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Effects of Waterlogging on the Yield and Yield Components of Sugarcane

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Sugarcane (*Saccharum officinarum*) is an important industrial-cum- cash crop in Bangladesh. This crop undergoes different climatic changes during its long growing period. The crop is usually planted in winter months (Nov-Jan). After winter, summer starts when irrigation is needed to meet up its evapotranspiration demand for successful cultivation. After summer, rainy season starts and sometimes heavy rainfall creates temporary waterlogging condition which is harmful for normal crop growth. Again heavy continuous rainfall creates flood for several weeks. Obviously, situation goes against growing any crop including sugarcane. Long time waterlogging affects all plant parameters and ultimately crop yield is badly affected. Again it is well known that yield of sugarcane is decreased considerably due to vulnerability of sugarcane to waterlogging. Estimate shows that about 50% of sugarcane is planted on land where water remains stagnant for a longer period or become submerged flood (Anonymous, 1992). Therefore, considering above facts controlled study with lysimeter was conducted in 1994 to investigate the effects of waterlogging on different yield parameters as well as yield of sugarcane variety Isd 21.

The experiment was conducted in five Lysimeter boxes (2m x 1m) of lysimetric set up at the Bangladesh Institute of Nuclear Agriculture (BINA) farm, Mymensingh. The experiment could not be replicated because of limited Lysimeter boxes. The details of lysimetric set up has been described by Hasan et al. (1995). Before transplanting, soil of lysimeter boxes were well prepared using spade upto 30 cm depth. At final soil preparation stage, the soil was fertilized with recommended basal doses of fertilizers (90 Kg N ha-1 as urea, 140 kg P2O5 ha-1 as TSP, 40 kg S ha-1 as gypsum and 8 kg Zn ha-1 as zinc oxide. Additional 90 kg N ha-1 from urea was applied in two equal splits during the growth period. The settlings of variety Isd 21 was transplanted on 10th January 1994 along the length of the lysimeter (2m) maintaining 40 cm plant to plant distance. All boxes were irrigated until waterlogging is created and treatment starts. First irrigation (IW) was based on field capacity of soil and commenced on 20 February 1994. There were two additional irrigations at 66 and 176 DAP based on IW/CPE ratio =0.6 obtained from earlier findings (Anon 1993). Waterlogging treatments were started considering the beginning of rainy season of this area. Waterlogging was created through bottom feeding of lysimeter system from June 18, 1994 and maintained 10 cm water level above soil surface of lysimeter.

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Following five treatments were practiced :

Do = Full drainage (no standing water), D_{15} = 15 days waterlogging and then full drainage, D_{30} = 30 days waterlogging and then full drainage, D_{60} = 60 days waterlogging and then full drainage, D_{90} = 90 waterlogging and then full drainage

Waterlogging treatments were started since 18 June 1994. At the end of waterlogging, crop was not irrigated up to harvest. During growth period normal cultural practices were done. Data on plant height and number of tillers per plant at 10 d interval were recorded upto harvest. Soil moisture data at planting, before irrigation and at harvest were measured using neutron moisture meter. Runoff and deep percolation volumes of water were collected and measured during growth period. Data on number of tillers per lysimeter, number of internode per plant, stalk diameter, number of millable cane per lysimeter, weight per cane, percent and yield per lysimeter were recorded at harvest.

Evapotranspiration of sugarcane was calculated using the following water balance equation for the whole growth period.

$$E_t = R+I+\Delta SM-D-Ro$$

Where, E_t = Evapotranspiration (cm)

R= Rainfall (cm)

I = Irrigation (cm)

ΔSM = Changes in soil moisture storage from planting to harvest (cm)

D = Deep percolation (cm)

R_0 = Runoff (cm)

Effects of waterlogging on yield and yield components of sugarcane are presented in the Table 1. Yield components of sugarcane like plant height, number of internodes per plant, stalk diameter, weight per cane and recovery % showed negative association with waterlogging duration. All components showed insignificant effects due to waterlogging except cane yield. Cane yield showed significant negative association with waterlogging. Yield of cane decreased as the period of waterlogging increased. The highest yield was obtained in lysimeter with full drainage provision, and the lowest in 90 days period of continuous waterlogging. Waterlogging showed insignificant positive association with yield components like number of tiller and number of millable cane per lysimeter (Table 1).

