.10	$S_1N_3Zn_1$	0.87	3.35
CD at 5%	0.08	0.29	$S_2N_1Zn_0$	0.69	3.27
Interaction (SxN)			$S_2N_1Zn_1$	0.76	3.45
S_1N_1	0.60	2.92	$S_2N_2Zn_0$	0.81	3.48
S_1N_2	0.73	3.13	$S_2N_2Zn_1$	0.91	3.71
S_1N_3	0.84	3.24	$S_2N_3Zn_0$	0.95	3.79
S_2N_1	0.73	3.36	$S_2N_3Zn_1$	1.21	4.31
S_2N_2	0.86	3.59	$S_3N_1Zn_0$	0.63	3.07
S_2N_3	1.08	4.05	$S_3N_1Zn_1$	0.70	3.45
S_3N_1	0.67	3.26	$S_3N_2Zn_0$	0.73	3.47
S_3N_2	0.78	3.55	$S_3N_2Zn_1$	0.83	3.62
S_3N_3	0.94	3.94	$S_3N_3Zn_0$	0.85	3.67
S.Em±	0.061	0.213	$S_3N_3Zn_1$	1.04	4.21
CD at 5%	NS	NS	S.Em±	0.086	0.301
Interaction (SxZn)			CD at 5%	NS	NS
S_1Zn_0	0.68	2.98	S_1: 50 kg seeds ha^{-1}		
S_1Zn_1	0.77	3.22	S_2:75 kg seeds ha^{-1}		
S_2Zn_0	0.82	3.51	S_3:100 kg seeds ha^{-1}		
S_2Zn_1	0.96	3.82	N_1: 100 kg nitrogen ha^{-1}		
S_3Zn_0	0.74	3.41	N_2:125 kg nitrogen ha^{-1}		
S_3Zn_1	0.85	3.76	N_3: 150 kg nitrogen ha^{-1}		
S.Em±	0.050	0.174	Zn_0: 0 kg zinc ha^{-1}		
CD at 5%	NS	NS	Zn_1: 10 kg zinc ha^{-1}		

Discussion

Higher crude protein content at 150 kg nitrogen per ha was due to higher nitrogen concentration in the plant thus emphasized the fact that nitrogen played great role in the protein synthesis. Apart from this nitrogen plays an important role in plant metabolism as a constituent of amino acids (DNA and RNA). Eltelib *et al*. (2006) [6], Bhilare *et al*. (2002) [4] and Sindhu *et al*. (2006) [13] also reported similar findings. And due to the higher crude protein content and dry matter yield with increased nitrogen levels resulted in higher crude protein yield. Similar result was revealed (Manjanagouda *et al*., 2017) [9] in fodder pearl millet.

Lower fiber content at 150 kg N per ha was due to the fact that higher nitrogen result in higher protein synthesis and proteins are formed from manufactured carbohydrates which lowers soluble carbohydrates thus less carbohydrate is deposited in the vegetative portion, more protoplasm is formed and because protoplasm is highly hydrated, results a more succulent plant and decreases pectin, cellulose and hemi cellulose content which are major constituents of crude fiber. These results are conformity with the findings of Somashekar *et al*. (2018) [15].

It was also observed that zinc application at 10 kg per ha recorded decreased fiber content. This could be attributed to more protein synthesis at higher zinc rates thereby decreasing the fiber content of fodder. Similar results were obtained by Surendra mohan (2015) [16] and Mehdi *et al*. (2012) [10].

Table 3: Uptake of nitrogen, phosphorus, potassium and zinc by fodder maize as influenced by different levels of seed rate, nitrogen and zinc

