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GROWTH CHARACTERS AND YIELD OF SUGARCANE SHORT CROP INFLUENCED BY FERTILIZERS AND MICROBIAL INOCULANTS

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ABSTRACT

A field experiment was conducted at Agricultural Research Station, Perumallapalle, Tirupati, Acharya N.G. Ranga Agricultural University, Andhra Pradesh, India during 2021-22 to study the effect of fertilizers and microbial inoculants on growth and yield of sugarcane short crop. The experiment was laid out in randomized block design with ten treatments and replicated thrice. The treatments consists of 75%, 100% and 125% RDF in combination of solid and liquid microbial inoculants (*Gluconacetobacter*, PSB and KSB). Data on dry matter production, yield characters and yield parameters were recorded. Results revealed that 100% RDF along with sett treatment with liquid *Gluconacetobacter* @ 1 L ha^{-1}, PSB @ 1.25 L ha^{-1} and KSB @ 1.25 L ha^{-1} resulted significantly the highest dry matter production (6684, 29821, 37530 kg ha^{-1} at tillering, grand growth and harvest stages, respectively). It also enhanced tillering (119364 ha^{-1}), stalk population (93465 ha^{-1}), cane length (248 cm) and cane yield (97 t ha^{-1}).

KEYWORDS: Growth, Inorganic fertilizers, Microbial inoculants, Sugarcane and yield.

INTRODUCTION

Sugarcane is the most important commercial crop of India and plays a vital role in the agricultural as well as industrial economy. Sugarcane is a multipurpose crop that provides sugar, fiber, bio-fuel and manure apart from many by-products. It constitutes the major raw material for sugar production and for making gur and khandasari. Sugarcane has unique character of ratooning as several succeeding crops are raised from a single planting which is an integral component of the sugarcane production system.

Sugarcane (*Saccharum officinarum*) is a nutrient exhaustive crop that can uptake great amount of soil nutrients for its biomass production. In addition to micronutrient exportation, about 65 kg N, 90 kg P_2O_5 and 170 kg K_2O are taken up for a target yield of 50 t ha^{-1} (Kathiresan, 2008). A permanent manurial trial, conducted for 33 years at RARS, Anakapalle (Andhra Pradesh), revealed that sugarcane crop without addition of fertilizers yielded about 40 t ha^{-1} of cane annually. The soil nitrogen reserve under this crop, however, increased by 50 per cent of the initial value which was clearly indicated that the root-associated diazotrophs contributed significant quantity of nitrogen for sustaining the production of sugarcane (Suman, 2003). Inoculation of N-fixing microbes to sugarcane has increased the cane yield by 5-15 per cent and also improved the juice quality parameters, *viz*., sucrose and purity (Hari, 1995).

Gluconacetobacter diazotrophicus is a nitrogen-fixing bacterium highly specific to sugar-rich crops. It can excrete about half of its fixed nitrogen in a form that plant can use. It has also been reported that besides N fixation, all the strains of *G. diazotrophicus* produced Indole acetic acid in a culture medium supplemented with tryptophan in the range of 0.14 to 2.42 l g ml^{-1} (Fuentez *et al*., 1993). Furthermore, it has been reported its ability to solubilize inorganic phosphates from the soil and make available P for the inoculated crops. Hence, *Gluconacetobacter* inoculation to sugarcane significantly increased the cane length, dry matter production and number of stalks, resulting in the more cane yield. PSB application which constitutes increased P solubilization which by production of organic acids which solubilizes the fixed form of phosphates into available form resulting in more available P in soil. KSB is more effective in releasing K from inorganic and insoluble fractions of total soil K through solubilization. With this view, a field experiment was conducted to study the effect of soil application and sett treatment of solid and liquid *G. diazotrophicus,* PSB and KSB along with fertilizers on growth characters and yield of sugarcane short crop.

MATERIAL AND METHODS

A field experiment was conducted during 2021-22 at Agricultural Research Station, Perumallapalle, Tirupati, Acharya N. G. Ranga Agricultural University, geographically situated at 13° 36' 761" N latitude and

