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Influence of irrigation and nutrient management on fruit quality in banana 'Nendran' under precision farming

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Abstract

The present investigation was carried out for two consecutive seasons from 15 February 2012 to 10 November 2013 in the Instructional Farm of College of Agriculture, Vellayani to study the effect of irrigation and nutrient management through fertigation and foliar nutrition on fruit quality in banana 'Nendran' under precision farming. The experiment was carried out in split plot design with six main plots and three sub plots, replicated thrice. Irrigation and nutrient management practices adopted under main plots included basin and drip irrigation with soil application of full dose of nutrients and drip fertigation using different water soluble fertilizers at 60 % of recommended dose. Foliar nutrition included 19-19-19 foliar spray, Sulphate of Potash (SOP) bunch spray and water spray. The study revealed that irrigation and nutrient management practices had significant influence on all quality attributes except TSS (Total Soluble Solids) and ascorbic acid content in banana fruits in both the years. Soil application of full dose of nutrients with drip irrigation, fertigation of 60 % of RDN (recommended dose of nutrients) as 10-10-10, urea and SOP and fertigation of 60 % of RDN as 13-0-45, 0-0-50 and DAP (Diammonium Phosphate) were equally effective in enhancing total sugars, reducing sugars, non-reducing sugars and pulp-peel ratio. More over spraying with SOP in the bunches @ 2 % after complete bunch emergence and three weeks after first application significantly improved all fruit quality parameters.

Key words : Banana, Fertigation, Foliar nutrition, Precision farming, Quality

INTRODUCTION

Banana is a high calorie tropical fruit rich in health benefiting anti-oxidants, minerals, vitamins, simple sugars and soluble dietary fibres. Nendran is the most popular variety among banana with multiple benefits like wide adaptability, year round availability, affordability, yield stability, taste and high nutritive and medicinal value. There has been an increase in the area and production of banana to the tune of 66 and 87 % respectively in 2012-2013 compared to 2001-2002[1]. This tremendous increase shows the wide preference and acceptability of the crop among farmers and consumers.

Banana is a shallow rooted crop with high water and nutrient requirement. But, the plant has poor ability to draw water from soil beyond field capacity and is highly sensitive to soil water deficiency. Hence, it requires a continuous supply of nutrients and water at its proper growth stages. Since fruit quality is a desirable character need to be improved, application of right quantity of all major nutrients and water at its proper growth stages is to be ensured. In fact, the crop is being raised under traditional method of basin irrigation and soil application of nutrients in monthly splits. This inefficient crop husbandry practices adopted by banana farmers lead to poor utilization of nutrients and water resulting in wastage of inputs and low fruit quality. In this context, precision farming offers tremendous advantage in efficient and rational use of fertilizers and water for enhancing fruit quality. Through fertigation and drip irrigation, crop nutrient and water requirements can be met accurately. Deep ploughing and taking raised beds are the improved land management practices adopted in precision farming to provide precise rhizosphere environment for the effective utilization of the inputs. Moreover, foliar nutrition which is a widely accepted ecofriendly practice enable application of nutrient supplements directly to the crop canopy in limited amounts for rapid and efficient response to need of the crop. Post-shoot stage spray of nutrients also enhances the fruit quality[2] Hence the precision farming practices are gaining importance in the context of enhancing fruit quality. With this background, the present trial was conducted to study the effect of irrigation and nutrient management through fertigation and foliar nutrition on fruit quality in banana under precision farming.

MATERIALS AND METHODS

The present experiment was conducted in the Instructional Farm of College of Agriculture, Vellayani in tissue culture banana 'Nendran' during two consecutive seasons from 15 February 2012 to 10 November 2013. The field was located at 8° 25' 46"N latitude and 76° 59'24" E longitude and at an altitude of 19 m above mean sea level. The soil of the experimental site was sandy clay loam which belonged to the order oxisols, Vellayani series. The mean monthly maximum temperature, minimum temperature and pan evaporation during the cropping period varied from 29.1 to 33.1°C, 22 to 25.8 °C and 2.5 to 4.5 mm, respectively. The total rainfall received were 774.5 mm and 1996.7 mm for first crop and second crop respectively.

