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Effect of planting geometry and integrated nitrogen management on growth and green cob yield of sweet corn. (*Zea mays* L. saccharata) var. sakata-16

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Abstract
A field experiment was conducted during the *kharif* season 2017 on sweet corn crop (var. Sakata-16) at the Crop Research Farm, Department of Agronomy, Naini Agricultural Institute, SHUATS, Allahabad (U.P.). The soil of the experiment plot was sandy loam in texture, neutral in soil reaction (pH 7.5), low organic carbon (0.281), available P (12.4), E.C (0.325), available K (163.8). The treatment comprised of three planting geometries *viz*. 60 cm row to row spacing, but three different plant to plant spacings *viz*., 20cm, 25cm and 30cm and three integrated nitrogen management treatments *viz*. 90 kg nitrogen/ha provided through urea and 30 kg nitrogen/ha provided either through poultry manure (PM), Farm Yard Manure (FYM) or through Vermicompost (VC), which were tried with and without *Azospirillum* seed innoculation. Thus the experiment consisted of 18 treatment combinations, replicated thrice. The experiment was laid out in Randomized Block Design. The experimental results recorded maximum green cob yield (6.77 t ha^{-1}), green fodder yield (15.63 t ha^{-1}), maximum net return of ₹99881.45 and B.C. ratio 2.80 under 60cm x 20cm spacing and 90 kg N through (urea) + 30kg N through (Poultry Manure) + Azospirillum (seed inoculation).

Keywords: sweet corn, integrated nitrogen management, planting geometry, pm, fym, vermicompost, *azospirillium*, fodder yield, green cob yield and economics

Introduction
Corn is a versatile crop, which finds a place in the human diet, animal feed, fodder and industrial raw material. Specialty corn such as baby corn and sweet corn have emerged as alternative food sources, especially for the rich society. Sweet corn is used as a human food in the soft dough stage with succulent grain. The higher content of water-soluble polysaccharide in the kernel adds texture and quality in addition to sweetness (Venkatesh *et al*., 2003) [9]. Sweet corn is gaining popularity both in rural and urban areas because of its higher sugar (14-20%), low starch contents, delicious taste and better market value as compared to *Zea mays* green cobs (Sahoo and Mahapatra, 2007) [7].

Amongst various agricultural inputs, fertilizer is and will remain as a chief source in achieving the food production targets. For higher productivity, there is a need for the application of higher dose of fertilizers but the increased use of high analysis fertilizers and adaptation of high yielding cultivars demanding more secondary and micronutrients for enhancing food grain production has resulted in their deficiencies and declined growth and productivity of crop due to continued removal of nutrients from soil. From the results of the long term fertilizer experiments conducted in different parts of the country, it has been well established that under high input production system, where crop productivity cannot be further increased with incremental use of fertilizer alone, addition of organic sources could again increase the yield by increasing the soil productivity and fertilizer use efficiency. Thus sustainable agriculture, in years to come should ideally be based on integrated plant nutrient supply (Makinde and Ayoola, 2010) [5].

The present experiment was conducted to find out the best organic manure and urea combination which could boost the green cob yield and profits of sweet corn production at optimum plant spacing.

Materials and Methods
A field experiment was conducted during the *kharif* season 2017 to study the effects of integrated nitrogen management and planting geometry on the growth and yield of Sweet corn (var. Sakata-16) at Crop Research Farm, Department of Agronomy, Naini Agricultural Institute,

SHUATS, Allahabad, Uttar Pradesh. The soil of the experimental field was sandy loam. The field experiment consisted of 18 treatments replicated thrice and laid out in Randomized Block Design. The treatment comprised of three planting geometries *viz*. 60 cm row to row spacing, but three different plant to plant spacings *viz*., 20cm, 25cm and 30cm and three integrated nitrogen management treatments *viz*. 90 kg nitrogen/ha provided through urea and 30 kg nitrogen/ha provided either through poultry manure (PM), Farm Yard Manure (FYM) or through Vermicompost (VC), which were tried with and without *Azospirillum* seed innoculation. Thus the experiment consisted of 18 treatment combinations, replicated thrice. Half dose of N and full doses of P and K were applied as basal and the remaining nitrogen was applied in two equal splits at knee height and taselling stage. The whole amount of the organic manures (according to the treatment requirement) was applied as basal.

