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Foliar application of micronutrients for enhancing productivity of banana under irrigated conditions through farmers' participatory approach

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Abstract

In India, banana is the second largest cultivating fruit crop, exhausts major and micronutrients from the soil. Location specific nutrient management with proper demonstration through participatory approach might be the solution to address these nutrient deficiencies and to improve the banana productivity. In this context, on farm assessment trials with foliar nutrition were conducted at Virudhunagar district, Tamil Nadu, India. It is concluded from the study that the optimized nutrient and crop management package including quality banana suckers, application of RDF fertilizers @ 160:50:390 N:P:K g/plant in three splits at 3, 5, and 7th after planting along with two foliar spray of banana special or banana sakthi during fruit development stage can be adopted as a package to increase the banana productivity under irrigated vertisol tracts of Virudhunagar district. In places of low soil nitrogen fields, additional dose of 25 percent N is recommended for higher yield and net income.

Keywords: Banana, nutrient management, foliar spray, micronutrients

Introduction

Banana (*Musa* spp.), one of preferred plantation crops in the world, having very high heritage and culture. Banana plant is noted as symbol of prosperity, wealth and fertility. Globally, India stands first in both area and production of banana and contributes more than 20 percent of global production but has very less (< 0.05 %) contribution to the international banana market. The year around demand leads to continuous production, which in turn supports lively hood of the farmers, labourers, traders and retailers, thus helping in poverty alleviation (Mustaffa and Kumar, 2012) [7]. In India, banana is the 2nd most important cultivable fruit crop, then to mango (Chhuria, Mandal, Biswal, & Thriveni, 2016) [2].

Intensive agriculture and continuous mono cropping leads to decline in productivity and need to be restored up to sustainable level for many commercial cultivars. Poor agricultural and field management practices, especially improper nutrition leads to large losses in yield and fruit quality. The quality characteristics of ripened fruits are mainly determined by the genetic potential of the cultivar and nutrient status of the soil (Roy and Chakroborty, 1993) [8]. Many earlier studies inferred that the yield of banana be increased by 21 to 60% with adoption of improved technologies such as improved variety, recommended dose of fertilizer, weed management and plant protection. Selection of location specific and purpose specific varieties, disease free rhizomes, maintaining optimum population, Soil test based timely application of nutrients and water are to be precised to reduce the gap between actual and potential yield. (Mustaffa and Kumar, 2012) [7].

Banana crop requires large amount nutrients and it exhausts both the major and micronutrients for its growth, development and yield (Thangaselvabai, Suresh, Joshua, & Sudha, 2009; Hazarika and Ansari, 2010) [9, 4], especially nitrogen and potassium. This nutrient needs should be replenished to maintain soil fertility and to sustain the productivity. Several workers have studied the effect of micronutrients and inferred that the application of micronutrients in enhanced the various processes, growth and yield parameters of banana. Foliar spray of nutrients is a contingent measure for the crop which suffers from nutrient deficiencies. The foliar spray of urea (1%), Murate of potash (2%) as mixture increased the bunch weight and fruit quality (Vijayaraghavan and Ayyamperumal, 2000) [12]. Foliar application of ZnSO₄ 0.5%, FeSO₄ 0.2%, CuSO₄ 0.2% and H₃BO₃ 0.1% during 3, 5 and 7th months after planting

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increased the bunch weight and TSS in ripe fruits (Kumar and Jeyakumar, 2001) [6].

Virudhunagar district in Tamil Nadu is growing banana under irrigated condition, in patches where ground water potential is available. The preliminary survey in Virudhunagar district indicated that about 67 percent farmer growing banana are small farmers and nearly 75 percent of the farmers' are getting the productivity of 30 - 35 t/ha. The survey also inferred that, the banana crop is grown under irrigated conditions, the yield was low due to lack of knowledge on recent technologies, availability of quality materials for planting and low access to credit and imbalanced fertilizer management. Though numerous technologies have been developed, the gap between potential and actual yield is still wider. The main reason for the failure of technologies that identified as "successful" is due to wrong selection and partial adoption of technological packages. Location specific technologies with proper demonstration through participatory approach might be the solution to improve the banana productivity of Virudhunagar district. In this context, on farm assessment trials with foliar nutrition were conducted at 10 locations of Virudhunagar district to maximize the banana productivity and quality through Farmers Participatory Approach, is discussed hereunder.

