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Yield and quality of sweet corn under varying irrigation regimes, sowing methods and moisture conservation practices

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Abstract
Studies were conducted during spring season of 2017 and 2018 at Govind Ballabh Pant University of Agriculture and Technology, Pantnagar to determine the effect of irrigation scheduling (IW/CPE 1.4,1.2 and 1.0), method of establishment (flat and furrow sowing) and moisture conservation practices (control, mulch and biochar) on yield components, sugar and protein content of fresh sweet corn. Experiments were carried out in split plot design with two main factor and one sub plot factor and replicated thrice. Results revealed that IW/CPE 1.4 gave significantly higher dehusked cob weight and biological yield (213 g, 39.47 t ha^{-1}) and was followed by 1.2 (203 g, 38.09 t ha^{-1}). However, the highest TSS (15.58) was obtained in IW/CPE 1.0 which was followed by 1.2 (14.99). Furrow method was superior to flat sowing with respect to yield attributing characters and biological yield (7.4% increase over flat sowing). Mulch and biochar resulted in significantly higher biological yield as compared to control. Furrow sowing method and moisture conservation practices resulted in numerically higher values of TSS and sugar content as compared to flat sowing and control. The protein content was non significantly affected due to various management practices. As an interaction effect, the dehusked cob weight under IW/CPE 1.2 furrow sowing was at par with IW/CPE 1.4 flat sowing during both the years. Conclusively, for obtaining better quality and productivity spring season sweet corn should be sown under furrow method, irrigated at IW/CPE 1.2 and applied with mulch or biochar under sandy loam soils.

Keywords: Biochar, furrow, IW/CPE, mulch, quality, sweet corn

Introduction
Maize is a major staple cereal crop having wide environmental range and biological efficacy. Sweet corn is a hybrid type of maize having higher sucrose content, kernel protein and many other minerals. Popularity of sweet corn is increasing amongst the farmers due to its short duration and high economic returns. Besides providing green cobs, it also produces good quality fodder for milch animals (Abebe *et al*., 2016) [1]. Spring season cultivation results in higher productivity due to higher bright sunshine hours, reduced pest and disease attack but high ET owing to high temperature enforces increased irrigation frequency which leads to high cost of cultivation. Morpho-physiological and biochemical attributes of maize has been reduced when maize is subjected to water stressed conditions at tasseling stage (Anjum *et al*., 2011) [2]. Besides, there is reduction in grain filling and restricted root growth which eventually hampers productivity. Thus, judicious use of irrigation water together with moisture conservation is necessary to meet the crop water requirement and reduce pressure on the existing water resources.

Furrow sowing curtails evaporation losses as it applies water directly to the crop root zone. Rice straw is a major component of agricultural field and is often considered as a liability. If this rice straw is used as mulch, it will help in addition of considerable amount of organic matter and nutrients to the soil (Muhammad *et al*., 2009) [8], maintain soil moisture regime and structural stability. Moreover, rice straw in the form of biochar has capability of carbon sequestration, moisture retention, reducing soil compaction, improving soil physical condition and enhancing nutrient uptake from the soil (Lehmann, 2007) [6]. Thus, the present study was conducted to find out the best combination of irrigation water management for achieving higher yield and quality of sweet corn.

Methodology
Field experiments were conducted during spring season of 2017 and 2018 at Govind Ballabh Pant University of Agriculture and Technology, Pantnagar to investigate the effect of irrigation scheduling, method of establishment and moisture conservation practices in spring sweet corn. Sweet corn was irrigated at three ratios (IW/CPE of 1.0, 1.2 and 1.4). Sowing was done in flat plots and furrows and moisture conservation practices like mulch @ 6.0 t $ha^{-1}$and biochar @

Sweet corn was irrigated at three ratios (IW/CPE of 1.0, 1.2 and 1.4). Sowing was done in flat plots and furrows and moisture conservation practices like mulch @ 6.0 t $ha^{-1}$and biochar @ 3.0 t $ha^{-1}$was adopted. Sugar 75 variety was sown @ 10 kg ha^{-1}at 60 x 20 cm geometry. Biochar was applied in prepared field prior to opening of furrows and mulch (loose rice straw) was applied within 1-2 days of sowing. Five cobs from the net plot were weighed with husk. The husk was removed from the above cobs for recording weight per cob without husk. The husk percentage was calculated on the basis of the observations recorded on five cobs.

$$\text{Husk (\%)} = \frac{\text{Cob weight with husk - cob weight without husk}}{\text{Cob weight with husk}} \text{ x } 100$$

Number of grains per cob was calculated by multiplying average number of grain rows/cob and average number of grains per row. The total biological yield was calculated by addition of green fodder yield and total husked cob yield. The total soluble solids (TSS) were measured with hand refractometer. Reducing sugar was estimated by the "Lane and Eynon" method described by Ranganna, 1986. The filtrates left after obtaining reducing sugar was used for total sugar estimation. The non reducing sugar was obtained by subtracting reducing sugar from total sugar and multiplied by 0.95. Nitrogen content in the grains was multiplied by 6.25 to get the protein content in grains (AOAC, 1964) [3]. Data were analysed under split plot design with two main plot factors and one sub plot factor with the help of OPSTAT statistical programme developed by HISAR (Sheoran *et al*., 1998) [10]. The analysis of variance was calculated and the least significant difference (LSD) values were used to compare treatment means at p =0.05.

