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Splitting dose influence the nutrient acquisition of *Saccharum officinarum* L. under calcareous soil conditions

Surendra Bhilala, Lalita Rana, Navnit Kumar, Anil Kumar, CK Jha, Sunita Kumari Meena and AK Singh

Abstract
Results of the experiment conducted at Sugarcane Research Institute in early maturing variety Rajendra ganna-1 in year 2020-21 in split plot design having 2 factor in main plot (Broadcasting and Band Placement) and 4 sub-plot factor(RDN + RDK in five splits, six splits, 7 splits and RDF) replicated thrice. The results revealed that cane yield was increased by 17.3 % under the band placement over broadcasting. Uptake of N, P and K was significantly higher in band placement method of fertilizer application accounting 14.13, 36.06 and 17.14 % respectively. Similarly N, P and K uptake was significantly higher with seven splits of nitrogen and potassium to the tune of 25.9, 13.8 and 33.4 % respectively.

Keywords: Band placement, split, uptake

1. Introduction
Precision nutrient management is a comprehensive practise that improves the synchronisation of nutrient supply and crop demand, ensures the health of the soil through prudent chemical fertiliser use, establishes good harmony between soil quality and agronomic management of field soil, assesses variations in soil fertility, and suggests nutrient-based recommendations in accordance with the 4R concept (right rate, right time, right source and method). With the help of different technologies, such as soil test-based integrated plant nutrient supply (IPNS), site-specific nutrient management (SSNM), and real-time N management with some decision support systems, the importance of PNM is highlighted. (Dwivedi *et al*., 2016) [5]. Urea is the most widely used nitrogenous fertiliser for sugarcane because it is less expensive per unit of nitrogen than ammonium sulphate (AS) and ammonium nitrate (AN). Urea, on the other hand, is prone to substantial $NH4^+$ losses due to volatilization (Trivelin and colleagues, 2002; Cantarella *et al*., 2008; Mariano *et al*., 2012) [17, 3, 11]. Sugarcane, on the other hand, seldom recovers more than 40% of its nitrogen fertiliser. Because its main value is from its high-grade sugar content, sugarcane is special in terms of K requirements. For a crop to have high sugar content and avoid any physiological limitations that would prevent sugar accumulation and storage, K must be available anytime it is needed throughout crop growth and development (Filho, 1985; Kwong and Pasricha, 2002; Yadav, 2006; Medina and colleagues, 2013) [6, 9, 22]. In order to achieve these important goals, a well-balanced fertiliser application that contains a large amount of N and K would be a good starting point. The phrase "split application" describes the practise of supplying fertiliser in accordance with a predetermined target yield and a particular amount of soil moisture, then giving the remaining nitrogen and potassium when moisture conditions improve. Split nutrient treatments allow farmers to have more control over their fertiliser programme. Sugarcane plants should receive a good quantity of nitrogen (N) fertiliser with phosphorus (P) and potassium (K) in balanced manner. Factors within farmers' control that limit sugarcane output appear to be more pressing and, moreover, resolvable. Balanced N and P fertilisation principles, suggestions, and practices have been effectively promoted among sugarcane growing farmers in India, and split nitrogen application is also extremely frequent. Simultaneously to achieve high nutrient use efficiency and high crop productivity is necessary in modern agriculture (Cassman *et al*., 2003) [4]. Although sugarcane is an important crop in Bihar, information on split application and method of application very less. Keeping the above facts in view, a field study was conducted to study the optimizing method of fertilization of nitrogen and potassium.

2. Materials and Methods

The current investigation was carried out at the crop research centre, Pusa farm of Sugarcane Research Institute (S.R.I.), Dr. Rajendra Prasad Central Agricultural University, Pusa, Samastipur, (Bihar) in spring season (2020-21). The soil of the field was sandy loam in texture and its pH 8.1. The available nitrogen level is low (215.3 kg/ha) and the available phosphorus and potassium content is medium (23.6 and 141.2 kg/ha). The experiment was set up as a split plot deigns with 3 replications. The main plot was consisted of two methods of fertilizer application (band placement and broadcasting) and subplot factor (RDN + RDK in five splits, six splits, 7 splits and RDF).The weather parameters were taken during the year of experimentation (as depicted in fig.1).