Treatments	Nitrogen (kg ha^{-1})	P_2O_5 (kg ha^{-1})	K_2O (kg ha^{-1})	Zn (g ha^{-1})	Treatments	Nitrogen (kg ha^{-1})	P_2O_5 (kg ha^{-1})	K_2O (kg ha^{-1})	Zn (g ha^{-1})
Seed rate (S)					**Interaction (NxZn)**				
S_1	113.88	30.58	100.51	254.91	N_1Zn_0	99.48	28.70	92.72	218.52
S_2	141.62	35.75	118.65	304.00	N_1Zn_1	111.04	31.01	102.73	289.14
S_3	130.99	33.13	110.19	280.27	N_2Zn_0	117.85	31.75	105.36	241.42
S.Em±	3.89	1.00	3.29	8.691	N_2Zn_1	132.23	34.10	113.00	316.49
CD at 5%	11.20	2.87	9.45	24.979	N_3Zn_0	137.13	35.18	115.21	262.04
Nitrogen level (N)					N_3Zn_1	165.98	38.20	125.72	356.76
N_1	105.25	29.85	99.08	253.83	S.Em±	5.511	1.414	4.618	12.291
N_2	125.04	32.92	109.27	278.95	CD at 5%	NS	NS	NS	NS
N_3	151.55	36.69	121.00	309.40	Interaction (SxNxZn)				
S.Em±	3.89	1.00	3.29	8.691	$S_1N_1Zn_0$	88.28	25.91	85.99	197.06
CD at 5%	11.20	2.87	9.45	24.979	$S_1N_1Zn_1$	101.46	29.51	97.93	275.29
Zinc level (Zn)					$S_1N_2Zn_0$	107.90	29.91	99.25	227.30
Zn_0	118.15	31.87	105.27	240.66	$S_1N_2Zn_1$	120.67	31.71	105.22	295.71
Zn_1	136.41	34.44	114.30	320.80	$S_1N_3Zn_0$	125.70	32.33	107.31	245.51
S.Em±	3.18	0.81	2.68	7.10	$S_1N_3Zn_1$	139.31	34.16	113.36	318.61
CD at 5%	9.14	2.34	7.72	20.40	$S_2N_1Zn_0$	111.07	31.83	105.63	242.66
Interaction (SxN)					$S_2N_1Zn_1$	120.62	33.17	110.09	309.12
S_1N_1	94.87	27.71	91.96	232.64	$S_2N_2Zn_0$	129.13	34.21	113.53	260.11
S_1N_2	114.29	30.81	102.24	253.17	$S_2N_2Zn_1$	142.84	36.16	120.01	337.42
S_1N_3	132.51	33.25	110.33	278.74	$S_2N_3Zn_0$	151.72	36.95	122.63	280.92
S_2N_1	115.84	32.50	103.78	275.89	$S_2N_3Zn_1$	194.36	42.19	140.03	393.76
S_2N_2	135.99	35.18	116.49	298.77	$S_3N_1Zn_0$	99.08	28.36	94.12	215.85
S_2N_3	173.04	39.57	129.71	337.34	$S_3N_1Zn_1$	111.05	30.36	100.75	283.01
S_3N_1	105.06	29.36	97.44	250.00	$S_3N_2Zn_0$	116.53	31.12	103.28	236.84
S_3N_2	124.85	32.79	108.81	277.25	$S_3N_2Zn_1$	133.17	34.45	114.33	316.33
S_3N_3	149.11	37.27	121.34	309.46	$S_3N_3Zn_0$	133.97	36.27	115.70	259.68
S.Em±	6.750	1.732	5.655	15.054	$S_3N_3Zn_1$	164.26	38.26	126.99	357.92
CD at 5%	NS	NS	NS	NS	S.Em±	9.54	2.44	8.05	21.289
Interaction (SxZn)					CD at 5%	NS	NS	NS	NS
S_1Zn_0	107.30	29.38	97.51	223.29	S_1: 50 kg seeds ha^{-1}				
S_1Zn_1	120.48	31.79	105.50	296.54	S_2:75 kg seeds ha^{-1}				
S_2Zn_0	130.64	34.33	111.40	261.23	S_3:100 kg seeds ha^{-1}				
S_2Zn_1	152.61	37.18	121.91	346.76	N_1: 100 kg nitrogen ha^{-1}				
S_3Zn_0	116.53	31.92	104.37	237.46	N_2:125 kg nitrogen ha^{-1}				
S_3Zn_1	136.16	34.36	114.02	319.09	N_3: 150 kg nitrogen ha^{-1}				
S.Em±	5.511	1.414	4.618	12.291	Zn_0: 0 kg zinc ha^{-1}				
CD at 5%	NS	NS	NS	NS	Zn_1: 10 kg zinc ha^{-1}				

Nitrogen uptake by the crop: Among the seed rate, significantly higher nitrogen uptake was recorded at harvest stage with seed rate of 75 kg per ha (141.62 kg ha^{-1}) as compared to seed rate of 50 kg per ha (113.88 kg ha^{-1}) and it was on par with seed rate of 100 kg per ha (130.99 kg ha^{-1}).The higher nitrogen uptake at seed rate of 75 kg per ha was mainly due to reduced competition within the intra row spacing as compared to higher seed rate. The findings of Singh and Sumeriya (2005) [14] and Bhavya *et al*. (2016) [3] confirmed these results.

