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COMBINED EFFECT OF CHEMICAL FERTILIZERS, ORGANIC MANURES AND BIO-FERTILIZERS ON JUICE QUALITY OF SUGARCANE-RATOON CROPPING SYSTEM

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ABSTRACT

An experiment was conducted at Crop research centre of G.B. Pant University of Agriculture and Technology, Pantnagar during spring seasons from 2002-05 to assess the combined effect of chemical fertilizers, organic manures and bio-fertilizers on juice quality of sugarcane-ratoon cropping system. Results indicated that juice extraction per cent varied significantly owing to different nutrient management practices at harvest stage of both plant and ratoon crops. Juice extraction per cent tended to decrease with crop age. The maximum juice extraction of 54.6 and 52.4 % in plant and ratoon crops, respectively was recorded under T_{10} being significantly higher than that of T_7 and T_1. Juice quality parameters like juice sucrose, purity coefficient and reducing sugars at harvest stage in plant crop did not vary significantly under different treatments. In plant crop, at harvest (February), T_9 resulted in highest juice brix (19.3%), sucrose (15.79%), available sugar (10.50%), purity coefficient (81.8%) and reducing sugars (1.18%). In ratoon crops, juice quality parameters like brix, sucrose, available sugar and reducing sugars were significantly influenced by different treatments. T_7 exhibited higher juice brix (19.8%), sucrose (16.21%), available sugar (10.78%) and purity coefficient (83.9%).

***Key words :** Sugarcane, Juice quality, sucrose, available sugar, INM*

Sugarcane is very large nutrient demanding crop and removes large amount of nutrients from the soil and leads to create the deficiencies of the essential nutrients in the soil and disturbs the nutrient balance into soil. Therefore, there is pre-requisite to add sufficient substitution of the major portion of chemical fertilizers with other alternatives chiefly organic manures like FYM, pressmud, vermicompost, green manuring in order to enhancement in juice quality improvement in terms of brix, sucrose, sugar % and CCS% in cane juice.

Espada and Tapay (1982) observed non significant response of sugarcane crop to trash and N-fertilization in terms of sugar yield and cane quality. Shinde *et al*. (1990) from Pune noted that incorporation of sugarcane trash had no adverse effect on juice quality. Reddy *et al*. (2001) reported that juice sucrose under trash incorporation with fungal culture (18.88%) was at par with that of trash burning (18.95%) indicating no influence of decomposing material on juice sucrose content. Khandagave (2002) observed that incorporation of trash @ 8 t ha^{-1} in combination with urea and cellulolytic decomposing micro-organisms significantly increased the commercial cane sugar yield by 11.67 per cent over control.

Excess nitrogen prolongs vegetative growth, delays maturity/ ripening phase and lowers juice purity (Jeyaraman *et al*., 2003). The lower juice purity may be due to more accumulation of monosaccharide in juice (Kapoor *et al*., 1993). More juice extraction was observed with increasing nutrient supply of NPK fertilizers because of more succulency with less cane fibre and more juice in cane stalk. These results are in accordance with the findings of Patel *et al*. (2003). Keeping these issues in mind, the present investigation was undertaken to test the effect of integrated use of nutrient sources on juice quality of sugarcane-ratoon cropping system.

MATERIALS AND METHODS

A field experiment was conducted during spring seasons of 2002-05 at Crop Research Center of G.B. Pant University of Agriculture and Technology, Pantnagar in sugarcane plant–ratoon cropping sequence. The fertility status of the experimental ;plot was silty clay loam, neutral in reaction, low in N,

medium in organic C, available P_2O_5 and K_2O. Treatments were placed in sugarcane plant and ratoon crops as per standard randomized block design with four replications depicted in tables. All the agronomical practices were followed as per need of sugarcane plant-ratoon crops. Observations were recorded on juice quality parameters like juice extraction%, corrected brix%, sucrose%, reducing sugar%, purity coefficient% and available sugar% in cane juice as described by Spencer and Meade (1955).