Methodology

Field particulars

Field experiment was conducted at farmers' fields as on-farm research trial in 10 locations spread over three blocks viz., Aruppukottai, Virudhunagar and Srivilliputtur blocks of Virudhunagar district by Krishi Vigyan Kendra, Aruppukottai, Tamil Nadu, India to study the impact of foliar micronutrient on the yield and quality of banana under irrigated vertisol conditions. The study area is belongs to southern agro climatic zone of Tamil Nadu.

Climatic conditions and soil

The annual normal rainfall of experimental area is 760 mm, of which season wise rainfall distribution is North East Monsoon (NEM) - 363 mm (17 days), South West Monsoon (SWM) - 206 mm (11 days), Summer - 152 mm (8 days) and Winter - 39 mm (2 days). During the cropped year 2014 -15, the rainfall was 602 mm, 237 mm (Summer 2014), 109 mm (SWM 2014), 242 mm (NEM 2014) and 14 mm (Winter 2015), which was 20 percent lesser than normal. The soil of the experimental sites in all the 10 farms was medium deep black clay in texture and belongs to *Chromoustert* of the order Vertisol. Surface soil samples were drawn from 0-15 cm for the estimation of initial soil chemical properties. The initial soil physio chemical status is furnished in table 1. Stubbles of previous Cotton crop was ploughed *in situ*, and tilled twice for optimum soil tilth. The land was shaped in to ridges and furrows @ 1.8 m interval. During Aril 2014, under irrigated condition, good quality, disease free and approximately 1.5 kg weighed Robusta banana rhizomes were planted in small pits @ 1.8 m interval. These pits were filled with mixture of top soil, 5 kg farm yard manure, 150 g of neem cake and 10 g carbofuran 3G granules.

Experiment details

Initially, a "Farmer - Scientists" interaction meeting followed by a survey was conducted to identify the constraints of banana production at Virudhunagar district. The interaction and survey revealed that use of local varieties, poor quality rhizomes, micronutrient deficiency in soil and improper

fertilizer usage are the major constraints for lesser yield. Based on the information, special foliar nutrition was suggested along with recommended dose of fertilizers for banana in addition to the selection of banana variety and quality rhizome. The same was experimented in the farmer's field as On Farm Trial (OFT) in 10 locations.

Trial included three foliar nutrient spray technology options and one control plot viz., i. RDF + Foliar spray with ZnSO₄ @ 0.5 %, + FeSO₄ @ 1 % + citric acid 0.1 % + 0.2 % boric acid, ii. RDF + Foliar spray with Banana Sakthi of NRCB, Trichy iii. RDF + Foliar spray with Banana special of IIHR, Bangalore and iv. Farmer's local practice (100: 50: 250 g N:P:K g/plant without soil or foliar micronutrient application). The foliar nutrient spray was done twice during fruit development stage. The TNAU's Recommended Dose of Fertilizer (RDF) for Banana (160:50:390 NPK g/plant) and time schedule (3rd, 5th & 7th month) were followed in all type of foliar nutrients spray. Since the soil available N status was low in all the experimental locations, a 25 percent extra dose of N was given along with RDF for all the treatments except farmer's practice. The other cultural operations were carried out timely as and when needed and harvested the bunches by February - March 2015.

In each location, each treatment plot had 300 plants (25 cents), totally one acre for four treatments. Each location was considered as one replication, totally 10 replications with 4 treatments were analyzed statistically in RBD. The results obtained from observed and analyzed data are presented below.

Banana Sakthi is a foliar micronutrient formulation developed by ICAR - National Research Center for Banana (NRCB), Tiruchirapalli during 2007. It contains 2.5% boron, 2.4% copper, 4.75% iron, 4.5% manganese, 5.25% zinc in easily dissolvable solid mixture. The mixture was soaked overnight @ 30 kg/ha and the supernatant solution alone sprayed after filtering the sediments as scheduled in treatment.

Banana Special is a foliar micronutrient formulation developed by Indian Institute of Horticultural Research (IIHR) Bangalore. Banana special was sprayed @ 12.5 kg/ha by mixing 75 grams of banana special in 15 liters of water with one shampoo packet and one lemon as scheduled in treatment.