The experiment was laid out in split plot design with six main plots and three sub plots in three replications. Gross plot size was 24 m^2. Main plot treatments were n_1-soil application of full dose of nutrients with basin irrigation, n_2- soil application of full dose of nutrients with drip irrigation, n_3-drip irrigation alone without fertilizer, n_4-soil application of 100 % P as rock phosphate and fertigation with 60 % N and K as urea and MOP (Muriate of Potash), n_5- fertigation of 60 % RDN as 10-10-10, urea and Sulphate of Potash (SOP) and n_6- fertigation of 60 % RDN as 13-0-45, 0-0-50 and DAP (Diammonium Phosphate). The sub-plot treatments were water spray (s_1), foliar application of 19-19-19 @ 0.50 % (2, 4 and 6 MAP) (s_2) and bunch spray with 2 % SOP (after complete bunch emergence and three weeks after first application) (s_3).

Initial soil samples were collected from different parts of the field after land preparation and analysed for major, secondary and micronutrients.The general practices such as deep ploughing (50 cm), taking raised beds (30 cm height, 3 m width) and organic manure application (15 kg/plant) were uniformly followed. Pits of 50 cm x 50 cm x 50 cm size were taken at 2 m x 2 m spacing and lime @ 500 g/plant was applied to these pits. Tissue culture plants of 'Nendran' were planted in the centre of the pits and irrigation and shading were given to the plants for three weeks to ensure proper establishment of plantlets. Nutrient recommendation of Kerala Agricultural University @ 300-115-450 g N-P-K /plant/year was followed. But for fertigation treatments (n_4, n_5 and n_6) 60 % of the recommended dose was used. In general, two hand weedings and one earthing up at 4 MAP were provided. Periodic desuckering was also followed up to bunch emergence.

In those plots receiving treatments as basin irrigation, uniform irrigation was given @ 5 L/plant daily up to 1 MAP (month after planting), @ 20 L/plant at 2nd and 3rd MAP and @ 40 L/plant from 4 MAP to two weeks before harvesting on alternate days. Irrigation schedule was started from the third week onwards. Drip irrigation was scheduled daily to meet the crop water requirement. Irrigation water requirement through drip (volume in litres/plant/day) was computed using the following relationship based on the pan evaporation data.

IR = Epan x Kp x Kc x spacing x wetted area, where

IR = Irrigation requirement (mm)

Epan = Pan evaporation rate (mm) from U.S class A open pan evaporimeter

Kp = Pan co-efficient (0.75)

Kc = Crop co-efficient (initial stage- 0.50; mid stage 1.10; late stage 1.00)[3]

Spacing = 2 m x 2 m (4 m^2)

Wetted area = 0.70 $m^{2(4)}$

To deliver water and fertilizer to the respective plots, five sub mains were laid out in the field. From each sub mains, two laterals were connected to the respective plots. On the laterals, drippers (pressure compensating) with a discharge rate of 8 L/h were connected to deliver water to individual plots. Fertigation was carried out using ventury unit. Fertigation was done at weekly interval and a total of 24 fertigations were given from one month after planting to one month after complete bunch emergence.

The fully ripe index finger was used for quality analysis. The middle finger in the top row of the second hand (from the base of the bunch) was designated as the index finger for studying the fruit characters. Known weight of samples taken from three portions *viz*., top, middle and bottom of the sample fruit were macerated in a blender and made up to a known volume. Aliquots taken from these samples were used for the quality analysis of the fruit. All quality parameters (total sugars, reducing sugars, non-reducing sugars, TSS, Sugar-acid ratio, ascorbic acid and pulp-peel ratio) were estimated as per the method developed by Ranganna[5]. The data was analyzed statistically by applying the techniques of analysis of variance[6].

