INFLUENCE OF SOIL AMELIORANT, FERTILIZER APPROACHES AND IRRIGATION METHODS ON GROWTH AND YIELD OF SWEET CORN (*Zea mays saccharata* L.) UNDER *KONKAN* CONDITION

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ABSTRACT

Two years field investigation was carried out to evaluate impact of soil ameliorant, fertilizer approaches and irrigation methods on sweet corn under lateritic soil of Konkan condition. The results revealed that drip irrigated sweet corn sown on soil ameliorated with 50% lime requirement and supplied with soil test based fertilizer requirement of N,P,K and micronutrients (Cu, Zn, B and Mn) recorded the highest growth and yield of the produce. Drip irrigated corn grown on soil ameliorated with 25% lime requirement and supplied with either soil test based fertilizer requirement of N,P,K and micronutrients (Cu, Zn, B and Mn) or soil test based fertilizer requirement of NPK also noticed optimum growth and yield of crop. Check basin irrigated sweet corn sown on no lime applied soil and no fertilizer application failed to show significant effect on growth and yield of corn.

Keywords: check basin, drip irrigation, soil ameliorant, soil test based approach, micronutrients and N, P, K.

I. INTRODUCTION

Maize is the third most important cereal crop next to wheat and rice in the world agriculture economy both as food for man and feed for animal. It has cultivated over an area of about 157.51 million hectare with a production of about 781.36 million metric tons and recorded 4.96 tones average yield per hectare. In India it is grown over an area of 8.49 million hectare with total production of about 21.28 million tones and average yield of 2.024 tons per hectare (Anonymous, 2011) [1]. It is peculiarly an American crop and introduced in India from USA. The corn is also called the Indian corn, sweet corn, sugar corn or pole corn. It is also commonly known as "simply corn" in United States, Canada, Australia and New Zealand, where as "Milho Verde" (Green corn) in

Brazil. 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. It is bred to have a higher level of natural sugars, which makes it very popular. Sweet corn varieties form normally essential gene that decreases the starch synthesis in the seed endosperm. The higher content of water soluble polysaccharide in the kernel adds texture and quality in addition to sweetness (Venkatesh *et al.* 2003). [2]

Sweet corn can be a promising short duration cash crop and wide scope during *rabi* season for cultivation, as it fetches better market price if timely sowing and proper managerial practices are followed under *konkan* region. Therefore, to achieve the potential yield of sweet corn under acidic soils of *konkan* region the use of drip irrigation, soil test based fertilizer approach for macro and micronutrients and use of soil ameliorant can envisage not only the productivity of crop but also sustaining the soil health. So, an attempt was made to study effect of soil ameliorant, approaches of fertilizer application and irrigation methods on performance of sweet corn under *Konkan* condition during *rabi* season of 2012-13 and 2013-14.

II. MATERIAL AND METHODS

Two years experiment was conducted at Agronomy farm, Department of Agronomy, Dr. B.S.K.K.V., Dapoli during *rabi* season 2012-13 and 2013-14 using strip split plot design with 24 treatment combinations replicated in three times. The plot representing acidic pH was selected for experimentation, besides this it was moderately high in organic carbon content, medium in available nitrogen, low in available phosphorus and fairly high in available potassium. Also, soil was high in available copper and manganese content, while low in zinc and boron content. Main plots (horizontal level) consisting of two irrigation methods, check basin (I_1) and drip irrigation (I_2). However, the vertical levels comprised of four different approaches of fertilizer applications as control (F_0), recommended dose of fertilizer (200:60:60 kg NPK ha^{-1}) (F_1), soil test based fertilizer requirement of NPK (F_2) and soil test based fertilizer requirement of NPK and micronutrients (Cu, Zn, B and Mn) (F_3). In sub plot, treatment comprised of three levels of soil ameliorant i.e. no lime (L_0), 25% lime requirement (L_1) and 50% lime requirement (L_2) to ameliorate the soil. Lime requirement was determined as suggested by Shoemaker *et al.* (1961) [3]. The sweet corn cultivar Sugar-75 was sown at 60 X 30-30 cm using paired row planting system maintaining about 55,555 plants ha^{-1}. The plot size of was 4.80 m X 3.60 m. The fertilizers (NPK and micronutrients) 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 in two half doses at 30 DAS and at 60 DAS. The periodic growth observations were recorded at 15 days interval.

