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Effect of FYM and silicon on productivity of organic sweet corn (*Zea mays saccharata*)

B SRI SAI SIDDARTHA NAIK[1]*, S K SHARMA[2], ROSHAN CHOUDHARY[3], SHARVAN KUMAR YADAV[4], GAJANAND JAT[5] and BHAWANI SINGH PRAJAPTH[6]

ICAR-All India Network Project on Organic Farming, Maharana Pratap University of Agriculture and Technology, Udaipur, Rajasthan 313 001, India

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ABSTRACT

Sweet corn (*Zea mays saccharata*) under organic farming is becoming popular in India. Field experiment was conducted during 2019 and 2020 to investigate the effect of nitrogen through FYM and silicon on growth and yield of sweet corn under organic farming at Organic Farming Unit, Maharana Pratap University of Agriculture and Technology, Udaipur, Rajasthan. The experiment was conducted in split-plot design with three replications and treatments consisted of four doses of recommended dose of nitrogen (RDN) applied through farmyard manure (FYM), i.e. control, 100, 75 and 50% of RDN through FYM and four levels of silicon, i. e. control, 100, 150 and 200 kg silicon/ha. Significantly higher plant height, dry matter accumulation, leaf area index, cob length, number of grains/cob, green-cob yield, green fodder yield and biological yield of sweet corn were obtained with the application of 100% RDN through FYM followed by application of 75% RDN through FYM and silicon @ 200 kg/ha followed by application of silicon @ 150 kg/ha. Interaction effect of application of 100% RDN through FYM in combination with silicon @ 200 kg/ha recorded significantly higher green-cob yield in comparison to 100% RDN through FYM without silicon as well as at lower levels of silicon. Thus, it may be concluded that application of 100% RDN through FYM with integration of silicon @ 200 kg/ha gives better green-cob yield of sweet corn under organic farming.

Keywords: FYM, Green-cob yield, Organic farming, Silicon, Sweet corn

Area under organic cereals was 3.6 million ha during 2019-20 in the world which was 0.6% of the total cereal area in the world (718 million ha in 2019; FAOSTAT). The organic cereal area has more than tripled since 2004 (1.3 million ha). In 2017, the area under organic maize was increased by 4.5–5.1%. Organic cultivation of maize is increasing in India. Maize is one of the important crop of organic farming systems in India. However, 20–40% yield reduction in organic maize has been observed in comparison to maize grown with chemical farming (Yadav *et al*. 2021). Sweet corn (*Zea mays saccharata*) is one type of specialty maize which is grown for fresh green cobs for human consumption and also used as raw and processed material for the food industry throughout the world. Among the several corn species, sweet corn has become more important especially as a vegetable. It is thus, sometimes referred as vegetable maize. This specialty corn with its high market value is very suitable for peri-urban agriculture. Increasing attention is now being paid to explore potential of sweet corn grown without fertilizer and pesticides in different parts of the country.

To achieve higher productivity under organic farming, application of recommended dose of nitrogen through organic source is a challenge. FYM is the main source of nutrient application in organic farming (Alam *et al*. 2014). In addition, there are other elements that benefit plant nutrition, such as silicon (Takahashi and Miyake 1977). It is suggested that silicon plays a crucial role in preventing or minimizing the lodging incidence in cereal crops (Singh *et al*. 2005). Silicon fertilization with other nutrients has always shown a highly significant synergistic effect and it is an option to mitigate soil fertility problem as it exploits available organic and inorganic nutrients for sustainable agricultural production and productivity. Keeping this in view, a field experiment was carried out to evaluate effect of varied rates of N application through FYM and different doses of silicon on growth, yield attributes and yield of sweet corn.

MATERIALS AND METHODS

Experimental site and treatment details: A field experiment was conducted during *kharif* 2019 and 2020 on

Present address: [1]ICAR-AINPOF, Maharana Pratap University of Agriculture and Technology, Udaipur, Rajasthan. *Corresponding author e-mail: siddunaik08@gmail.com.