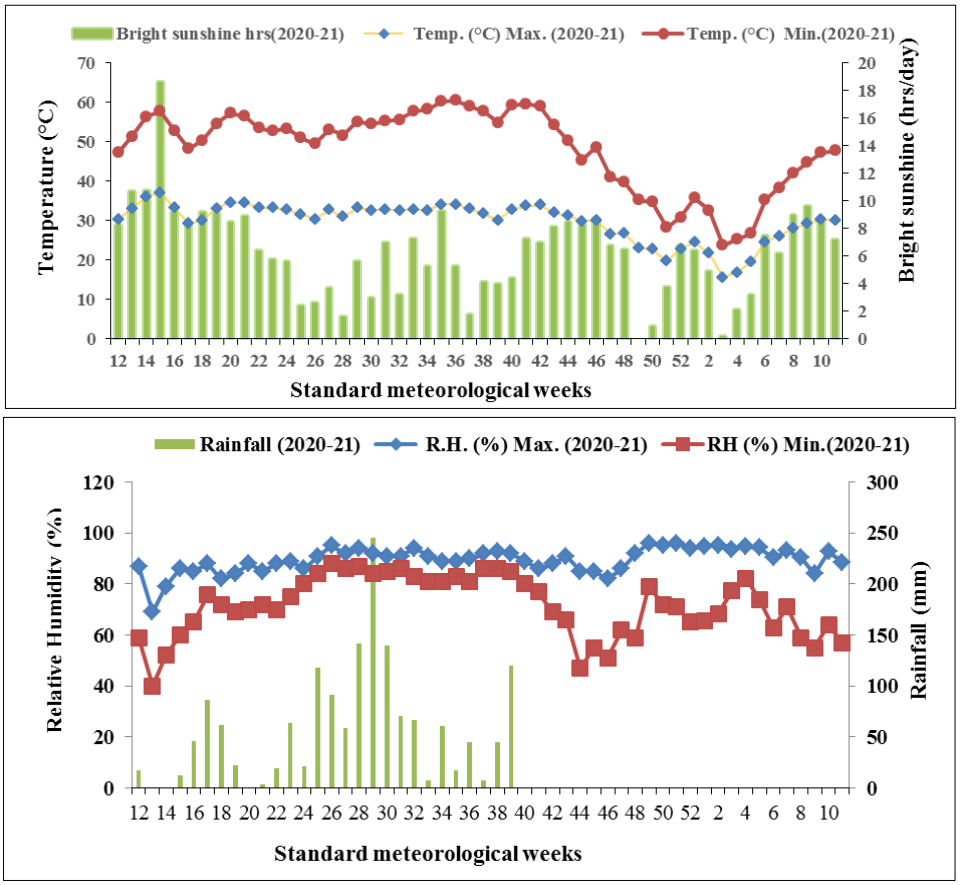

Fig 1: Meteorological parameters during the cropping season (2020-2021)

3. Results and Discussion

3.1 Growth attributes and Yield

Data presented in table 1. revealed that plant height at harvest increased by 3.04 % when applied nitrogen and potassium through band placement method while it was increased by 3.72 % in seven splits of N and K. Similarly, Mohammed (1997) [13] noted that, the increase in plant height with regard to increasing nitrogen rate shows the highest physiological growth and development of plant under adequate nitrogen availability. Furthermore, Taye and Yifru (2010) [16] discovered that when there is no split application of N, resulted in the lowest plant height. Sugarcane plant height was affected by the timing and rate of nitrogen fertilizer treatment (Wiedenfeld and Enciso 2008) [19]. According to Gana (2008) [7], increasing N rate and application time resulted with longer stalks. Similar findings were also recorded by Vashishtha and Sinha (2004) [18].

