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Effect of Nutripellet Pack Placement on Yield and Quality in Sugarcane

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ABSTRACT

A field experiment was carried out in sugarcane cv CO 86032 with the placement of Nutripellet Pack (NPP). NPP is a composition for the slow release of nutrients made by sealing fertilizer pellet in a polymer coated paper pouch and then wrapping in a paper along with manure pellet. Evaluation of slow release characteristics of NPP was done in 9 treatments, which included four levels of nutrients viz. 50% NPK (T_1), 75% NPK (T_2), 100% NPK (T_3), 125% NPK (T_4). The other NPP treatment combinations were 100% NPK + Micronutrient mixture (T_5), 100% NPK + Sugar industry biocompost (T_6), 100% NPK + Mulching (T_7). Surface application of 100% NPK (T_8) and no fertilizer addition (T_9) were evaluated for comparison. The result showed that fertilization with NPP containing 100% NPK + micronutrient (T_5) recorded the highest values in yield parameters such as single cane weight (1.55 kg), No. of canes per hill (10.8), survived hill population (7122) and cane yield (116.2 t ha^{-1}), similarly in sugar quality parameters such as Brix (22.9%), POL (20.12%), Purity (89.61%) and Sugar recovery (14.18%).

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INTRODUCTION

Sugarcane is the promising sugar crop of India grown in 5.06 M ha of land. India stands 2nd in area and sugar production and 4th in productivity in the World (DOA & FW 2018). For growth, sugarcane requires adequate irrigation, a heavy dose of fertilizer NPK and micronutrients. Commonly the continuous dumping of fertilizers tends to deteriorate the soil health and quality, which makes the soil sick by losing its inherent capacity to support crop further. At present, sugarcane is grown in about 4.01 lakhs ha area under surface irrigation in India. It is evident that present position of India in production is not comparable with its productivity (Thava et al. 2014). The wide variation in soil fertility is a major limitation in reaching higher yield goals, which can be improved by balancing N, P, K and micronutrients (Singh et al. 2008). Balanced nutrition of crop can be achieved by split doses of fertilizer nutrients in surface dressing, fertigation or by deep placement of slow release forms such as Nutripellet Pack (NPP). NPP is a packet containing fertilizer pellet encapsulated in polymer coated paper pouch along with manure pellet. Polymer coated paper encapsulation imparts slow release characteristics after placement in soil.

Sugarcane is a long duration crop that requires a high quantity of nutrients. Moreover, continuous growing of sugarcane in the same field depletes substantial amount of soil nutrients. Differences in soils, environmental factors (Knust 1954) and sugarcane cultivars (Verna 1965) greatly influence the yield and performance of sugarcane. A crop having yield

of about 100 t ha^{-1} removed nearly 207 kg N, 30 kg P_2O_5 and 233 kg K_2O from the soil. Therefore, these nutrients must be added in adequate quantities in the root zone of the crop to obtain high yield (Saleem et al. 2012). Among these nutrients N is the primary nutrient limiting sugarcane production throughout the World (Wiedenfeld and Enciso 2008). Recommended rates of N fertilizer for sugarcane production vary between 45 and 300 kg ha^{-1} yr^{-1} in various countries (Srivastava and Suarez 1992).

In general sugarcane growers follow the method of surface application of fertilizers, which is not nutrient efficient. The efficiency can be improved by deep placement methods like Nutripellet Pack technology in which encapsulated fertilizer pellet is placed in the crop root zone. It is a much simplified method, which can be much preferable as it can be placed in soil as single time or two times in split doses. In this present study, the effect of prolonged nutrient availability from NPP in the root zone on growth and yield of sugarcane was studied by comparing with the existing method of fertilization.

MATERIALS AND METHODS

The Nutripellet Pack (NPP) has 2 parts viz., manure pellet at top and encapsulated fertilizer pellet at bottom. The manure pellet is made up of vermicompost. Fertilizer pellet was prepared by compressing the calculated amount of NPK fertilizers in fertilizer pelleting machine, which was thereafter encapsulated in a polymer coated paper (degradable pouch. NPP placement was done in two times at the time of planting and earthing up (90th day).

