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Influence of Sowing Time and Integrated Nitrogen Management on Growth and Yield of Local Glutinous Maize (*Zea mays* L.)

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A B S T R A C T

A field experiment was conducted during the pre-*kharif* season of 2018 at experimental field of College of Agriculture, Central Agricultural University, Imphal, Manipur to study the influence of sowing time and integrated nitrogen management on growth and yield of local glutinous maize (*Zea mays* L.). The experiment was laid out in factorial randomized block design (FRBD) with 12 treatments and 3 replications. The treatment consisted of four different integrated nitrogen management practices and three sowing dates. The result revealed that maximum plant height, plant fresh weight, number of leaves and LAI were recorded with the application of RDN- 75% through urea + 25% through FYM (N_3) for the crop sown on 9th April (S_3). Similarly maximum number of cobs per plant, number of grain rows per cob, cob length, number of grains per cob and test weight of maize was observed in the treatment N_3S_3. The maximum grain and stover yield were obtained with the application of RDN- 75% through urea + 25% through FYM and the crop sown on 9th April. It can be concluded that the local glutinous maize (*Zea mays* L.) responded well to the integrated nitrogen management for the crop sown on 9th April (N_3S_3) as expressed in growth and yield.

Introduction

Maize (*Zea mays* L.) is one of the most important cereal crops in the world's agricultural economy both as food for man and feed for animals. Maize has been an important cereal crop owing to its highest production potential and adaptability to wide range of environment hence called as 'Queen of Cereals' (Choudhari and Channappagouda, 2015). It can be grown in *kharif*, *rabi* and summer seasons. Over 85 per cent of maize production in country is consumed as a source of human feed. Maize is grown in almost all the states of India and it occupy an area of about 9.86 million hectares with a production of 26.26 million tonnes and productivity of 2664 kg/ha (Anon., 2017). In Manipur, it covers an area of 26.19 thousand hectares with a production of 57.94 MT and productivity of 2240 kg/ha (Anon., 2016-17).

Local glutinous maize is popular and commonly grown cultivar in Manipur. It has unique characteristic of soft and stickiness of kernel even though it is dried and stored for long time unlike the normal maize. The local glutinous maize also fetches higher price in the local market as compared to the normal high yielding and hybrid maize. Among the agro-techniques non-monetary inputs like sowing time and nutrient are the two management aspects to be considered for improving the yield of maize.

Sowing at the right time will expose the maize crop to suitable weather elements required at different phenological stages resulting in better vegetative growth and yield. There are several factors like climate, nutrient availability and agronomic management practices including sowing time which affects the productivity of maize. In order for crops to best utilize moisture, nutrients and solar radiation, sowing must be done at optimum time.

Maize is a heavy feeder and remove large amount of nutrients from soil hence there is a need for proper and efficient nutrient management to harness the maximum yield potential of the crop. Continuous use of only chemical fertilizers in intensive cropping system will lead to imbalance of nutrients in soil, which has an adverse effect on soil health and also on crop yield. Again the use of organic manure (FYM) alone does not result in spectacular increase in crop yield, due to their low nutrient status.

In view to the declining productivity levels, increasingly greater emphasis is now being given to the integrated nitrogen supply system, which may play an important role in sustaining soil conditions. Thus highest productivity of crops in sustainable manner without deteriorating the soil and other natural resources could be achieved only by applying appropriate combination of different organic manures and inorganic fertilizers.

Materials and Methods

The field experiment was undertaken during the pre-*kharif* season of 2018 at College of Agriculture, CAU, Imphal, Manipur to study the influence of sowing time and integrated nitrogen management on growth and yield of local glutinous maize (*Zea mays* L.).

