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Effect of Post-shooting Spray of Sulphate of Potash (SOP) on Yield and Quality of Banana cv. Robusta (AAA- Cavendish)

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Abstract: An experiment was conducted at the Department of Fruit Crops, Tamil Nadu Agricultural University, Coimbatore to evaluate the effect of post shooting spray of Sulphate of Potash (SOP) on bunch yield and quality of Robusta banana and to integrate SOP on the nutrient management practices of banana. The experiment was conducted with cultivar Robusta (AAA- Cavendish) in a Randomized Block Design (RBD) with four treatments and five replications. The treatments were: Control (Water spray) (T_1), Spraying of 0.5% SOP (T_2), Spraying of 1.0% SOP (T_3) and Spraying of 1.5% SOP (T_4). Spraying was done twice, first immediately after opening of the last hand and second, 30 days after the first spray. The results of the study indicated the benefit of post shoot application of SOP. Foliar spray of SOP at 1.5 per cent concentration twice resulted in increased bunch weight with better bunch and quality traits, realizing a higher benefit: cost ratio.

Key words: Sulphate of Potash, banana, yield, quality

INTRODUCTION

Under traditional farming system, banana crop receives its last dose of fertilizers (nitrogen and potassium) at 7th month after planting (just before shooting) to support the requirement of nutrients until harvest since large quantity of photosynthates are to move from the source to the sink i.e. developing bunches at this phase. Any limitation in the supply of nutrients at this crucial stage affects the bunch size and quality. Because of this problem, poor filling and development of fingers is often reported in almost all the cultivars of commercial importance. Hence an additional dose of fertilizer after shooting becomes imperative. However, it is not wise to go for soil application of fertilizers at finger development stage, since the uptake is slow and low[17,3]. Many reports have indicated the usefulness of post shooting spray of various nutrients during fruit development in influencing the fruit yield, shelf life and quality[6,15]. Banana has been found to respond well to potash spray supplied through muriate of potash (MOP) or potassium di-hydrogen phosphate (KH_2PO_4)[19,8]. However, the effect of SOP as a post shooting applicant in banana has not been assessed earlier. With these ideas, an investigation was carried out to evaluate the effect of post shooting spray of SOP on bunch yield and quality of Robusta banana and to integrate SOP on the nutrient management practices of banana.

MATERIALS AND METHODS

An experiment was conducted at the Department of Fruit Crops, Tamil Nadu Agricultural University, Coimbatore on clay loam soil to evaluate the effect of post shooting spray of SOP on bunch yield and quality of Robusta banana and to integrate SOP on the nutrient management practices of banana. The experiment was conducted with cultivar Robusta (AAA- Cavendish) in a Randomized Block Design (RBD) with four treatments and five replications. The treatments were: Control (Water spray) (T_1), Spraying of 0.5% SOP (T_2), Spraying of 1.0% SOP (T_3) and Spraying of 1.5% SOP (T_4). Spraying was done twice, first immediately after opening of the last hand and second, 30 days after the first spray. The entire plant canopy including the developing bunches was sprayed. Due to the waxy nature of the leaf surface, a wetting agent APSA 80 @ 2 ml per 10 litres of spray solution was added. Since SOP is instantly and completely soluble in water, the required quantity of SOP viz., 5 g / lit for T_2, 10 g / lit for T_3, 15 g / lit for T_4 were dissolved and sprayed. For T_1, (water spray) mere water spraying was done.

The recommended dose of fertilizers (150: 35: 330 N, P2O5 and K2O g plant-1) were applied as urea, single super phosphate and muriate of potash. The nitrogen and potassium were applied in four splits i.e. at 2, 4, 6 and 8 months after planting while the entire dose of phosphorus was applied as basal. The plants were planted at a recommended spacing of 1.8 x 1.8 m.