It is expected that through the minute pores in the polymer coated paper nutrients slowly dissolve out and then diffuse in soil water. Thus, the slow release phenomenon can be achieved. Soon after planting chip buds, Nutripellet Packs were placed in soil at 5 cm depth and 5 cm horizontal distance from the chip bud as per treatments. There were 9 treatments imposed and replicated thrice in Randomized Block Design. The treatments were T_1 : 50% NPK as NPP ; T_2 : 75% NPK as NPP ; T_3 : 100% NPK as NPP ; T_4 : 125% NPK as NPP ; T_5 : 100% NPK + Micronutrient mixture as NPP ; T_6 : 100% NPK as NPP + Sugar industry biocompost (SIBC) ; T_7 : 100% NPK as NPP + Mulching ; T_8 : Surface application of 100% NPK + FYM and T_9 : No fertilizer (control).

The SIBC used in this experiment was procured directly from sugar industry. For the production of SIBC nutrient rich pressmud, one of the by products of sugar industry is being used as a main substance. In the compost yard pressmud is spread using machinery and then spent wash–a distillery waste and bioinoculants were adequately added. The mixture was decomposed with intermittent churning on its own. The SIBC is applied to the field at 2 t ha^{-1} at the field preparation before planting.

RESULTS AND DISCUSSION

The parameters attributing to the cane yield were recorded at harvest (Table 1). The survived hill popu-

Table 1. Yield parameters of sugarcane at harvest. MN–Micronutrient.

Treatments	Survived hill population (Nos.)	Cane wt. of hill (kg)	Single cane weight (kg)	No. of canes per hill	Yield (t ha^{-1})
T_1 50% NPK as NPP	6891	13.69	1.17	8.0	65.8
T_2 75% NPK as NPP	7002	14.52	1.32	9.0	85.4
T_3 100% NPK as NPP	7061	15.46	1.40	10.2	99.2
T_4 125% NPK as NPP	7104	15.55	1.49	10.5	105.9
T_5 100% NPK+MN as NPP	7122	16.14	1.55	10.8	116.2
T_6 100% NPK as NPP+Mulch	7078	15.18	1.49	10.2	103.2
T_7 100% NPK as NPP+SIBC	7080	15.69	1.51	10.7	105.2
T_8 100% NPK+FYM	7004	14.69	1.34	9.1	86.8
T_9 Control	6777	12.16	0.89	6.4	36.7
SEd	342.80	0.75	0.07	0.50	5.37
CD (p = 0.05)	726.73	1.60	0.16	1.06	11.39

lation was highest (7122 Nos.) in the treatment which received placement of NPP having 100% NPK + micronutrient (T_5) and it was on par with placement of NPP at 125% NPK (T_4). The highest cane weight per hill (16.14 kg) was recorded in the NPK + micronutrient applied treatment (T_5).

Cane weight per hill estimated by excluding the green tops, was highest in NPP with 100% NPK + micronutrient which significantly differed from other treatments. The highest single cane weight (1.55 kg) was comparable to placement of NPP with 100% NPK wherein application of SIBC was applied at 2 t ha^{-1}. Again, the number of canes per hill was highest (10.8) in NPP with 100% NPK + micronutrient, which was found to be on par with NPP with 100% NPK + SIBC (10.7) and NPP with 125% NPK.

Placement of NPP has showed prominent effect in promoting sugarcane growth particularly under the treatment having NPK as well as micronutrient mixture with in the composition of Nutripellet Pack. This was evidenced in yield parameters particularly in survived hill population, cane weight per hill, Nos. of cane per hill and single cane weight. This trend of response can be attributed to combining micronutrient fertilizer along with NPK fertilizer in the NPP, thereby the need of micronutrient for cane growth has been realized in the present study. The complementary role of micronutrients has caused tremendous influence on the growth and yield of cane proving its essentiality for sugarcane.

The highest single cane weight (1.55 kg) was noted in NPP with 100% NPK + micronutrient (T_5) which was followed by the treatment (T_7), which received sugar industry biocompost (1.51 kg). Similarly the Nos. of cane per hill was found to be high in NPK + micronutrient treatment (T_5).

The yield obtained varied among treatments. The highest cane yield (116.2 t ha^{-1}) was recorded in the treatment which received NPP having 100% NPK + micronutrient (T_5). Next in order, yield of 105.9 t ha^{-1} was recorded in 125% NPK as NPP (T_4) and 105.2 t ha^{-1} in 100% NPP along with SIBC (T_7). The significant yield increase recorded in placement of NPP with micronutrient might be due to immediate and balanced supply of required micronutrients for tiller production. Steady supply of plant nutrients throughout the growth period promoting growth and cane yield was reported by Choudhary and Sinha (2001) and Dev et al. (2011). An improvement in yield with application of N and K along with $FeSO_4$ +$ZnSO_4$ has also been reported by Kumar et al. (2003).