RESULTS AND DISCUSSION

Effect of INM on juice quality parameters in plant cane

Juice extraction per cent : The data revealed that integrated nutrient management practice had significant effect on juice extraction per cent at all the stages. Juice extraction per cent decreased with the advancement of crop age, irrespective of treatments. Highest juice extraction per cent (54.6%) was noted in the month of February (harvest) with T_{10}, followed by T_5 or T_6 and T_2. However, juice extraction per cent (42.0%) was noted from T_9; being statistically at par with that of T_7 or T_8 at all the stages. However, differences in juice extraction per cent between T_3 and T_1 were not significant except in month of November where former exhibited higher juice extraction per cent (46.4%) than that of later (39.8%). Similar trend was recorded at other stages.

Corrected brix : Differences in brix per cent owing to different treatments were significant at all the growth stages except in month of November. Brix per cent tended to increase with advancement in crop age. At harvest stage (February), crop fertilized with T_9 recorded significantly higher brix (19.3%); being at par with that of T_8 or T_7 but significantly higher than rest of the treatments. The minimum brix (17.9%) was however, observed where crop was fertilized with T_{10} which was at par with that of T_1 and T_5 or T_6. The differences in brix per cent between T_2 and T_3 were non-significant at all stages. Similar trend was obtained at other growth stages.

Sucrose per cent : Integrated use of different nutrient sources had non significant effect on the sucrose per cent in cane juice except in month of December and January. Sucrose per cent of cane juice increased with advancement of crop age. In month of February, T_9 exhibited maximum juice sucrose per cent (15.79%). However, crop fertilized with T_{10} recorded lowest juice sucrose content (14.40%). Similar trend was recorded at other growth stages.

Available sugar per cent : Differences in available sugar per cent owing to different treatments were significant at all the stages. Available sugar per cent tended to increase with crop age. At harvest stage (February), the maximum available sugar content (10.50%) was noted with T_9 which was significantly higher than other treatments. However, minimum available sugar per cent (9.49%) was noted with T_{10} which was statistically at par with that of T_1 and T_5. The differences in available sugar content between T_6 and T_2 were not significant. Similar trend was recorded at other stages.

Purity coefficient (%) : Variations in purity coefficient owing to different nutrient management sources were non-significant at all the stage except in November. The juice purity tended to increase with advancement of crop age and reached maximum at harvest (February). In month of February, crop receiving T_9 recorded highest purity coefficient (81.8%), however, lower purity coefficient (80.2%) was noted from T_1. Similar trend was found at other stages.

Reducing sugars (%) : Variations in reducing sugars content of cane juice due to different nutrient management practices were non-significant at all the growth stages. Reducing sugars per cent tended to decrease with advancement in crop age and reached maximum concentration at harvest stage. The perusal of data inferred that in month of February (harvest), T_{10} recorded maximum concentration of reducing sugars (1.18%). However, crop fertilized with T_9 exhibited minimum concentration of reducing sugars (1.05%) in cane juice. Similar trend was noted at other stages.

Effect of INM on juice quality parameters in sugarcane ratoon

Juice extraction per cent : The differences in juice extraction per cent due to different treatments were not significant at all the stages of ratoon crop, except in month of January. Juice extraction per cent decreased with the advancement in crop age, irrespective of treatments. In month of January, T_{10} exhibited significantly higher juice extraction per cent (52.4%) which was at par with that of T_6, T_5, T_3, T_2 and T_1. However, lowest higher juice extraction per cent (38.2%) was noted with T_7. This might be because of more succulency with less cane fibre and more juice in cane stalk under higher NPK fertilizer doses. These

Table-1: Effect of different treatments on juice extraction% and brix% in sugarcane plant and ratoon crop.

