Effect of plant densities and N level on the vegetative growth characteristic in Maize (Zea mays L.)

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ABSTRACT: ***The field investigations were conducted in two seasons to assess the impact of three plant spacing (60×25 cm, 60×20 cm and 60×30 cm) and four nitrogen level (Nitrogen level) (N_0-0 kg N, N_1-75 kg N ha^{-1}, N_2-150 kg N ha^{-1}, N_3- 225 kg N ha^{-1}) on growth of maize. A split plot design with twelve treatments were replicated thrice are used. Among the various treatments, D_2N_3 (225 kg N ha^{-1} + 60×20 cm (83000 plants ha^{-1}) significantly influenced the growth components viz., Plant height, LAI and DMP. The growth of maize was lower under no fertilizer treatment (D_2N_0).***

Keywords: Maize, N level, plant density, growth characters, nutrient uptake.

INTRODUCTION

Maize is the third most important cereal crop of the world after wheat and rice, growing everywhere in the irrigated as well as in rain fed areas. Botanically, it is known as *Zea mays* L. and belongs to family Poaceae. Basically it is a tropical plant but at present it is being cultivated extensively with equal success in temperate, tropical and sub-tropical regions of world. It is a short duration crop and is grown twice in a year. The increasing demand of maize as food and feed has forced to produce higher yield from a unit area of land and traditional varieties cannot meet the demand so hybrid maize can only fulfill the demand. There are a number of biotic and abiotic factors those affect maize yield considerably, however, it is more affected by variations in plant density and N level than other factors.

Plant density affects plant architecture, alters growth and developmental patterns and influences carbohydrate production. At low densities, many modern maize varieties do not tiller effectively and quite often produce only one ear per plant. Whereas, the use of high population increases interplant competition for light, water and nutrients, which may be determined to final yield because it stimulates apical dominance, induces barrenness, and ultimately decrease the number of ears produced per plant and kernels set per ear (Sangoi, 2001).

Nitrogen fertilization is one of the most important agronomic practices. N plays an essential role in the growth and development of the crop. It enhances the yield of crop. Lack of nitrogen results in stunted growth, pale yellow color, small grain size and reduced yield. It is an essential component of amino acid and protein. The growth of plant primarily depends on nitrogen availability in soil solution and its utilization by crop plants. Dry matter production and its conversion to economic yield is a cumulative effect of various physiological processes occurring during the life cycle of plant. Keeping in view the importance of plant density and N fertilization, the study was conducted to find out the optimum plant population and appropriate level of nitrogen for obtaining higher yield of maize.

MATERIALS AND METHODS

In order to study the "Effect of plant densities and N level on the vegetative growth characteristic in maize" an experiment was carried out at the Experimental Farm, Department of Agronomy, Annamalai University during 2011-2012. The following treatments and their sub-levels were studied during the experiment.

Main plot treatment: - (Plant density)

D_1 - 60 × 25 cm (66000 plants ha^{-1})
D_2 - 60 × 20 cm (83000 plants ha^{-1})
D_3 - 60 × 30 cm (55000 plants ha^{-1})

Sub plot treatment:- (Nitrogen levels)

N_0 - 0 kg N
N_1 - 75 kg Nitrogen ha^{-1}
N_2 - 150 kg Nitrogen ha^{-1}
N_3 - 225 kg Nitrogen ha^{-1}

The experiment was conducted in Split plot design with three replications. The plot size was kept at 5m × 4m. Maize hybrid Pioneer 3052 was used during the study. A seed rate of 15 kg ha^{-1} was followed. Sowing was done as per treatment schedule and the seeds were dibbled @ one seed per hole at a depth of 4 cm. The recommended fertilizer dose is 135:62.5:50 kg ha^{-1}. The entire dose of phosphorus and potassium were applied basally. Half dose of nitrogen as first top dressing and the remaining quarter dose of nitrogen as top dressing were applied on 25th and 45th days after sowing respectively in two splits. Soil analysis was carried out before sowing for total NPK status. The soil was low in available nitrogen, medium in available phosphorus and high in available potassium. All other agronomic practices (i.e. weeding, irrigation etc.) were kept uniform for all treatments. The following observations were recorded during the course of the study (plant height, LAI, dry matter production, nutrient uptake). The observations were recorded at 30 DAS, 60 DAS and at harvest.

