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Effect of Agro-Technological Manipulations in Improving the Productivity of Cane under Multiratooning System

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Abstract: A field experiment was conducted during 1998-99 to 2002-2003 at Sugar Research Station, Muzaffarnagar (U.P.) to find out the impact of various agro-technological manipulations on growth and yield of cane and sugar under multiratooning system. Results revealed that the combination of agro-techniques viz., dismantling of ridges + stubble shaving + sub-soiling along stubble rows + ploughing in between stubble rows + trash mulching @ 3.5 t ha^{-1} + earthing up in July (T_8) being statistically at par with T_7 (as in T_8 except earthing up in June in place of July) produced significantly higher values of growth attributes (No. of shoots, leaf area index, dry matter accumulation and net assimilation rate), number of millable canes and yield of cane and sugar as compared to rest of the agro-techniques assessed. The T_8 agro-technique produced the highest cane yield of 81.48, 75.56 and 66.65 tonnes per ha which was 31.68, 41.31 and 47.20% more than that obtained under farmers' practice i.e. T_1 (No cultural operation except trash burning) during I, II and III ratoon, respectively. Experimental results further indicated that the application of any of the combination of agro-techniques viz., dismantling of ridges, stubble shaving, sub-soiling, trash mulching or ploughing in between stubble rows proved advantageous in obtaining significantly higher yield of cane over farmers' practice in multiratooning system. On mean over basis, the above results exhibited that the cane yield obtained under T_7 and T_8 treatments was higher to the time of 15.69, 16.47 and 15.84 % during I, II and III ratoon, respectively as compared to combination of different agro-techniques excluding earthing up operations in June or July Yield of sugar was almost similar to the yield of cane under different treatments.

Key words: Agrotechniques · Yield · Quality · Multiratooning

INTRODUCTION

As per National Projection, 22.17 and 27.29 million tonnes of sugar would be required by 2010 and 2020 AD, respectively. Besides, country will also require 16.18 and 20.69 million tonnes of Indian jaggery during the same period to fulfill its domestic demand. In order to achieve these targets, 348.5 and 415 million tonnes of sugarcane would be required as source of sugar [1], compared to present production of 289.41 million tonnes. The possibility of increasing the area under sugarcane in the country is meagre and the only option to meet the above requirements is through increasing the productivity particularly from ratoon cane since it occupies more than 50% of the cane acreage and yield only 30% of the sugarcane production [2].

In sugarcane agriculture, ratoon cropping is an established practice contributing significantly to the over-all profitability. Ratoons are cheaper to grow by around 25-30% [3]. Since no cost is involved on fresh seed material and land preparation, besides saving in irrigation and crop maintenance through reduced crop duration. A current assessment made in Maharashtra, India, indicated that ratoon crop was cheaper by 45% with a net return twice that of a plant crop [4]. In many sugarcane growing countries of the world, raising several ratoons is a common practice and the number of ratoons ranges from 1 to 20 [5]. In India, multiratooning is seldom practiced due to yield decline in successive ratoons. However, it can be enhanced by following proper ratoon-management practices, loosening of inter-rows soil through sub-soiling and earthing up to reduce soil compaction for root development and conservation of trash to enrich soil organic matter for efficient utilization of water and nutrients. Therefore, a study was planned to assess the different agrotechniques and accordingly to develop a package in this context for higher and sustained yield of cane and sugar under multiratooning system.

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MATERIALS AND METHODS

The field experiment was conducted under irrigated condition during spring season from 1998-1999 to 2002-2003 at Sugarcane Research Station (U.P. Council of Sugarcane Research), Muzaffarnagar (U.P.), on clay loam soil, low in organic carbon (0.42%) and available nitrogen (156.8 kg ha^{-1}) and medium in available phosphorus (15.7 kg ha^{-1}) and potash (267 kg ha^{-1}) and slightly alkaline in reaction (pH 7.7).

The treatments consisted of various agrotechnological manipulations, viz., farmers' practice (No any cultural operation except trash burning) (T_1), dismantling of ridges + stubble shaving dismantling of ridges + stubble shaving + sub-soiling along stubble rows (T_3), dismantling of ridges + stubble shaving + sub-soiling along stubble rows + trash mulching @ 3.5 t ha^{-1} (T_4), T_3 + ploughing in between stubble rows (T_5), T_5 + trash mulching after ploughing (T_6), T_6 + earthing up in June (T_7) and T_6 + earthing up in July (T_7) and T_6 + earthing up in July (T_8). The experiment was laid out in Randomized Block Design with 4 replications keeping test variety of sugarcane CoS 88216 in the study. Planting of sugarcane plant crop was done at row spacing of 75 cm in second fortnight of February and harvested in February during both the crop cycles. After harvesting plant crop, various agrotechniques were applied. After harvesting first and second ratoon crops, the same set of treatments were repeated with same layout to observe their effect on second and third ratoon crops. All recommended cultural operations to raise the plant crop were given. However, for ratoon crops, the agro technological manipulations were applied as per treatments. Trash mulching @ 3.5 t ha^{-1} in between stubble rows was done as per treatment schedules. Sub-soiling was done through sub-soiler along stubble rows at the time of ratoon initiation while, ploughing was performed by cultivator. Total dry matter (plant + leaf) accumulation at the start of formative phase in July was studied. For this purpose, ten shoots were excised from sample rows and were chopped into small pieces and were taken for drying in a drier at a constant temperature of 70°C for a period of 72 hours till constant weight. The dry weight was computed on the basis of fresh weight. Leaf area index (LAI) and net assimilation rate (NAR) at peak tillering phase in June were calculated by the formulae as prescribed by Watson [6] and Radford [7], respectively. Observations on no. of shoots, millable canes and cane yield were recorded at their respective growth and harvesting stages. Juice quality viz., sucrose % was determined as per Meade and Chen [8], thereby commercial cane sugar (CCS) % was calculated.