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The total number of leaves retained at harvest was counted and expressed in number. The total chlorophyll content was estimated adopting the procedure of Yoshida *et al.*[20] and expressed as mg g^{-1} of fresh weight. Number of days taken from shooting to harvest (maturity days) was recorded. Weight of the bunch including the peduncle upto first bract leaf node above the first hand was recorded and expressed in kilogram (kg). Total number of hands and fingers in a bunch were counted and expressed in number. The middle fingers in the top and bottom rows of the second hand were selected as representative fingers[5] to record average weight of the finger and expressed in gram (g). Fully ripe fruit was weighed and peeled. The peel was weighed and pulp weight was arrived by the difference between the two. The pulp-peel ratio was computed.

Representative fingers were allowed for natural and uniform ripening and these fruits were utilized for determining different quality parameters. The Total Soluble Salts (TSS) was determined by using Carl-Zeiss Hand Refractometer and the results were expressed in percentage. The total, reducing and non-reducing sugars were estimated as per the method suggested by Somogyi[14] and expressed in percentage. Titrable acidity was estimated by adopting the procedure suggested by AOAC[1] and expressed in terms of malic acid equivalents in percentage. The sugar/acid ratio was computed by dividing the total sugars by the acidity.

Physiological loss in weight of fruits was calculated as per the formula given below and expressed in percentage.

$$PLW = \frac{\text{Initial weight - weight at the end of shelf life}}{\text{Initial weight}} \times 100$$

The sum of green and yellow life, upto edible fruit stage formed the total shelf life of fruits.

The cost of cultivation was worked out taking into account of various inputs for cultivation during the entire experimental period. Benefit cost ratio was worked out using the formula. Benefit cost ratio = Gross return (Rs ha^{-1}) / Cost of cultivation

RESULTS AND DISCUSSION

Number of Leaves: In a determinate crop like banana, retention of more number of green leaves at post flowering phase contributes a sizeable portion of currently synthesized assimilates to the developing sink through current photosynthesis, especially when assimilate flow from other plant parts become limiting. Similarly, the leaf also contributes its own stored assimilates to the sink while senescing. In the present study the number of leaves at harvest was found to differ significantly due to post shooting spray of SOP. With an increase in concentration of SOP, there was an increase in number of leaves; however SOP at 1.5 per cent did record significantly higher number of leaves than rest of the concentrations (Table 1). Lahav[7], Mustaffa[12] and Baruah and Mohan[2] indicated that the reduced longevity of banana leaves was due to high mobility of K from old leaves to other parts and as a result the leaf duration was severely hampered by low K content. In the present investigation, the relative decrease in the leaf number at harvest was low in post shoot sprayed plants.

Total Chlorophyll: In banana, retention of higher chlorophyll pigment during post shooting stage helps the bunches to accumulate more of photosynthates, thus reflecting in bunch size and yield. Higher chlorophyll content in leaves and developing fruits reflects the efficiency of photosynthesis. Post shooting spray of SOP significantly altered the chlorophyll contents of leaves at the time of harvest. With an increase in SOP concentration, there was an increase in total chlorophyll content. The highest chlorophyll content was recorded with 1.5 per cent SOP. In the present investigation, the total chlorophyll contents estimated at harvest stage indicated that post shooting nutrient spray of SOP (1.5 per cent) resulted in higher contents of these pigments. This suggested that the sprayed plants were more efficient in maintaining a better photosynthetic status, which ultimately reflected on various bunch characters.

Maturity Days: Post shooting spray of SOP significantly reduced the maturity days. When compared to control, SOP spray took lesser number of days for fruit maturity and it was the shortest at SOP 1.5 per cent but was on par with 1.0 per cent SOP. In post shooting nutrient spray investigation, the reduction in bunch development phase was noticed due to faster growth rate of fingers that was evident from higher leaf chlorophyll contents owing to additional nutrient supply and faster rate of translocation of assimilates from source to sink, aided by additional K. Potassium is a general metabolic activator, increasing the respiration and photosynthetic rate. Thus, additional K application as foliar spray induced faster development of bunches[4,10].