RESULTS

1. Effect of nutrient sources and irrigation on TSS, ascorbic acid content and acidity in fruits

Data furnished in Table 1 revealed that the different nutrient

Table 1: Effect of nutrient sources, irrigation and foliar nutrition on TSS, ascorbic acid content and acidity in fruits.

	TSS (%)		Ascorbic acid (mg/100g)		Acidity (%)	
	I Year	II Year	I Year	II Year	I Year	II Year
Nutrient sources & irrigation						
n_1	31.66	31.66	14.08	14.40	0.25	0.25
n_2	31.72	31.33	14.82	15.50	0.30	0.28
n_3	31.33	31.11	13.02	14.58	0.33	0.35
n_4	31.61	31.22	13.85	13.85	0.31	0.30
n_5	32.08	31.88	12.84	14.01	0.31	0.32
n_6	30.94	31.55	14.56	14.95	0.31	0.32
SEm (?)	0.448	0.357	0.560	0.446	0.013	0.012
CD (0.05)	NS	NS	NS	NS	0.043	0.040
Foliar nutrition						
s_1	31.54	30.72	12.82	14.12	0.32	0.32
s_2	31.33	31.38	14.13	14.57	0.30	0.30
s_3	31.80	32.27	14.63	14.95	0.29	0.29
SEm (?)	0.261	0.325	0.302	0.311	0.008	0.008
CD (0.05)	NS	0.950	0.882	NS	NS	0.023

sources and irrigation had significant influence on acidity of fruits in both the years. Drip irrigation alone without any fertilizer (n_3) recorded the highest acidity (0.33 %) and it was on par with all other sources except n_1 in first year. In second year also, same treatment (n_3) recorded the highest acidity of fruits (0.35 %) which was on par with n_5 and n_6. TSS and ascorbic acid content were not significantly influenced by the treatments.

2. Effect of nutrient sources and irrigation on total sugar, reducing sugar, non-reducing sugar, sugar-acid ratio and pulp-peel ratio

The effect of nutrient sources and irrigation on sugar content in banana fruits are presented in Table 2. Fertigation of 60 % RDN as 13-0-45, SOP and DAP significantly enhanced total sugar content of fruits in first year (21.57 %) and second year (21.73 %). When it was on par with n_2 in first year, it was on par with all treatments except n_3 in second year. Soil application of full dose of nutrients with drip irrigation registered the highest value for reducing sugar (18.76 %) which was on par with n_1 and n_6 in first year. In second year, n_2 was on par with n_6, n_5 and n_4 with highest value of 19.22 %. Non-reducing sugar was significantly increased (3.57 %) by n_6 in first year which was on par with n_5. But, it was not altered by nutrient sources and irrigation in second year. A higher sugar-acid ratio of 81.64 and 85.25 was obtained in soil application of full dose of nutrients with basin irrigation in first year and second year respectively. Regarding pulp-peel ratio, the highest pulp-peel ratio of 3.58 was recorded by soil application of full dose of nutrients with basin irrigation which was on par with n_2, n_6 and n_5 in first year. Whereas in second year, all the treatments except n_3 significantly increased the pulp-peel ratio.

3. Effect of foliar nutrition on quality attributes in fruits

Bunch spray of SOP @ 2 % significantly increased ascorbic acid, total sugar, reducing sugar, non-reducing sugar and sugar-acid ratio and it was on par with foliar application of 19-19-19 @ 0.05 % in ascorbic acid and non-reducing sugar content (Tables 1 and 2) in first year. While in second year, it significantly increased all quality attributes except ascorbic acid content. Pulp-peel ratio was also found to be significantly increased by bunch spray of SOP during first year (3.73) and second year (3.65). Regarding TSS and acidity of fruits, higher TSS and acidity were recorded by SOP bunch spray and water spray respectively during second year. Lower values of acidity registered by bunch spray with SOP confirmed its superiority over other treatments in fruit quality.

