

Original Research Article

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Methods of Irrigation, Fertilizer Approaches and Soil Ameliorant Use in Rabi Sweet Corn (*Zea mays saccharata* L.) in Lateritic Soils of Konkan

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ABSTRACT

Keywords

Irrigation, NPK, Micronutrients, Profitability, Soil ameliorant and soil test based approach.

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Two years field experiment was conducted during consecutive years of *rabi* 2012-13 to 2013-14 at Department of Agronomy, Dr. BSKKV, Dapoli on lateritic soils of *Konkan*, to determine suitability of irrigation method, fertilizer approaches and levels of soil ameliorant to sweet corn. Sweet corn grown under drip irrigation noticed significantly higher green cob, fodder and total biomass (1.67, 1.73 and 3.40 t/ha, respectively) with increment of 10.78, 4.05 and 7.35 %, respectively over check basin method of irrigation. Application of soil test based fertilizer requirement of N,P,K and micronutrients (Cu, Zn, B and Mn) had significantly highest green cob yield (2.05 t/ha) and increment was 71.66, 13.27 and 5.97% over control, recommended dose of fertilizer and soil test based fertilizer requirement of NPK, respectively. However, corn ameliorated with 50% lime requirement recorded the highest green cob and fodder yield (1.67 and 1.74 t/ha, respectively) with increment in the magnitude of 10.40% and 6.03%, respectively over lime control and 25% lime requirement. Economics of treatments revealed that, drip irrigated sweet corn has more net monetary returns (₹151.17x10³/ha) with benefit: cost ratio of 2.16:1. Sweet corn grown with application of soil test based fertilizer requirement of N,P,K and micronutrients (Cu, Zn, B and Mn) noticed profitable yield potential with high net returns of ₹ 257.14 x10³/ha and 2.31:1 benefit: cost ratio. However, corn ameliorated with 50% lime requirement recorded highest net returns ₹ 210.84x10³/ha, but profitability was highest with application of 25% lime requirement with B:C ratio of 2.20:1.

Introduction

The corn is also called the Indian corn, sweet corn, sugar corn or pole corn. Sweet corn is peculiarly an American crop and introduced in India from USA. Sweet corn (*Zea mays saccharata* L.) is one of the groups of maize (*Zea mays*) and is classified on the basis of kernel characteristics which have high sugar content in the milk on early dough stage. The higher content of water soluble polysaccharide in the kernel adds texture and quality in addition to sweetness (Venkatesh *et al.*, 2003).

Sweet corn is a versatile crop, which finds place in the human diet, animal food, fodder and industrial raw material. It is bred to have a higher level of natural sugars, which makes it very popular in rural as well as in urban area.

The red lateritic soil of *konkan* region is characterized by distinct acidity by presence of Al, Fe and Mn in soil solution at toxic level as majority of bases are removed by intense rainfall. Nutritional imbalance due to increase

or decrease concentration of ions in the soil solution, deficiency of phosphorus, boron, zinc and molybdenum and poor microbiological activity leading to low availability of nitrogen and sulphur. Since, application of lime to acid soil can stimulate crop growth by eliminating toxicities of Al and Mn and increase the availability of certain plant nutrients (Fageria and Baligar, 2008).

The luxurious corn production under application of major and micro nutrients based on soil test approach is necessary to get full advantage of applied nutrients with higher nutrient use efficiency of nutrients. Though annual rainfall is exceeding >3000 mm, the cool temperature and water shortage in post rainy season is very common in *konkan* region. To cope up such condition and better water use efficiency during *rabi* season through water saving and by use of micro irrigation techniques has key role not only in increased profit by raising crop yield by 20 to 100 per cent as compared to conventional method but also saving of labour.

Beware of this sweet corn can be a promising and high yield potential, short duration cash crop with wide scope for cultivation during *rabi* season. Proper managerial practices fetches better market price under *konkan* region. Therefore, there is need to ameliorate the soil by using desired quantity of liming materials like CaCO_3 , suitable fertilizer approach and to mitigate water requirement in post rainy season with high water use efficiency. Hence, effort was undertaken to study use of soil ameliorant, soil test based fertilizer approach for macro and micronutrients and irrigation methods which can envisage not only the productivity of crop but also sustaining soil health.