III. RESULTS

3.1 Effect of irrigation methods:

The data presented in Table 1 and 2 revealed that, during both the years all growth attributes *viz.* plant height, leaf area, stem girth and dry matter accumulation in different plant parts and its partitioning were significantly influenced under study. Among various irrigation methods, the drip irrigated sweet corn recorded significantly more plant height, leaf area, stem girth and dry matter accumulation in different parts of corn over check basin irrigated corn during both the years of experimentation. Moreover, the mean per cent dry matter accumulation in leaves, stem, kernels, cob sheath and cob axis of sweet corn was 23.40 and 23.27, 24.54 and 24.08, 25.89 and 26.10, 13.81 and 14.09, and 12.36 and 12.47 per cent during the years 2012-13 and 2013-14, respectively (Fig. 1) [1]. Similar findings were reported by the Viswanatha *et al.* (2000) [4] and Ganesaraja *et al.* (2009). [5]

The green cob, green fodder and total biomass yield of sweet corn was significantly influenced and noticed the highest under drip irrigated corn over check basin irrigated sweet corn during both the years and in pooled analysis. The increase in the green cob, green fodder and total biomass yield over check basin irrigation due to drip irrigated corn was to the tune of 10.43, 4.17 and 7.25 per cent in the pooled data, respectively (Table 3). These results corroborated the findings of Ramulu *et al.* (2010). [6]

3.2 Effect of fertilizer approaches:

The scrutiny of data presented in Table 1 and 2 implies that, different fertilizer approaches significantly influenced all the growth attributes during both the years. The corn fertilized with soil test based fertilizer requirement of NPK and micronutrients (Cu, Zn, B and Mn) approach i.e. F_3 recorded significantly more plant height, leaf area^{-1}, stem girth and dry matter accumulation and its partitioning in different plant parts of sweet corn than rest of fertilizer approaches i.e. F_2, F_1 and F_0 in that descending order of significance during both years of investigation. However, the treatment difference due to soil test based fertilizer requirement of NPK and micronutrients (Cu, Zn, B and Mn) i.e. F_3 and soil test based fertilizer requirement of NPK (F_2) were on par in respect of stem girth during the year 2012-13 as well as 2013-14. The dry matter accumulation in cob axis during both years under treatment F_2 i.e. soil test based fertilizer requirement of NPK approach and recommended dose of fertilizer approach (F_1) were remained statistically on par with each other. Similar types of findings were reported by Kalanath *et al.* (2009) [7] and Singh *et al.* (2011). [8]

Data presented in Table 3 insinuates that, there were significant difference in green cob, green fodder and total biomass yield of sweet corn during the years 2012-13, 2013-14 and in pooled analysis due to various fertilizer approaches. Soil test based fertilizer requirement of NPK and micronutrients (Cu, Zn, B and Mn) i.e. F_3 recorded significantly the highest green cob, green fodder and total biomass yield over rest of the fertilizer approaches as soil test based fertilizer requirement of NPK (F_2), recommended dose of fertilizer (F_1) and control (F_0) in that descending order of significance. However, green cob and total biomass yield recorded under soil test based fertilizer requirement of NPK approach (F_2) and recommended dose of fertilizer approach (F_1) were on par during the year 2012-13 while green cob yield during both the years and in pooled data. The increase in green cob, green fodder and total biomass yield in pooled data over control due to fertilizer approaches F_3, F_2, and F_1 was to the tune of 71.66, 69.86 and 67.32 per cent; 50.16, 47.58 and 46.88 per cent and; 61.03, 58.80 and 56.82 per cent respectively. The results are in agreement with those reported by Paramasivan *et al.* (2011). [9]

3.3. Effect levels of soil ameliorant:

The plant height, leaf area plant^{-1}, stem girth and dry matter accumulation and its partitioning in different plant parts were significantly influenced during entire period of investigation. Significantly more growth attributes were recorded when 50% lime requirement (L_2) was used to ameliorate the soil over 25% lime requirement (L_1) and no lime application (L_0) during both the years. No lime application (L_0) noticed the least values of all the crop growth attributes than its elevated levels of soil ameliorants i.e. L_2 and L_1 during both the years (Table 1 and 2). These findings are in line with Ramesh and Ananthanarayana (2012). [10]