Component of evapotranspiration and water use efficiency of sugarcane under waterlogging is shown in the Table 2. Evapotranspiration values for all treatments are found to be similar. It has been reported earlier that evapotranspiration increased with increased frequency of irrigation due to higher transpiration rate (Anon 1993). In this experiment, evaporation was prominent because evaporation from open pan occurred during waterlogging period and continued upto condition till soil moisture was above field capacity. Water use efficiency was found to be the highest under control condition due to higher yield. Run-off was higher in treatment of long duration waterlogging compared to other treatments. Again the highest deep percolation was found in control compared to long duration waterlogging. This fact suggests that cane growers should provide better management practices to increase cane yield by removing excess water either by deep percolation or by run-off as far as practicable in areas of short duration waterlogging.

Considering the performance of variety Isd 21 against waterlogging, it can be said that the variety is well tolerant. In yield point of view, if yield m^{-2} is converted into yield ha^{-1} than it becomes 116.10 tons ha^{-1} and 154.90 tons ha^{-1} under 3 months waterlogging and full drainage condition, respectively. The variety showed similar yield under waterlogging condition and non-waterlogged condition (Anon 1994). Except under full drainage condition , it has a good number of adventitious roots above ground surface around cane base for all plants in waterlogging treated lysimeters. The adventitious roots were maximum in long duration waterlogging treated lysimeter. This may be one of the characters, which made the variety waterlogging tolerant. These special characteristics may be assessed by cane physiologist. All other yield components of Isd 21 were prominent as under normal water management condition. This result also explains that the variety is waterlogging tolerant. Furthermore, results of this study can be verified by a field experiment to see the actual field performance of variety Isd 21 under waterlogging condition.

Table 1. Effects of waterlogging on yield and yield components of sugarcane (var. Isd 21).

Treat ment	Plant height (m)	No.of tillers lysimeter^{-1}	No. of internode plant^{-1}	Cane diameter (cm)	No. of millable cane lysimeter^{-1}	Weight cane^{-1} (gm)	Yield lysimeter^{-1} (kg)	Recovery index (%)
Do	2.42	81	25	1.95	40	794	31.80	10.21
D_{15}	2.30	81	24	1.88	41	721	29.60	9.88
D_{30}	2.21	78	22	1.84	50	559	28.00	10.18
D_{60}	2.27	107	23	1.84	47	586	27.51	9.67
D_{90}	2.18	76	22	1.82	44	538	23.70	9.62
R	-o.78	+0.17	-0.76	-0.84	+0.39	-0.84	-0.976	-0.83

Table 2. Components of evapotranspiration and water-use efficiency of Isd 21 under waterlogging condition.

Parameters	Treatments				
	Do	D_{15}	D_{30}	D_{60}	D_{90}
Rainfall (cm)	158.20	158.20	158.20	158.20	158.20
Irrigation water application (cm)	12.00	12.00	12.00	12.00	12.00
No. of irrigation	3	3	3	3	3
Irrigation interval from the date of planting	40,65,116	40,65,116	40,65	40,65	40,.65
Waterlogging duration (days)	0	15	116 30	116 60	116 90
Soil water depletion (cm)	6.66	8.37	8.25	12.89	12.17
Run-off (cm)	1.35	8.05	10.51	20.12	56.2
Deep percolation (cm)	60.10	55.55	50.84	46.22	6.86
Evapotranspiration (cm)	115.41	114.97	117.10	116.75	119.31
Yield (kg m^{-2})	30.98	29.60	28.53	27.58	23.21
Water-use efficiency (kg m^{-2} cm^{-1})	0.134	0.129	0.122	0.118	0.017
Pan evaporation	125.58	124.58	125.58	128.58	125.5

However, for an interim period we can recommend the variety Isd 21 as a waterlogging tolerant variety to grow in areas prone to flash flood or long duration water-logging due to heavy rainfall.

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