Materials and Methods

Field experiment was conducted at Agronomy farm, Department of Agronomy, Dr.

B.S.K.K.V., Dapoli during two consecutive *rabi* seasons of 2012-13 and 2013-14. The plot representing acidic pH (5.63) was selected for experimentation which was moderately high in organic carbon content (0.98%), medium in available nitrogen (371.14 kg/ha), low in available phosphorus (10.86 kg/ha) and fairly high in available potassium (265.90 kg/ha).

Experimental plot has high in available copper (1.92 mg/kg) and manganese (60.52 mg/kg), while low in zinc (0.42 mg/kg) and boron (0.27 mg/kg) content.

Main plot (horizontal levels) treatments consisting two irrigation methods *viz.*, check basin and drip irrigation and vertical levels consisted four different fertilizer applications approaches *viz.* control, recommended dose of fertilizer (200:60:60 NPK kg/ha), soil test based fertilizer requirement of NPK (200:75:60 NPK kg/ha) and soil test based fertilizer requirement of NPK and micronutrients (Cu, Zn, B and Mn) *i.e.* 200:75:60 NPK kg/ha and copper 3 kg/ha, zinc 6.25 kg/ha and boron 1.25 kg/ha. Sub plot treatment comprised of 3 levels of soil ameliorant as, lime control, 25% lime requirement and 50% lime requirement to ameliorate the soil. Lime requirement was determined as procedure given by Shoemaker *et al.*, (1961).

Analysis was done using strip split plot design with three replications. Sweet corn cultivar Sugar-75 was sown in paired row planting system with 60 X 30-30 cm spacing. The fertilizers were applied as per treatments. The full dose of P, K and all micronutrients were applied as basal dose, while nitrogen was applied in three splits *i.e.* 50% N at time of sowing and remaining N was top dressed in 2 equal splits (at 30 DAS and at 60 DAS). The periodic growth observations were recorded at 15 days interval.

Results and Discussion

Yield attributes and yield

Green cob, green fodder and total biomass yield of sweet corn was significantly influenced and recorded highest under drip method of irrigation over check basin irrigation. The increment in green cob, green fodder and total biomass yield was to the magnitude of 10.43, 4.17 and 7.25%, respectively over check basin method of irrigation (Table 1). The drip irrigated corn also recorded significantly higher number of cobs per ha during both years of experimentation. This may be ascribed due maintenance of ample soil *rhizosphere* moisture throughout the crop growing season owed to drip irrigation method and this is congenial for growth and development of higher yield attributes and subsequently into crop yields. Gautam *et al.*, (2000) reported under moisture stress condition all the growth factors were affected adversely to a greater extent in check basin irrigation. These findings are in line with the findings of Bharati *et al.*, (2007) and Ramulu *et al.*, (2010).

Sweet corn applied with soil test based fertilizer requirement of NPK and micronutrients (Cu, Zn, B and Mn) recorded significantly the highest green cob, green fodder and total biomass yield 2.05, 2.0 and 4.05 t/ha, respectively with increment to the tune of 5.97, 13.27 and 71.66%, respectively over soil over test based fertilizer requirement of NPK, recommended dose of fertilizer and control in that descending order of significance.

Moreover, green cob yield recorded with treatment soil test based fertilizer requirement of NPK and recommended dose of fertilizer were at par with each other. The number of cobs per ha was also significantly higher in soil test based fertilizer requirement of NPK

and micronutrients (Cu, Zn, B and Mn) over control during both years. The results are in agreement with those reported by Paramasivan *et al.*, (2011). Optimum availability of major as well as micro nutrient often may lead higher growth and yield attributes which might be reflected significantly in higher green cob and fodder yield of corn compared to rest of fertilizer approaches. These results were attributed by Gzazia *et al.*, (2003) and Bindhani *et al.*, (2007).

The elevated levels of application of lime requirement has significant effect on green cob, green fodder, total biomass and number of cobs per ha. Soil ameliorated with 50% lime requirement recorded significantly more green cob (1.67 t/ha) and fodder yield (1.74 t/ha) of sweet corn over soil ameliorated with 25% lime requirement (1.57 t/ha) and lime control (1.50 t/ha). Increase in green cob yield over lime control and 25% lime requirement due to 50% soil amelioration was to the tune of 10.40 and 4.64 per cent, respectively. Amelioration of soil owing to lime application might have reduced the soil acidity, improved base saturation pH, reduced toxicity of elements Al, Fe and Mn as corroborated by Dixit and Sharma (1993). Similarly, Dixit (2006) reported, the phosphorus level in soil was increased due to elevated levels of soil ameliorants and as phosphorus is an essential nutrient being involved in strengthening of roots, cell division, elongation, production of ATP and various metabolic reactions, thereby improving the productivity of crops which might have improved the crop yield.