Results and discussion

Growth Attributes

The plant height of Sweet corn at 40 DAS was recorded to be highest (73.45cm) for the treatment T_7 (60cm x 30cm spacing + 90 kg N through urea + 30kg N through Poultry Manure + *Azospirillum* seed innoculation). It was followed by treatment T_4 (60cm x 25cm spacing + 90 kg N through urea + 30kg N through PM + *Azospirillum* seed inoculation) whereas number of leaves plant^{-1}(12.23) at 40 DAS recorded highest in treatment T_4 (60cm x 25cm spacing + 90 kg N through (urea) + 30kg N through (Poultry Manure) + *Azospirillum* seed inoculation). It was followed by treatment T_7 (60cm x 30cm spacing + 90 kg N through urea + 30kg N through Poultry Manure + *Azospirillum* seed innoculation). Plant dry weight (70.90g) at 40 DAS, Crop growth rate (28.35 g m^{-2} day^{-1}) at 40 DAS and Relative growth rate(0.152 g g^{-1} day^{-1}) were recorded highest in treatment T_1(60cm x 20cm spacing + 90 kg N through (urea) + 30kg N through (Poultry Manure) + *Azospirillum* seed inoculation). It was followed by treatments T_4, T_{10} and T_8 respectively. This might be due to the incorporation of organic manures which played a significant role in enhancing the growth and development of a plants by improving physical properties and also helped in slow release of nitrogen by absorption of nitrogen on soil colloids (Aravinth, 2017) [1].

Yield and yield attributes

The yield attributes of sweet corn *viz*., number of cobs plant^{-1}(1.23) and Cob length (14.78cm) were recorded to be highest in treatment T_7 (60cm x 30cm spacing + 90 kg N through urea + 30kg N through Poultry Manure + *Azospirillum* seed innoculation). It was followed by treatment T_4 (60cm x 25cm spacing + 90 kg N through urea + 30kg N through Poultry Manure + *Azospirillum* seed innoculation). This might be due to less inter plant competition in 60 x 30 cm spacing for space, light, nutrients and moisture and better utilization of available resources. Suryavanshi *et al.*, (2008) [8]. Number of grains cob^{-1} (437.72), with husk cob weight (220.33 g) and without husk cob weight (156.07 g) were recorded to be highest in treatment T_7: (60cm x 30cm + 90 kg N (urea) + 30kg N (PM) + *Azospirillum* seed innoculation). It was followed by treatment T_9 (60cm x 30cm spacing + 90 kg N through urea + 30kg N through Vermicompost + *Azospirillum* seed innoculation). The green cob yield (6.77 t ha^{-1}) and green fodder yield (15.63 t ha^{-1}) were recorded highest in treatment T_1 (60cm x 20cm spacing + 90 kg N through urea + 30kg N through Poultry Manure + *Azospirillum* seed innoculation). It was followed by treatment T_4 (60cm x 25cm spacing + 90 kg N through urea + 30kg N through Poultry Manure + *Azospirillum* seed innoculation). This might due to more plant population at 60x 20cm spacing which resulted in higher green cob and fodder yield Raja (2001) [6]. Increased in green cob and green fodder yield might be due to increase in the number of plants per unit area. Widdicombe and Thelen (2002) [10].

Economics

A perusal of the table 3 clearly revels that treatment T_1 recorded maximum net return of (₹99881.45), followed by treatment T_4 (₹89261.45) giving a B:C ratio of (2.80) and (2.61) respectively. The plant spacing of 60 cm x 20 cm gave the highest net profit and benefit:cost ratio due to maximum cob and green fodder yield than the others spacings. These findings are similar to those obtained by Kunjir (2004) [4].

Table 1: Growth parameters of sweet corn as influenced by different treatments at 40 DAS

