Section A-Research paper

Interactive effect of different spacing and nitrogen levels on maize (*Zea mays*. L) growth and yield attributes

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Abstract

Field experiments were conducted at eastern block farm, Tamil Nadu Agricultural University, Coimbatore during *kharif* 2022 and *rabi* 2022-2023 seasons to find out the effect of different nitrogen levels and spacing on the growth and yield attributes of maize. The field trials were laid out in split plot design with three replications. Main plots different nitrogen levels *viz*., N_1, N_2, N_3 and different spacing *viz*., S_1, S_2 were taken as subplot. The results revealed that different nitrogen levels and spacing had significant influence on growth and yield attributes of maize. Higher values of plant height were recorded with S_1- 45×25 with N_3-125% RDN during the kharif and rabi season. Yield parameters *viz*., cob length, cob girth, cob weight, number of grains per cob, and 100 grain weight were higher under S_2-60×25 with N_3- 125% RDN when compared to other treatments.

Keywords*: Maize, nitrogen, plant height, spacing, yield attributes.*

Introduction

Maize (*Zea mays* L.) is one of the world's most important cereal crops, helping to ensure food security in the majority of developing countries. Maize is one of the most adaptive developing crops, with greater adaptation under a wide range of agro-climatic conditions and successful production in a wide range of seasons and ecologies for a wide range of applications. (Agricultural statistics at a glance, 2014). Plant population and fertilizer management usually effect on crop environment, which influence crop growth and yield. Less plant population and poor nutrient management practices are the major yield reducing factors in maize (Dawadi and Sah, 2012). Nitrogen fertilizer is universally accepted as a key component to high yield and optimum economic return as it plays very important part in crop productivity and its deficiency is one of the major yields limiting factors for cereal production. Balanced and optimum use of nitrogen plays a pivotal role in increasing

the yield of maize. Nitrogen increases biomass production of a crop which largely depends on the function of leaf area development and consequential photosynthetic activity (Sanjeev and Bangarwa, 1997).

Plant spacing is another important factor which plays a significant role on growth, development and yield of maize. Optimum plant population provides scope to the plants for efficient utilization of solar radiation and nutrients (Sivamurugan *et al*.,2017) Sunlight can penetrate more easily and can reach the soil surface which may cause excessive evaporation of soil moisture. Closer spacing hampers intercultural operations and as such more competition arises among the plant for nutrients, air and light. As results, plant becomes shorter, weaker, thinner and consequently reduces yield of maize (Barbieri *et al*., 2013). The objective of the study is to examine the effects of planting density and different Nitrogen fertilizer levels on maize growth and yields attributes through field experiments.

Materials and methods

Experimental site

The field study was conducted at two cropping seasons from *Kharif* 2022 and *Rabi* 2022 - 2023 at the Eastern block Farm, Department of Agronomy, Tamil Nadu Agricultural University, Coimbatore. The experimental site is located between 11°83' N latitude and 76°71' E longitude at an elevation of 426.7 m above the mean sea level.

The climate of the region is semiarid tropical and mean annual rainfall of 674.2 mm were received in 47 rainy days. The maximum and minimum annual mean temperature are 31.5^{o}C and 21^{o}C, respectively. The mean relative humidity ranges from 49.1 per cent (14:22 hours) to 84.9 per cent (07:22 hours). The mean bright sunshine hour is 7.3 hours per day with a mean solar radiation of 429.2 cal/cm^{2}/day.

The soil of experiment site was sandy clay loam texture with a pH value of 7.7, EC (dS m^{-1}) 0.17, Organic carbon (g kg^{-1}) 3.7, Available N (kg ha^{-1}) 137, Available P_2O_5 (kg ha^{-1}) 8, Available K_2O (kg ha^{-1}) 152, Bulk density (Mg cm^{-3}) 1.23, Particle density (Mg cm^{-3}) 2.54, Porosity (%) 51.6 in the top 30 cm soil layer.