Entisols soil, low in organic carbon (0.58%) and nitrogen (225 kg/ha), medium in available phosphorus (34.30 kg/ha), high in potassium (245.50 kg/ha), low in DTPA extractable iron (3.08 ppm) and zinc (0.45 ppm) at Organic Farming Unit, Rajasthan College of Agriculture, MPUAT, Udaipur (24°35' N latitude and 72°42' E longitude and at an elevation of 582.17 m amsl). The experiment was laid out in a split-plot design (SPD) with three replications. The treatment consists of four doses of N through FYM, viz. M_1-Control (no nitrogen); M_2- 100% RDN through FYM; M_3- 75% RDN through FYM; and M_4- 50% RDN through FYM in main-plots and four silicon doses, viz. S_1- Control (no silicon); S_2- silicon @ 100 kg/ha, S_3- silicon @ 150 kg/ha and S_4- silicon @ 200 kg/ha in sub-plots. The sweet corn was grown under organic management practices as per standards of National Programme on Organic Production (NPOP) (APEDA 2018).

Treatment application: The variety Sugar 75 of organic sweet corn was sown at a spacing of 60 cm row to row × 25 cm plant to plant. Nitrogen @ 90 kg/ha was applied to the crop through FYM before seed sowing and 50% of total dose of silicon was applied at the time of sowing and rest of two doses were applied with 25% of total dose of silicon at 30 DAS and remaining dose of 25% of total dose of silicon at silking stage of organic sweet corn.

Observations recorded: Five randomly selected plants were used to record the cob length, girth, number of filled cobs/plant and number of grains/cob, whereas the total biomass and green-cob yield (kg/ha) were calculated on the basis of total weight of harvested green fodder and green cob of sweet corn from the experimental plot.

Statistical analysis: The experimental data were statistically analyzed by using Analysis of Variance Method (ANOVA) procedure (Gomez and Gomez 1984) for the SPD using R Studio software. The least significant difference test was used to interpret the treatment effect at the 5% level of significance ($P<0.05$).

RESULTS AND DISCUSSION

Effect of nitrogen through FYM on growth, yield attributes and yield

Plant height: Data (Table 1) depicts that the effect of application of 100% RDN, 75% RDN and 50% RDN through FYM on plant height at harvest of sweet corn was significant over control but was found at par with each other during both the year. The significant increase in plant height with different levels of nitrogen through FYM might be due to the increased protoplasmic constituents and acceleration in the process of cell division and thereby resulted into higher growth (Dey *et al.* 2019).

Dry matter accumulation at harvest: Application of 100% RDN through FYM recorded significantly higher dry matter accumulation over the application of 75% RDN through FYM, 50% RDN through FYM and control. However, application of 50% RDN through FYM was found at par with control during 2019 and 2020 (Table 1).

LAI at harvest: The maximum and significant leaf area index at harvest of sweet corn during 2019 and 2020 was recorded with application of 100% RDN through FYM (3.34 and 3.34, respectively) over the application of 75% RDN through FYM, 50% RDN through FYM and control, respectively (Table 1).

Cob length: The maximum cob length of sweet corn during 2019 and 2020 was recorded with application of 100% RDN through FYM (19.11 and 19.50 cm, respectively) which was significantly superior over control (13.94 and 14.32 cm, respectively), but its effect was at par with application of 75% RDN through FYM (18.54 and 18.84 cm) (Table 2). This might be due to increasing dose of

Table 1 Effect of different doses of nitrogen application through farmyard manure and silicon on growth attributes of sweet corn under organic management