Leaf area index and dry matter accumulation was significantly influenced by method and split application of N and K. However, it was found highest in band placement over broadcasting method. Split application of N and K in 7 times increases leaf area index (LAI) and dry matter accumulation (DMA) by 14.8 and 9.9 % respectively. Similarly, results given by Bokhtiar and Sakurai (2005) [1], Islam *et al*. (2009) [8] and Singh *et al*. (2008). The more split application of nitrogen decreased LAI (Wiedenfeld, 1997) [20].

Among the method of application fertilizer, significantly higher cane yield of sugarcane was recorded under band placement (86.70 t ha^{-1}) as compared to the broadcasting (73.90 t ha^{-1}). Similarly, in the split application of nitrogen in combination with potassium. The maximum cane yield was registered in treatment seven splits (85.20 t ha^{-1}) when applied N along with K as compared to the treatment recommended dose of fertilizer (71.60 t ha^{-1}). The necessity of nutritional balance, particularly between nitrogen and potassium, in achieving the desired yield has always been emphasized (Ng Kee Kwong 2001) [14].

3.1 NPK uptake

In band placement method of fertilizer application was recorded significantly higher plant uptake of N (284.05 kg ha^{-1}), P (34.90 kg ha^{-1}) and K (292.96 kg ha^{-1}) at harvest as compared to broadcasting. At harvest, similarly, plant uptake of N, P and K was significantly higher under when applied nitrogen and potassium in seven splits (297.96 kg ha^{-1}), (33.73 kg ha^{-1}) (306.46 kg ha^{-1}) than recommended dose of fertilizer (236.62 kg ha^{-1}), (29.65 kg ha^{-1}) and (229.78 kg ha^{-1}) respectively as depicted in fig 2. Split application of nutrient,

the growth and development phase of plant constituent result of several vital metabolisms other activity which is simultaneously cussing inside and in their vicinity of root hair. Similar result revealed that by Bokhtiar & Sakurai (2005) [1], Madhu *et al*. (2017) [10] and Wubale & girma (2018) [21].

3.2 Fertility status of post-harvest soil

3.2.1 Available soil nitrogen, phosphorus and potassium (kg ha^{-1})

In band placement method of fertilizer application remarkably greater available N (204.38 kg ha^{-1}) at post-harvest of soil was observed compared to broadcasting. Similarly, available N of post-harvest soil was significantly higher when applied nitrogen and potassium in seven times (203.97 kg ha^{-1}) than RDF (192.90 kg ha^{-1}). Among the method of fertilizer application, maximum available P and K was found under band placement (11.10 and 120.52 kg ha^{-1}) in post-harvest soil analysis as compared to broadcasting. In split application of nitrogen and potassium, remarkably higher available K (124.30 kg ha^{-1}) of post-harvest soil was noticed under seven splits application of nitrogen in combination with potassium and minimum was noticed in recommended dose of fertilizer (104.62 kg ha^{-1}). The highest available P of post-harvest soil was registered in seven splitting of N and K in comparison to RDF (Figure 3.)

Table 1: Effect of split application of nitrogen (N) and potassium (K) on growth, yield and economics of sugarcane

Treatment	Plant height at harvest	LAI at 180 DAS	DMA at harvest	Cane yield (t/ha)	Gross returns (₹/ha)	Net returns (₹/ha)	Benefit: cost ratio
Method of application							
Broadcasting	219.4	2.87	314.92	73.90	210615	71271	1.51
Band placement	226.3	3.34	358.62	86.70	246853	105448	1.75
SEm±	0.89	0.08	6.97	2.07	6921.36	6921.36	0.04
CD (P=0.05)	5.41	0.46	42.42	12.62	21456	21456	NS
CV (%)	1.38	8.50	7.17	8.95	5.34	13.83	8.98
Split application of fertilizer							
F_1 (RDN+RDK in 5 splits)	220.9	2.98	331.84	80.60	229710	89336	1.64
F_2 (RDN+RDK in 6 splits)	223.2	3.18	340.17	83.80	238830	97425	1.69
F_3 (RDN+RDK in 7 splits)	228.0	3.34	353.47	85.20	242820	100384	1.70
F_4 (RDF)	219.5	2.91	321.61	71.60	203575	66292	1.49
SEm±	0.89	0.08	4.80	2.83	4093.00	4093.00	0.06
CD (P=0.05)	3.51	0.24	14.78	8.71	12609.89	12609.89	NS
CV (%)	1.25	6.27	3.49	8.62	4.38	11.35	8.56