Though the main effect showed significant effect on the quality parameters in banana fruits, interaction had no significant influence on fruit quality.

DISCUSSION

Data furnished in Table 1 showed that the drip irrigation alone without any fertilizer (n_3) recorded the highest acidity of fruits in both the years. This high acidity might be due to low quantity of nutrient, K. This is evident from the report of El-Razek *et al.*[7] who mentioned that high K fertilization produced grape fruits with low acidity. It was observed from the data (Table 2) that the drip irrigation treatments (n_6, n_2 and n_5) recorded higher values of

Table 2: Effect of nutrient sources, irrigation and foliar nutrition on total sugar, reducing sugar, non-reducing sugar and sugar acid ratio

	Total sugar (%)		Reducing sugar (%)		Non-reducing sugar (%)		Sugar- acid ratio		Pulp-peel ratio	
	I Year	II Year	I Year	II Year	I Year	II Year	I Year	II Year	I Year	II Year
Nutrient sources & irrigation										
n_1	20.61	21.16	18.02	18.22	2.58	2.93	81.64	85.25	3.58	3.64
n_2	21.06	21.42	18.76	19.22	2.29	2.20	70.73	76.89	3.55	3.60
n_3	19.32	19.56	17.12	17.20	2.20	2.36	59.44	57.12	2.87	2.84
n_4	20.30	21.21	17.86	18.48	2.43	2.72	67.08	71.88	3.23	3.51
n_5	20.37	21.47	17.22	18.74	3.15	2.73	64.18	67.33	3.30	3.49
n_6	21.57	21.73	17.99	18.84	3.57	2.88	70.53	66.36	3.42	3.42
SEm (?)	0.282	0.256	0.271	0.295	0.186	0.219	3.947	3.174	0.109	0.104
CD (0.05)	0.889	0.807	0.856	0.932	0.588	NS	12.43	10.00	0.345	0.328
Foliar nutrition							9	1		
s_1	19.36	19.94	17.02	17.67	2.33	2.27	63.52	63.02	3.10	3.22
s_2	20.66	20.98	17.81	18.19	2.84	2.78	67.70	70.56	3.15	3.37
s_3	21.60	22.36	18.66	19.49	2.94	2.86	75.58	78.85	3.73	3.65
SEm (?)	0.206	0.309	0.225	0.210	0.154	0.135	2.515	2.523	0.067	0.055
CD (0.05)	0.603	0.903	0.657	0.613	0.449	0.395	7.343	7.366	0.196	0.161

total sugars, reducing sugars and non-reducing sugars. Under conditions of limited water, the starch hydrolysis would be enhanced resulting in high total sugar[8].Better fruit quality, especially high sugar content in fertigated crop could be explained by the role K plays in synthesis, breakdown and translocation of carbohydrate[9]. Regarding the pulp-peel ratio of fruits, the highest pulp obtained by the different sources had contributed to increased pulp-peel ratio.

Data presented in Tables 1 and 2 showed that bunch spray of SOP @ 2 % significantly increased fruit quality parameters (ascorbic acid, total sugar, reducing sugar, non-reducing sugar and sugar-acid ratio). This quality improvement in fruits was attributed to the role of K in phloem loading and unloading of sucrose and amino acids, and storage of starch in developing fruits by activating the enzyme starch synthase[10].

CONCLUSION

The study showed that fertigation of 60 % RDN as 10-10-10, urea and SOP (n_5) and fertigation of 60 % RDN as 13-0-45, 0-0-50 and DAP (n_6) were equally effective as soil application of full dose of nutrients with drip irrigation in enhancing sugar content of fruits (total sugars, reducing sugars and non-reducing sugars). Bunch spraying with SOP @ 2 per cent in two times (s_3) also found beneficial in improving fruit quality parameters. The study concluded with a clear cut idea about the improvement of fruit quality with lower dose of fertilizers (60 % RDN) with optimum quantity of water through fertigation along with timely application of bunch spray.

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