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Effect of Different Levels of Seed Rate, Nitrogen and Zinc on Growth and Yield of Fodder Maize (*Zea mays* L.)

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A B S T R A C T

Field experiment on Effect of different levels of seed rate, nitrogen and zinc on yield and quality of fodder maize (*Zea mays* L.) was conducted at Zonal Agricultural Research Station, UAS, GKVK, Bengaluru during *kharif* 2017. 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 dry matter accumulation (104.32 g plant^{-1}) and green fodder yield of 34.29 t ha^{-1} when compared to seed rate of 50 kg ha^{-1} (98.60 g plant^{-1} and 29.58 t ha^{-1} of dry matter accumulation and green fodder yield respectively), and was on par with seed rate 100 kg ha^{-1} (102.75 g plant^{-1} and 32.50 t ha^{-1} of dry matter accumulation and green fodder yield respectively). Application of 150 kg nitrogen ha^{-1} resulted significantly higher dry matter accumulation of 107.87 g plant^{-1} and green fodder yield (34.56 t ha^{-1}) over nitrogen at 100 kg ha^{-1} and 125 nitrogen per ha. Application of 10 kg zinc ha^{-1} recorded significantly higher dry matter accumulation of 103.69 g plant^{-1} and green fodder yield (33.07 t ha^{-1}) over no zinc application (30.78 t ha^{-1}).

Introduction

Fodder maize being highly nutritious and more palatability fodder among the different fodder and forage crops. There are many constraints for low productivity of fodder maize and among then maintaining optimum plant population is the major problem being a non tillering requires optimum seed rate to get higher population and in turn for more productivity per unit area. After seed rate important management factor for higher yield is nutrient management and 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 yields limiting factor for cereal production (Shah *et al.,* 2003). Nitrogen plays the important role in vegetative growth and development of any crop and fodder and forages are harvested for

vegetative biomass and to put forth more vegetative growth nitrogen require in abundance. Zinc micro nutrient deficiency appears to be the most widespread in most Indian soils and zinc play an important role in 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. The information available on seed rate, nitrogen and zinc levels was very meagre and therefore field experiment on effect of different seed rate, nitrogen and zinc on growth and yield was undertaken.

Materials and Methods

Field experiment on Effect of different levels of seed rate, nitrogen and zinc on yield and quality of fodder maize (*Zea mays* L.) was taken during the *kharif* 2017. The material used and methods used during the course investigation are described in this chapter. The experiment was conducted at Zonal Agricultural Research Station (ZARS), Gandhi Krishi Vignana Kendra, University of Agricultural Sciences, Bengaluru which is situated at 13º 05' North latitude and 77º 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 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 65^{0}C till attaining constant weight, the green fodder yield was converted into dry matter yield (t/ha). Later data was Panse and Sukhatme (1967)

Treatment details

T_1: 50 kg seed rate + 100 kg nitrogen + 0 kg zinc

T_2: 50 kg seed rate + 100 kg nitrogen + 10 kg zinc

T_3: 50 kg seed rate + 125 kg nitrogen + 0 kg zinc

T_4: 50 kg seed rate + 125 kg nitrogen + 10 kg zinc

T_5: 50 kg seed rate + 150 kg nitrogen + 0 kg zinc

T_6: 50 kg seed rate + 150 kg nitrogen + 10 kg zinc

T_7: 75 kg seed rate + 100 kg nitrogen + 0 kg zinc

T_8:75 kg seed rate + 100 kg nitrogen + 10 kg zinc

T_9: 75 kg seed rate + 125 kg nitrogen + 0 kg zinc

T_{10}: 75 kg seed rate + 125 kg nitrogen + 10 kg zinc

T_{11}: 75 kg seed rate + 150 kg nitrogen + 0 kg zinc

T_{12}:75 kg seed rate + 150 kg nitrogen + 10 kg zinc

T_{13}: 100 kg seed rate + 100 kg nitrogen + 0 kg zinc

T_{14}: 100 kg seed rate + 100 kg nitrogen + 10 kg zinc

T_{15}: 100 kg seed rate + 125 kg nitrogen + 0 kg zinc

T_{16}: 100 kg seed rate + 125 kg nitrogen + 10 kg zinc

T_{17}: 100 kg seed rate + 150 kg nitrogen + 0 kg zinc

T_{18}: 100 kg seed rate + 150 kg nitrogen + 10 kg zinc

Observations on growth parameters

The various growth parameters such as plant height, number of leaves plant^{-1}, leaf: stem ratio and dry matter accumulation

Plant height

The plant height (cm) was recorded from five randomly selected and labelled plants.