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79° 20' 704" E longitude with an altitude of 182.9 m above the mean sea level, which falls under Southern agroclimatic zone of Andhra Pradesh. The experiment soil was sandy loam in texture, neutral in reaction (7.36), normal in soluble salt concentration (0.232 dS m^{-1}), low in organic carbon (0.49%), available nitrogen (212 kg ha^{-1}) and medium in available phosphorus (40.12 kg ha^{-1}) and high in available potassium (282 kg ha^{-1}). The experiment consist of ten treatments *viz*., T_1: 100% RDF, T_2 : 125% RDF, T_3: 100% RDF + soil application of solid *Gluconacetobacter* + PSB + KSB, T_4 : 100% RDF + sett treatment with solid *Gluconacetobacter* + PSB + KSB, T_5 : 75% RDF + soil application of solid *Gluconacetobacter* + PSB + KSB, T_6 : 75% RDF + sett treatment with solid *Gluconacetobacter* + PSB + KSB, T_7 : 100% RDF + soil application of liquid *Gluconacetobacter* + PSB + KSB, T_8 : 100% RDF + sett treatment with liquid *Gluconacetobacter* + PSB + KSB, T_9 : 75% RDF + soil application of liquid *Gluconacetobacter* + PSB + KSB and T_{10} : 75% RDF + sett treatment with liquid *Gluconacetobacter* + PSB + KSB was laid out in randomized block design with three replications.

The crop was sown with a seed rate of 40,000 three budded setts ha^{-1}. The variety Swarnamukhi was planted. Recommended dose of inorganic fertilizers *viz*., 224:112:112 kg N : P_2O_5 and K_2O ha^{-1}, respectively were applied as per the treatments. Solid *Gluconacetobacter*, PSB and KSB were applied @ 10 kg ha^{-1} each as soil application. The recommended dose of solid biofertilizers for sett treatment was 10 kg - 1.25 kg - 1.25 kg ha^{-1} of *Gluconacetobacter,* PSB and KSB, respectively. Recommended dose of liquid *Gluconacetobacter*, PSB and KSB for soil application was 1 L, 1.25 L and 1.25 L ha^{-1}, respectively. Similar quantity of liquid *Gluconacetobacter*, PSB and KSB was used for sett treatment. All the other recommended practices were also adopted as per the crop requirement. Data on dry matter production, tiller count, stalk population, cane length and cane yield was recorded at respective stages. The collected data was statistically analyzed by following the analysis of variance for randomized block design as outlined by

Table 1. Dry matter production of sugarcane short crop as influenced by application of microbial inoculants and inorganic fertilizers

Treatments	Dry matter production (kg ha^{-1})		
	Tillering stage	Grand growth stage	At harvest
T_1	4704^{h}	20146^{g}	26057^{h}
T_2	5483^{f}	23426^{e}	30099^{ef}
T_3	5797^{d}	24956^{d}	31910^{c}
T_4	6291^{b}	27896^{b}	34960^{b}
T_5	5088^{g}	21495^{f}	28145^{g}
T_6	5436^{f}	23392^{e}	30463de
T_7	6021^{c}	26308^{c}	32971^{c}
T_8	6684^{a}	29821^{a}	37530^{a}
T_9	5179^{g}	22293^{f}	29476^{g}
T_{10}	5640^{e}	24235de	30395^{d}
F-Value	87.68**	73.06**	58.29**
P-Value	<0.01	<0.01	<0.01

**Significant at P = 0.01 level
Note : Same set of alphabets indicates no significant difference or at par with each other (DMRT)

Panse and Sukhatme (1985). Statistical significance was tested with ‘F’ test at 5 percent and 1 per cent level of probability. Further, multiple comparison tests have been done using Duncan’s multiple range test (DMRT) to identify the homogenous groups of treatments using SPSS-20.

RESULTS AND DISCUSSION

Dry matter production

Data pertaining to dry matter production at tillering, grand growth and harvest was represented in Table 1. Application of 100% RDF + sett treatment with liquid *Gluconacetobacter* + PSB + KSB (T_8) resulted significantly the highest dry matter production at all stages of crop growth (6684, 29821 and 37530 kg ha^{-1}, respectively) followed by 100% RDF + sett treatment with solid *Gluconacetobacter* + PSB + KSB (T_4) at all stages of crop growth while the lowest was observed in control (100% RDF) (T_1) (4704, 20146 and 26057 kg ha^{-1}, respectively).

The highest dry matter production recorded with the combined application of 100% RDF and sett treatment with liquid *Gluconacetobacter* + PSB + KSB (T_8). This might be due to higher germination per cent which leads to more tiller population, shoot population caused by bioinoculants which produces more growth promoting substances, increased availability of nutrients due to atmospheric nitrogen fixation in the rhizosphere, solubilization of mineral nutrients, nutrient recycling by microbial inoculants and also readily available nutrients from inorganic fertilizers. (Viana *et al*., 2019). These results are in line with the findings of Banerjee *et al*. (2018).

