J. Indian Soc. Coastal Agric. Res. 35(2): 59-63 (2017)

Nutrient Uptake and Quality of Sweet Corn as Influenced by Drip Lateral Spacing and Fertigation Levels

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Received: 22.06.2017 Accepted: 27.11.2017

A field experiment was conducted consecutively for two years (2007-08 and 2008-09) during *rabi* seasons at Soil and Water Management Research Farm, Navsari Agricultural University, Navsari (Gujarat). In all 10 treatments, comprising nine combinations arising out of three levels each of lateral spacing (L_1: 1.2 m, L_2: 1.8 m and L_3: 2.4 m) and fertigation (F_1: 60%, F_2: 80% and F_3: 100% RDF i.e.120:60:60 kg NPK ha^{-1}) and one surface control (1.00 IW/CPE ratio + 100% RDF) were tested in factorial RBD with four replications. The L_1 among lateral spacing and F_3 among fertigation rates recorded significantly higher values of total uptake of N, P and K by sweet corn. The combination L_1F_3 registered significantly higher values of N, P and K uptake by sweet corn as compared to rest of the combinations. The surface control recorded higher uptake of N, P and K in comparison to drip mean. However, it was significantly less than the best drip treatment (L_1F_3). Further, there was no effect of treatments on distribution of N, P and K in different components of sweet corn. However, proportion of N and P removal through grain was more than stover and husk and that of K was more by stover. Protein content in sweet corn grain was not affected significantly due to main effect of lateral spacing and fertigation as well as their interactive effect. But, total sugar, reducing sugar and non-reducing sugar content in sweet corn grain were conspicuously affected only due to main effect of fertigation. In all the cases, *viz.,* total sugar (28.76%), reducing sugar (3.80%) and non-reducing sugar (23.71%), F_3 recorded significantly higher values in comparison to F_1 and F_2.

*(**Key words**: Fertigation, Lateral spacing, Nutrient uptake, Sugar content, Sweet corn)*

Sweet corn cultivation now-a-days has become popular among the farmers of South and middle Gujarat especially in the peri-urban areas. In general, due to adoption of conventional methods of irrigation, farmers are over irrigating the crop which causes loss of precious water resource and ultimately leading to low irrigation efficiency and productivity of sweet corn. Besides these, they generally follow blanket application of fertilizers to their crop without knowing the actual nutrient requirement of the crop resulting in poor nutrient use efficiency. For achieving better water and nutrient use efficiency, quality as well as productivity, it is advisable to adopt drip method of irrigation along with fertigation (Grazia *et al.,* 2003 and Lamm and Trooien, 2003). Further, sweet corn being consumed as fresh cob, its quality parameters *viz.*, sugar and protein content are important from consumers' preference point of view. As the information on these aspects for sweet corn was not available for South Gujarat region, the present field experiment was undertaken to relate the effect of different lateral spacing and fertigation levels on nutrient uptake and quality of sweet corn.

MATERIAL AND METHODS

A field experiment was conducted at Soil and Water Management Research Farm, Navsari Agricultural University, Navsari (Gujarat) during *rabi* seasons of 2007-08 and 2008-09. The soil of the experimental field was clay in texture, low in available N (235 kg ha^{-1}), high in available P (39 kg ha^{-1}) and fairly high in available K (459 kg ha^{-1}). In all nine treatment combinations consisting of three levels each of drip lateral spacing (L_1: 1.2 m, L_2: 1.8 m and L_3: 2.4 m) and fertigation (F_1: 60%, F_2: 80% and F_3: 100%, RDF: 120:60:60 NPK kg ha^{-1}) along with surface control (1.00 IW/CPE ratio + 100% RDF) were evaluated in factorial randomized block design with four replications. The sweet corn variety 'Sugar 75' was sown on 20th December and 22nd November during 2007-08 and 2008-09, respectively. Two common irrigations each of 60 mm depth were applied first at the time of sowing and second around 15 days after sowing for the purpose of proper emergence and establishment of crop in all the treatments. For drip irrigation treatments, the required quantity of water was applied on alternate day on the basis of pan evaporation