Plant height was taken from the base of the plant to tip of the newly opened leaf.

The mean plant height was worked out and expressed in centimeter.

Number of leaves

Total number of fully opened green leaves of five plants was counted and their average was taken as the number of leaves plant^{-1}.

Leaf: stem ratio

Leaf: stem ratio was calculated from five randomly selected plants from each plot. The leaves were separated from the stem and fresh weight of both leaves and stem were noted separately and leaf: stem ratio is calculated by dividing the leaves weight by stem weight and expressed in ratio.

$$\text{Leaf: stem} = \frac{\text{Weight of leaves}}{\text{Weight of stem}}$$

Dry matter accumulation

At each sampling after recording the observations, the plants were uprooted and oven dried at 65°C to a constant weight. The mean of five plants in each treatment was calculated and expressed in g per plant.

Observation on yield parameter

Green fodder yield

Green fodder yield from each net plot (kg plot^{-1}) was recorded after harvest of the crop and converted into tonnes per hectare.

Statistical analysis and interpretation of data

The experimental data collected on growth, yield and quality components of plant were subjected to Fisher's method of "Analysis of Variance" (ANOVA) as outlined by Panse and Sukhatme (1967). Wherever, F- test was significant, for comparison among the treatment means, an appropriate value of

critical difference (C.D.) was worked out. If F-test found non-significant, against C.D. values NS (Non-Significant) was indicated. All the data were analyzed and the results were presented and discussed at a probability level of five per cent.

Results and Discussion

Plant height

Significantly higher plant height was recorded with seed rate of 75 kg per ha (179.49 cm) as compared to seed rate of 50 kg per ha (160.16 cm) and it was on par with seed rate of 100 kg per ha (170.48 cm). Significantly higher plant height 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 of 100 kg per ha. The findings are in conformation of the results of Abdulgani *et al.,* (2018).

Plant height differed significantly due to the nitrogen levels and higher plant height of 181.89 cm was obtained with the application of 150 kg nitrogen per ha compared to 100 kg nitrogen per ha. The positive effect of nitrogen on the plant vegetative that led to progressive increase in the internode length.

These results collaborate with the finding of Eltelib *et al.,* (2006), Mehdi *et al.,* (2012). Zinc at 10 kg per ha has significantly increased the plant height of fodder maize (175.69 cm) as compared to no zinc application. Since zinc helps in the biosynthesis of Indole 3-acetic acid, a growth hormone, enhances stem elongation, hence the increase in the plant height. Earlier Patel *et al.,* (2007) and also described a significantly increase in the plant height of fodder maize with soil application of zinc over its foliar application and control. The interactions between seed rate, nitrogen and zinc levels found not significant (Table 1).

Number of leaves

Different levels of seed rate did not cause any significant influence on the number of leaves plant^{-1}. Significant increase was observed in number of leaves per plant with increase in the nitrogen at 150 kg per ha (13.19) as compared to application of 100 kg nitrogen per ha (11.00). An increase in number of green leaves might be due to the availability of sufficient amount of nitrogen in all the growth stages. Increased plant height resulted in more number of nodes per plant which accommodated more number of leaves per plant. Again nitrogen helped in rapid growth and development of plants as they help in photosynthesis and various plant biochemical processes which responds towards growt. Zinc application at 10 kg per ha significantly increased the number of leaves plant^{-1} of the fodder maize (12.55) over no zinc application (11.80). It was due to synergistic effect of both nitrogen and zinc on growth and development of plants. The results are in confirmation with the findings of Surendra Mohan (2015). All the interactions were found non-significant.