Tiller count and stalk population

Data pertaining to tiller count and stalk population was presented in Table 2. Application of 100% RDF + sett treatment with liquid *Gluconacetobacter* + PSB + KSB (T_8) resulted in significantly highest number of tillers at 90 DAP and stalk population at 240 days after planting followed by 100% RDF + sett treatment with solid *Gluconacetobacter* + PSB + KSB (T_4). The lowest number of tillers and stalk population was observed in control (100% RDF) (T_1). Improvement in plant population in terms of number of tillers and stalk population might be due to immediate supply of nutrients from inorganic fertilizer and sustained supply of nutrients from organics along with biofertilizers during the plant growth. Application of biofertilizers increased tiller number, and stalk population probably due to plant growth regulator hormones secreted by microbial inoculants. Ethylene is the foremost phytohormone regulating this physiological process in sugarcane (Mishra *et al*., 2014). Moreover, application of PSB has ability to produce cytokinins which will be essential for cell division in tiller buds. These results are in conformity with the findings of Thakur *et al*. (2010) and Singh *et al*. (2016).

Cane length

Cane length of sugarcane was significantly affected by the application of microbial inoculants along with fertilizers (Table 2). Significantly the highest cane length (248 cm) was observed with the application of 100% RDF + sett treatment with liquid *Gluconacetobacter* + PSB + KSB (T_8) followed by 100% RDF + sett treatment with solid *Gluconacetobacter* + PSB + KSB (T_4) (242 cm). The lowest cane length (217 cm) was observed with (100% RDF) (T_1). Application of 100% RDF supplies nutrients in available form at initial stages of plant growth which plays an important role in metabolic process and activation of number of enzymes participating photosynthesis which inturn increased the plant growth and cane length. Application of biofertilizers improved soil environment in respect of nutrients for crop growth at active growing stages as a result of elevated root proliferation, cell multiplication and elongation leading to increased cane length. These findings are corroborated with the results obtained by Mathew and Varughese (2005), Shankaraiah (2007) and Singh *et al*. (2014).

Cane yield

Cane yield of sugarcane short crop was significantly differed with microbial inoculants and fertilizers application (Table 2). Significantly the highest cane yield (97 t ha^{-1}) was recorded with the application of 100% RDF + sett treatment with liquid *Gluconacetobacter* + PSB + KSB (T_8) and followed by 100% RDF + sett treatment with solid *Gluconacetobacter* + PSB + KSB (T_4) (92 t ha^{-1}**)**. The control (100% RDF) (T_1) produced significantly the lowest cane yield (69 t ha^{-1}). The highest cane yield with 100% RDF + sett treatment with liquid *Gluconacetobacter* + PSB + KSB might be due to direct utilization of sugars present in setts by microbes as a food source which inturn leads to more microbial multiplication and leads to production of growth promoting substances. It helps in photosynthesis and translocation of substrates from source to sink *i.e.,* cane and leads to more cane yield. Sufficient quantity of nutrients supplied through chemical fertilizers provides readily available nutrients and application of biofertilizers may hasten the constant nutrient supply by nitrogen fixation in the rhizosphere, solubilization of mineral nutrients, enhanced rooting and

Table 2. Tiller count, stalk population, cane length and cane yield of sugarcane short crop as influenced by application of microbial inoculants and inorganic fertilizers

Treatments	Tiller count ha^{-1} at 90 DAP	Stalk population ha^{-1} at harvest	Cane length (cm)	Cane yield (t ha^{-1})
T_1	96005^h	69484^g	217^h	69^h
T_2	107512^e	78626^e	229^f	77^f
T_3	111477^d	83468^c	235^d	85^d
T_4	116508^b	88686^b	242^b	92^b
T_5	101752^g	74368^f	223^g	74^g
T_6	104542^f	79464de	232^e	82^e
T_7	113603^c	84648^c	239^c	88^c
T_8	119364^a	93465^a	248^a	97^a
T_9	103585^f	77864^{ef}	228^f	81^e
T_{10}	110596^d	80542^d	234^d	84^d
F-Value	55.87**	62.14**	96.42**	80.08**
P-Value	<0.01	<0.01	<0.01	<0.01

**Significant at P = 0.01 level
Note : Same set of alphabets indicates no significant difference or at par with each other (DMRT)

plant establishment, better uptake of immobile nutrients such as P, improved nutrient cycling, improved plant tolerance to stress (biotic and abiotic) and amelioration of physical and biological environment. (Surendran and Vani, 2013). Similar results were reported by Indi *et al*. (2014) and Vajantha *et al*. (2019).

It can be concluded that combined application of 100% RDF + sett treatment with liquid *Gluconacetobacter* + PSB @ + KSB @ 1.25 is the most efficient nutrient management practice to obtain better growth, higher yields and quality of sugarcane short crop. Hence, it is the best practice to sustain higher productivity and to achieve economic profitability in Southern Agroclimatic Zone of Andhra Pradesh.

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