The nitrogen uptake increased significantly with increase in levels of nitrogen. Significantly higher nitrogen uptake was obtained with application of 150 kg nitrogen per ha (151.55 kg ha^{-1}) as compared to 100 kg nitrogen per ha (105.25 kg ha^{-1}) and 125 kg nitrogen per ha (125.04 kg ha^{-1}). It was mainly due to increased nitrogen application increases nitrogen uptake, in plant more availability of nitrogen and the higher dry matter production and green fodder yield and also due to favourable influence of phosphorus on higher degree of root proliferation, anchorage and deep penetration which in turns absorbs higher amount of nitrogen from the rhizosphereand supply to the crop. The results were in conformity with the findings of Prajwal kumar (2017) [9] and Somashekar *et al*. (2018) [15]. Zinc application at 10 kg per ha significantly increased the nitrogen uptake (136.41 kg ha^{-1}) by fodder maize over no zinc application (118.15 kg ha^{-1}). This could be attributed to synergistic effect between nitrogen and zinc. Similar results were also noticed by Patel *et al*., 2007 and Mehdi *et al*., 2012 [10]. The interaction of seed rate, nitrogen and zinc were found non-significant on nitrogen uptake.

Phosphorus uptake by the crop

Seed rate of 75 kg per ha was recorded significantly higher Phosphorus uptake (35.75 kg ha^{-1}) as compared to seed rate of 50 kg per ha (30.58 kg ha^{-1}) and was on par with seed rate of 100 kg per ha (33.13 kg ha^{-1}). It might be due to reduced competition within the intra row spacing and higher dry matter as compared to higher seed rate. The results are in confirmation with the findings of Abdulgani *et al*. (2018) [1].

Application of nitrogen 150 kg ha^{-1}recorded significantly higher phosphorus uptake (36.69 kg ha^{-1}) as compared to nitrogen 100 kg ha^{-1} (29.85 kg ha^{-1}). It was mainly due to the higher green fodder yield and dry matter production and also due to increasing root growth, increasing ability of roots to absorb and translocate phosphorus and by decreasing soil pH as a result of absorption of NH_4^+ and thus increase solubility of fertilizer phosphorus. The results were conformity with the findings of Manjanagouda *et al*. (2017) [9]. Zinc application at 10 kg per ha significantly increased the phosphorus uptake (34.44 kg ha^{-1}) by fodder maize over no zinc application (31.87 kg ha^{-1}). It was due to application of zinc led to higher dry matter yield.

Potassium uptake by the crop

Seed rate of 75 kg per ha recorded significantly higher potassium uptake (118.65 kg ha^{-1}) as compared to seed rate of 50 kg per ha (100.51 kg ha^{-1}) and was on par with seed rate of 100 kg per ha (110.19 kg ha^{-1}). It might be due to reduced competition within the intra row spacing and higher dry matter yield. The results are in confirmation with the findings of Abdulgani *et al*. (2018) [1].

Application of nitrogen 150 kg ha^{-1} recorded significantly higher potassium uptake (121 kg ha^{-1}) as compared to nitrogen 100 kg ha^{-1} (99.08 kg ha^{-1}). It was mainly due to the higher green fodder yield and dry matter production. The results were conformity with the findings of Manjanagouda *et al*. (2017) [9]. Zinc application at 10 kg ha^{-1} significantly increased the potassium uptake (114.30 kg ha^{-1}) by fodder maize over no zinc application (105.27 kg ha^{-1}). It was due to application of zinc leads to higher dry matter yield. The results are in line with the findings of Surendra mohan (2015) [16].

The interaction of seed rate, nitrogen and zinc were found non-significant on potassium uptake.

Zinc uptake by the crop

As regards the effect of seed rates, the results revealed that seed rates of 75 kg ha^{-1}significantly improved the zinc uptake (304 g ha^{-1}) by fodder maize over 50 kg seed rate per ha (254.91 g ha^{-1}) and it was on par with seed rate of 100 kg ha^{-1} (280.27 g ha^{-1}). These results could be attributed to higher dry matter production recorded at 75 and 100 kg seed rate per ha compared to 50 kg seed rate per ha.