Leaf: stem ratio

Significantly higher leaf: stem ratio was recorded with seed rate of 75 kg per ha (0.56) as compared to seed rate of 50 kg per ha (0.50) and it was on par with seed rate of 100 kg per ha (0.55). The higher leaf: stem ratio with the seed rate of 75 kg per ha was due to increased leaf size and decreased stem girth. In higher seed rate because of more population per unit area led to grassy shoot appearance. At lower seed rate, more space is available for crop growth and development resulted in more stem girth which led to lower leaf: stem ratio similar results were reported by Verma (2005) and Bishnol *et al.,* (2005). Fodder maize at 150 kg nitrogen per ha recorded significantly higher leaf: stem ratio (0.60) as compared to 100 kg nitrogen per ha (0.48).

Table.1 Plant height, number of leaves and leaf: stem ratio of fodder maize at harvest as influenced by different levels of seed rate nitrogen and zinc

Treatments	Plant height (cm)	Number of leaves plant^{-1}	Leaf: stem ratio	Treatments	Plant height (cm)	Number of leaves plant^{-1}	Leaf: stem ratio
Seed rates (S)				Interaction (N x Zn)			
S_1	160.16	12.15	0.49	N_1Zn_0	158.33	11.15	0.46
S_2	179.49	12.28	0.56	N_1Zn_1	163.31	12.09	0.48
S_3	170.48	12.20	0.55	N_2Zn_0	167.00	11.53	0.52
S.Em$\pm$	3.49	0.27	0.01	N_2Zn_1	176.55	12.17	0.54
CD 5%	10.04	NS	0.03	N_3Zn_0	176.55	13.00	0.57
Nitrogen level (N)				N_3Zn_0	187.22	13.39	0.62
N_1	160.82	11.00	0.47	S. Em$\pm$	4.94	0.38	0.02
N_2	171.77	11.85	0.53	CD at 5%	NS	NS	NS
N_3	181.89	13.19	0.60	Interaction (S x N x Zn)			
S.Em$\pm$	3.49	0.27	0.01	$S_1N_1Zn_0$	153.33	11.00	0.46
CD at 5%	10.04	0.78	0.03	$S_1N_1Zn_1$	157.00	11.33	0.47
Zinc level (Zn)				$S_1N_2Zn_0$	158.67	12.00	0.49
Zn_0	167.29	11.80	0.50	$S_1N_2Zn_1$	166.00	12.33	0.50
Zn_1	175.69	12.55	0.55	$S_1N_3Zn_0$	169.33	13.00	0.52
S.Em$\pm$	2.85	0.22	0.01	$S_1N_3Zn_1$	180.67	13.33	0.55
CD at 5%	8.19	0.63	0.02	$S_2N_1Zn_0$	166.33	11.27	0.47
Interaction (S x N)				$S_2N_1Zn_1$	171.27	11.60	0.49
S_1N_1	150.16	11.17	0.46	$S_2N_2Zn_0$	177.33	12.00	0.56
S_1N_2	160.33	12.17	0.49	$S_2N_2Zn_1$	182.67	12.33	0.58
S_1N_3	170.00	13.17	0.53	$S_2N_3Zn_0$	187.00	13.00	0.61
S_2N_1	168.80	11.43	0.47	$S_2N_3Zn_1$	192.33	13.50	0.68
S_2N_2	180.00	12.17	0.56	$S_3N_1Zn_0$	155.33	11.19	0.48
S_2N_3	189.66	13.25	0.64	$S_3N_1Zn_1$	161.67	13.33	0.50
S_3N_1	158.50	12.26	0.48	$S_3N_2Zn_0$	165.00	10.60	0.53
S_3N_2	173.00	11.22	0.54	$S_3N_2Zn_1$	181.00	11.83	0.56
S_3N_3	181.00	13.17	0.62	$S_3N_3Zn_0$	182.50	13.00	0.59
S.Em$\pm$	6.05	0.47	0.02	$S_3N_3Zn_1$	188.67	13.33	0.65
CD 5%	NS	NS	NS	S. Em$\pm$	8.55	0.66	0.03
Interaction (S x Zn)				CD at 5%	NS	NS	NS
S_1Zn_0	160.44	12.00	0.49	S_1: 50 kg seeds ha^{-1}			
S_1Zn_1	167.88	12.33	0.50	S_2:75 kg seeds ha^{-1}			
S_2Zn_0	176.88	12.09	0.54	S_3:100 kg seeds ha^{-1}			
S_2Zn_1	182.08	12.48	0.58				
S_3Zn_0	182.08	11.60	0.53	N_1: 100 kg nitrogen ha^{-1}			
S_3Zn_1	177.11	12.83	0.56	N_2:125 kg nitrogen ha^{-1}			
S.Em$\pm$	4.94	0.38	0.02	N_3: 150 kg nitrogen ha^{-1}			
CD at 5%	NS	NS	NS	Zn_0: 0 kg zinc ha^{-1}			
				Zn_1: 10 kg zinc kg ha^{-1}			