Treatment	Plant height (cm)		Dry matter accumulation (g/plant)		Leaf area index	
	2019	2020	2019	2020	2019	2020
% RDN application through FYM						
M_1 – Control	182.70	184.15	223.83	225.08	2.74	2.80
M_2 – 100	224.98	224.85	301.63	303.20	3.32	3.33
M_3 – 75	215.08	216.54	275.11	276.87	3.10	3.08
M_4 – 50	214.13	215.44	241.31	243.61	2.88	2.89
SEm±	5.64	6.16	6.54	6.82	0.03	0.02
CD (P=0.05)	19.51	21.30	22.65	23.58	0.12	0.07
Silicon (kg/ha)						
S_1 – Control	182.32	183.12	197.93	199.00	2.69	2.71
S_2 – 100	202.38	203.66	236.96	238.67	2.90	2.91
S_3 – 150	219.55	220.34	283.43	285.51	3.13	3.14
S_4 – 200	232.65	233.87	323.58	325.58	3.33	3.34
SEm±	3.54	2.61	6.13	4.10	0.03	0.02
CD (P=0.05)	10.34	7.61	17.89	11.96	0.09	0.04

Table 2 Effect of different doses of nitrogen application through FYM and silicon on yield attributes and yield of sweet corn under organic management

Treatment	Cob length (cm)		Number of grains/ cob		Green-cob yield (kg/ha)		Green-fodder yield (kg/ha)		Biological yield (kg/ha)	
	2019	2020	2019	2020	2019	2020	2019	2020	2019	2020
% RDN application through FYM										
M_1 – Control	13.94	14.32	236.25	242.25	2403	2445	7268	7360	9670	9805
M_2 – 100	19.11	19.50	334.92	338.33	4650	4865	16124	16609	20774	21474
M_3 – 75	18.54	18.84	315.67	322.75	4080	4228	13069	13470	17149	17698
M_4 – 50	14.88	15.03	270.50	277.92	3478	3518	10468	10798	13946	14316
SEm±	0.30	0.42	7.90	6.70	98	81	304	247	298	240
CD (P=0.05)	1.03	1.46	27.34	23.19	341	281	1051	854	1032	830
Silicon (kg/ha)										
S_1 – Control	15.19	15.41	239.17	244.77	3060	3156	9867	10083	12927	13238
S_2 – 100	15.69	15.91	265.67	271.85	3433	3558	11155	11380	14588	14939
S_3 – 150	17.23	17.62	298.33	304.85	3846	3974	12331	12776	16176	16750
S_4 – 200	18.36	18.76	354.17	359.77	4271	4368	13576	13999	17847	18367
SEm±	0.27	0.30	2.89	3.71	49	60	197	225	211	236
CD (P=0.05)	0.80	0.87	8.43	10.84	144	175	574	656	615	690

nitrogen application through FYM which enhance the morphological as well as physiological parameters thereby higher plant height, accumulation of dry matter per plant and leaf area index. Similar, observation was also recorded by Gunjal *et al.* (2020).

Number of grains per cob: Application of 100% RDN through FYM recorded significantly higher number of grains/ cob over the control. However application of 100% RDN through FYM was found at par with application of 75% RDN through FYM during 2019 and 2020. It might be due to higher fertility of flowers and increase in leaf area due to application of higher quantity of FYM which resulted into supply of required quantity of nutrients for formation of photosynthates. Similar, results were also reported by Gunjal *et al.* (2020).

Yield: Significantly higher green-cob yield (4650 kg/ ha and 4865 kg/ha), green-fodder yield (16124 kg/ha and 16609 kg/ha) and biological yield (20774 kg/ha and 21474 kg/ha, respectively) was obtained with the application of 100% RDN through FYM over the application of 75% RDN through FYM, 50% RDN application through FYM and control during 2019 and 2020. This might be due to quick release of nutrients and high availability of nitrogen in soil. These results are in conformity with Chhetri and Sinha (2019), Dey *et al.* (2019), Gunjal *et al.* (2020) and Yadav *et al.* (2021).

Effect of doses of silicon on growth, yield attributes and yield

Growth attributes: During 2019 and 2020, application of silicon @ 200 kg/ha recorded maximum plant height (232.65 and 233.87 cm, respectively), dry matter accumulation (323.58 and 325.58 g/plant, respectively) and leaf area index (3.33 and 3.35, respectively) at harvest which was found significantly superior over silicon @ 150 kg/ha, silicon @ 100 kg/ha and control (Table 1). This might be due to the fact that silicon fertilization increases nutrient availability, photosynthesis rate and dry matter accumulation (Pati *et al*. 2016).