The data presented in Table 3 revealed that green cob, green fodder and total biomass yield was significantly influenced due to different levels of soil ameliorant during both the years and in pooled analysis. Sweet corn was grown over the soil ameliorated with 50% lime requirement (L_2) recorded significantly more green cob and green fodder yield over the soil ameliorated with 25% lime requirement (L_1) and no lime application (L_0) during year 2013-14 and in pooled data. However, the differences due to 50% lime requirement and 25% lime requirement were on par in case of green cob and green fodder yield during the year 2013-14 and total biomass yield during both years and also in pooled data. Whereas an increase in green cob, green fodder and total biomass yield over control due to levels of soil ameliorant L_2, and L_1 was to the tune of 10.40 and 4.64 per cent, 6.46 and 4.60 per cent and; 8.39 and 4.62 per cent, respectively in the pooled analysis. These findings are in accordance with Dixit (2006). [11]

3.4 Interaction effects:

An interaction effect among irrigation method, fertilizer approaches and levels of soil ameliorant was not up to the mark in respect of all the growth attributing characters.

Table 4 indicated that interaction between irrigation methods and fertilizer levels were found to be significant in respect of green cob yield during both years. Drip irrigated sweet corn when supplied with soil test based fertilizer requirement of NPK and micronutrients (Cu, Zn, B and Mn) approach (I_2F_3) recorded significantly the highest green cob yield over all the other treatment combinations during both the years, but it was found to be statistically at par with treatment combination of I_2F_2 and I_1F_3, during the year 2012-13. However green cob yield in pooled analysis, the fertilizer approaches and levels of soil ameliorants were found to be significant and treatment combination of F_3L_2 recorded significantly more green cob yield over rest of treatment combinations, which was followed by the treatment combination of F_3L_1. While the lowest under treatment combination of F_0L_0 (Table 5).

The green fodder yield was significantly influenced during the year 2012-13 due to interaction among irrigation methods and fertilizer approaches. Drip irrigated corn fertilized with soil test based fertilizer requirement of NPK and micronutrient (Cu, Zn, B and Mn) approach i.e. I_2F_3 recorded significantly more green fodder yield over rest of treatment combinations except, treatment combination of I_1F_3, which was at par with I_2F_3 (Table 6). Moreover, in pooled analysis interaction between irrigation methods and levels of soil ameliorant (Table 7) and fertilizer approaches and levels of soil ameliorant (Table 8) were found to be significant. Treatment combination of I_2L_2 recorded significantly the highest green fodder yield over all the other treatment combinations. Similarly, treatment combination of F_3L_2 recorded more green fodder yield which was significantly superior over rest of treatment combinations.

The data presented in Table 9 insinuates that soil test based fertilizer requirement of NPK and micronutrients (Cu, Zn, B and Mn) when supplied to sweet corn grown on the soil ameliorated with 50% lime requirement i.e. F_3L_2 recorded significantly more total biomass yield of sweet corn over all the other treatment combinations in pooled data and the lowest under treatment combination of L_0F_0. These results are in conformity with the results reported by Selvaraju and Iruthayaraj (1995) [12] and Kamala kumari and Singaram (1996). [13]

IV. CONCLUSION

To achieve optimum growth, development and yield of sweet corn it should be grown on soil ameliorated with 50% lime requirement under drip irrigation and supplied with soil test based fertilizer requirement of NPK and micronutrients (Cu, Zn, and Mn) which tends to higher values of growth and yield of sweet corn under *Konkan* condition.

Table 1. Effect of irrigation methods, fertilizer approaches and soil ameliorant on plant height, leaf area and stem girth of sweet corn