Treatment	Plant height(cm)	No of leaves/Plant	Dry weight (g)	CGR (g m^{-2} day^{-1})	RGR (g g^{-1} day^{-1})
T_1: 60cm x 20cm + 90 kg N (urea) + 30kg N (PM) + Azospirillum	68.34	11.27	70.90	17.57	0.057
T_2: 60cm x 20cm + 90 kg N (urea) + 30kg N (FYM) + Azospirillum	63.96	10.90	51.20	19.78	0.051
T_3: 60cm x 20cm + 90 kg N (urea) + 30kg N (VC) + Azospirillum	64.30	11.20	59.27	20.75	0.055
T_4: 60cm x 25cm + 90 kg N (urea) + 30kg N (PM) + Azospirillum	73.00	12.23	61.87	19.51	0.062
T_5: 60cm x 25cm + 90 kg N (urea) + 30kg N (FYM) + Azospirillum	70.63	11.57	53.77	16.96	0.052
T_6: 60cm x 25cm + 90 kg N (urea) + 30kg N (VC) + Azospirillum	71.71	11.93	53.83	16.96	0.060
T_7: 60cm x 30cm + 90 kg N (urea) + 30kg N (PM) + Azospirillum	73.45	12.07	45.03	18.72	0.054
T_8: 60cm x 30cm + 90 kg N (urea) + 30kg N (FYM) + Azospirillum	71.28	11.03	49.87	13.50	0.047
T_9: 60cm x 30cm + 90 kg N (urea) + 30kg N (VC) + Azospirillum	71.82	11.80	52.60	15.63	0.052
T_{10}: 60cm x 20cm + 90kg N (urea) + 30kg N (PM)	63.96	10.83	60.53	18.48	0.054
T_{11}: 60cm x 20cm + 90kg N (urea) + 30kg N (FYM)	57.71	10.27	39.63	15.92	0.037
T_{12}: 60cm x 20cm + 90kg N (urea) + 30kg N (VC)	59.69	10.50	42.53	17.35	0.039
T_{13}: 60cm x 25cm + 90kg N (urea) + 30kg N (PM)	66.29	11.73	58.30	18.42	0.055
T_{14}: 60cm x 25cm + 90kg N (urea) + 30kg N (FYM)	60.27	11.00	47.93	15.18	0.044
T_{15}: 60cm x 25cm + 90kg N (urea) + 30kg N (VC)	61.29	11.20	52.50	16.52	0.054
T_{16}: 60cm x 30cm + 90kg N (urea) + 30kg N (PM)	66.31	11.00	47.27	15.95	0.044
T_{17}: 60cm x 30cm + 90kg N (urea) + 30kg N (FYM)	61.83	10.60	40.30	10.44	0.035
T_{18}: 60cm x 30cm + 90kg N (urea) + 30kg N (VC)	64.33	10.70	43.83	11.21	0.039
SEd±	4.42	0.26	7.54	2.86	0.004
CD(*P*=0.05)	8.98	0.54	15.31	5.80	0.007

Table 2: Yield attributes and yield

Treatment	No. of cobs plant $^{-1}$	Cob length (cm)	No. of grain/cob	With husk cob weight (g plant $^{-1}$)	Without husk cob weight (g plant $^{-1}$)	Green cob yield (t ha^{-1})	Green fodder yield (t ha^{-1})
T_1: 60cm x 20cm + 90 kg N (urea) + 30kg N (PM) + Azospirillum	1.13	14.09	387.27	201.00	142.60	6.77	15.63
T_2: 60cm x 20cm + 90 kg N (urea) + 30kg N (FYM) + Azospirillum	1.00	13.10	356.03	170.13	120.35	5.53	12.93
T_3: 60cm x 20cm + 90 kg N (urea) + 30kg N (VC) + Azospirillum	1.00	13.99	361.65	174.07	129.03	5.82	14.73
T_4: 60cm x 25cm + 90 kg N (urea) + 30kg N (PM) + Azospirillum	1.20	14.37	417.40	205.11	151.83	6.20	15.13
T_5: 60cm x 25cm + 90 kg N (urea) + 30kg N (FYM) + Azospirillum	1.00	13.11	362.88	176.55	127.45	5.34	13.13
T_6: 60cm x 25cm + 90 kg N (urea) + 30kg N (VC) + Azospirillum	1.10	14.18	393.33	200.40	147.30	5.78	14.07
T_7: 60cm x 30cm + 90 kg N (urea) + 30kg N (PM) + Azospirillum	1.23	14.78	437.72	220.33	156.07	5.73	13.67
T_8: 60cm x 30cm + 90 kg N (urea) + 30kg N (FYM) + Azospirillum	1.13	13.95	404.47	207.53	129.80	4.90	12.50
T_9: 60cm x 30cm + 90 kg N (urea) + 30kg N (VC) + Azospirillum	1.17	14.28	417.71	215.00	143.93	5.72	13.62
T_{10}: 60cm x 20cm + 90kg N (urea) + 30kg N (PM)	1.00	13.41	357.27	165.67	130.43	5.69	13.17
T_{11}: 60cm x 20cm + 90kg N (urea) + 30kg N (FYM)	1.00	13.00	320.97	142.33	118.53	5.03	13.00
T_{12}: 60cm x 20cm + 90kg N (urea) + 30kg N (VC)	1.00	13.20	341.07	162.13	121.07	5.68	13.13
T_{13}: 60cm x 25cm + 90kg N (urea) + 30kg N (PM)	1.00	13.61	362.23	181.00	134.83	5.47	13.10
T_{14}: 60cm x 25cm + 90kg N (urea) + 30kg N (FYM)	1.00	13.07	345.77	162.10	125.80	5.03	12.97
T_{15}: 60cm x 25cm + 90kg N (urea) + 30kg N (VC)	1.00	13.21	361.92	168.73	129.77	5.25	13.07
T_{16}: 60cm x 30cm + 90kg N (urea) + 30kg N (PM)	1.00	13.89	377.21	187.75	137.43	5.19	13.17
T_{17}: 60cm x 30cm + 90kg N (urea) + 30kg N (FYM)	1.00	13.17	351.43	166.97	121.80	4.72	13.01
T_{18}: 60cm x 30cm + 90kg N (urea) + 30kg N (VC)	1.00	13.24	365.27	171.43	129.80	4.99	12.47
SEd±	0.05	0.73	36.41	20.84	11.29	0.50	0.78
CD(*P*=0.05)	0.10	1.49	73.99	42.35	22.95	1.01	1.58