Experimental design

The experimental plot size was 5 m × 5 m (25m^{2}) using maize hybrid COH (M) 8. Moreover, this experiment was laid out in split plot design with three replications. The main plot consists of different Nitrogen levels *viz*., N_1-75 % of RDN, N_2- 100% of RDN and 125% of RDN) and sub-plot consisted of spacing *viz*., S_1-60×25 and S_2-45×25 (Table 1).

A Recommended dose of Fertilizer (RDF) was 250:75:75 N: P_2O_5: K_2O kg ha^{-1} was adopted. The fertilizers Urea, Single Super Phosphate, and Muriate of Potash were used as a fertilizer source for N, P, and K respectively. The entire dose (100%) of P_2O_5, K_2O was applied basally before planting. The N was applied in split doses 50:25:25 per cent at 0, 30, and 60 days after sowing respectively.

Table 1. Treatment details

Main plot/Subplot	N_1-75 %RDN	N_2-100% RDN	N_3-125%RDN
S_1 - 60 x 25	T_1	T_2	T_3
S_2 - 45 x 25	T_4	T_5	T_6

Statistical analysis

SPSS software was used to do all data analysis. ANOVA was performed to assess significant differences, and the LSD (Least Significance Difference) test was employed to compare the means at a 5% probability level. The mean values are reported as mean SE (standard error), based on three replicates per treatment.

Results and discussion

Plant height

Different nitrogen fertilizer levels and spacings interaction ($p<0.05$) effects influenced plant height of maize (Table 2 and Table 3). The plant sown at T_6 (45 cm row spacing with N_3 fertilizer level) has significantly higher plant height followed by T_3 (60 cm row spacing with N_3 fertilizer level) at 30,60 and 90 DAS during kharif 2022 (96 cm, 224 cm and 225 cm respectively) and Rabi 2022 (93 cm, 193 cm and 205 cm respectively). The plant height was significantly decreased at T_1 (60 cm row spacing and N_1 fertilizer level) at 30, 60, and 90 DAS during *Kharif* 2022 (68 cm, 185 cm and 215 cm, respectively) and *Rabi* 2022 (64 cm,162 cm and 168 cm, respectively).

The positive effect of nitrogen on growing cell wall material, which led to an increase in cell size, could be the cause of the increase in growth metrics including plant height, number of leaves, dry matter accumulation, number of internodes, thickness, and length with increase in nitrogen levels. It aids in cell elongation and cell division (Golla *et al.,* 2018; Meena *et al.,* 2022).

Table 2 Effect of different nitrogen levels and different spacing on Plant height during *Kharif* 2022

Treatments	Plant height (cm)											
	30 DAS				60 DAS				90 DAS			
	N_1	N_2	N_3	Mean	N_1	N_2	N_3	Mean	N_1	N_2	N_3	Mean
S_1	68	82	96	**82.7**	185	216	224	**209.3**	215	220	236	**225.0**
S_2	**79**	**88**	**98**	**87.7**	196	219	228	**213.7**	216	232	240	**228.7**
Mean	**73.5**	**85.0**	**97.0**		**190.5**	**217.5**	**226.5**		**215.5**	**226.0**	**239.0**	
	N	**S**	**N*S**	**S*N**	**N**	**S**	**N*S**	**S*N**	**N**	**S**	**N*S**	**S*N**
SEd	1.14	0.83	1.53	1.44	0.89	1.28	1.81	2.22	2.08	2.76	3.97	4.78
Cd(0.05)	3.17	2.03	4.02	3.52	2.41	3.14	4.57	5.45	5.77	6.75	10.07	11.70

S_1-60×25 S_2-45×25

N_1-75% RDN N_2-100% RDN N_3-125% RDN

Table 3 Effect of different nitrogen levels and different spacing on Plant height during *Rabi* 2022-2023