Treatments	Plant height (cm)		Leaf area (dm^2)		Stem girth (cm)	
	2012-13	2013-14	2012-13	2013-14	2012-13	2013-14
Irrigation methods (I)						
I_1 - Check basin	168.42	167.90	73.29	76.27	7.77	7.90
I_2 - Drip irrigation	178.50	175.87	76.66	79.67	8.11	8.24
S.Em. ±	1.16	1.30	0.81	0.85	0.06	0.07
C.D. at 5%	3.51	3.99	2.41	2.56	0.26	0.27
Fertilizer approaches (F)						
F_0 - Control	152.04	151.92	69.87	72.86	6.84	6.97
F_1 - RDF (200:60:60 NPK kg ha^{-1})	174.32	173.33	74.87	77.80	8.19	8.31
F_2 - Soil test based fertilizer requirement of NPK	181.01	178.71	76.98	80.00	8.35	8.47
F_3 - Soil test based fertilizer requirement of NPK and Micronutrients (Cu, Zn, B and Mn)	186.46	183.58	78.19	81.23	8.40	8.53
S.Em. ±	0.71	0.67	0.21	0.22	0.02	0.02
C.D. at 5%	2.08	2.03	0.64	0.66	0.05	0.06
Soil ameliorant (L)						
L_0 - Control	169.84	170.72	73.21	76.23	7.70	7.82
L_1 - 25 % Lime requirement	171.61	173.32	75.18	78.18	7.93	8.06
L_2 - 50 % Lime requirement	174.21	176.34	76.54	79.51	8.20	8.33
S.Em. ±	0.19	0.17	0.13	0.12	0.01	0.01
C.D. at 5%	0.58	0.56	0.38	0.37	0.04	0.03
Interactions						
I X F	NS	NS	NS	NS	NS	NS
I X L	NS	NS	NS	NS	NS	NS
F X L	NS	NS	NS	NS	NS	NS
I X F X L	NS	NS	NS	NS	NS	NS
General mean	**171.88**	**173.46**	**74.98**	**77.97**	**7.95**	**8.07**

Table 2. Effect of irrigation methods, fertilizer approaches and soil ameliorant on dry matter accumulation in different parts of sweet corn

Treatments	Dry matter (g)											
	Leaves		Stem		Kernel		Cob Sheath		Cob Axis		Total	
	2012-13	2013-14	2012-13	2013-14	2012-13	2013-14	2012-13	2013-14	2012-13	2013-14	2012-13	2013-14
Irrigation methods (I)												
I_1 - Check basin	43.82	45.11	45.96	46.68	48.49	50.61	25.86	27.31	23.15	24.18	187.29	193.89
I_2 - Drip irrigation	47.65	48.94	50.02	50.62	52.37	54.40	30.75	32.08	25.46	26.45	206.25	212.49
S.Em. ±	1.07	1.09	0.99	1.07	1.09	1.12	0.41	0.44	0.29	0.34	2.87	3.11
C.D. at 5%	3.21	3.30	3.04	3.27	3.30	3.40	1.26	1.37	0.93	1.06	8.99	9.55
Fertilizer approaches (F)												
F_0 - Control	38.85	40.14	40.45	41.13	43.40	45.52	21.53	23.00	23.50	24.62	167.73	174.40
F_1 - RDF (200:60:60 NPK kg ha^{-1})	43.71	45.00	45.18	45.93	48.37	50.35	25.60	26.98	24.19	25.23	187.03	193.48
F_2 - Soil test based fertilizer requirement of NPK	48.63	49.92	51.39	51.99	53.45	55.60	31.48	32.81	24.36	25.29	209.29	215.59
F_3 - Soil test based fertilizer requirement of NPK and Micronutrients (Cu, Zn, B and Mn)	51.77	53.06	54.95	55.55	56.52	58.55	34.61	35.99	25.18	26.14	223.02	229.29
S.Em. ±	0.20	0.21	0.21	0.19	0.11	0.13	0.07	0.07	0.06	0.06	0.61	0.57
C.D. at 5%	0.66	0.67	0.64	0.61	0.36	0.40	0.24	0.23	0.18	0.20	0.86	1.80
Soil ameliorant (L)												
L_0 - Control	44.01	45.30	46.21	46.98	48.94	51.03	26.92	28.29	23.58	24.66	189.65	196.26
L_1 - 25 % Lime requirement	45.83	47.12	48.00	48.60	50.36	52.45	28.37	29.75	24.46	25.45	197.02	203.37
L_2 - 50 % Lime requirement	47.37	48.66	49.76	50.36	52.01	54.04	29.62	31.05	24.88	25.85	203.64	209.95
S.Em. ±	0.08	0.09	0.08	0.08	0.10	0.09	0.08	0.08	0.06	0.06	0.27	0.29
C.D. at 5%	0.26	0.29	0.23	0.24	0.28	0.27	0.24	0.24	0.18	0.17	0.85	0.86
Interactions												
I X F	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
I X L	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
F X L	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
I XF X L	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
General mean	**45.74**	**47.07**	**47.99**	**48.65**	**50.43**	**52.50**	**28.30**	**29.70**	**24.31**	**23.52**	**196.77**	**203.19**

