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Improving growth and yield of winter initiated sugarcane (*Saccharum* spp hybrid complex) ratoon through bioagents-amended pressmud cake in sub-tropical India*

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In sub-tropical India, after harvest of main crop, most often, stubble buds do not sprout properly due to low temperature. Unsprouted stubbles cause gaps in stubble rows resulting in low initial shoot population and yield of cane (Singh *et al*. 2011). Several agro-techniques, viz trash mulching, polyethylene mulching (Kanwar and Kaur 1977, 1981), inter cropping of wheat and potato and potassium application (Singh *et al*. 2010) have been used) to enhance stubble bud sprouting in ratoon cane but much success could not be achieved in this direction. Poor tilth due to compaction of soil in the root zone of the crop restricts the vigour of root system. As a result, sugarcane ratoon experiences inadequate soil aeration. This condition decreases intake of water and uptake of nutrients by roots. The ratoon suffers most due to restricted stubble roots. Application of FYM and biofertilizer improves soil organic carbon and increased carbon helps in sustaining soil health for longer period (Singh *et al*. 2007). Enrichment of organic (humus) nitrogen in the soil after application of bio waste compost has been observed.

Application of farmyard manure enriched with *Gluconacetobacter* and *Trichoderma* improved soil organic carbon which in turn helped in sustaining soil health for a longer period. FYM provided organic carbon for enhanced multiplication of inoculated microbial agents and provided a suitable niche for plant-microbe interaction. *Gluconacetobacter diazotrophicus* and *Trichoderma viride* owing to their plant growth promotion ability produced synergistic effect with FYM unlike NPK application. Growth-promoting substances released by application of *Trichoderma* and N fixation by *Gluconacetobacter* enhanced uptake of nutrients and yield (Suman *et al.* 2005). Use of phosphate-solubilizing bacteria (PSB) with inorganic source of P increases response to P_2O_5. In sugarcane ratoon, addition of organic matter due to trash, root biomass and rhizodeposition of plant crop increase effectiveness of *G. diazotrophicus.* Thus, it improves soil health and crop growth (Suman *et al.* 2005). Keeping these points in view, present research work was taken up at Indian Institute Sugarcane Research, Lucknow to improve growth and ratoon cane yield of winter initiated ratoon.

An experiment was conducted during cropping season of 2005–07 at Indian Institute of Sugarcane Research, Lucknow located at 26°56' N, 80° 52' E and 111m above MSL with semi arid sub-tropical climate having dry hot summer and cold winter. The soil of the experimental field was sandy loam (13.3% clay, 24.5% silt and 62.25% sand) of Indo-Gangetic alluvial origin, very deep (>2m) well drained, flat and classified as non calcareous mixed *hyperthermic udic ustochrept.* Before planting of the experimental crop, soil samples from 0–15 cm depth were collected by core sampler of 8cm diameter from five spots in the field. These samples were pooled together and representative homogeneous sample drawn for determination of organic carbon (Walkley and Black 1934) available N ($KMnO_4$ method), 0.5 M sodium bicarbonate ($NaHCO_3$, *p*H 8.5) - extractable P and 1N NH_4OAC-extractable K, following Jackson (1973). The organic carbon content of the soil was 0.47%, available N 179 kg/ha available P content, 12.5 kg/ ha and available K content was 198 kg/ ha.

The sugarcane (*Saccharum* spp hybrid complex) main crop (early variety CoS 96268) was planted using 38 000 three-bud cane setts /ha on 10 March 2005 and these seed setts were placed horizontally, end to end, in 10 cm deep furrow opened 75 cm apart with tractor-drawn furrow opener. Before placing setts in the furrows, half the dose of required nitrogen, ie 150 kg N/ ha and 26 kg P and 50 kg K/ ha were applied in furrows beneath the cane setts using urea (46.4% N), single super phosphate (6.98% P) and potassium chloride

*Short note

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(KCl, 49.8% K). Chlorpyriphos 20% EC was sprayed over cane setts before covering them to guard against termite and early shoot borer. The field was irrigated after 45 days after planting with 7.5cm irrigation water. The crop received three pre-monsoon irrigations, ie up to June. When soil moisture attained a workable stage, inter-row spaces were intercultural manually using hand hoe. In the last week of June, remaining dose of 75 kg N/ ha through urea was top-dressed uniformly. Thus uniform plant crop of sugarcane raised and harvested in December.