Bunch Traits: Increased bunch weight is the culmination of all desirable traits that perform well under optimum conditions including balanced nutrition. Different concentrations of SOP differed significantly for bunch weight. SOP at 1.5 per cent concentration produced heavier bunches which was on par with SOP at 1.0 per cent (Table 1).

Table 1: Effect of post-shooting spray of SOP on number of leaves at harvest, total chlorophyll and bunch traits of banana cv. Robusta

Treatment	Number of leaves	Total chlorophyll (mg/100g)	Maturity days	Bunch weight (kg)	Number of hands	Total number of fingers	Finger weight (g)	Pulp:peel ratio
Control (Water spray)	7.01	1.159	117.7	25.27	9.00	162.0	142.0	4.59
Spraying of 0.5% SOP	8.31	1.330	114.7	28.43	9.00	165.3	146.3	5.09
Spraying of 1.0% SOP	10.3	1.654	106.0	31.13	10.00	181.0	154.8	5.32
Spraying of 1.5% SOP	11.7	1.911	103.7	31.97	10.00	188.7	167.3	5.37
SEd	0.17	0.075	2.82	0.50	0.25	4.30	4.58	0.10
CD (p=0.05)	0.34	0.155	5.77	1.02	0.52	8.79	9.36	0.20

Table 2: Effect of post-shooting spray of SOP on quality traits, post-harvest life and benefit:cost ratio of banana cv. Robusta

Treatment	TSS (%)	Reducing sugars (%)	Non-reducing sugars (%)	Total sugars (%)	Acidity (%)	Sugar:acid ratio	PLW (%)	Shelf-life (days)	B:C ratio
Control (Water spray)	19.32	16.31	1.60	17.90	0.25	71.69	12.83	6.3	3.37
Spraying of 0.5% SOP	20.61	16.44	1.87	18.31	0.21	87.28	10.95	7.8	3.75
Spraying of 1.0% SOP	21.90	16.83	2.08	18.90	0.19	99.66	10.40	8.7	4.09
Spraying of 1.5% SOP	22.62	17.62	2.18	19.80	0.16	123.75	9.48	8.7	4.19
SEd	1.01	0.50	0.05	0.58	0.01	3.29	0.71	0.48	-
CD (p=0.05)	2.06	1.02	0.10	1.18	0.02	6.72	1.45	0.98	-

SOP concentrations exerted significant influence in affecting the number of hands. SOP spray either at 1.0 or 1.5 per cent resulted in producing the higher number of hands which were however on par with each other (Table 1). Significant differences were obtained for total number of fingers among the concentrations of SOP. Though the concentrations 1.0 and 1.5 per cent were superior, they remained on par with one another.

Different concentrations of SOP exhibited significant differences among themselves in producing bigger fruits. Spraying of SOP at 1.5 per cent was found to be better than other concentrations with respect to finger weight.

Perceptible differences were realized for pulp: peel ratio among the different concentrations of SOP. Spraying of 1.0 and 1.5 per cent of SOP relatively registered higher ratios and were also on par with one another. In post shooting spray experiment, the increase in bunch weight was due to increase in finger characters, such as, number of fingers, finger weight, and pulp: peel ratio, which have close bearing on general appeal of the hands tending to increase its marketable value.

Quality Traits: In high value crop species like banana, quality standards have become the most important factor influencing monetary yield and farmer's income. Any management system should aim to produce quality fruits, besides maximizing the productivity. In banana, fruit quality is mainly judged by the sugar content and acidity in the pulp.

The effect of SOP spray on total sugar content of fruits was statistically significant. In Robusta, the concentrations 1.0 and 1.5 per cent produced significantly better results than other concentrations which were also on par with one another (Table 2). The effect of different concentrations of SOP on reducing sugar content of the fruits was similar as that of total sugars. The non-reducing sugar content of fruits showed significant differences due to SOP spray. Spraying of SOP at 1.5 per cent recorded the highest non-reducing sugar content which was significantly different from other concentrations whereas control recorded the least content of non- reducing sugars.