Table 3: Effect of Integrated Nitrogen Management and Planting Geometry on Economics of Sweet corn.

Treatments	Gross return (₹ ha^{-1})	Cost of cultivation (₹ ha^{-1})	Net return (₹ ha^{-1})	B : C ratio
T_1: 60cm x 20cm + 90 kg N (urea) + 30kg N (PM) +Azospirillum	155220.00	55338.55	99881.45	2.80
T_2: 60cm x 20cm + 90 kg N (urea) + 30kg N (FYM) + Azospirillum	127280.00	52658.55	74621.45	2.42
T_3: 60cm x 20cm + 90 kg N (urea) + 30kg N (VC) + Azospirillum	137373.33	62018.55	75354.78	2.22
T_4: 60cm x 25cm + 90 kg N (urea) + 30kg N (PM) + Azospirillum	144600.00	55338.55	89261.45	2.61
T_5: 60cm x 25cm + 90 kg N (urea) + 30kg N (FYM) + Azospirillum	124911.11	52658.55	72252.56	2.37
T_6: 60cm x 25cm + 90 kg N (urea) + 30kg N (VC) + Azospirillum	134733.33	62018.55	72714.78	2.17
T_7: 60cm x 30cm + 90 kg N (urea) + 30kg N (PM) + Azospirillum	132626.67	55338.55	77288.12	2.40
T_8: 60cm x 30cm + 90 kg N (urea) + 30kg N (FYM) + Azospirillum	115900.00	52658.55	63241.45	2.20
T_9: 60cm x 30cm + 90 kg N (urea) + 30kg N (VC) + Azospirillum	132316.67	62018.55	70298.12	2.13
T_{10}: 60cm x 20cm + 90kg N (urea) + 30kg N (PM)	130486.67	55328.55	75158.12	2.36
T_{11}: 60cm x 20cm + 90kg N (urea) + 30kg N (FYM)	119533.33	52648.55	66884.78	2.27
T_{12}: 60cm x 20cm + 90kg N (urea) + 30kg N (VC)	130244.44	62008.55	68235.89	2.10
T_{13}: 60cm x 25cm + 90kg N (urea) + 30kg N (PM)	126766.67	55328.55	71438.12	2.29
T_{14}: 60cm x 25cm + 90kg N (urea) + 30kg N (FYM)	119433.33	52648.55	66784.78	2.27
T_{15}: 60cm x 25cm + 90kg N (urea) + 30kg N (VC)	123200.00	62008.55	61191.45	1.99
T_{16}: 60cm x 30cm + 90kg N (urea) + 30kg N (PM)	122522.22	55328.55	67193.67	2.21
T_{17}: 60cm x 30cm + 90kg N (urea) + 30kg N (FYM)	114575.56	52648.55	61927.01	2.18
T_{18}: 60cm x 30cm + 90kg N (urea) + 30kg N (VC)	117311.11	62008.55	55302.56	1.89

Conclusion

From the experimental findings it can be concluded that for obtaining better sweet corn green cob yield, higher green fodder yield and higher net returns, the crop should be sown at a spacing of 60 cm x 20 cm, fertilized with 120 kg nitrogen, of which 90 kg nitrogen/ha should be provided through urea, 30 kg nitrogen/ha through poultry manure and the seeds should be inoculated with *Azospirillum* culture, in addition to

recommended doses of phosphorus and potassium application.

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