Treatments			Juice extraction %							Brix %						
	Plant	Ratoon	Plant				Ratoon			Plant				Ratoon		
			Nov	Dec	Jan	Feb	Nov	Dec	Jan	Nov	Dec	Jan	Feb	Nov	Dec	Jan
T_1	100% NPK	100% NPK	44.7	41.6	40.3	39.8	51.0	49.7	45.2	15.9	16.7	17.4	18.1	17.2	17.6	18.2
T_2	75% NPK+25% N (FYM)	100% NPK+trash	54.2	49.3	48.0	47.6	51.6	50.1	46.3	16.3	17.2	17.9	18.5	17.8	18.1	18.5
T_3	75% NPK+25% N (CSPM)	100% NPK+trash	53.3	48.1	47.6	46.4	52.8	50.7	47.8	16.4	17.5	18.0	18.6	17.4	17.8	18.3
T_4	100% NPK	75% NPK+GM	45.0	42.6	41.4	40.2	48.7	45.0	42.6	15.9	16.6	17.3	18.1	18.4	1.1	19.4
T_5	75% NPK+25% N (FYM)+BF	100% NPK+trash+BF	56.4	51.8	50.6	49.5	52.9	51.8	49.3	16.0	17.0	17.4	18.2	18.1	18.5	19.1
T_6	75% NPK+25% N (CSPM)+BF	100% NPK+trash+BF	54.5	50.3	49.5	48.7	55.4	53.0	50.3	16.2	17.2	17.7	18.3	18.0	18.3	18.8
T_7	50% NPK+25% N (FYM)+ BF	50% NPK+GM+BF	52.6	47.9	46.9	45.5	45.0	43.6	38.3	16.7	18.0	18.2	18.9	19.2	19.6	19.8
T_8	50% NPK+25% N (CSPM)+BF	50% NPK+GM+BF	50.4	45.9	44.8	43.4	47.3	43.5	40.7	16.9	18.2	18.6	19.1	18.6	19.4	19.7
T_9	50% NPK+25% N (VC)+BF	75% NPK+ 25% N (VC)+ BF	48.0	44.5	43.1	42.0	49.2	47.2	44.0	17.2	18.4	18.8	19.3	18.5	19.2	19.5
T_{10}	100% NPK+25% N (FYM)+ BF	100% NPK+trash+BF	57.8	56.0	55.3	54.6	56.2	54.6	52.4	15.0	16.4	17.0	17.9	18.3	18.8	19.3
SEm±			1.9	2.2	2.5	2.5	3.1	3.8	2.7	0.55	0.15	0.14	0.15	0.12	0.13	0.14
CD (P=0.05)			5.7	6.5	7.5	7.2	NS	NS	7.9	NS	0.44	0.42	0.44	0.34	0.39	0.43

Table-2: Effect of different treatments on juice sucrose% and available sugar% in sugarcane plant and ratoon crop.

Treatments			Juice sucrose %							Available sugar %						
	Plant	Ratoon	Plant				Ratoon			Plant				Ratoon		
			Nov	Dec	Jan	Feb	Nov	Dec	Jan	Nov	Dec	Jan	Feb	Nov	Dec	Jan
T_1	100% NPK	100% NPK	11.32	13.37	13.92	14.52	13.73	14.33	15.22	6.92	8.75	9.14	9.55	9.01	9.49	10.24
T_2	75% NPK+25% N (FYM)	100% NPK+ trash	11.68	13.75	14.46	15.07	14.16	14.70	15.46	7.17	9.00	9.55	10.00	9.26	9.72	10.40
T_3	75% NPK+25% N (CSPM)	100% NPK+ trash	11.72	14.22	14.58	15.18	13.85	14.56	15.37	7.18	9.39	9.64	10.08	9.04	9.65	10.36
T_4	100% NPK	75% NPK+ GM	11.25	13.05	13.66	14.46	14.46	15.03	15.89	6.85	8.46	8.90	9.49	9.38	9.77	10.57
T_5	75% NPK+25% N (FYM)+BF	100% NPK+ trash+ BF	11.39	13.43	13.91	14.64	14.27	14.83	15.68	6.96	8.76	9.10	9.64	9.25	9.74	10.44
T_6	75% NPK+25% N (CSPM)+BF	100% NPK+ trash+ BF	11.56	13.86	14.41	14.96	14.21	14.70	15.56	7.08	9.14	9.52	9.94	9.26	9.66	10.40
T_7	50% NPK+25% N (FYM)+BF	50% NPK+ GM+ BF	12.18	14.45	14.70	15.35	14.90	15.43	16.21	7.57	9.51	9.70	10.16	9.62	10.04	10.78
T_8	50% NPK+25% N (CSPM)+BF	50% NPK+ GM+ BF	12.30	14.63	15.00	15.47	14.66	15.36	16.15	7.63	9.63	9.89	10.23	9.53	10.03	10.75
T_9	50% NPK+25% N (VC)+BF	75% NPK+ 25% N (VC)+ BF	13.04	14.98	15.32	15.79	14.52	15.11	16.02	8.30	9.90	10.16	10.50	9.41	9.81	10.67
T_{10}	100% NPK+25% N (FYM)+BF	100% NPK+ trash+ BF	11.20	13.02	13.51	14.40	14.35	14.92	15.78	7.06	8.51	8.84	9.49	9.31	9.74	10.48
SEm±			0.46	0.05	0.05	0.43	0.06	0.05	0.06	0.05	0.05	0.05	0.05	0.07	0.05	0.07
CD (P=0.05)			NS	0.15	0.14	NS	0.17	0.16	0.19	0.15	0.14	0.14	0.16	0.21	0.17	0.23