During the trial, yield parameters viz., individual bunch weight, number of hands per bunch, number of fruits per hand, fruit length and total bunch yield were recorded and economic parameters viz, gross cultivation expenses, gross income, net income and BC ratio were calculated.

Results

Initial soil analysis

The Initial soil samples were collected from all the experimental farms and analysed for available macro and micronutrients in soil (Table 1). The analysis of initial soil samples indicated that soil was slightly calcareous in nature, free from salinity and low in organic carbon status. All the experimental farms are low in available nitrogen, medium in available P and medium to high in available K. The DTPA extractable Fe and Zn were showed deficient status, whereas Mn and Cu were sufficient. The HWSB boron was also deficient in all the farm sites of study area.

Yield parameters

Data on the effect of foliar nutrient application on yield parameters of banana is depicted in Table 2. The results indicated that, the foliar nutrition have significantly positive

influence on the yield parameters. The mean hands per bunch was ranged from 7.4 to 8.5 and maximum was observed in both Banana Sakthi and Banana special treatments, which were on statistically par and then followed by individual nutrient application. The farmer method had observed with significantly lowest hands per bunch than all other method. Number of fruits per hand was ranged between 10.9 and 12.9. There were significantly maximum number of fruits were observed in banana special treatment which was statistically on par with banana sakthi and followed by individual nutrient sprayed treatments. All the treatments were significantly varied to each other. Similar results were observed in mean fruit length (cm) and mean bunch weight (kg/bunch). The mean fruit length was ranged between 14.7 and 18.4 cm. The mean bunch weight was ranged between 11.6 and 18.3 kg. These variations in the yield parameters were significantly influenced the total yield of treatments and the total bunch yield were ranged between 29294 and 45831 kg/ha. The yield was significantly maximum in banana special foliar treatment plot, which was statistically on par with banana sakthi and

significantly varied with individual nutrient treatment. The farmer's method was significantly lowest among all other treatments.

Data on the effect of foliar nutrient application on the economics of banana cultivation is depicted in Table 3. The mean cost of cultivation is varied from 218200 to 228200 and maximum expenditure was observed in banana sakthi treatment followed by banana special, individual nutrient application. Lowest expenses was observed in farmer's method. The net income per hectare was significantly varied among the treatments and maximum in banana special (Rs. 3, 24, 272/-) followed by banana sakthi (Rs. 3, 03, 184) and then in individual nutrient treatment (Rs. 2, 00, 524/-). The farmers practice was recorded significantly lowest net income (Rs. 133328/-). The B: C ratio was ranged between 1.78 and 2.44 and significantly varied among the treatments. The significantly highest BC ratio was recorded in banana special (2.44) followed by banan sakthi (2.33), individual tratment (1.89) and the significantly lowest BC ratio was observed in farmers method (1.78).

Table 1: Initial soil phyio – chemical status of experimental farms

Soil properties	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10
Soil pH	7.9	7.9	8.1	8.1	8.2	7.9	8.3	8.4	8.3	8.4
Electrical conductivity(dS/m)	0.4	0.3	0.4	0.4	0.4	0.4	0.4	0.4	0.3	0.3
Organic carbon (g/kg)	4.9	4.7	4.1	5.1	4.9	4.4	4.3	4.2	4.0	4.5
Available nitrogen (kg/ha)	188	175	170	192	176	175	184	210	194	182
Available phosphorus (kg/ha)	15	15	14	17	16	14	14	16	14	13
Available potassium (kg/ha)	260	255	288	295	290	286	274	310	340	275
DTPA- Fe (mg/kg)	3.1	3.0	3.2	3.4	3.6	3.1	3.0	3.3	3.4	3.2
DTPA- Mn (mg/kg)	5.1	5.6	5.8	6.2	5.9	5.7	6.1	5.4	5.2	5.7
DTPA- Zn (mg/kg)	0.8	0.9	1.0	1.0	0.8	0.7	0.6	0.9	1.1	1.0
DTPA- Cu (mg/kg)	1.5	1.7	1.4	1.4	1.5	1.5	1.6	2.1	2.4	1.8
HWS boron (mg/kg)	0.4	0.3	0.4	0.3	0.3	0.4	0.4	0.4	0.4	0.3