Table.2 Dry matter accumulation and green fodder yield of fodder maize at harvest as influenced by different levels of seed rate nitrogen and zinc

Treatments	DMA (g plant^{-1})	GFY (t ha^{-1})	Treatments	DMA (g plant^{-1})	GFY (t ha^{-1})
Seed rates (S)			Interaction (N x Zn)		
S_1	98.60	29.58	N_1Zn_0	96.11	28.45
S_2	104.32	34.29	N_1Zn_1	97.53	30.09
S_3	102.75	32.50	N_2Zn_0	100.77	30.81
S.Em+	1.11	0.91	N_2Zn_1	103.14	33.10
CD 5%	3.21	2.63	N_3Zn_0	105.13	33.10
Nitrogen level (N)			N_3Zn_0	110.40	36.03
N_1	96.83	29.14	S. Em+	1.58	1.297
N_2	101.96	31.85	CD at 5%	NS	NS
N_3	107.87	34.56	Interaction (S x N x Zn)		
S.Em+	1.11	0.91	$S_1N_1Zn_0$	95.00	26.96
CD at 5%	3.21	2.63	$S_1N_1Zn_1$	96.46	28.63
Zinc level (Zn)			$S_1N_2Zn_0$	98.60	29.02
Zn_0	100.67	30.78	$S_1N_2Zn_1$	99.90	30.77
Zn_1	103.69	33.07	$S_1N_3Zn_0$	102.31	31.38
S.Em+	0.91	0.74	$S_1N_3Zn_1$	105.30	33.15
CD at 5%	2.62	2.15	$S_2N_1Zn_0$	96.83	30.89
Interaction (S x N)			$S_2N_1Zn_1$	98.72	32.19
S_1N_1	95.73	27.80	$S_2N_2Zn_0$	102.21	33.20
S_1N_2	99.25	29.89	$S_2N_2Zn_1$	105.25	35.09
S_1N_3	103.80	32.26	$S_2N_3Zn_0$	107.08	35.86
S_2N_1	97.77	31.54	$S_2N_3Zn_1$	115.81	38.57
S_2N_2	103.73	34.14	$S_3N_1Zn_0$	96.52	27.52
S_2N_3	110.53	37.22	$S_3N_1Zn_1$	97.43	29.46
S_3N_1	96.82	28.49	$S_3N_2Zn_0$	101.52	30.20
S_3N_2	101.96	31.82	$S_3N_2Zn_1$	104.28	33.43
S_3N_3	107.77	34.22	$S_3N_3Zn_0$	106.62	34.08
S.Em+	1.93	1.588	$S_3N_3Zn_1$	110.11	36.36
CD 5%	NS	NS	S. Em±	2.73	2.24
Interaction (S x Zn)			CD at 5%	NS	NS
S_1Zn_0	98.63	29.12	S_1: 50 kg seeds ha^{-1}		
S_1Zn_1	100.55	30.85	S_2:75 kg seeds ha^{-1}		
S_2Zn_0	101.43	33.31	S_3:100 kg seeds ha^{-1}		
S_2Zn_1	106.59	35.28			
S_3Zn_0	101.96	29.93	N_1: 100 kg nitrogen ha^{-1}		
S_3Zn_1	103.94	33.08	N_2:125 kg nitrogen ha^{-1}		
S.Em+	1.58	1.297	N_3: 150 kg nitrogen ha^{-1}		
CD at 5%	NS	NS			
			Zn_0: 0 kg zinc ha^{-1}		
			Zn_1: 10 kg zinc kg ha^{-1}		

It was mainly due to rapid expansion of dark green foliage which could intercept and utilize the incident solar radiation in the production of photosynthates and finally resulting in higher meristematic activity and increased leaf stem ratio of fodder maize.