The experiment was laid out in factorial randomized block design (FRBD) with 12 treatments and 3 replications. The treatment consisted of four different integrated nitrogen management treatments and three sowing dates. FYM was applied 20 days before sowing as per treatment and well incorporated to the soil. Required quantities of nitrogen in the form of urea (46% N) and uniform dose of 30 kg P_2O_5/ha in the form of single superphosphate (16% P_2O_5) and 20 kg K_2O/ha in the form of muriate of potash (60% K_2O) were applied one day before sowing of crop to the respective plots a basal dose and the remaining dose of nitrogen was top dressed in two equal splits at knee high stage and tasseling stage. Measurements on growth attributing parameters were recorded at 25 days interval from sowing till harvest.

Treatment details

Sowing time: 3

S_1 – 1st March
S_2 – 20th March
S_3 – 9th April

Nitrogen management: 4

N_1 – RDN (100 % through urea)

N_2 – RDN (50 % through urea + 50 % through FYM)

N_3 – RDN (75 % through urea + 25% through FYM)

N_4 – RDN (100 % through FYM)

Results and Discussion

Effect of sowing time and integrated nitrogen management on growth of local glutinous maize

The growth of local glutinous maize was significantly influenced by different nitrogen management practices and sowing time and presented in Table 1. The maximum plant height was recorded in nitrogen management N_3. This finding is also supported by Rasool *et al.,* (2015) and Singh *et al.,* (2018). The beneficial effect of incorporation of FYM and nitrogen on plant height of maize was also reported by Oad *et al.,* (2004), Karki *et al.,* (2005) and Tetarwal *et al.,* (2011). Among the different integrated nitrogen management, the highest plant dry weight was observed in treatment N3 which remained at par to N_2 at 25 DAS but significantly superior at 50, 75, 100 DAS and at harvest. Integrated nitrogen management facilitated better nutrient and soil moisture absorption by plants and it enhanced the photosynthesis and translocation of the metabolites to different plant parts.

The findings are in agreement with those of Sepat and Kumar (2007), Jadhav (2010), Rasool *et al.,* (2015), and Singh *et al.,* (2018) in maize. It is found that the maximum dry matter accumulation per plant was the positive effect of growth characters. Application of integrated nitrogen enhanced significantly the leaf area index of the plant over application of either fertilizer or organic manures alone. At 25 and 50 DAS, the significantly higher LAI was observed in treatment N_3 which remained at par to treatment N_2. In the succeeding three stages, maximum LAI was recorded in N_3 and it showed significant superiority over the other treatments. Similar finding was also reported by Sepat and Kumar (2007), Jadhav (2010) and Rasool *et al.,* (2015).

Different sowing time significantly influencethe growth of local glutinous maize. Significantly highest plant height was observed in 9th April (S_3) sowing which remained at par to 20th March (S_2) sown plants. It enhanced the plant height with respective sowing date due to optimum sowing time and favourable climatic conditions. The variation in plant height with different sowing time was also reported by Verma (2013) and Sulochana *et al.,* (2015) in maize. The maximum plant dry weight was obtained in 9th April (S_3) sowing which remained at par to 20th March (S_2) sown plants. Variation in dry weight of plant among different sowing time was supported by Law-Ogbomo and Remison (2009), Sulochana *et al.,* (2015) and Keerthi and Reddy (2017). Highest LAI was observed in 9th April (S_3) sowing which remained at par to 20th March (S_2) sowing but significantly higher to 1st March (S_1) sowing. It enhanced the leaf area index resulting in more photosynthesis, which improved the growth, development and dry matter production per plant with respective date of sowing due to optimum sowing time, favourable climatic conditions especially temperature and suitable growth period. Such variation in leaf area index among different sowing time was supported by Law-Ogbomo and Remison (2009) and Sulochana *et al.,* (2015).

The interaction between sowing time and integrated nitrogen management could not give significant effect on growth parameters.

Effect of sowing time and integrated nitrogen management on yield contributing factors of local glutinous maize

Integration of inorganic fertilizer and FYM influenced the total number of cobs per plant, number of grain rows per cob, length of cob, number of grain rows per cob and test weight and are presented in Table 2.