RESULTS AND DISCUSSION

1. Growth attributes: Experimental data presented in Table 1 clearly indicated that the various agrotechniques for multiratooning showed non-significant variation in plant crop yield during both the years. However, the effect of treatment on growth attributes viz. number of shoots, leaf area index (LAI), total dry matter accumulation and net assimilation rate (NAR) were significant in multi-ratooning system. Combination of different agrotechniques (T_8) recorded significantly higher number of shoots, LAI, total dry matter accumulation and NAR as compared to rest of the agro-technique treatments but, it was statistically at par with T_7 treatment during I, II and III ratoon. Moreover, all the agro-techniques treatments were significantly superior to farmers' practice (T_1) in obtaining higher values of growth attributes. Ahmad and Giridharan [9] also reported the beneficial effect of such agrotechnique on production of higher number of shoots. Higher LAI and NAR under T_8 and T_7 agro-technique treatments (dismantling of ridges + stubble shaving + sub-soiling along stubble rows + ploughing in between stubble rows + trash mulching + earthing up in June or July) was due to higher leaf area on account of higher growth and vigour of cane plants under pulverized and good physical condition of soils which paved the way for higher number of shoots and accordingly intercepted more solar radiation and higher CO_2 concentration in the vicinity of crop canopy resulted to increased LAI and NAR whereas in other agro-techniques including farmers' practice, the lower number of shoots lead to lower values of leaf area index and net assimilation rate. The lowest values of above growth attributes under T_1 agro-technique treatment was due to soil compaction which is one of the main problems in multiratooning leading to growth and yield decline in successive rations. Braunack *et al*. [10] reported that soil compaction occurs due to in-field mechanization and labour movement for various field operations and irrigation. This leads to increased bulk density, reduced soil aeration, infiltration and storage of water, root growth and its activity, microbial activity and field drainage. These reasons might have adversely affected the uptake of nutrients and water besides the activity of beneficial microorganisms in T_1 treatment whereas in other

Table 1: Effect of agro-techniques on growth, yield and quality of ratoon crops (I, II and III) of sugarcane (Pooled over data of two crop cycle)

		No. of shoots (000/ha)			Leaf area index (LAI)			Total dry matter/ accumulation in July (t/ha)			Net assimilation rate (10-3 g/cm2/day)		
	Yield of plant cane (t/ha)	I Ratoon	II Ra-toon	III Ratoon	I Ratoon	II Ratoon	III Ratoon	I Ratoon	II Ratoon	III Ratoon	I Ratoon	II Ratoon	III Ratoon
Treatment*	(1998-2000)	(1999-2001)	(2000-2002)	(2001-2003)	(1999-2001)	(2000-2002)	(2001-2003)	(1999-2001)	(2000-2002)	(2001-2003)	(1999-2001)	(2000-2002)	(2001-2003)
T1	80.30	195	178	125	3.95	3.81	3.68	9.23	8.83	7.88	0.45	0.42	0.38
T2	82.15	230	195	173	4.11	4.02	3.52	10.84	9.38	8.45	0.56	0.53	0.51
T3	81.35	226	203	191	4.18	4.06	3.68	10.79	8.92	8.37	0.55	0.50	0.46
T4	80.65	229	208	181	4.22	4.11	3.65	10.42	8.15	8.02	0.58	0.54	0.49
T5	82.52	248	212	189	4.21	4.08	3.61	11.59	9.49	9.44	0.62	0.59	0.52
T6	81.43	243	214	204	4.22	4.01	3.68	11.80	10.86	9.77	0.65	0.60	0.50
T7	80.15	270	219	220	4.45	4.25	4.03	12.85	11.87	10.45	0.78	0.72	0.65
T8	82.05	291	235	227	4.52	4.28	4.09	12.96	12.08	10.85	0.81	0.77	0.68
CD (P=0.05)	NS	20.58	14.71	15.62	0.18	0.22	0.26	1.02	0.84	0.62	0.11	0.09	0.13