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fraction (PEF) of 0.6 mm depth. In surface irrigated plots, the entire quantity of P and K and 50 per cent of N were applied as basal using single super phosphate, muriate of potash and urea, respectively. Remaining 50 per cent of N was applied through urea in two equal split at knee high stage *i.e.,* 30 DAS and tasseling stage *i.e.,* 55 DAS. In drip irrigated plots, the entire quantity of P as per treatment was band placed using single super phosphate at the time of sowing. The treatment wise N and K were applied through drip (fertigation) in five equal splits at 10 days interval starting from 35 DAS. Grains were randomly collected from the cobs of selected plants from treatment (two plants from each row) and used for determining quality parameters. For dry matter yield, representative green cob (grain and husk) and stover were collected and dried in oven at $60^{o} \pm 2^{o}$C till constant weight. The average dry weight of grain, husk-sunk and stover were recorded and converted on hectare basis. Total and reducing sugars content in sweet corn grain was estimated (Somogyi, 1945) and expressed in

Table 1. *Effect of different treatments on total N, P and K uptake (kg/ha) by sweet corn*

Fertigation	Lateral spacing			Mean (F)
	L_1	L_2	L_3	
		Nitrogen		
F_1	43.8	26.9	21.5	30.7
F_2	64.9	32.3	22.7	40.0
F_3	69.5	34.0	24.6	42.7
Mean (L)	59.4	31.1	22.9	
Treat. mean				37.8
Control				42.2
	F	L	FxL	Control *vs* Rest
SEm ±	0.5	0.5	0.6	0.5
CD @ 5 %	1.5	1.5	1.8	1.4
CV (%)	8.3			
		Phosphorus		
F_1	16.5	10.3	7.9	11.6
F_2	24.5	12.2	8.6	15.1
F_3	25.9	12.8	9.4	16.0
Mean (L)	22.3	11.8	8.7	
Treat. mean				14.3
Control				15.8
	F	L	FxL	Control *vs* Rest
SEm ±	0.3	0.3	0.4	0.3
CD @ 5 %	0.9	0.9	1.0	NS
CV (%)	11.0			
		Potassium		
F_1	52.3	32.7	25.5	36.8
F_2	76.7	37.9	26.8	47.2
F_3	82.4	40.8	29.8	51.0
Mean (L)	70.5	37.1	27.3	
Treat. mean				45.0
Control				50.0
	F	L	FxL	Control *vs* Rest
SEm ±	0.9	0.9	1.0	0.7
CD @ 5 %	2.4	2.4	2.8	1.9
CV (%)	9.3			

percentage. Non-reducing sugar was computed by using formula given below and expressed in percentage.

Non-reducing sugar = (Total sugar – Reducing sugar)/0.95

The N, P and K content in different components of sweet corn was estimated by micro Kjeldahl (Waranke and Barber, 1974), vanadomolybdic yellow color (Jackson, 1967) and flame photometric (Jackson, 1967) methods, respectively. The component wise uptake of N, P and K by sweet corn was calculated separately. Subsequently, total removal of N, P and K was computed by summing up the component wise uptake.

RESULTS AND DISCUSSION

Nutrient uptake

The results presented in Table 1 revealed that L_1 among lateral spacing registered significantly higher total uptake of N (59.4 kg ha^{-1}), P (22.3 kg ha^{-1}) and K (70.5 kg ha^{-1}) as compared to L_2 and L_3. Similarly, F_3 among fertigation rates registered significantly higher total uptake of N (42.7 kg ha^{-1}), P (16.0 kg ha^{-1}) and K (51.0 kg ha^{-1}) in comparison to its lower levels. The treatment L_1F_3 ranked first among all the combinations by recording 69.5, 25.9 and 82.4 kg ha^{-1} total uptake of N, P and K, respectively. The control *vs* rest analysis showed significant impact on total uptake of N and K by sweet corn. In both the cases, the extent of total uptake of N and P was the maximum through grain and that of K through grain and stover. In terms of percentage, around 63 per cent N and 56 per cent of P was removed by grain of sweet corn. While in the case of total uptake of K, stover alone could remove about 61 per cent of K (Table 2). Similarly, accumulation of P in husk-sunk was relatively more (20%) than N (12%) and K (14%). Critical perusal of the results further revealed that the treatments had no influence on the proportion of removal of N, P and K either by grain or stover or husk-sunk. This implies that the significant effect of L, F and LF on total uptake of N, P and K was only due to variation in the quantity of dry matter produced under different treatments (Table 3). In other words, the uptake pattern of N, P and K by sweet corn is mainly governed by the amount of dry matter production. This is substantiated by the significantly higher dry matter yield observed in the treatments L_1F_3 and L_1F_2. When sweet corn was irrigated through drip by using laterals spaced at 1.2 m apart along with 100 per cent fertigation (L_1F_3), it could remove 69.5 kg N, 25.9 kg P and 82.4 kg K per hectare. The respective values of N, P and K uptake under control are 42.2, 15.8 and 50 kg ha^{-1} which are about 65 per cent less than in L_1F_3 treatment. This increase in nutrient removal by sweet corn under drip irrigation could be credited to the congenial soil-water-air proportion maintained in root zone of sweet corn. Similar results of better nutrient utilization by sweet corn/corn were also reported by Zue *et al*., (2007) on sandy loam soil of Georgia and Stone *et al.,* (2008) on sandy loam soil of South Carolina.