The TSS content of fruits was found to be influenced significantly by SOP spray. All the concentrations of SOP relatively recorded the maximum content which was on par with each other. The nutrient sprays with SOP appeared to be the best for enhancing the various quality parameters such as TSS, reducing, non-reducing and total sugars and acidity. Venkatarayappa *et al*.[18] obtained better quality parameters with foliar spray of potassium.

The acid content of fruits was significantly influenced by post shooting SOP spray. The lowest fruit acidity was realized at 1.5 per cent SOP as against control.

Post shooting spray of SOP exerted significant influence on sugar: acid ratio and the trend observed was similar to that of acidity.

Higher fruit quality especially higher sugar content can be explained by the role of potassium which is involved in carbohydrate synthesis, breakdown and translocation and synthesis of protein and neutralization of physiologically important organic acids [16]. Potassium is responsible for energy production in the form of ATP and NADPH in chloroplasts by maintaining balanced electric charges. Besides, K is involved in phloem loading and unloading of sucrose and amino acids and storage in the form of starch in developing fruits by activating the enzyme starch synthase[11].

Post shooting application of K also favours the conversion of starch into simple sugars during ripening by activating sucrose synthase enzyme, resulting in higher sugar content in fruits. In plants well supplied with K, the osmotic potential of the phloem sap and the volume flow rate are higher than in plants supplied with low K level and as a result, sucrose concentration in the phloem sap is increased[9]. Additional dose of K as post shooting spray resulted in reduced acid content of fruits. This could be due to the fact that under low K regime, phosphoenol pyruvate (PEP) was apparently shunted into alternate pathways resulting in shortage of acetyl CO-A[13]. Hence, oxalo acetate appeared to be preferentially formed from PEP in plants with low levels of K and this organic acid derivative accumulated. Neutralization of organic acids due to high K level in tissues could have also resulted in reduction in acidity[16].

Post Harvest Life: Weight loss from harvested fruits i.e. PLW, especially under tropical conditions causes severe loss to the producer and seller which also leads to quality deterioration with low consumer preference. Several workers have tried post shooting nutrient treatments to reduce weight loss in fruits[15]. Distinct differences were obtained among the different concentrations of SOP for PLW. In Robusta, SOP spray at 1.0 and 1.5 per cent produced lesser PLW than other treatments; however they remained on par with one another. In the present study, there was extension of ripening duration, because of addition of K in the form of K_2SO_4.

In general, the green life i.e. the preclimacteric life and yellow life were significantly influenced by maturity. It is obvious that once the climacteric phase commences the rate of respiration is at its maximum reducing the shelf life. It is interesting to note that fruits from post shooting spray with SOP extended the shelf-life in the present investigations. The days to edible ripening in fruits took lesser days in treatments which received nutrients through spray. This might be due to the lesser PLW experienced in fruits of post

shooting sprays. There were significant differences among the concentrations of SOP shelf-life of fruits under ambient conditions. With respect to Robusta, the green life was not observed, since the colour break could not be detected visually because of green peel colour, but significant differences were noticed for shelf-life of fruits due to SOP spray.

B:C Ratio: Post shooting SOP spray was found to alter the benefit: cost ratio. The benefit: cost ratio was in the order of 1.5> 1.0> 0.5> 0.0 per cent which denoted the efficacy of SOP spray in terms of economics (Table 2).

Conclusion: The results of the overall study clearly indicated the benefit of post shoot application of SOP which resulted in increased bunch weight with better bunch and quality traits, realizing a higher benefit: cost ratio. Hence, it can be concluded that along with the recommended dose of fertilizers (150: 35: 330 N, P2O5 and K2O g plant-1), SOP can be integrated in banana nutrition as foliar spray at 1.5 per cent concentration twice, first at the time last hand emergence and second 30 days thereafter so as to produce quality bunches, which is cost wise very economical.

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