Table 2. Dry matter of sugarcane in stalk, leaves and green tops at harvest stage.

	Treatments	Stalk (kg ha^{-1})	Leaves (kg ha^{-1})	Green tops (kg ha^{-1})
T_1	50% NPK as NPP	22143	3422	4059
T_2	75% NPK as NPP	27776	3797	4666
T_3	100% NPK as NPP	32342	4253	5268
T_4	125% NPK as NPP	35075	4437	5451
T_5	100% NPK+MN as NPP	35794	4650	5673
T_6	100% NPK as NPP+ Mulch	32290	4343	5272
T_7	100% NPK as NPP+ SIBC	32202	4364	5449
T_8	100% NPK+FYM	28378	3867	4727
T_9	Control	13202	2562	3125
	SEd	1655	215	262
	CD (p=0.05)	3509	455	556

Udaykumar (2016) reported that application of $ZnSO_4$ at 25 kg ha^{-1}, $FeSO_4$ at 50 kg ha^{-1} and biofertilizers along with high dose of NPK lowered the quality parameters, which might be due to higher dose of N addition resulting in vigorous crop growth leading to increased diversion of photosynthates and minerals to meet out the requirements for vegetative growth. Also, utilization of photosynthates for sucrose accumulation lowering Brix % was reported by Rakkiyappan et al. (2007).

The dry matter recorded at harvest (Table 2) indicated that stalk dry matter was far high (35,794 kg ha^{-1}) in the treatment which received 100% NPK + micronutrient in the form of NPP (T_5), which was followed by placement of NPP with 125% NPK (T_4) with dry matter of 35,075 kg ha^{-1}. The dry matter was found to be high in the leaves (4,650 kg ha^{-1}) and in the green tops (5,673 kg ha^{-1}) in the treatment which received NPP with NPK + micronutrient (T_5).

Table 3. Sugar quality parameters at harvest.

	Treatments	Brix (%)	PoI (%)	Purity (%)	Sugar recovery (%)
T_1	NPP : 50% NPK	19.7	18.2	86.4	12.2
T_2	NPP : 75% NPK	21.1	18.8	87.3	12.9
T_3	NPP : 100% NPK	21.4	19.4	88.3	13.4
T_4	NPP : 125% NPK	21.8	19.6	88.9	13.9
T_5	NPP : 100% NPK + MN	22.9	20.1	89.6	14.1
T_6	NPP : 100% NPK + Mulch	22.1	19.4	88.7	13.5
T_7	NPP : 100% NPK + SIBC	22.2	19.7	88.4	13.6
T_8	SA : 100% NPK + FYM	21.1	18.9	87.6	13.1
T_9	Control	18.2	17.3	84.5	11.0
	SEd	1.10	0.94	4.27	0.66
	CD (p = 0.05)	2.34	1.99	9.05	1.39

The highest Brix (22.9%) content at the harvest stage was observed in NPP which had 100% NPK+ micronutrient (T_5). Ramesh et al. (2002) reported that the optimum and balanced supply of nutrients along with micronutrients applied throughout the growth period of cane improved the Brix of juice. Singh et al. (1997) also observed a significant increase in Brix in sugarcane due to application of Zn.

The POL (20.1%) and the Purity (89.6%) were also noted to be high in T_5. Chinnamade et al. (2003) reported that the juice quality analysis for purity indicated that NPK application beyond the recommended dose of 250-75-75 kg ha^{-1} did not result in any improvement in juice quality, while addition of micronutrients mixture or addition of organics recorded an opposite effect. Ravindra and Bhupal (2004) revealed that foliar application of $FeSO_4$ twice at 45 and 60 days after planting of sugarcane along with 100% NPK recorded significantly higher POL (19.93%). Tomer and Malik (2004) recorded significant differences in Brix and POL in juice for the soil application of $ZnSO_4$ with NPK as compared to NPK only. Thangavelu (2007) also recorded significantly higher Brix and POL in juice of cane grown with Zn fertilization, in addition to NPK as compared to those without fertilizers or supplied only with NPK.

It may be that adequate and balanced fertilization as well as micronutrients supply from applied sources increased juice quality parameters (Bokhtiar and Sakurai 2004). The highest sugar recovery of 14.1% was noted in T_5. The Brix, POL and Purity in juice of cane grown with placement of NPP with 100% NPK + micronutrients was found to be the highest. Hence, the prominent effect of fertilizing sugarcane by the placement of NPP having NPK + micronutrients has been brought out in the present study (Table 3).

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