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EFFECT OF DIFFERENT PLANT GEOMETRY AND NITROGEN LEVELS, INRELATION TO GROWTH CHARACTERS, YIELD AND ECONOMICS ON SWEET CORN (*ZEA MAYS SACHHARATA* L.) AT BASTAR PLATEAU ZONE

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ABSTRACT

Field experiment was conducted during *Rabi* season of 2014 at the S G College of Agriculture and Research Station, Jagdalpur (Chhattisgarh). The soil was sandy loam in texture, low in organic carbon (0.48%). available N (185 kg ha^{-1}), available phosphorus (20.9 kg ha^{-1}) and medium in available potassium (186 kg ha^{-1}) with soil reaction (pH 6.8). The experiment was laid out in split-plot design by keeping four plant geometry, *viz*. G1-(30 x 30 cm), G2-(50 x 30 cm),G3-(30 x 60 cm) and G4-(50 x 50 cm) as a main plot and four nitrogen levels *i.e*. N1-(50 kg ha^{-1}), N2-(75 kg ha^{-1}), N3-(100 kg ha^{-1}) and N4-(125 kg ha^{-1}) as a sub-plot plot and was replicated three times. Plant population (94415), plant height (169.78 cm) and LAI (5.04) was recorded significantly highest in treatment G1 (30 x 30 cm) followed by G2 (50 x 30 cm). Fresh kernel weight (32.75 g) recorded significantly higher under treatment G4 (50 x 50 cm) among all plant geometry but it was significantly at par with G3 (60 x 30 cm) and minimum weight was gained by G1 (30 x 30 cm). In case of weight of cob with and without cover (246.47g and 216.77 g), and weight of cobs ha^{-1} (18507 kg ha^{-1}) was recorded significantly highest in treatment G4 (50 x 50 cm). Net income (Rs.172513) was recorded significantly highest in G1 (30 x 30). However, B: C ratio was recorded statistically similar result in all plant geometry but highest value was obtained with G1 (30 x 30 cm).In case of different nitrogen levels, N4 (125 kg N ha^{-1}) was recorded significantly tallest plant height (178 cm), days to 50% flowering (51 DAS), No. of cobs ha^{-1} (84860) and LAI (5.35). Significantly highest fresh kernel weight (34.51 g), weight of cob with (256.77) and without cover (236.80), weight of cobs ha^{-1} (21504.28) and number of cobs ha^{-1} (84860) was recorded under N4 (125 kg ha^{-1}) among all the nitrogen levels. Highest gross income (Rs. 212833), net income (Rs. 175418) and B: C ratio (4.60) was recorded significantly higher in N4 (125 kg ha-1).

INTRODUCTION

Maize is one of the most widely grown cereals in the world and has great significance as human food, animal feed and raw material for large number of industrial products. In India, about 50 to 55 per cent of the total maize production is consumed as food, 30 to 35 per cent goes for poultry, piggery and fish meal industry and 10 to 12 per cent to wet milling industry. The green ears of maize are consumed directly as food in and around cities. Sweet corn is a medium plant type and provides green ears in 65 to 75 days after sowing. These are harvested earlier by 35 to 45 days compared to normal grain maize. The demand for sweet corn as a crunchy bite in the amusement parks, theatres, circus and exhibitions is increasing with increasing urban population. Due to its increasing demand, there is an increasing tendency for commercial production of sweet corn, Arun Kumar *et al*. (2007). Maize has high production potential especially under irrigated condition when compared to any other cereal crop. The productivity of maize largely depends on its nutrient requirement and management particularly that of nitrogen, phosphorus and potassium, Arun Kumar *et al*. (2007). In modern maize production systems, enhanced plant-to-plant variability often results from increased competition among individual plants at progressively higher plant densities for limiting resources such as N, incident photosynthetically active radiation and soil moisture. Past studies have often emphasized that stand uniformity is essential for high productivity levels, and that the increased plant-to-plant variability reduces per-unit-area maize grain yields through reduced stress tolerance, Tollenaar and Wu (1999). At higher plant populations, resource availability must be adequate to help maintain uniform growth, development, and grain yield of adjacent plants in a maize canopy (Rao *et al.,* 2014).

The plant growth involves various environmental and agronomical factors, such as water, temperature, light, nutrients, Liu *et al.* (2004), Yadav (2008), and Yuan *et al.* (2003). The nitrogen is a vital nutrient for the activity of plant organs. It is a fraction of many components such as; amino acids, nucleic acids, chlorophyll and etc. Thus, plant growth can be affected by the amount of nitrogen, Najm *et al.* (2012) and Taiz and Zeiger (2002). Previous studies have shown that nitrogen fertilizer can increase the growth characteristics, such as; plant height, shoot dry matter, and Leaf Area Index (LAI), Hay and Walker (1989), Sattelmacher *et al.* (1990), Biemond (1992), Vos and Biemond (1992). Honeycutt *et al.* (1996) and Sincik *et al.* (2008). Nitrogen is an essential mineral nutrient for plant growth. High rate of nitrogen application leads to more rapid leaf area development prolongs life of foliage, increases leaf area duration after flowering and enhance on the whole crop assimilation, consequently contributing to increase in seed production Khaliq *et al.* (2008) and Khaliq *et al.* (2009). Nitrogen is one of the main plant nutrients affecting plant growth and yield Tafteh and Sepaskhah (2012). Leaf area and LAI increase with increase in N level, Bhatt (2013). Maize crop differs in its ability to maintain LAI, CGR and above ground dry matter production at different levels of N application, Pandey *et al.* (2000). Assessment of crop leaf area index (LAI) and its spatial distribution in agricultural landscapes are of importance for addressing various agricultural issues such as: crop growth monitoring, vegetation stress, crop forecasting, yield predictions, and management practices. Indeed, LAI is a canopy biophysical variable that plays a major role in vegetation physiological processes, and ecosystem functioning, Baret and Guyot (1991), Daughtry *et al.* (1992), Chen and Cihlar (1996) and Haboudane *et al.* (2004).