*T1: Farmers' practice (No cultural operations except trash burning), T2: Dismantling of ridges + stubble shaving, T3: Dismantling of ridges + stubble shaving + sub-soiling along stubble rows T4: Dismantling of ridges + stubble shaving + sub-soiling along stubble rows + trash mulching @ 3.5 t ha^{-1},T5: T3 + ploughing in between stubble rows,T6: T5 + trash mulching after ploughing T7: T6 + earthling up in June,T8: T6 + earthing up in July

Table 2: Effect of agro-techniques on number of millable canes and yield of cane and sugar of ratoon crops (I, II and III) of sugarcane (Pooled over data of 2 crop cycles)

	No. of millable canes (000/ha)			Cane yield (t ha^{-1})			Commercial Cane Sugar (CCS) %			Sugar yield (t ha^{-1})		
Treatment	I Ratoon (1999-2001)	II Ratoon (2000-2002)	III Ratoon (2001-2003)	I Ratoon (1999-2001)	II Ratoon (2000-2002)	III Ratoon (2001-2003)	I Ratoon (1999-2001)	II Ratoon (2000-2002)	III Ratoon (2001-2003)	I Ratoon (1999-2001)	II Ratoon (2000-2002)	III Ratoon (2001-2003)
T_1	108	99	85	6.05	4.89	3.87	55.67	44.35	35.19	10.86	11.03	10.99
T_2	119	109	98	6.95	6.60	5.92	65.01	60.49	52.31	10.69	10.91	11.31
T_3	113	104	94	6.94	6.66	6.14	64.47	61.36	54.42	10.76	10.88	11.29
T_4	114	104	90	6.71	6.57	6.03	63.45	59.36	53.37	10.58	11.06	11.30
T_5	126	121	98	7.66	6.95	6.40	72.50	63.69	58.33	10.57	10.92	10.98
T_6	130	123	103	7.97	7.45	6.61	73.65	68.48	59.39	10.82	10.88	11.13
T_7	142	136	114	8.66	7.94	7.33	79.40	74.51	65.38	10.91	10.65	11.21
T_8	146	138	120	8.68	8.20	7.49	81.48	75.56	66.65	10.95	10.85	11.24
CD (P=0.05)	10.17	10.60	6.68	1.31	1.26	1.37	5.96	6.45	6.08	NS	NS	NS

treatments from T_2 to T_8, it had beneficial impact to soil pulverizing agro-techniques including mulching of sugarcane dry leaves which must have improved the physical condition of soils and utilization efficiency of nutrients and water in addition to enrichment of soil organic mater.

2. Productivity of cane and sugar: Experimental data presented in Table 2 revealed that combination of agro-technique viz., dismantling of ridges + stubble shaving + sub-soiling along stubble rows + ploughing in between stubble rows + trash mulching @ 3.5 t ha^{-1} + earthing up in July (T_8), being statistically at par with T_7 (as in T_8 except earthing up in June in place of July) produced significantly higher number of millable canes and yield of cane and sugar as compared to rest of the agro-techniques assessed. The T_8 agro-technique produced the highest cane yield of 81.48, 75.56 and 66.65 tonnes per ha which was 31.68, 41.31 and 47.20% more than that obtained under farmers' practice i.e. T_1 (No cultural operation except trash burning) during I, II and III ratoon, respectively. Results further indicated that the application of any of the combination of agro-techniques viz., dismantling of ridges, stubble shaving, sub-soiling, trash mulching or ploughing in between stubble rows proved advantageous in obtaining significantly higher number of millable canes and yield of cane and sugar over farmers' practice (T_1) in multiratooning system. On mean over basis, the above results exhibited that the cane yield obtained under T_7 and T_8 treatments was higher to the tune of 15.69, 16.47 and 15.84% during I, II and III ratoon, respectively as compared to combination of different agro-techniques excluding earthing up operations in June or July. Sugar yield exhibited almost similar trend as the yield of cane under different treatments. Sundara [11] also reported similar findings. He indicated that in multiratooning systems, trash management is one of the great agro-techniques and is the first job to be attended to after the plant crop or and ratoon in harvested. Burning of trash is undesirable considering the amount of nutrients any organic matter present is the trash. Bal Coelho *et al*. [12]

pointed out that conserving trash and its application to improve soil fertility and productivity should be the goal. He found 17 t ha^{-1} higher cane yield under mulched condition in multiratooning system over trash burn treatment. Higher cane yield under T_2 to T_8 treatments over T_1 in multiratooning system was also due to the combined effect of stubble shaving, dismantling of ridges, sub-soiling along stubble rows, must have improved the porosity in soil, reduced soil compaction, improved root penetration and physical conditions of soil for vigorous growth and development of cane plants. Lin *et al*. [13] also corroborate the above findings.

The higher cane yield as obtained under T_7 and T_8 treatments over others (T_2 to T_6) where earthing up operation was done either in June or July with t he above agro-techniques was apparently due to higher number of millable canes. In these treatments (T_7 and T_8), the earlier tillers must have been saved for their higher growth and vigour through the earthing up operation in June or July otherwise valuable energy is wasted in the form of water shoots and late tillers which are, in general, un productive and parasite to earlier formed tillers.

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