Soon after harvest of plant crop, dry cane leaves left in the field were burnt and field irrigated to facilitate stubble sprouting for ratoon cropping. When soil moisture attained a workable condition, bullock-operated country plough was run close to stubble rows on both sides to cut old roots, in the furrows opened on both sides along the stubble rows. In the ratoon crop, recommended nitrogen (200 kg N/ ha) was applied. Half amount of nitrogen (N) was applied in inter-row spaces at the time of ratoon initiation. Remaining half N was applied in second week of April along the rows. Inter-row spaces were also ploughed up. The ratoon crop received three pre-monsoon irrigations up to the end of June. After each irrigation, intercultural operations were done in the ratoon crop also. Four treatments were applied at the time of ratoon initiation, viz T_1 Control (farmers practice), T_2 *Trichoderma* with press mud cake (PMC @ 5 tonnes/ha), T_3 *Gluconacetobacter diazotrophicus* + 5 tonnes PMC (press mud cake/ha), and T_4 PSB (phosphate solubilising bacteria) + PMC. *Trichoderma viride* @ 20 kg/ha (1.7×10^8 cfu (colony-forming unit) /g culture, *G. diazotrophicus* @ 1.4×10^7 cfu/ g culture (12.5 kg/ ha) and phosphate solubilising bacteria (PSB) 1.6×10^7 cfu/g culture @ 12.5 kg/ha were applied in different treatments as per requirement. These treatments were applied under exposed stubble (without soil cover) and soil covered stubble situation. Thus eight treatments were evaluated in randomized block design with three replications. Net plot size was kept to 8m × 6m.

Periodic shoot population density in ratoon cane increased up to June (Figs 1, 2). After that tiller number decreased due to their mortality. Application of PSB + PMC moderately increased shoot population density in ratoon crop. Higher temperature alongwith low humidity during summer months favoured tillering in sugarcane (Shukla 2007). Application of PMC provided favourable microclimate that improved reducing sugar content of stubble and increased shoot population density. It facilitated crop establishment with production of greater number of primary and higher order shoots (Shukla *et al*. 2009). Higher number of millable cane in ratoon was counted with PSB + PMC. It was due to vigorous tillers formed in ratoon crop that contributed larger share in millable cane formation compared to control.

Stubble covered with soil decreased shoot population density in ratoon crop as compared to exposed stubble (Fig 2). Physical hindrances caused by soil cover during initiation of tillers ultimately reduced tiller number on one hand and improved vigour of produced tillers on other hand. This is reflected by longer, thicker and heavier millable canes produced under soil cover compared to exposed stubble (Table 1). Higher number of millable cane in ratoon crop was counted in former situation was due to limited production and greater survival of tillers.

Application of PSB + PMC improved production of millable cane (98 200/ha, Table 1), cane length (186.3 cm), diameter (2.08 cm) and individual cane weight (810.0 g) in significant manner. Ratoon yield was improved by 15.86% over control. The highest commercial cane sugar (8.01 tonnes/ ha) was obtained with PSB+ PMC. Covering of stubble with soil in winter season improved number of millable cane significantly in the ratoon and it also improved individual cane length (183.9 cm), diameter (2.06 cm) and weight (798.3 g) significantly. Thus ratoon yield under soil covered stubble improved by 8.47% over uncovered (exposed) stubble

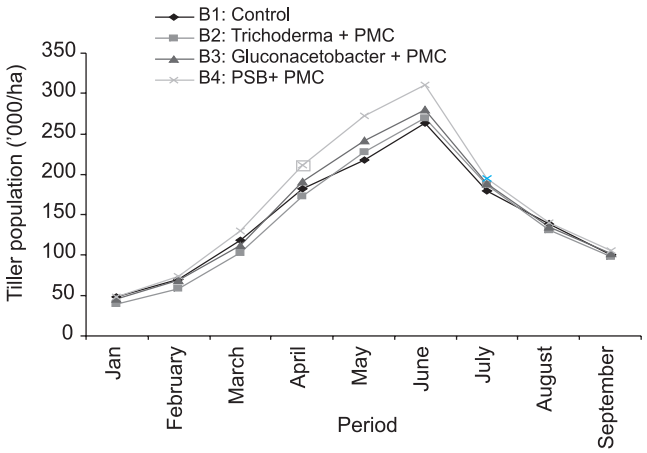

Fig 1 Tillering pattern in sugarcane ratoon as influenced by bioagents-amended pressmud cake