Treatments	Plant height (cm)											
	30 DAS				60 DAS				90 DAS			
	N_1	N_2	N_3	Mean	N_1	N_2	N_3	Mean	N_1	N_2	N_3	Mean
S_1	64	76	88	**84.5**	162	171	184	177.5	168	184	196	**190.0**
S_2	**71**	**80**	**93**	**84.0**	172	178	193	185.5	**181**	**190**	**205**	**197.5**
Mean	**67.5**	**78.0**	**90.5**		**167.0**	**174.5**	**188.5**		**174.5**	**187.0**	**200.5**	
	N	**S**	**N*S**	**S*N**	**N**	**S**	**N*S**	**S*N**	**N**	**S**	**N*S**	**S*N**
SEd	0.73	0.59	1.04	1.03	3.06	3.37	5.15	5.84	0.23	2.87	3.52	4.97
Cd(0.05)	2.05	1.46	2.71	2.53	8.52	8.26	13.20	14.31	0.65	7.03	8.63	12.18

S_1-60×25 S_2-45×25

N_1-75% RDN N_2-100% RDN N_3-125% RDN

Yield attributes

Different nitrogen fertilizer levels and spacings interaction ($p<0.05$) effects influenced by yield attributes of maize (Table 4, 4a and Table 5, 5a). Maize yield attributes at T_3 (60 cm row spacing with N_3 fertilizer level) have significantly higher and followed by T_6 (45 cm row spacing with N_3 fertilizer level) at cob length, cob girth cob weight, number of grains per cob and 100 seed weight during *kharif* 2022 (29.8 cm, 18.8 cm and 271 gram, 487 and 37.03

gram, respectively) and *rabi* 2022 (27.2 cm,18.4 cm and 266 gram,472 and 36.31 gram, respectively).

The yield attributes were significantly decreased at T_4 (45 cm row spacing and N_1 fertilizer level) cob length, cob girth, cob weight, number of grains per cob and 100 seed weight during *kharif* 2022 (25.5 cm, 14.9 cm and 213 gram, 415 and 30.74 gram, respectively) and *rabi* 2022 (22.3 cm, 14.4 cm and 208 gram, 372 and 30.35 gram, respectively).

A faster growth under the influence of higher level of nitrogen rate and moderate plant density might have played a significant role in utilizing the available resources including nitrogen with reduced intraspecific competition and resulting in higher photosynthate production and healthy plants. The increased availability of photosynthetic products might have enhanced number of flowers and their fertilization that in turn obviously increase the yield attributing traits including ear weight.

Regarding yield attributes, COH(M)6 showed greater cob length, cob girth, number of grain rows per cob, number of grains per row, and 100 seed weight for the planting density. 60 x 20 cm showed greater cob length, cob girth, number of grain rows per cob, number of grains per row, and 100 seed weight, and it was comparable with 50 x 20 cm. When compared to 50 cm × 20 cm spacing, 60 cm x 20 cm spacing had improved performance of yield qualities because of better availability of light, aeration, and nutrients. Muthukumar *et al*. (2005) Sathyapriya *et al*. (2019) also reported similar results.

Table 4 Effect of different nitrogen levels and different spacing on yield attributes during *Kharif* 2022

Treatments	Yield Attributes											
	Cob length (cm)				Cob girth (cm)				Cob Weight (gram)			
	N_1	N_2	N_3	Mean	N_1	N_2	N_3	Mean	N_1	N_2	N_3	Mean
S_1	25.8	28.3	29.8	**28.0**	15.6	17.0	18.8	**17.1**	237	244	271	**250.7**
S_2	25.5	25.9	26.9	**26.1**	14.9	16.5	16.8	**16.1**	213	239	256	**236.0**
Mean	**25.65**	**27.1**	**28.35**		**15.25**	**16.75**	**17.8**		**225**	**241.5**	**263.5**	
	N	**S**	**N*S**	**S*N**	**N**	**S**	**N*S**	**S*N**	**N**	**S**	**N*S**	**S*N**
SEd	0.42	0.45	0.69	0.78	0.20	0.16	0.28	0.28	2.79	2.46	4.11	4.27
Cd	1.18	1.10	1.79	1.91	0.56	0.40	0.74	0.69	7.75	6.03	10.68	10.45