Results and Discussions

Experimental results revealed that significantly higher dehusked cob weight was recorded under IW/CPE 1.4 as compared to the other ratios. Similar findings have also been reported by Mathukia *et al*. (2014) [7] in *rabi* sweet corn. An increase in dehusked cob weight to the extent of 7.3 percent was registered under furrow sowing over flat method. Mulch and biochar were found superior to control and recorded higher dehusked cob weight over control. Significant interaction between irrigation levels and sowing method on dehusked cob weight was observed during both the years. Irrigation at IW/CPE 1.2 in furrow sowing was significantly at par with that of IW/CPE 1.4 in flat sowing. At lower ratio also, furrow sowing recorded higher husked cob weight that flat sowing.

Difference in husk percentage under irrigation levels was statistically equal. Furrow sowing and flat sowing were statistically at par, however numerically higher value was found with flat sowing. Reduced husk percentage was noted with mulch and biochar but the differences were statistically non significant.

The number of grains per cob was found to be significantly higher in IW/CPE 1.4 in comparison to 1.2 and 1.0. Significant variations in the number of grains per cob are due to variations in the number of row and number of grain per row. Barpete *et al*. (2009) [4] reported that the irrigation scheduled at 80% PE resulted in higher number of grains per cob than lower PE irrigation treatments. Furrow sowing brought an increase in number of grains per cob to the tune of 5.9 % over flat sowing probably owing to better plant growth. Biochar application resulted in significantly higher number of grains per cob (605) over mulch (581) and control (530).

Table 1: Effect of irrigation levels, sowing methods and moisture conservation practices on yield attributes and yield of sweet corn (mean of two years)

Treatment	Dehusked cob weight (g)	Husk percentage (%)	Number of grains per cob	Biological yield (t ha^{-1})
Irrigation level				
IW/CPE 1.0	180	30.15	531	33.85
IW/CPE 1.2	203	30.29	576	38.05
IW/CPE 1.4	213	29.52	608	39.47
SEm±	1	0.53	7	0.28
CD 5%	4	NS	22	0.89
Sowing method				
Flat	192	29.33	555	35.81
Furrow	206	30.64	588	38.45
SEm±	1	0.43	6	0.23
CD 5%	4	NS	18	0.73
Moisture conservation practice				
Control	190	30.89	530	35.86
Mulch	203	29.36	581	37.65
Biochar	204	29.71	605	37.86
SEm±	2	0.53	6	0.31
CD 5%	6	NS	17	0.89

Table 2: Interaction effect between irrigation level and sowing method on dehusked cob weight of sweet corn during both the years

Irrigation level	Sowing method			
	2017		2017	
	Flat	Furrow	Flat	Furrow
IW/CPE 1.0	155	176	183	207
1.2	185	192	215	221
1.4	188	205	223	237
SEm±	2		3	
CD 5%	7		8	

The biological yield increased with increase in irrigation number being the highest at IW/CPE 1.40 (39.47 t ha^{-1}). Sonpure *et al*. (2015) [12] also found an increment in the total biomass of sweet corn under frequent irrigation application. Sowing method significantly influenced the biological yield, with furrow planting having the highest value (7.4%) over flat sowing. Among the moisture conservation practices, mulching and biochar application significantly influenced biological yield. The higher moisture availability under IW/CPE 1.4, furrow sowing, mulch and biochar led to improved physiological process in sweet corn which eventually resulted in higher biological yield.

The total soluble solids (TSS) content was affected significantly by irrigation scheduling only. Comparatively higher TSS was recorded under IW/CPE 1.0 and was found to be at par with IW/CPE 1.2. Higher soluble solid was due to moisture stress condition under IW/CPE 1.0 as compared to the higher ratios. These results coincided with that of Shivakumar *et al*. (2011) [11] who reported higher taste and juiciness in baby corn when subjected to relatively stressed conditions. Furrow method of sowing did not produce significantly superior value in terms of TSS over flat sowing. Among moisture conservation practices biochar and mulch were superior to control which helped in better nutrient availability to the crop leading to higher TSS content in the grains.