RESULTS AND DISCUSSION

Plant height

Table -1 showed that plant density and N level had significant effect on the plant height of maize. The adoption of 60×20 cm (83000 plant ha^{-1} spacing and application of 225 kg of nitrogen ha^{-1} (D_2N_3) recorded the highest plant height of 94.40, 148.29 and 165.88 cm during Summer, 97.46, 167.73 and 188.55 cm during Kharif 2012 at 30, 60 DAS and at harvest, respectively. The least plant height was recorded in D_2N_0 (60×20 cm spacing and no fertilizer application) 62.36, 95.22 and 103.50 cm and 64.69, 85.86 and 113.05 cm of Summer and Kharif seasons 2012 at 30, 60 DAS and harvest, respectively. This was mainly due to increased competition for light. Adhikari *et al*., (2004) reported that, plant density increased the height of maize hybrid. Higher N applications increase the cell division, cell elongation, nucleus formation as well as green foliage. It also encourages the shoot growth. Therefore, higher doses of N increased the chlorophyll content which increased the rate of photosynthesis and extension of stem resulting increased plant height.

Leaf area index (LAI)

LAI is an important parameter of maize. There was significant interaction between plant density and levels of nitrogen on the LAI of maize. The adoption of 60×20 spacing and application of 225 kg of nitrogen ha^{-1} (D_2N_3) recorded the highest LAI of 3.84, 6.78 and 6.05 during Summer, 3.98, 6.23 and 5.81 during Kharif, 2012 at 30, 60 DAS and at harvest, respectively. The least LAI was recorded in D_2N_0 (60×20 spacing with no fertilizer application) 1.13, 2.39 and 2.28 and 1.09, 1.65 and 1.57 of Summer and Kharif seasons 2012 at 30, 60 DAS and harvest, respectively. Previous research findings also indicated that in high maize density, LAI, DMP and CGR increased than low maize density throughout crop growth season. (Saberali, 2007).

Dry matter production (DMP)

There was significant interaction between plant density and levels of nitrogen on the DMP of maize. The adoption of 60×20 spacing with a plant density of 83000 plants ha^{-1} and application of 225 kg of nitrogen ha^{-1} (D_2N_3) recorded the highest DMP of 6582, 8652 and 9268 kg ha^{-1} during Summer, 6830, 9281 and 9933 kg ha^{-1} during Kharif, 2012 at 30, 60 DAS and harvest, respectively. The least DMP was recorded in D_2N_0 (no fertilizer application) with 3657, 5184 and 5661 kg ha^{-1} and 3749, 5013 and 5623 kg ha^{-1} of Summer and Kharif seasons 2012 at 30, 60 DAS and harvest, respectively. The enhanced growth characters might be due to more availability of N during different growth stages from inorganic sources, which might have helped in the promotion of growth characters. The enhanced growth characters might be due to more availability of N during different growth stages from inorganic sources, which might have helped in the promotion of growth characters. Similar findings have been reported by Muhammad Asif Rafig *et al*., (2010) and Zamir *et al*., (2011).

