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Original Research Article

Impact of Red Rot Disease on Nutrient Status of Sugarcane

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Keywords

Sugarcane, red rot, micro and macro nutrient

A B S T R A C T

Red rot disease is aptly called as cancer of sugarcane and it causes differential accumulation in micronutrient like iron content and depletion in copper and zinc content in cane juice. The maximum accumulation of iron content was observed in variety BO120 and minimum in BO130. Depletion of both copper and zinc content was found maximum in cane variety BO120 followed by BO102, CoS767, BO131, BO132, BO139, BO91 and minimum in BO130 respectively. These alterations in micronutrient contents were directly proportional to the resistance of cane varieties. The disease has also affected the contents of macronutrients like Nitrogen, Phosphorus and Potash in cane juice. There was an accumulation of Nitrogen content and depletion of Phosphorus and Potash content. Accumulation of Nitrogen content was found maximum in BO120 and minimum in BO130. A considerable reduction in both Phosphorus and Potash content was found maximum in variety BO120 and minimum in BO130 respectively. Intermediate losses in Phosphorous and Potash were found in varieties viz., BO102, CoS767, BO131, BO132, BO139 and BO91 respectively. Due red rot infection a differential accumulation or depletion of nutrients were varied according to resistance of the cane varieties.

Introduction

Sugarcane (*Saccharum officinarum* L.), belongs to the family Poaceae is an important traditional valuable food–cum-cash crop. It is grown mainly in tropical and sub-tropical regions of India. Red rot is widely distributed and has been reported in 68 sugarcane growing countries of the world (Bharti *et al.*, 2012). In our country tropical state, Maharashtra, Andhra Pradesh, Karnataka and Tamil Nadu are the chief cane growing belts with highest yield per unit area. However, about 70 percent of total cane area is concentrated in subtropical states like Utter Pradesh, Bihar, Punjab, Haryana and Rajasthan. In Bihar, it occupies an area of 2.3 lakh hectares with the annual production of 11.58 million tones and its productivity 49.40 tones/hectare (Cooperative Sugar, 44(4), 2012). Sugarcane is cultivated in most of the state of India with total area coverage of 4.2 million hectare and it is second most important agro industrial crop in India, next only to cotton but the productivity of sugarcane per unit input is very low. However various biotic and abiotic factors are responsible for its low yield but diseases are the major cause of concern. Rott *et al.,* (2000) reported that about hundred diseases of sugarcane reported from different parts of the world. Of all the sugarcane diseases like fungal, bacterial, viral and phytoplasmal diseases in which fungal diseases are gaining international importance (Bharti *et al.,* 2012). Jayashree *et al.,* (2010) reported that in India, the estimated average loss in crop production due to fungal disease is about 18-31 %. Red rot, wilt and smut are important fungal diseases in sugarcane growing countries. Red rot disease caused by *Colletotrichum falcatum* went is the most destructive one, which is aptly called as "cancer" of sugarcane (Sharma *et al.,* 2015). Red rot of sugarcane has been reported from 68 sugarcane growing countries of the world (Bharti *et al.,* 2012). Red rot disease is considered as the main constraint for sugarcane production in India (Viswanathan *et al.,* 2008). In India, the first documented epidemic of red rot occurred in 1895-1901 and subsequent years a number of major outbreaks have been recorded as regular event in the tropical and subtropical regions of the country (Satyavir, 2003). This disease has been blamed for 5 to 10% cane yield and sugar recovery loss worldwide. It has been reported as most damaging disease of sugarcane cultivars in Australia, Bangladesh, Pakistan, Taiwan and USA (Viswanathan and Samiyappa, 2008). The productivity of sugarcane is low in India as compare to other cane growing countries of the world. The varietal incidence of the disease varies from 2-64% depending upon varieties in different countries (Satyavir, 2003). Many resistant cultivars of sugarcane have been become susceptible due to red rot disease (Jayashree, 2010). Losses to the sugarcane crop by red rot are due to deterioration of planted seed piece and stubbles, death of individual stalk or plant, reduction in sugar content and juice quality and resultant problems in processing. Sugar yield of the diseased crop is considerably reduced due to lowered weight and sugar content of the canes as well as impaired quality of juice (Recaud *et al.,* 1989). Considerable reduction in nutrient status has been observed due to red rot disease and thereby is posing a great challenge to quality assurance and profitable cultivation of sugarcane. It creates an imbalance in the nutrition availability and ultimately reduces the quality of sugarcane products. No extensive work has been done on nutrient status of diseased canes. Present study was carried out to know the differential nutrients alteration according to susceptibility or resistance of cane varieties due to red rot disease.