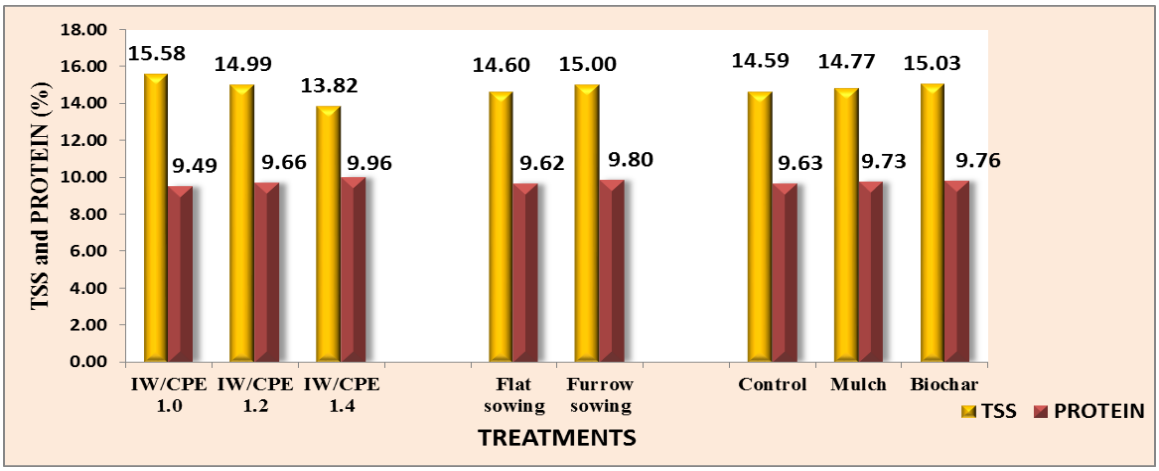

Fig 1: Effect of various irrigation levels, sowing methods and moisture conservation practices on TSS (ºBrix) and protein content (%)

Crude protein content of sweet corn was non significantly influenced by irrigation levels, sowing method and moisture conservation practices in both the years. Protein content ranged between 9.49 to 9.96%. The higher protein value (non significant) in plots with higher number of irrigations, furrow method, mulch and biochar might be due to better moisture regime, absorption and translocation of nitrogen from leaves to grain.

The total sugar, non reducing and reducing sugar was found to be the highest under IW/CPE 1.0 and was at par with 1.2. Lesser the number of irrigations, more is the sugar content. Finding reports of Ertek and Kara (2013) [5] also confirm higher sugar content water deficit treatments. Invariably, the reducing sugar content was less as compared to non reducing sugar under all the treatments. Different sowing methods and moisture conservation practices were comparable with each other for reducing sugar. However, value was numerically higher under mulch and biochar. Mulch improves soil biological activities and creates favourable condition for higher nutrient uptake. Biochar is highly porous in nature and has high surface area which helps in better retention of nutrients and water within the pore space.

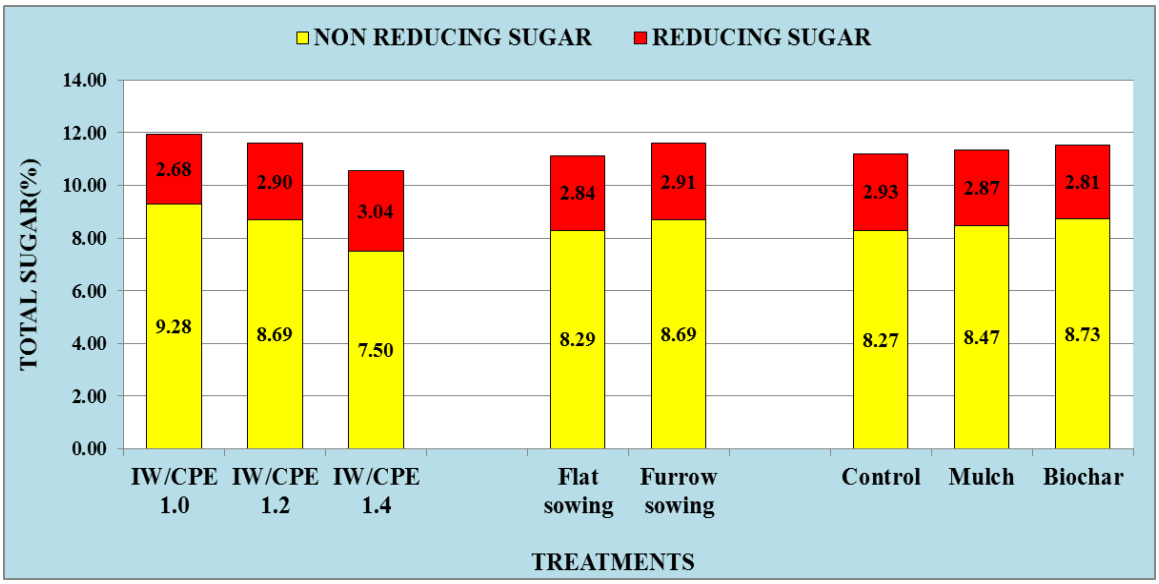

Fig 2: Effect of various irrigation levels, sowing methods and moisture conservation practices on reducing, non-reducing and total sugar content (%)

Thus, based on the above experimental findings and to strike a balance between yield and quality, it can be concluded that spring sweet corn should be irrigated at IW/CPE 1.2 and sown under furrow method. For further moisture conservation and quality enhancement, mulch or biochar should be applied.

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