Table-3 : Effect of different treatments on purity coefficient% and reducing sugar% in sugarcane plant and ratoon crop.

Treatments			Purity coefficient %						Reducing sugar %					
	Plant	Ratoon	Plant			Ratoon			Plant			Ratoon		
			Nov	Dec	Jan	Feb	Nov	Dec	Jan	Nov	Dec	Jan	Feb	Nov	Dec	Jan
T_1	100% NPK	100% NPK	71.1	79.5	80.0	80.2	79.8	81.2	83.6	1.72	1.38	1.27	1.14	1.69	1.37	1.19
T_2	75% NPK+25% N (FYM)	100% NPK+trash	71.6	79.4	80.7	81.4	79.4	81.1	83.6	1.69	1.31	1.21	1.10	1.62	1.27	1.13
T_3	75% NPK+25% N (CSPM)	100% NPK+trash	71.4	80.7	81.0	81.6	79.2	81.5	83.9	1.67	1.30	1.20	1.09	1.66	1.33	1.16
T_4	100% NPK	75% NPK+GM	70.7	78.1	78.9	79.8	78.3	78.6	81.9	1.74	1.40	1.30	1.16	1.53	1.11	0.92
T_5	75% NPK+25% N (FYM)+BF	100% NPK+trash+BF	71.1	79.0	79.4	80.4	78.7	80.1	82.0	1.71	1.36	1.25	1.13	1.55	1.16	0.99
T_6	75% NPK+25% N (CSPM)+BF	100% NPK+trash+BF	71.3	80.5	80.9	81.7	78.9	80.2	82.7	1.70	1.33	1.21	1.11	1.60	1.20	1.11
T_7	50% NPK+25% N (FYM)+BF	50% NPK+GM+BF	72.9	80.2	80.7	81.2	77.6	78.7	81.8	1.66	1.29	1.18	1.09	1.36	1.04	0.87
T_8	50% NPK+25% N (CSPM)+ BF	50% NPK+GM+BF	72.7	80.3	80.6	80.9	78.6	79.1	82.0	1.64	1.27	1.16	1.08	1.40	1.06	0.84
T_9	50% NPK+25% N (VC)+BF	75% NPK+ 25% N (VC)+ BF	75.8	80.9	81.4	81.8	78.1	78.4	82.2	1.60	1.25	1.13	1.05	1.47	1.09	0.90
T_{10}	100% NPK+25% N (FYM)+ BF	100% NPK+trash+BF	74.6	79.3	79.4	80.4	78.2	79.2	81.6	1.75	1.44	1.33	1.18	1.53	1.14	0.97
SEm±			0.67	0.59	0.60	0.52	0.61	0.58	0.73	0.06	0.10	0.06	0.06	0.07	0.07	0.05
CD (P=0.05)			1.9	NS	NS	NS	NS	1.6	NS	NS	NS	NS	NS	NS	NS	0.15

results are in accordance with the findings of Patel *et al*. (1993) who observed higher juice extraction with increasing nutrient supply.