Economics

Drip irrigated sweet corn recorded higher net returns (₹ 218.15 ×10³/ha) with more benefit: cost ratio of 2.16:1 over check basin method of irrigation method (₹151.17×10³/ha and 1.95:1 B: C ratio).

Table.1 Effect of irrigation methods, fertilizer approaches and soil ameliorant on green cob, fodder and total biomass yield of sweet corn (two years pooled mean)

Treatments	Green cob yield (t/ha)	Green fodder yield (t/ha)	Total Biomass (t/ha)	Number of cobs/ha	
				2012-13	2013-14
Irrigation methods (I)					
Check basin	1.49	1.66	3.15	63457	65500
Drip irrigation	1.67	1.73	3.40	72237	75013
S.Em. ±	0.01	0.01	0.02	2831	2400
C.D. at 5%	0.04	0.04	0.07	8589	7230
Fertilizer approaches (F)					
Control	0.58	1.00	1.58	59743	61249
RDF (200:60:60 NPK Kg ha ⁻¹)	1.78	1.88	3.65	68247	70949
Soil test based fertilizer requirement of NPK	1.92	1.90	3.83	70102	71506
Soil test based fertilizer requirement of NPK and Micronutrients (Cu, Zn, B and Mn)	2.05	2.00	4.05	73296	77323
S.Em. ±	0.01	0.01	0.01	559	580
C.D. at 5%	0.02	0.03	0.04	1685	1741
Soil ameliorant (L)					
Control	1.50	1.63	3.13	61991	63989
25 % Lime requirement	1.57	1.71	3.28	69735	72629
50 % Lime requirement	1.67	1.74	3.42	71815	74152
S.Em. ±	0.00	0.00	0.01	447	422
C.D. at 5%	0.01	0.01	0.02	1345	1267
Interactions					
I X F	NS	NS	NS	SIG	SIG
I X L	NS	SIG	NS	SIG	SIG
F X L	SIG	SIG	SIG	NS	NS
I X F X L	NS	NS	NS	NS	NS
General mean	1.58	1.69	3.27	67847	70257

Table.2 Interaction effects between fertilizer approaches X levels of soil ameliorant on green cob, fodder and total biomass yield (t/ha) of sweet corn

Treatments	Green cob yield (t/ha)			Green fodder yield (t/ha)			Total biomass yield (t/ha)		
	L ₀	L ₁	L ₂	L ₀	L ₁	L ₂	L ₀	L ₁	L ₂
F ₀	0.45	0.58	0.71	0.89	1.01	1.08	1.35	1.59	1.79
F ₁	1.67	1.78	1.87	1.79	1.90	1.88	3.52	3.68	3.75
F ₂	1.92	1.95	1.91	1.85	1.94	1.96	3.71	3.89	3.87
F ₃	1.96	1.98	2.20	1.97	1.98	2.04	3.94	3.95	4.25
S.Em. ±	0.02			0.01			0.03		
C.D. at 5%	0.05			0.04			0.09		

Table.3 Interaction effects between irrigation methods X levels of soil ameliorant on green fodder yield (t/ha) of sweet corn

Treatments	Green fodder yield (t/ha)		
	L ₀	L ₁	L ₂
I ₁	161.46	167.45	168.10
I ₂	164.35	174.06	180.24
S.Em. ±	0.62		
C.D. at 5%	1.89		

Table.4 Interaction effects between irrigation methods X levels of soil ameliorant on number of cobs/ha of sweet corn

Treatments	2012-13			2013-14		
	L ₀	L ₁	L ₂	L ₀	L ₁	L ₂
I ₁	61713	64144	63958	63840	66298	66364
I ₂	62268	75325	79673	64138	78960	81941
S.Em. ±	899			848		
C.D. at 5%	2690			2534		

Table.5 Interaction effects between fertilizer approaches X irrigation methods on number of cobs/ha of sweet corn.