Materials and Methods

In order to found out the impact of red rot disease on nutrient status like nitrogen, phosphorus, potash, calcium, magnesium, iron, copper and zinc in cane juice were taken into consideration. Total 50 cane of each variety (BO91, BO102, BO120, BO130, BO131, BO132, BO139 and CoS767) were inoculated with red rot pathogen, applying plug method and planted in 5 rows of 10 m long. Healthy cane setts were also planted in 5 rows and treated as control. In order to determine the nitrogen content by Kjeldah's method (Jackson, 1967) 10ml cane juice was mixed with 5g potassium sulphate (K_2 SO_4), 1g copper sulphate ($(CuSO_4).5H_2O$) and 30ml concentrated sulphuric acid(H_2SO_4. Specific gravity =1.84) and kept in Kjeldah's flask and heated for digestion. After completion of digestion, it was allowed for cooling and then whole material was transferred into distillation flask. In distillation flask red litmus paper was inserted and 40% sodium hydroxide (NaOH) solution was added till red litmus paper turned blue. In receiver (500 ml conical flask) 20ml of 2% boric acid (H_3BO_3) solution was taken and 2 to 3drops of mixed indicator (Methyl red and bromocresol green) was added.

After that distillation was done and 200-250 ml distillate was collected in receiver. Titration was done against N/20 sulphuric acid solution and content of nitrogen was determined by Kjeldah's method (Jackson, 1967).

In order to find out the phosphorus content by blue method in hydrochloric acid system (Jackson,1967) 10 ml juice from healthy and inoculated cane was digested in tri-acid as (Nitric acid (HNO_3): Perchloric acid ($HClO_4$): sulphuric acid (H_2SO_4) 10:4:1 respectively. The flask was kept on sand bath for 30 minutes. When juice became sticky, the flask was cooled gently and 10 ml of tri-acid were added, Digestion process was continued until appearance of dense white fume was stopped and clear colorless solution was obtained. The flask was cooled down and the content was filtered in 50 ml volumetric flask and volume was made upto 50 ml with distilled water. The content of phosphorus was determined with the help of colorimeter by applying 660 nm red filter and using chlorostanous reduced molybdophosphoric blue method in hydrochloric acid system (Jackson, 1967).

In order to determination potassium content 10 ml cane juice was taken and digested with 10 ml tri-acid. After completion of digestion it was filtered and the volume was made upto 50 ml with distilled water. From that aliquot potassium content was determined by using flame photometer (Jackson, 1967).

For determination of calcium and magnesium content in cane juice, 10 ml of cane juice was taken 100 ml conical flask and digested with 10 ml of tri-acid. After completion of digestion, it was filtered and volume was made upto 50 ml with distilled water. Determination of calcium and magnesium was done with the help of complex metric titration method or EDTA (0.01 N) *i.e.* Ethylene Diamine Tetra Acetic Acid titration method on Versente titration method (Jackson, 1967).

In order to determine the content of iron (Fe), Copper (Cu) and Zinc (Zn) in cane juice, 10 ml of cane juice was digested with 10 ml tri-acid solution and filtered. The volume was made upto 50 ml with distilled water. The concentration of iron, copper and zinc were determined with the help of atomic absorption spectro- photometer (Model GBC 902) and the data were recorded in ppm.

Results and Discussion

The result of the impact of red rot infection on nutrient status clearly indicated that there was a considerable alteration in cane juice varied upon cane cultivars. Disturbed mineral nutrition is one of the most common effects of plant disease (Huber, 1978). This result on the effect of red rot infection on nitrogen content in cane juice clearly indicated an increased nitrogen level.

However, the magnitude of accumulation varied according to the degree of resistance of cane varieties. Maximum accumulation (23.4 %) was recorded in variety BO120 while least (6.1%) in variety BO130 and (8.4-15.4%) in rest varieties. Huber (1978), Rao and Sharma (1978), Kumar *et al.*, (1999) and Kumar *et al.*, (2000) also observed an accumulation of nitrogen content in cane juice due to red rot infection.

Table.1 Alternation in macronutrients of cane juice to red rot disease

Varieties	Nitrogen Content (mg/100 ml)			Phosphorous Content (mg/100 ml)			Potassium Content (mg/100 ml)		
	Diseased	Healthy	Increase %	Diseased	Healthy	Reduction %	Diseased	Healthy	Reduction %
BO 91	114.0	105.6	8.4	238.0	276.5	13.9	8.5	9.6	11.4
BO 102	128.0	112.6	15.4	204.9	286.5	28.4	7.5	9.5	21.0
BO 120	118.0	94.6	23.4	172.5	251.8	31.4	7.2	9.8	26.5
BO 130	102.5	96.4	6.1	260.5	284.6	8.4	8.4	9.2	8.6
BO 131	118.6	104.5	14.1	206.8	274.2	24.5	7.8	9.4	17.0
BO132	108.5	97.4	11.1	221.6	279.5	20.7	7.2	8.4	14.2
BO139	112.5	102.7	9.8	226.5	278.4	18.6	7.6	8.8	13.6
CoS767	121.8	106.5	15.3	201.4	272.6	26.1	7.6	9.3	18.2

Table.2 Alternation in Calcium and magnesium content in red rot infected cane juice

Varieties	Calcium content (mg/100 ml)			Magnesium content (mg/100 ml)		
	Diseased	Healthy	Increase %	Diseased	Healthy	Reduction %
BO 91	1.98	1.82	8.7	3.54	4.08	13.2
BO 102	2.18	1.76	23.8	3.10	4.28	27.5
BO 120	2.24	1.72	30.2	3.12	4.36	28.4
BO 130	2.08	1.94	7.2	4.38	4.54	3.5
BO 131	2.12	1.79	18.4	3.36	4.46	24.6
BO132	1.96	1.74	12.6	3.92	4.67	16.0
BO139	2.06	1.80	14.4	3.28	4.12	20.3
CoS767	2.12	1.78	19.1	3.42	4.56	25.0