Table.1 Effect of sowing time and integrated nitrogen management on growth of local glutinous maize

Treatment	Plant height (cm)					Dry matter production (g/plant)					LAI				
	25 DAS	50 DAS	75 DAS	100 DAS	HARVEST	25 DAS	50 DAS	75 DAS	100 DAS	HARVEST	25 DAS	50 DAS	75 DAS	100 DAS	HARVEST
S: Sowing time															
S_1	12.75	34.86	135.85	188.77	231.75	0.13	11.18	20.10	53.48	96.55	0.34	1.27	1.57	1.95	1.10
S_2	14.19	48.87	141.12	193.73	235.06	0.18	11.74	22.01	58.51	100.33	0.45	1.64	1.91	2.60	1.27
S_3	16.57	60.93	144.39	197.67	236.67	0.21	12.34	22.65	60.44	102.04	0.57	2.22	2.24	2.70	1.32
SE d (±)	**0.63**	**1.83**	**1.75**	**2.08**	**1.36**	**0.011**	**0.25**	**0.77**	**1.16**	**0.84**	**0.02**	**0.08**	**0.07**	**0.05**	**0.03**
CD (P=0.05)	**1.31**	**3.80**	**3.64**	**4.32**	**2.81**	**0.02**	**0.51**	**1.61**	**2.40**	**1.74**	**0.04**	**0.17**	**0.16**	**0.11**	**0.07**
N management															
N_1	13.91	46.35	136.07	189.38	233.16	0.16	11.30	20.56	55.82	95.69	0.44	1.61	1.79	2.34	1.23
N_2	15.02	50.12	147.22	197.80	236.85	0.18	12.18	22.68	61.18	105.89	0.47	1.77	1.99	2.54	1.32
N_3	15.95	53.34	151.91	204.45	241.45	0.20	13.07	24.72	66.06	108.97	0.50	1.89	2.25	2.75	1.44
N_4	13.14	43.07	126.62	181.92	226.51	0.15	10.47	18.39	46.84	87.46	0.41	1.57	1.59	2.04	0.93
SE d (±)	**0.73**	**2.11**	**2.03**	**2.40**	**1.57**	**0.01**	**0.28**	**0.89**	**1.34**	**0.97**	**0.02**	**0.09**	**0.09**	**0.06**	**0.04**
CD (P=0.05)	**1.51**	**4.38**	**4.20**	**4.99**	**3.25**	**0.02**	**0.59**	**1.85**	**2.77**	**2.01**	**0.05**	**0.19**	**0.18**	**0.12**	**0.08**

Table.2 Effect of sowing time and integrated nitrogen management on yield contributing factors of local glutinous maize

Treatment	No. of cobs/plant	No. of grain row/cob	Cob length (cm)	No. of grains/cob	Test weight (g)
S: Sowing time					
S_1	1.20	14.17	14.6	272.58	247.08
S_2	1.30	15.04	15.2	289.00	250.17
S_3	1.35	15.44	15.5	292.75	253.08
SE d (±)	0.06	0.32	0.23	2.86	2.31
CD (P=0.05)	NS	0.66	0.48	5.93	NS
N management					
N_1	1.27	14.41	14.75	262.56	248.00
N_2	1.33	15.37	15.91	312.33	253.89
N_3	1.38	16.25	16.97	337.89	257.00
N_4	1.16	13.51	12.76	226.33	241.56
SE d (±)	0.07	0.37	0.27	3.30	2.67
CD (P=0.05)	0.15	0.76	0.56	6.84	5.53

Table.3 Effect of sowing time and integrated nitrogen management on grain yield, stover yield and harvest index of local glutinous maize

Treatment	Grain yield (q/ha)	Stover yield (q/ha)	Harvest index (%)
S: Sowing time			
S_1	25.65	52.12	32.85
S_2	27.49	55.40	32.98
S_3	28.23	57.49	32.75
SE d (±)	0.38	1.25	0.41
CD (P=0.05)	0.78	2.58	NS
N management			
N_1	24.67	51.81	32.29
N_2	30.15	58.74	33.92
N_3	32.90	62.53	34.49
N_4	20.78	46.92	30.73
SE d (±)	0.44	1.44	0.47
CD (P=0.05)	0.91	2.98	0.98