These results are conformity with the findings of Manjangouda *et al.,* (2017) and Somashekar (2018). Application of zinc at 10 kg per ha caused discernible increase in leaf: stem ratio (0.55) over no zinc application (0.50). As zinc is involved in auxin synthesis

which in turn induces cell division and as such higher cell division with zinc application would lead to increase in leaf: stem ratio. Increase in leaf stem ratio with zinc application has also been reported by Patel *et al.,* (2007).

The interaction between seed rate, nitrogen and zinc levels on leaf to stem ratio was found to be non-significant.

Dry matter accumulation

Among the different seed rates 75 kg per ha recorded significantly higher dry matter accumulation (104.32 g plant^{-1}) as compared to 50 kg seed rate per ha (98.60 g plant^{-1}) and it was on par with 100 kg ha^{-1} seed rate (102.75 g plant^{-1}). The higher dry matter accumulation in seed rate of 75 kg per ha was mainly due to higher plant height, leaf-stem ratio. Apart from this the over burden of the plant population which might compete for light and nutrients which leads to lanky growth and grassy shoot appearance resulted in lower dry matter accumulation in seed rate of 100 kg ha^{-1}. The results are in line with the findings of (Pathan *et al.,* 2007; Somashekar *et al.,* 2018) (Table 2).

The dry matter accumulation was significantly higher with application of nitrogen 150 kg per ha (107.87 g plant^{-1}) over 100 kg nitrogen per ha (96.83 g plant^{-1}). This may be attributed to nitrogen is an essential constituent of plant tissue and is involved in cell division and cell elongation, its beneficial effect on the growth characters *viz*., plant height and stem diameter. Earlier Eltelib *et al.,* (2006) and Manjanagouda *et al.,* (2017) also reported similar findings. Significant increase in dry matter accumulation of fodder maize (103.69 g plant^{-1}) with the application of 10 kg zinc per ha over no zinc application (100.67 g plant^{-1}). It might be due to zinc act as catalyst in various growth processes and in

hormone production as well as in protein synthesis, which have increased the dry matter accumulation. Similar observations were observed by (Surendra mohan, 2015) and (Mehdi *et al.,* 2012).

The interaction between seed rate, nitrogen and zinc levels on dry matter accumulation was found to be non-significant.

Green fodder yield

Significantly higher green fodder yield was recorded with seed rate of 75 kg per ha (34.29 t ha^{-1}) as compared to seed rate of 50 kg per ha (29.58 t ha^{-1}) and it was on par with seed rate of 100 kg ha^{-1} (32.50 t ha^{-1}). The higher green fodder yield in seed rate of 75 kg per ha was mainly due to higher plant height and leaf to stem ratio. Apart from this the over burden of the plant population which might compete for light and nutrients which leads to lanky growth and grassy shoot appearance resulted in lower green fodder yield in seed rate of 100 kg ha^{-1}. These results are in conformity with the findings of Pathan *et al.,* (2007), Somashekar *et al.,* (2018) and Patel *et al.,* 1990).

Among the nitrogen levels significantly higher green fodder yield was recorded with application of 150 kg nitrogen per ha (34.56 t ha^{-1}) compared to 100 kg nitrogen per ha (29.14 t ha^{-1}) and 125 kg N per ha (31.85 t ha^{-1}). This may be mainly attributed to improved growth and yield parameters, *viz*., plant height, leaf: stem ratio and the beneficial effects of nitrogen on cell division and elongation, formation of nucleotides and coenzymes which resulted in increased meristematic activity and photosynthetic area and hence more production and accumulation of photosynthates, yielding higher green fodder. The results are in agreement with the findings of Ayub *et al.,* (2002), Joshi and Kuldeep Kumar (2007).

Application of zinc at 10 kg per ha significantly improved the green fodder yield (33.07 t ha^{-1}) of maize over no zinc application (30.78 t ha^{-1}). This increase in fodder yield due to zinc application might be the role of zinc in various enzymatic reactions. Zinc act as catalyst in various growth processes and in hormone production as well as in protein synthesis, which have increased the entire yield attributing parameters *viz.*, shoot length, number of leaves, dry matter production etc. thereby final yield (Patel *et al.,* 2007 and Parik *et al.,* 1993).

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