Table 3. Effect of irrigation methods, fertilizer approaches and soil ameliorant on dry matter accumulation in different parts of sweet corn

Treatments	Green cob yield (q ha^{-1})			Green fodder yield (q ha^{-1})			Total Biomass (q ha^{-1})		
	2012-13	**2013-14**	**Pooled**	**2012-13**	**2013-14**	**Pooled**	**2012-13**	**2013-14**	**Pooled**
Irrigation methods (I)									
I_1 - Check basin	146.18	152.77	149.48	153.52	177.82	165.67	299.70	330.59	315.14
I_2 - Drip irrigation	149.67	184.12	166.89	160.55	185.22	172.88	310.22	369.34	339.78
S.Em. ±	0.87	1.98	1.12	1.33	1.88	1.23	0.95	3.61	2.01
C.D. at 5%	2.86	6.48	3.96	4.63	6.10	4.28	3.09	12.57	7.23
Fertilizer approaches (F)									
F_0 - Control	47.43	68.61	58.02	81.54	117.70	99.62	128.97	186.32	157.64
F_1 - RDF (200:60:60 NPK Kg ha^{-1})	178.50	176.58	177.54	176.31	198.79	187.55	354.82	375.37	365.09
F_2 - Soil test based fertilizer requirement of NPK	180.02	204.93	192.47	178.61	201.52	190.06	358.63	406.44	382.54
F_3 - Soil test based fertilizer requirement of NPK and Micronutrients (Cu, Zn, B and Mn)	185.76	223.65	204.70	191.67	208.06	199.86	377.42	431.71	404.57
S.Em. ±	0.83	0.96	0.80	0.86	1.09	0.88	1.26	1.51	1.27
C.D. at 5%	2.51	2.90	2.42	2.70	3.28	2.68	3.81	4.80	3.90
Soil ameliorant (L)									
L_0 - Control	141.72	158.19	149.95	151.24	174.58	162.91	292.96	332.76	312.86
L_1 - 25 % Lime requirement	150.40	164.10	157.25	159.26	182.24	170.75	309.66	346.34	328.00
L_2 - 50 % Lime requirement	151.66	183.04	167.35	160.60	187.74	174.17	312.26	370.78	341.52
S.Em. ±	0.55	0.83	0.45	0.49	0.64	0.33	0.72	1.20	0.78
C.D. at 5%	1.65	2.50	1.34	1.40	1.92	0.95	2.15	3.46	2.26
Interactions									
I X F	**SIG**	**SIG**	NS	**SIG**	NS	NS	NS	NS	NS
I X L	NS	NS	NS	NS	NS	**SIG**	NS	NS	NS
F X L	NS	NS	**SIG**	NS	NS	**SIG**	NS	NS	**SIG**
I XF X L	NS	NS	NS	NS	NS	NS	NS	NS	NS
General mean	**147.93**	**168.44**	**158.19**	**157.03**	**181.52**	**169.28**	**304.97**	**349.96**	**327.46**

Table 4. Green cob yield (q ha^{-1}) of sweet corn as influenced by interaction effects among irrigation methods X fertilizer approaches during 2012-13 and 2013-14

Treatments	2012-13		2013-14	
	I_1	I_2	I_1	I_2
F_0	46.54	48.32	58.36	78.87
F_1	165.59	170.18	149.89	203.28
F_2	184.73	188.78	198.64	211.21
F_3	187.86	191.41	204.20	243.10
S.Em. ±	2.08		2.20	
C.D. at 5%	6.32		6.63	

Table 5. Green cob yield (q ha^{-1}) of sweet corn as influenced by interaction effects between fertilizer approaches X levels of soil ameliorant in pooled data

Treatments	Pooled		
	L_0	L_1	L_2
F_0	45.22	57.95	70.90
F_1	166.97	178.30	187.36
F_2	192.00	194.65	190.77
F_3	195.62	198.11	220.39
S.Em. ±	1.78		
C.D. at 5%	5.37		

Table 6. Green fodder yield (q ha^{-1}) of sweet corn as influenced by interaction effects between irrigation methods X fertilizer approaches during year 2012-13

Treatments	2012-13	
	I_1	I_2
F_0	81.29	81.79
F_1	161.62	170.07
F_2	182.55	194.72
F_3	188.62	195.60
S.Em. ±	2.41	
C.D. at 5%	7.30	