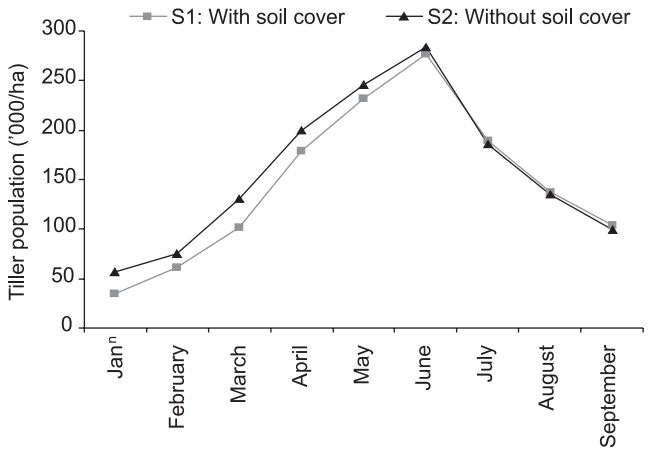

Fig 2 Tillering pattern in sugarcane ratoon as influenced by soil cover on stubble

Table 1 Effect of bioagents-amended treatments and soil cover on growth attributes, juice quality and cane yield in ratoon crop

Treatment	No. of millable canes ('000/ha)	Cane length (cm)	Cane diameter (cm)	Cane weight (g)	Cane yield (tonnes/ha)	Brix	Pol juice (%)	Purity	CCS (tonnes/ha)
Main plot treatments (biofertilizer)									
B_1 Control	79.53	169.3	1.99	733.3	58.57	21.11	18.19	86.16	7.28
B_2 *Trichoderma* + PMC	95.05	182.2	2.04	773.3	63.27	20.78	17.98	86.52	7.79
B_3 *Gluconacetobacter* + PMC	97.32	181.3	2.03	783.3	62.63	20.73	17.96	86.16	7.67
B_4 PSB+ PMC	98.20	186.3	2.08	810.0	67.86	20.16	17.31	85.86	8.01
CD (*P*=0.05)	3.77	6.88	0.06	42.24	3.35	NS	NS	NS	0.52
Sub-plot treatments (soil cover)									
S_1 With soil cover	94.48	183.9	2.06	798.3	65.56	20.75	17.88	86.16	8.00
S_2 Without soil cover	90.56	175.9	2.01	731.7	60.44	20.14	17.33	86.04	7.15
CD (*P*=0.05)	2.81	4.86	0.04	28.94	2.37	0.58	0.49	NS	0.41

* PSB, Phosphate-solubilizing bacteria; PMC, pressmud cake

(60.44 tonnes/ha,Table 1).

Thus, it is concluded that growth and yield of winter initiated ratoon could be improved by application of phosphate-solubilizing bacteria (PSB) + pressmud cake (PMC), followed by covering of stubble through soil.

SUMMARY

Application of PSB + PMC moderately increased shoot population density in ratoon cane. It facilitated crop establishment with production of greater number of primary and higher order shoots. Higher number of millable cane in ratoon was counted with application of PSB + PMC. It was due to vigorous tillers formed in ratoon cane that contributed larger share in millable cane formation as compared to control. Stubble covered with soil during initiation of ratoon decreased shoot population density as compared to exposed stubble in subsequent crop. Application of PSB+ PMC improved production of millable cane (98 200/ha), cane length (186.3 cm), diameter (2.08 cm) and individual cane weight (810.0 g) significantly. Ratoon yield improved by 15.86% with application of PSB + PMC over control (67.86 tonnes/ha). Soil covered stubble also improved by 8.47% ratoon cane yield over exposed stubble (60.44 tonnes/ha).

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