CD: Critical difference at 0.05 % level; CV: Coefficient variation (%), RDN: Recommended dose of nitrogen; RDK: Recommended dose of potassium

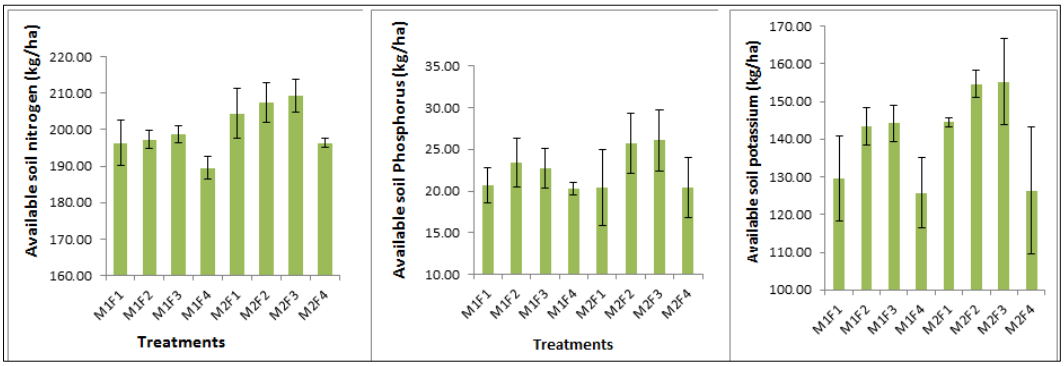

Fig 2: Available soil Nitrogen, Phosphorus and Potassium (kg/ha) as influenced by method and split application of nitrogen and potassium during spring 2020-21

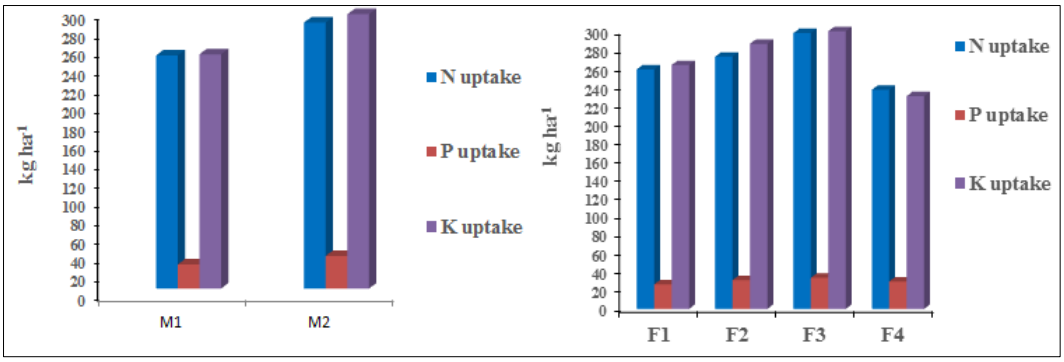

Fig 3: Uptake of N P and K (kg ha^{-1}) as affected by splits applications of Nitrogen and Potassium

4. Conclusions

It can be concluded from our results that nutrient uptake by plant and available N, P, K is influenced by splitting of nitrogen and potassium. Nutrients application through splitting in 7 times along with band placement method was more remunerative for achieving higher productivity and sustained agriculture.

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