Yield attributes: Data (Table 2) showed that during 2019 and 2020 application of silicon @ 200 kg/ha recorded maximum cob length (18.36 and 18.76 cm) and number of grains per cob (354.17 and 359.77, respectively) which was significantly superior over the application of silicon @ 150 kg/ ha, silicon @ 100 kg/ha and control. Silicon improves nutrient availability; growth rate enhances photosynthetic activity, higher translocation and accumulation of carbohydrates and ultimately seed weight of increases. Similarly, significantly higher number of grains per cob, fodder and biological yield were recorded with soil application of silicon @ 100 kg/ha over control. These findings were supported by Singh *et al*. (2007), and Aarekar (2014).

Yield: Data presented in Table 4 reveal that during 2019 and 2020, application of silicon @ 200 kg/ha recorded maximum green-cob yield (4271 kg/ha and 4368 kg/ha, respectively), green-fodder yield (13576 kg/ha and 13999 kg/ha, respectively) and biological yield (17847 kg/ha and 18367 kg/ha, respectively) of sweet corn which was significantly superior over the application of silicon @ 150 kg/ha, silicon @100 kg/ha and control. Green-cob and green stover yield might be owing to enhanced dry matter yield attributes due to application of higher dose of silicon. These findings corroborate the findings of Singh *et al.* (2007), Aarekar (2014) and Meena *et al.* (2016). Similarly, application of silicon recorded significantly higher biological yield which might be due to increase the green-cob and stover yield. Similar results were also observed by Sharma and Shankhdhar (2017) and Jawahar *et al*. (2019).

Table 3 Interaction effect of different doses of FYM and silicon on green-cob yield of sweet corn under organic management

M×S	Green cob yield (kg/ha) 2019					2020					Pooled				
	M_1	M_2	M_3	M_4	Mean	M_1	M_2	M_3	M_4	Mean	M_1	M_2	M_3	M_4	Mean
S_1	2111	3950	3469	2711	3060	2093	4129	3603	2796	3156	2102	4039	3536	2753	3108
S_2	2333	4320	3876	3203	3433	2407	4556	4011	3258	3558	2370	4438	3943	3231	3496
S_3	2499	4877	4302	3703	3846	2537	5144	4455	3758	3974	2518	5010	4378	3731	3910
S_4	2666	5450	4672	4293	4271	2740	5629	4843	4258	4368	2703	5539	4758	4276	4319
Mean	2403	4650	4080	3478		2445	4865	4228	3518		2424	4757	4154	3498	
	SEm±		*CD (P=0.05)*			*SEm±*		*CD (P=0.05)*			*SEm±*		*CD (P=0.05)*		
M at S	98		287			119		349			51		142		
	SEm±		*CD (P=0.05)*			*SEm±*		*CD (P=0.05)*			*SEm±*		*CD (P=0.05)*		
S at M	130		420			132		411			77		217		

Interaction effect of nitrogen through FYM and doses of silicon on yield: A close examination of data (Table 3) shows that interaction between different levels of % RDN application through FYM and varied level of silicon doses reflect significant influence on green-cob yield during 2019, 2020 as well as on pooled data basis. Pooled data of both year show that application of 100% RDN through FYM with application of 200 kg/ha silicon resulted in significantly highest green-cob yield compared to rest of the other treatment combinations. It might be due to application of nitrogen through FYM and silicon increased the supply of all nutrients and promoted growth and yield of sweet corn in comparison to lower supply of nitrogen and other nutrients in comparison to lower doses of FYM. Similar results were also observed by Hellal *et al*. (2012).

It can be stated that higher green-cob yield of sweet corn under organic farming can be obtained with the application of recommended dose of nitrogen through FYM along with the application of silicon @ 200 kg/ha. Hence, application of silicon along with recommended dose of FYM is beneficial for sweet corn production under organic management.

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