Corrected brix : The variations in corrected brix per cent owing to various treatments were significant at all the crop growth stages of ratoon crop. Corrected brix per cent tended to increase with advancement in crop age, irrespective of treatments. The data indicated that at harvest stage (January), highest corrected brix of 19.8% was noted under T_7 followed by T_8, T_9 and T_4, being significantly higher than rest of the treatments. The lowest corrected brix (18.2%) was, however, noted under T_1, though at par with that of T_3 and T_2. The differences in corrected brix per cent between T_6 and T_{10} were significant, where former exhibited lower juice brix (18.8%) than that of later (19.3%).

Sucrose per cent : Integrated use of nutrient sources had significant effect on the sucrose percent at all the stages of ratoon crop. Sucrose per cent in juice increased with advancement in crop age, irrespective of treatments. The data inferred that in month of January, ratoon crop significantly recorded highest sucrose content (16.21%) under T_7 which remained at par with T_8 except in month of November. T_1 resulted in significantly minimum sucrose content (15.22%) which was at par with that of T_3 (15.37%). There was progressive improvement in juice sucrose wherever, chemical fertilizers was substituted by organics and or bio-fertilizers. Lower juice sucrose content in plant and ratoon crops under high nutrient supply may be largely due to more nitrogen available to the crop. There is negative correlation between nitrogen supply and juice sucrose due to increase in proteinous substances in juice (Kapoor *et al*., 1993).

Available sugar per cent : Variations in available sugar owing to different treatments were significant at different growth stages of ratoon crop. Available sugar content increased with advancement in crop age. In month of January, T_7 resulted in significantly higher available sugar (10.78%), being at par with T_8 and T_9, except in month of December, but significantly superior to rest of the treatments. However, the lowest available sugar (10.24%) was recorded with T_1 which was at par with that of T_3 and T_6 at all stages, except in month of November. The differences in available sugar content between T_4 and T_{10} were not significant. Almost similar trend was observed at other stages. The lowest available sugar may be attributed to variations in juice sucrose and brix.

Purity coefficient (%) : The purity coefficient recorded at different growth stages of ratoon crop exhibited non significant variations owing to different treatments, except in month of December. These were remarkable improvement in juice purity with advancement in crop age, irrespective of the treatments. In month of December, T_3 significantly higher purity (81.5%), being at par with that of T_1, T_2, T_5 and T_6 but significantly superior to rest of the treatments. The differences in purity coefficient between T_7 and T_{10} were not significant. The minimum purity (78.4%) was, however, noted with T_9 which remained at par with T_4. Excess nitrogen prolongs vegetative growth, delays maturity/ repining and lowers juice purity (Jeyaraman *et al*., 2003). The lower juice purity may be due to more accumulation of monosaccharides in juice (Patil and Shingate, 1982 and Kapoor *et al*., 1993). The juice purity which is coefficient of juice sucrose to brix was also of lower order under T_{10} indicating that more nitrogen supply leads to more of reducing sugars.

Reducing sugars (%) : Reducing sugars did not show any significant variations at all the growth stages of ratoon crop, except in month of January owing to different treatments. Contrary to sucrose content, the reducing sugars tended to decline with the advancement in crop age till harvest stage of ratoon crop. T_1 exhibited significantly highest reducing sugars (1.19%), being at par with that of T_2, T_3 and T_6. However, lowest reducing sugars content (0.84%) was noted with T_8. The differences in reducing sugars among rest of the treatments were, however, non-significant.

It might be concluded that integrated nutrient supply system improved the juice quality parameters in terms of available sugar and sucrose concentration in cane juice which consequently led to enhancement in sugar recovery under sugarcane-ratoon cropping system.

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