Table 2: Effect of nutrient management package on the mean yield parameters of banana

Particulars	Hands/ bunch (Nos.)	Fruits/ hand (Nos.)	Fruit length (cm)	Bunch weight (kg/bunch)	Yield (kg/ha)
T1 - Foliar spray - Individual nutrients	7.8	11.6	16.4	14.2	35477
T2 - Foliar spray - Banana Sakthi (NRCB)	8.5	12.6	17.9	17.5	44282
T3 - Foliar spray - Banana Special (IIHR)	8.5	12.9	18.4	18.3	45831
T4 - Farmers practice - No foliar spray	7.4	10.9	14.7	11.6	29294
Mean	8.1	12.0	16.9	15.4	38721
SEd	0.2	0.2	0.3	0.4	931
Cd (0.05)	0.4	0.4	0.6	0.9	1910

Table 3: Effect of nutrient management package on economics of banana cultivation

Particulars	Yield (kg./ha)	Gross income (Rs./ha)	Gross expenses (Rs. /ha)	Net income (Rs. /ha)	B:C ratio
T1 - Foliar spray - Individual nutrients	35477	425724	225200	200524	1.89
T2 - Foliar spray - Banana Sakthi (NRCB)	44282	531384	228200	303184	2.33
T3 - Foliar spray - Banana Special (IIHR)	45831	549972	225700	324272	2.44
T4 - Farmers practice - No foliar spray	29294	351528	218200	133328	1.78
Average	38721	464652	224325	240327	2.11
SEd	931	13962	5172	21708	0.05
Cd (0,05)	1910	28649	NS	44542	0.10

Discussion

Balanced nutrient management, with timely application of foliar micro nutrients enhanced both growth and yield parameters such as number of hands per bunch, fingers per hand, fruit length and the bunch yield. Among the nutrients, nitrogen plays the major role, which is an important constituent of amino acids, proteins, enzymes, nucleic acids and chlorophyll content. When the recommended dose of fertilizers is given in split doses increases the yield by enhancing effect of metabolism and hence productivity

improvement. The micronutrients helps in the metabolism and in the translocation of major nutrients to the source and produced photosynthate from the source to sink (Welch and Shuman, 1995) [13]. The 25 percent additional nitrogen along with foliar micronutrient spray to meet out the low soil N status and crop micronutrient demand, might be the reason for increased bunch weight and fruit yield.

Results from this banana trail clearly inferred that the location specific optimized crop nutrient management package was superior to farmer practice in growth, yield and economics.

The same had been experienced in another study, when the NPK applied in three splits and micronutrients (banana special) foliar spray, which increased the vegetative growth, higher bunch weight, number of hands, number of fruits per hand, fruit weight finally the total fruit yield of banana (Hegde and Srinivas, 1991) ^[5]. The increase in growth and yield due to improved nutrient management was in line with many earlier studies. (Chandrasekhar and Bangarusamy, 2003; Umamaheswarappa, Krishnappa, Murthy, Adivappar, & Muthu, 2005; Umamaheswarappa, Krishnappa, Murthy, Adivappar, & Muthu, 2005; Vanilarasu *et al.*, 2018) ^[9, 10, 10, 11]. They detailed the facts as enhanced cell elongation, synthesis of carbohydrates and photosynthetic activity due to optimum nutrient management. In general, timely supply of both water and nutrient during the critical stages of the crop helps in attaining maximum growth and yield. Under rainfed vertisol conditions, the shortage for moisture availability and soil calcareous restricts the plant roots from essential nutrients uptake. Under such circumstances foliar spray enables the plant to intake the nutrients through foliage and meet out their requirements.

Conclusion

It is concluded from the experiment that, the optimized nutrient and crop management package including quality banana suckers, application of RDF fertilizers @ 160:50:390 N: P: K g/plant in three splits at 3, 5, and 7th after planting along with two foliar spray of banana special or banana sakthi during fruit development stage can be adopted as a package to increase the banana productivity under irrigated vertisol tracts of Virudhunagar district. In places of low soil nitrogen fields, additional dose of 25 percent N is also recommended for higher yield and net income.

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