Table 7. Green fodder yield (q ha^{-1}) of sweet corn as influenced by interaction effects between irrigation methods X levels of soil ameliorant in pooled data

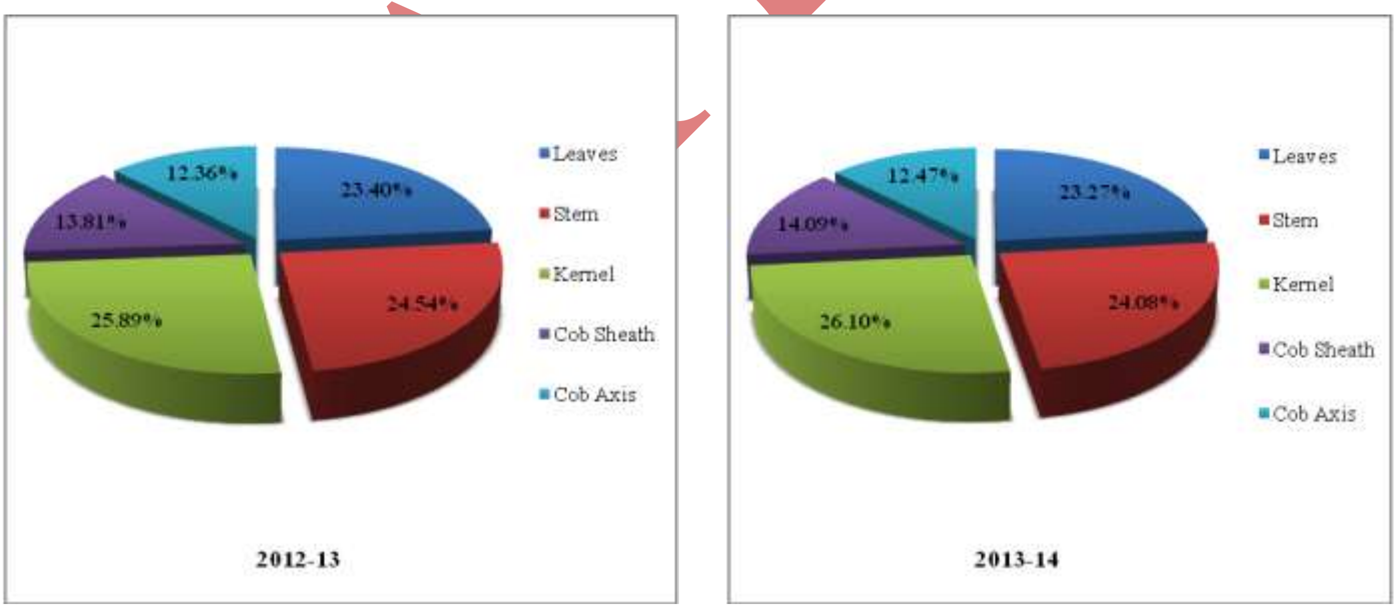
Treatments	Pooled		
	L_0	L_1	L_2
I_1	161.46	167.45	168.10
I_2	164.35	174.06	180.24
S.Em. ±	0.62		
C.D. at 5%	1.89		

Table 8. Green fodder yield (q ha^{-1}) of sweet corn as influenced by interaction effects among fertilizer approaches X levels of soil ameliorant in pooled data

Treatments	Pooled		
	L_0	L_1	L_2
F_0	89.35	101.33	108.18
F_1	179.33	190.05	187.85
F_2	184.76	194.39	196.48
F_3	197.24	198.18	204.17
S.Em. ±	1.27		
C.D. at 5%	3.78		

Table 9. Total biomass yield (q ha^{-1}) of sweet corn as influenced by interaction effects between fertilizer approaches X levels of soil ameliorant in pooled data

Treatments	Pooled		
	L_0	L_1	L_2
F_0	134.57	159.28	179.08
F_1	351.73	368.34	375.20
F_2	371.33	389.04	387.24
F_3	393.80	395.35	424.55
S.Em. ±	3.20		
C.D. at 5%	9.06		



[1] **Fig 1. Effect of irrigation methods, fertilizer approaches and levels of soil ameliorant on dry matter accumulation in different plant parts (%) at harvest of sweet corn during 2012-13 and 2013-14.**

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