Quality parameters

As the sweet corn cobs are consumed fresh, its quality parameters *viz.,* total sugar, reducing sugar and non-reducing sugar were also determined (Table 4). The total sugar, reducing sugar and non-reducing sugar were affected conspicuously only due to main effect of fertigation *i.e.,* lateral spacing and its interaction with fertigation failed to exert significant effect on the content of different sugars in sweet corn grain. Among the fertigation levels, F_3 recorded significantly higher values

Table 2. *Component wise distribution (%) of N, P and K uptake by sweet corn under different treatments*

Treatment	N			P			K		
	Grain	Stover	Husk-Sunk	Grain	Stover	Husk-Sunk	Grain	Stover	Husk-Sunk
F_1L_1	63.2	23.8	13.0	55.9	22.9	21.1	23.5	62.1	14.4
F_1L_2	63.6	23.2	13.1	56.0	23.6	20.4	22.8	62.9	14.4
F_1L_3	63.6	23.8	12.6	55.0	23.7	21.3	22.8	62.3	14.9
F_2L_1	63.5	23.9	12.6	56.5	22.3	21.2	23.2	62.5	14.3
F_2L_2	63.7	23.6	12.7	57.5	23.3	19.2	24.0	61.6	14.4
F_2L_3	63.6	23.6	12.9	57.2	21.9	20.9	23.9	61.0	15.2
F_3L_1	63.0	23.5	13.5	55.9	23.2	20.9	23.7	61.6	14.7
F_3L_2	63.1	23.4	13.5	56.5	22.3	21.1	23.6	61.1	15.3
F_3L_3	62.9	24.0	13.1	56.3	23.5	20.2	23.2	62.2	14.5
Control	62.8	24.1	13.1	56.9	23.0	20.0	23.0	62.4	14.6

Table 3. *Effect of different treatments on total dry matter production (*t ha^{-1}*) of sweet corn*

Fertigation	Lateral spacing			Mean (F)
	L_1	L_2	L_3	
F_1	7.73	4.79	3.69	5.40
F_2	11.21	5.57	3.95	6.91
F_3	12.02	6.00	4.35	7.46
Mean (L)	10.32	5.45	3.99	
Treat. mean				6.59
Control				7.31
	F	L	FxL	Control *vs* Rest
SEm ±	0.08	0.08	0.09	0.06
CD @ 5 %	0.22	0.22	0.26	0.18
CV (%)	6.04			

Table 4. *Effect of different treatments on sugar content (%) in sweet corn grain*

Treatment	Total sugar	Reducing sugar	Non-reducing sugar
Lateral spacing			
L_1	25.78	3.27	21.38
L_2	26.13	3.29	21.70
L_3	26.10	3.28	21.67
SEm ±	0.40	0.08	0.35
CD @ 5 %	NS	NS	NS
Fertigation			
F_1	23.07	2.85	19.21
F_2	26.13	3.22	21.77
F_3	28.76	3.80	23.71
SEm ±	0.40	0.08	0.35
CD @ 5 %	1.14	0.21	1.00
Interaction	NS	NS	NS
Control *vs.* Rest			
Drip mean	25.99	3.29	21.56
Control Mean	27.10	3.49	22.43
SEm ±	0.30	0.06	0.26
CD @5 %	NS	NS	NS
CV (%)	7.21	10.90	7.60

of 28.76 per cent total sugar, 3.8 per cent reducing sugar and 23.71 per cent non-reducing sugar as compared to F_2, F_1 and control.

This implies that reducing fertilizer application adversely affected the quality of sweet corn grain, as sugar have direct bearing on sweetness of the grain. However, at similar level of fertilizer application through drip and surface method of irrigation, drip showed an edge over surface method. The reasons given earlier under section nutrient uptake are also tenable for quality parameters. The results of the present study are in close agreement with those earlier reported by Arunkumar *et al.* (2007) on *Vertisols* of Dharwad (Karnataka). Based on the results of present study, it is concluded that for getting higher biomass yield with more sweetness, sweet corn crop should be irrigated by drip method with fertigation of 120:60:60 kg NPK ha^{-1}.

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