Treatments	2012-13		2013-14	
	I ₁	I ₂	I ₁	I ₂
F ₀	54552	64933	56312	66186
F ₁	61186	67089	64696	70773
F ₂	68683	71520	69869	73144
F ₃	69405	85405	71125	89950
S.Em. ±	1148		1009	
C.D. at 5%	3449		3028	

Table.6 Effect of irrigation methods, fertilizer approaches and soil ameliorant on economics of sweet corn

Treatments	Cost of Cultivation (X ₹10 ³ /ha)	Gross Returns (X ₹10 ³ /ha)	Net Returns (X ₹10 ³ /ha)	B:C ratio
Irrigation methods (I)				
Check basin	159.16	310.33	151.17	1.95
Drip irrigation	188.39	406.55	218.15	2.16
Fertilizer approaches (F)				
Control	139.04	215.72	76.67	1.55
RDF (200:60:60 NPK kg ha ⁻¹)	176.14	367.29	191.16	2.09
Soil test based fertilizer requirement of NPK	183.11	396.80	213.69	2.17
Soil test based fertilizer requirement of NPK and Micronutrients (Cu, Zn, B and Mn)	196.82	453.96	257.14	2.31
Soil ameliorant (L)				
Control	149.43	286.39	136.96	1.92
25 % Lime requirement	171.83	378.02	206.19	2.2
50 % Lime requirement	200.07	410.90	210.84	2.05
General mean	173.78	358.44	184.66	--

Soil test based fertilizer requirement of NPK and micronutrients (Cu, Zn, B and Mn) recorded the highest net returns with higher benefit to cost ratio ($257.14 \times 10^3/\text{ha}$ and 2.17:1 over soil test based fertilizer requirement of NPK, recommended dose of fertilizer approach and control. Those results are confirmatory with those reported by Viswanatha *et al.*, (2000). Though, there were meager differences among 50% lime requirement and 25% lime requirement in respect of gross and net monetary returns of sweet corn due to levels of soil ameliorant. The soil ameliorated with 50% lime requirement showed higher net monetary return of corn ($210.84 \times 10^3/\text{ha}$) over the corn grown on soil ameliorated with 25% lime requirement ($206.19 \times 10^3/\text{ha}$) and lime control ($136.96 \times 10^3/\text{ha}$). However, the profitability in terms of benefit: cost ratios was found to be maximum with corn ameliorated with 25% lime requirement was 2.20:1 with sustained yield (Table 6).

Interaction effects

The green cob, green fodder and total biomass yield of sweet corn was significantly influenced by interaction between different fertilizer approaches and levels of soil ameliorants. The nutrients applied as per soil test based fertilizer requirement of NPK and micronutrients (Cu, Zn, B and Mn) approach and soil ameliorated with 50% lime requirement produced significantly highest green cob, green fodder and total biomass yield (2.20, 2.04 and 4.25 t/ha, respectively) of sweet corn over rest of treatment combinations (Table 2). These results are in conformity with the results reported by Selvaraju and Iruthayaraj (1995) and Kamala kumari and Singaram (1996).

The interaction effect between irrigation methods and levels of soil ameliorants was significant for green fodder yield of corn, and

sweet corn grown under drip irrigation method on soil ameliorated with 50% lime required recorded highest green fodder yield (180.24 t/ha) over rest of treatment combinations (Table 3).

The interaction for number of cobs per ha was also found significant. The sweet corn grown under drip irrigation method on soil ameliorated with 50% lime required noticed highest number of cobs per ha (79673 and 81941) during *rabi* 2011-12 and *rabi* 2012-13, respectively over other treatment combinations (Table 4). Whereas, drip irrigated corn supplied with nutrients as per soil test based fertilizer requirement of NPK and micronutrients (Cu, Zn, B and Mn) approach registered significantly highest number of cobs per ha *i.e.* 85405 and 89950 during *rabi* 2011-12 and *rabi* 2012-13, respectively (Table 5).

In conclusion, under *konkan* condition sustainable yield production and profitability of sweet corn during *rabi* season could be achieved by raising sweet corn under drip irrigation on the soil, ameliorated with 25% lime requirement with soil test based fertilizer requirement of NPK and micronutrient (Cu, Zn, B and Mn).

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