Zinc uptake by fodder maize increased significantly with increase in nitrogen level upto 150 kg nitrogen per ha (309.40 g ha^{-1}) over 100 kg nitrogen per ha (253.83 g ha^{-1}). This could be due to higher dry fodder yield and higher zinc content recorded at higher nitrogen levels as nutrient uptake at harvest is the product of dry fodder yield and respective nutrient content. Singh and Singh (1998) also reported similar findings. Application of zinc at 10 kg ha^{-1} significantly increased zinc uptake (320.80 g ha^{-1}) by fodder maize over no zinc application (240.66 g ha^{-1}). This could be due to the fact that initial Zn status of soil was poor and the response of added zinc can be expected. Higher dry matter production recorded with zinc application led to higher zinc uptake by the plant and the results are in confirmation of findings of Ashoka *et al*. (2008).

The interaction of seed rate, nitrogen and zinc were found non-significant on zinc uptake.

References

1. Abdulgani Nabooji, Keshavaiah KV, Shirgapure KH, Shekara BG. Effect of seed rates and nitrogen levels on growth and fodder yield of sweet sorghum. J. Pharmacognosy Phytochemistry. 2018; 7(2):1391-1394.
2. Ashoka P, Mudalagiriyappa, Pujari BT, Hugar PS, Desai BK. Effect of micronutrients with or without organic manures on yield of baby corn (*Zea mays* L.) – Chickpea (*Cicer arietinum* L.) sequence. Karnataka J Agric. Sci. 2008; 21(4):485-487.
3. Bhavya V, Lalitha BS, Shekar BG, Somashekar KS. Effect of cluster bean genotypes (*Cyamopsis tetragonoloba* L.) with different seed rate on green fodder yield. National Academy Agric. Sci. 2016; 34(4):961-964.
4. Bhilare RL, Aher VR, Hiray AG, Gethe RM. Response of multi cut sorghum to nitrogen application. J. Maharashtra Agric. Univ. 2002; 27(3):339-340.
5. Doubetz A, Wells SA. Relationship of barley varieties to nitrogen fertilization. J Agric. Sci. Cabbridge. 1968; 70(1):253-256.
6. Eltelib HA, Hamad MA, Ali EE. The effect of nitrogen and phosphorus fertilization on growth, yield and quality of forage maize (*Zea mays* L.). Agron. J. 2006; 5(3):515-518.
7. Gomez KA, Gomez AK. Statistical procedure for Agricultural Research, 2nd Ed: John Wiley and Sons, New York, 1984, 105-114.
8. Mahadevan SA. Laboratory Manual for Nutrition Research, 1965, 56-58.
9. Manjanagouda S, Sannagoudar Lalitha BS, Prajwal Kumar GK, Prashant Bhavya V. Effect of varieties, cutting and nitrogen management on green fodder yield, nutrient uptake, available soil nutrient status and economics of dual Purpose Pearl Millet (*Pennisetum glaucum* L.). Int. J Curr. Microbiol. Appl. Sci. 2017; 6(12):214-226.
10. Mehdi SS, Husain B, Singh L. Influence of seed rate, nitrogen and zinc on fodder maize (*Zea mays*) in temperate conditions of western Himalayas. Indian J. Agron. 2012; 57(1):85-88.
11. Patel AS, Sadhu AC, Patel MR, Patel PC. Influence of nitrogen and zinc on maize (*Zea mays* L.). Forage Res. 2007; 34(4):209-212.
12. Prajwal Kumar Response of baby corn (*Zea mays* L.) for foliar application of macro and micro nutrients. M. Sc. (Agri.) Thesis, Univ. Agric. Sci., Bengaluru, 2017.
13. Sindhu VK, Tiwana US, Puri KP. Effect of Preceding crops on forage quality of maize and pearl millet under different nitrogen levels. Forage Res. 2006; 32(1):61-63.

14. Singh P, Sumeriya HK. Response of forage sorghum cultivars to different nitrogen levels under Udaipur conditions in Rajasthan, Forage Res. 2005; 31(1):51-54.
15. Somashekar KS, Shekara BG, Vidyashree DN, Lalitha B. S, Bhavya V. Effect of Different Seed Rates and Nitrogen Levels on Growth, Yield, Quality and Economics of Multi cut Fodder Sorghum (*Sorghum sudanense* L.). Int. J. Pure Appl. Bio. sci. 2018; 6(1):1108-1115.
16. Surendra Mohan, Magan Singh, Rakesh Kumar. Effect of nitrogen, phosphorus and zinc fertilization on yield and quality of kharif fodder -A review. Agric. Reviews. 2015; 36 (3):218-226.