Table.3 Alternation in micronutrients of cane juice to red rot disease

Varieties	Iron content (mg/100 ml)			Copper content (mg/100 ml)			Zinc content (mg/100 ml)		
	Diseased	Healthy	Increase %	Diseased	Healthy	Reduction %	Diseased	Healthy	Reduction %
BO 91	8.78	8.14	7.8	1.58	1.82	13.1	1.75	2.24	21.8
BO 102	9.02	7.86	17.4	1.33	1.78	25.2	1.42	2.15	33.9
BO 120	9.62	7.98	20.5	1.28	1.79	28.4	1.38	2.14	35.5
BO 130	8.74	8.21	6.4	1.68	1.89	11.7	1.86	2.21	15.8
BO 131	8.84	7.72	14.5	1.34	1.76	23.8	1.42	2.08	31.7
BO132	8.71	7.23	12.0	1.32	1.71	22.8	1.46	2.12	31.1
BO139	8.36	7.64	9.4	1.48	1.85	20.0	1.74	2.24	22.3
CoS767	9.12	7.36	18.7	1.35	1.82	25.8	1.36	2.08	34.6

The result on the impact of red rot infection on phosphorus content in cane juice clearly indicated that there was a decline in phosphorus content varied from 8.4 – 31.4 percent. However, the extent of its decline varied according to the nature of cane varieties. The maximum reduction (31.4 %) was found in variety BO120 followed by BO 102(27.4%), CoS767 (25.8%), BO131 (24.5%), BO132 (20.7%), BO91 (13.9 %) and BO130 (8.4%) respectively.

The reduction in Phosphorus might be due to accumulation of nitrogen content and also due to depletion in potassium content (Humbert, 1963). These findings are in conformity with the observation made by Rao *et al.*, (1984) and Kumar *et al.*, (2000).

Potassium played an important role in metabolic activity and maintains the membrane permeability. The data on potassium content in red rot infected cane juice revealed a significant decrease in all test cane varieties. The magnitude of depletion ranged between (8.6 to 26.4 percent) according to susceptibility of cane varieties. Maximum depletion (26.4%) was observed in variety BO120 and least in variety BO130 (8.6 %) and varieties followed the same trend. In response to red rot infection, the decline in potassium content was also confirmed by Humbert (1963), Zinde (1979), Rao *et al.,* (1984) and Kumar *et al.,* (1999).

Due to red rot infection, there was an increase in calcium content in cane juice. Highest accumulation of Ca content was observed in variety BO120 (30.2%) followed by BO102 (23.8%) and least in variety BO130 (7.2%). These findings confirmed the observation made by Dhumal *et al.,* (1982), Rao *et al.,* (1984) and Kumar *et al.,* (2000).Magnesium content was also declined in cane juice due to red rot infection. The maximum reduction was recorded in variety BO120 (28.4%) followed by BO102 (27.5%), CoS767 (25.0%), BO131 (24.6%), BO132 (16.0%), BO91 (13.2%) and least in BO130 (3.5%). The depletion of magnesium content might be possible due to utilization by red rot pathogen. In response to red rot infection, the depletion in magnesium content was also reported by earlier workers viz., Huber (1980), Rao *et al.,* (1984) and Kumar *et al.,* (1999).

The concentration of iron content was increased due to red rot infection in cane juice. However, the magnitude of accumulation was somewhat varied according to the degree of resistance of the cane varieties. The accumulation of iron might be possible by the action of pathogen which checks the enzymatic activity of the plant. The accumulation of iron content ranged from 6.4-20.5 percent. The highest accumulation (20.5%) was recorded in variety BO120, whereas it was lowest (6.4%) in variety BO130. In the rest it varied between 7.8-18.7 percent. Mishra and Mahmood (1989), Kumar *et al.,* (1992) and Kumar *et al.,* (2000) also found significant increase of iron content in infected cane juice.

The data on copper content due to red rot infection revealed a marked depletion in infected cane juice. The depletion of copper content might be possible due to antagonistic effect of iron. The reduction was varied from 8.5%- 29.0% in variety BO130 and BO120 respectively. These findings confirm earlier observation made by Zinde (1979), Rao *et al.,* (1984) and Kumar *et al.,* (2000).

Due to red rot infection, there was depletion in zinc content in cane juice. Zinc acts as catalyst and might be utilized by red rot pathogen as a substrate. The reduction in zinc content was varied in cane juice from 17.5 – 40.0 percent. It was found maximum in variety BO 120(40.0%) followed by BO102 (38.5%), CoS767 (36.3%), BO131 (35.8%), BO133 (31.0%), BO132 (21.2%), BO91 (20.3%) and minimum in BO130 (17.5%). These findings were confirmed the earlier observation recorded by Kumar *et al.,* (1990) and Kumar *et al.,* (2000).

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