S_1-60×25 S_2-45×25

N_1-75% RDN N_2-100% RDN N_3-125% RDN

Table 4a Effect of different nitrogen levels and different spacing on yield attributes during *Kharif* 2022

Treatments	Yield Attributes							
	Number of grains per cob				100 seed weight			
	N_1	N_2	N_3	Mean	N_1	N_2	N_3	Mean
S_1	396	464	487	**449.0**	35.08	36.17	37.03	**36.1**
S_2	415	440	472	**442.3**	30.74	32.26	34.1	**32.4**
Mean	**405.5**	**452.0**	**479.5**		**32.91**	**34.22**	**35.57**	
	N	**S**	**N*S**	**S*N**	**N**	**S**	**N*S**	**S*N**
SEd	8.44	6.88	11.93	11.92	0.54	0.52	0.84	0.90
Cd	23.45	16.84	31.17	29.17	1.51	1.28	2.17	2.21

S_1-60×25 S_2-45×25

N_1-75% RDN N_2-100% RDN N_3-125% RDN

Table 5 Effect of different nitrogen levels and different spacing on yield attributes during *Rabi* 2022-2023

Treatments	Yield Attributes											
	Cob length (cm)				Cob girth (cm)				Cob Weight (gram)			
	N_1	N_2	N_3	Mean	N_1	N_2	N_3	Mean	N_1	N_2	N_3	Mean
S_1	22.5	25.3	27.2	**25.0**	15.1	16.6	18.4	**16.7**	228	238	266	**244.6**
S_2	22.3	23.5	24.8	**23.5**	14.4	16.1	16.4	**15.6**	208	232	252	**230.6**
Mean	**22.4**	**24.4**	**26**		**14.75**	**16.35**	**17.4**		**225**	**241.5**	**263.5**	
	N	**S**	**N*S**	**S*N**	**N**	**S**	**N*S**	**S*N**	**N**	**S**	**N*S**	**S*N**
SEd	0.57	0.34	0.70	0.59	0.20	0.25	0.37	0.44	4.85	2.67	5.85	4.62
Cd	1.58	0.84	1.88	1.45	0.57	0.63	0.96	1.09	13.48	6.53	15.65	11.31

S_1-60×25 S_2-45×25

N_1-75% RDN N_2-100% RDN N_3-125% RDN

Table 5a. Effect of different nitrogen levels and different spacing on yield attributes during *Rabi* 2022

Treatments	Yield Attributes							
	Number of grains per cob				100 seed weight			
	N_1	**N_2**	**N_3**	**Mean**	**N_1**	**N_2**	**N_3**	**Mean**
S_1	388	452	472	**437.3**	34.49	35.42	36.31	**35.4**
S_2	372	431	456	**430.7**	30.35	32.56	33.38	**32.1**
Mean	**396.5**	**441.5**	**464.0**		**32.42**	**33.99**	**34.85**	
	N	**S**	**N*S**	**N*S**	**N**	**S**	**N*S**	**N*S**
SEd	3.26	1.17	3.56	2.02	0.19	0.40	0.53	0.70
Cd	9.06	2.86	9.71	4.96	0.55	0.99	1.33	1.72

S_1-60×25 S_2-45×25

N_1-75% RDN N_2-100% RDN N_3-125% RDN

Conclusion

The field experimental results, it could be concluded that Maize hybrid COH (M) 8 under different spacing *viz*., S_1-60 ×25, S_2-45×25 and different nitrogen levels *viz*., N_1-75% RDN, N_2-100 % RDN, N_3-125 % RDN among the treatments plant height was scientifically higher in S_2 with N_3 and yield attributes significantly higher in S_1 with N_3.

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