Nutrient uptake

There was significant interaction between plant density and nitrogen practices on the NPK uptake of maize. The treatment of 60×20 cm spacing along with 225 kg of nitrogen ha^{-1} (D_2N_3) recorded the highest NPK uptake of (N -178.32 kg ha^{-1} and 189.65 kg ha^{-1}, P - 36.29 kg ha^{-1} and 43.67 kg ha^{-1}, K - 106.29 kg ha^{-1} and 118.98 kg ha^{-1}) during Summer and Kharif seasons, 2012, respectively. The least NPK uptake was recorded in D_2N_0 (60×20 cm spacing and no fertilizer application) (N - 129.46 kg ha^{-1} and 132.33 kg ha^{-1}, P - 23.18 kg ha^{-1} and 30.33 kg ha^{-1}, K - 82.85 kg ha^{-1} and 98.15 kg ha^{-1}) during Summer and Kharif seasons of 2012, respectively. The combined application of plant density (83000plants ha^{-1}) and inorganic fertilizer might have increased the concentration of nutrient ions in the soil solution and their uptake by plant. All the nutrients are important in many physiological processes controlling growth and development in plants. These findings are in agreement with the reports by Srikanth *et al*., (2009) and Tetarwal *et al*., (2012)

Table – 1. Effect of plant density and N level on growth components of maize

Treatments	Growth components					
	Summer			*Kharif*		
	Plant height	LAI	DMP	Plant height	LAI	DMP
Plant density						
D_1	77.28	2.61	5140	80.98	2.50	5344
D_2	79.79	2.72	5231	82.79	2.67	5506
D_3	75.86	2.54	5078	79.41	2.41	5400
S.Ed	0.11	0.08	26.13	0.22	0.09	27.12
CD(P=0.05)	0.23	0.16	53.26	0.45	0.19	58.24
Nitrogen level						
N_0	66.48	1.62	4015	68.09	1.4	3787
N_1	74.63	2.36	4701	76.59	2.20	5163
N_2	82.57	3.11	5744	87.83	3.06	6218
N_3	86.53	3.41	6139	91.73	3.46	6499
S.Ed	0.6	0.11	12.15	0.36	0.12	22.25
CD(P=0.05)	0.11	0.22	23.30	0.72	0.24	44.50
D X N						
S.Ed	1.10	0.16	72.31	1.04	0.19	73.24
CD(P=0.05)	2.20	0.33	145.53	2.08	0,38	146.48
N X D						
S.Ed	1.07	0.24	71.25	1.01	0.26	69.36
CD(P=0.05)	2.14	0.48	142.80	2.03	0.53	139.55

Table – 2. Effect of plant density and N level on nutrient uptake of maize

Treatments	Nutrient uptake by maize					
	Summer			*Kharif*		
	N	P	K	N	P	K
Plant density						
D_1	159.28	29.50	95.25	167.59	36.94	108.35
D_2	159.91	30.21	95.95	169.18	37.66	109.42
D_3	159.22	29.39	94.87	168.72	36.67	108.24
S.Ed	0.45	0.22	0.22	0.47	0.22	0.22
CD(P=0.05)	0.96	0.45	0.45	0.94	0.45	0.45
Nitrogen level						
N_0	138.32	24.40	85.31	144.27	31.45	100.49
N_1	156.01	28.18	92.73	165.02	35.21	106.43
N_2	169.7	32.15	100.45	180.15	39.85	112.62
N_3	173.86	34.08	102.94	184.54	41.86	115.13
S.Ed	0.43	0.20	0.22	0.36	0.32	0.32
CD(P=0.05)	0.86	0.40	0.45	0.72	0.65	0.65
D X N						
S.Ed	1.07	0.78	0.80	1.04	0.57	0.58
CD(P=0.05)	2.15	1.60	1.60	2.09	1.17	1.17
N X D						
S.Ed	1.05	0.78	0.78	1.06	0.56	0.56
CD(P=0.05)	2.11	1.58	1.58	2.13	1.13	1.13

CONCLUSION

Based on the results of the experiments, it can be concluded that adoption of plant density (60×20cm) + 225 kg of nitrogen ha^{-1} will be economical for hybrid maize in addition to improvement in soil fertility. Thus, this agronomically feasible, scientifically sound, ecologically desirable, practically applicable and economically viable technology paves way for higher return per rupee invested in hybrid maize.

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