MATERIALS AND METHODS

Field experiments were conducted during *Rabi* season of 2014 at the S G College of Agriculture and Research Station, Jagdalpur (Chhattisgarh). The soil was sandy loam in texture, low in organic carbon (0.48%). available N (185 kg ha^{-1}), available phosphorus (20.9 kg ha^{-1}) and medium in available potassium (186 kg ha^{-1}) with soil reaction (pH 6.8). Olsen's method (Watanabe and Olsen, 1965), Neutral normal Ammonium Acetate extract using flame photometer (Hanway and Heidel, 1952) and Walkely and Black method (Jackson,1967) for the determination of available nitrogen (N),phosphorus (P2O5) potassium (K2O) and organic carbon, respectively. The pH of experimental site was determined through 1:2.5 soil and water suspension method (Jackson, 1967).

The experiment was laid out in a split-plot design by keeping four plant geometry, *viz.* G1-(30 x 30 cm), G2-(50 x 30 cm).G3-(30 x 60 cm) and G4-(50 x 50 cm) as a main plot and four nitrogen levels *i.e.* N1-(50 kg ha^{-1}), N2-(75 kg ha^{-1}), N3-(100 kg ha^{-1}) and N4-(125 kg ha^{-1}) as a sub-plot plot and was replicated three times. The succeeding winter crop was sown after harvesting of rice. Sweet corn (NS -680) was sown during the last week of November (25th November 2014). The entire experimental area was ploughed by cultivator in thrice. A Phosphoric and potassium fertilizer was given @ 60 kg ha^{-1} and 40 kg ha^{-1}, respectively at the time of sowing. Nitrogen was supplied through urea, 1/3rd as basal dose remaining nitrogen was given during knee high stage (1/3rd) and tassel stage (1/3rd). Weeding was done on need based and six irrigations were applied during experimentation.

RESULTS AND DISCUSSION

Effects of different treatments on yield attributing characters are presented in Table1. Plant population, plant height and LAI was recorded significantly highest in treatment G1 (30 x 30 cm) followed by G2 (50 x 30 cm) and lowest values were recorded in G4 (50 x 50 cm). Plant population was higher due the number of plants per unit area. This clearly indicates that increase in number of plants per unit area beyond optimum level certainly reduced the amount of light availability to the individual plant, especially, to lower leaves due to shading. As the intensity of shading increases due to high population densities, the plant tends to grow taller. The increase in LAI with increase in plant density was due to more number of plants per unit area. Such increase in height of the plant at

Table 1: Effect of different treatments on plant growth and yield attributing characters

Treatments	Plant population ha^{-1}	Plant height (cm)	Days to 50% flowering	Number of cobs plant^{-1}	Number of cobs ha^{-1}
Geometry					
G1 -30 x 30	94415	169.78	50	0.92	93957
G2 -50 x 30	54858	151.70	50	1.15	63135
G3 – 30 x 60	46013	143.50	50	1.28	59042
G4 – 50 x 50	32364	145.33	50	1.40	43408
SEm±	702	3.34	0.19	0.06	2721
CD at 5%	2477	11.78	NS	0.23	9598
Nitrogen levels (kg ha^{-1})					
N1 -50	56771	127.79	50	0.78	47143
N2 -75	57581	148.65	50	1.02	59900
N3 -100	56468	155.79	50	1.37	67640
N4 -125	56829	178.07	51	1.58	84860
SEm±	595	2.33	0.26	0.06	5304
CD at 5%	NS	6.85	0.77	0.19	15572

Table 2: Effect of different treatments on yield attributing characters

Treatments	LAI at harvest	100 seed weight (g)	Weight of cob with cover (g cob^{-1})	wt of cob without cover (g cob^{-1})	Weight of cob (kg ha^{-1})
Geometry					
G1 -30 x 30	5.04	25.60	192.54	153.68	11071.48
G2 -50 x 30	4.86	30.02	208.53	187.99	13640.72
G3 – 30 x 60	4.50	31.73	224.97	204.08	13463.07
G4 – 50 x 50	3.87	32.75	246.47	216.77	18507.21
SEm±	0.17	0.66	4.23	2.56	824.36
CD at 5%	0.60	2.33	14.92	9.05	2908.11
Nitrogen levels (kg ha^{-1})					
N1 -50	3.23	25.45	190.12	126.80	8586.42
N2 -75	4.40	28.98	204.51	181.88	11841.18
N3 -100	5.11	31.16	221.12	217.03	14750.59
N4 -125	5.35	34.51	256.77	236.80	21504.28
SEm±	0.16	0.65	3.24	5.07	1227.83
CD at 5%	0.47	1.92	9.52	14.90	3605.13