The highest number of cobs per plant (1.38) was recorded with treatment N_3 which remained at par to treatment N_2. The increase in number of cobs might be due to adequate supply of nitrogen and uptake by the plants. Similar finding was also reported by Mehta *et al.*, (2005) and Jadhav (2010). The mean number of grain rows per cob (16.25) was maximum due to application of RDN- 75% through urea + 25% through FYM (N_3) and showed its significant superiority over the rest of the treatments. The findings are in agreement with those of Mehta *et al.*, (2005), Rajeshwari *et al.*, (2007) and Jadhav (2010). The mean cob length was maximum (16.97 cm) and significantly more when crop was fertilized with RDN- 75% through urea + 25% through FYM (N_3). The results are in accordance with the earlier finding of Kumar and Puri (2001) and Rajeshwari *et al.*, (2007). The number of grains per cob (337.89) was significantly higher in treatment N_3compared to other treatments. The increase in yield attributes might have been owing to better utilization of resources under improved N supply, as it is an integral part of proteins the building blocks of plant (Singh *et al.*, 2000). These findings are also supported by Rajeshwari *et al.*, (2007) and Jadhav (2010). The maximum test weight (257) was recorded with the application of RDN- 75% through urea + 25% through FYM (N_3) which remained at par toN_2. The results are in accordance with the earlier findings of Balai (2007) and Jadhav (2010).

Though the highest number of cobs per plant (1.35) was observed at 9th April sowing (S_3) however the differences with 20th March (S_2) and 1st March sowing (S_1) was found to be not significant. The variation among different sowing time was also reported by Awasthi (2009). The highest number of grain rows per cob (15.44) was recorded at 9th April sowing (S_3) and it remained at par to sowing at 20th March (S_2). The highest mean cob length (15.5 cm) was recorded at 9th April sowing (S_3) and it remained at par to 20thMarch sowing (S_2). The number of grains per cob (292.75) was significantly higher in 9th April sowing (S_3) however the number of grains per cob did not differ significantly between S_3 and S_2. This could be due to the better growth and development of 9th April (S_3) sown crop. Such variation among different sowing time was also reported by Awasthi (2009) and Keerthi *et al.*, (2017)

The interaction between sowing time and integrated nitrogen management could not bring significant effect on yield attributes.

Effect of sowing time and integrated nitrogen management on grain yield, stover yield and harvest index of local glutinous maize

Integrated nitrogen management and different sowing time significantly influenced the grain and stover yield and are presented in Table 3. The highest grain yield (32.9 q/ha) and stover yield (62.53 q/ha) was recorded in treatment N_3 where RDN- 75% through urea+ 25% through FYM was applied. Owing to higher values of growth and yield attributes, the maximum grain yield was obtained in treatment N_3. The improved physical properties like water holding capacity and moisture retention provided a desirable soil condition for the root development, enhanced crop growth and yield (Selvi *et al.,* 2005). Similar findings were also reported by Rajeshwari *et al.*, (2007) and Jadhav (2010). The harvest index was significantly higher in treatmentN_3which remained at par to treatment N_2. The significantly higher harvest index under treatment N_3 was due to relatively greater seed yield than the remaining treatment. Similar results had also been reported by Kumar and Puri (2001) and Singh *et al.*, (2018).

Among the sowing dates, it could be seen from Table 3 that though sowing at 9th April (S_3) recorded the maximum grain yield (28.23 q/ha) and stover yield (57.49 q/ha) however it remained at par to sowing on 20th March (S_2) but was significantly superior over sowing at 1st March (S_1). The variation in among different sowing time was also supported by Taipodia and Shukla (2013), Verma (2013) and Sulochana *et al.,* (2015). The harvest index did not differ significantly among the different sowing dates.

The interaction between sowing time and integrated nitrogen management could not bring significant effect on yield.

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