Table 3: Effect of different treatments on economics

Treatments	Cost of cultivation (Rs. ha^{-1})	Grass income (Rs. ha^{-1})	Net income(Rs. ha^{-1})	B:C Ratio
Geometry				
G1 -30 x 30	47587	220100	172513	3.61
G2 -50 x 30	36337	157838	121500	3.33
G3 – 30 x 60	33697	147606	113909	3.36
G4 – 50 x 50	29827	113361	83533	2.78
SEm±	-	10876	10876	0.25
CD at 5%	-	38366	38366	NS
Nitrogen levels (kg ha^{-1})				
N1 -50	36309	106131	69822	1.89
N2 -75	36678	142502	105824	2.80
N3 -100	37047	177438	140391	3.79
N4 -125	37416	212833	175418	4.60
SEm±	-	11368	11368	0.28
CD at 5%	-	33379	33379	0.82

high population densities was reported by Ashok (2009) and Bhatt (2012). In case of days to 50% flowering, it was found similar result due to different plant geometry, but No. of cobs plant^{-1} was significantly higher in treatment G4 (50 x 50 cm) and lowest was recorded with G1 (30 x 30 cm). This clearly indicated that plants at lower density fully exploited the natural resources efficiently, besides responding to externally applied inputs and expressed the same liberally compared to plants at highest plant density where the competition was stiff(Bhatt, 2012). The similar findings confirmed of these results by Ashok (2009).

In case of different nitrogen levels, N4 (125 kg N ha^{-1}) was recorded significantly tallest plant height, days to 50% flowering, No. of cobs ha-1 and LAI. However, plant population was recorded non significant effect due to different nitrogen levels. As maize hybrids and sweet corn are highly responsive to applied inputs in particular, nitrogen at higher doses supported the crop requirement. Nitrogen at the rate of 125 kg ha^{-1} promoted better growth and resulted in higher uptake of nitrogen, phosphorus and potassium as compared to lower levels. These nutrients triggered the vigorous growth of plants, thereby achieving more LAI; this further boosted the dry matter production and hastened the flowering and maturity period. Similar response of growth parameters to applied nitrogen levels was reported by Muniswamy *et al.* (2007) and Bhatt (2012).

Table 2 reveals that fresh kernel weight recorded significantly higher under treatment G4 (50 x 50 cm) among all plant geometry but it was significantly at par with G3 (60 x 30 cm) and minimum weight was gained by G1 (30 x 30 cm). In case of weight of cob with and without cover, and weight of cobs ha^{-1} was recorded significantly highest in treatment G4 (50 x 50 cm) and lowest was recorded in G1 (30 x 30 cm). It might be due to less competition for the light, nutrient and moisture. The similar findings were confirmed by Bhatt (2012). Whereas, number of cobs ha^{-1} was recorded highest in G1 (30 x 30 cm) and minimum number was recorded with G4 (60 x 30 cm).

Effect of nitrogen levels was recorded significantly highest fresh kernel weight, weight of cob with and without cover, weight of cobs ha^{-1} and number of cobs ha^{-1} under N4 (125 kg ha^{-1}) among all the nitrogen levels and lowest were recorded in N1 (50 kg ha^{-1}).This evidently proved that increased availability of nitrogen to crop at higher levels resulted in production of longer cobs accompanied by increased grain filling that gave more kernels per cob. Not only grain filling but also size of grain was also better as supported from increase in 100 grain weight. Better corn and grain development was due to increased availability of nitrogen and greater production of photosynthates and their efficient translocation for development of reproductive parts. Similar results were reported by Sahoo and Mahapatra (2004), Kar *et al.* (2006), Bhatt (2012) and Singh *et al.* (2013).

Economics of sweet corn is presented in Table 3. Table shows that highest cost of cultivation required in G1 (30 x 30 cm) among all plant geometry. Net income was recorded significantly highest in G1 (30 x 30) and minimum net income was recorded in G4 (50 x 50 cm). However, B: C ratio was recorded statistically similar result in all plant geometry but highest value was obtained with G1 (30 x 30 cm). Different levels of nitrogen also affect the economics. Highest cost of cultivation, gross income, net income and B: C ratio was recorded significantly higher in N4 (125 kg ha-1), but B: C ratio was at par with N3 (100 kg ha^{-1}). There was a clear enhancement in net returns and benefit cost ratio with each successive increase in nitrogen level from 50 to 120kg ha^{-1}. The maximum net returns were noticed with 120 kg N ha^{-1}. The benefit cost ratio was also enhanced with higher nitrogen levels. Higher yields of green cobs and fodder directly contributed to the returns at higher nitrogen levels. Ashok (2009), Bhatt (2012) and Singh *et al.* (2013) observed similar results.

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