Sulfate of Potash Foliar Spray Effects on Yield, Quality, and Post-Harvest Life of Banana

By A. Ramesh Kumar and N. Kumar

The benefits of applying foliar K included increased fruit bunch yields and enhanced physical and market quality traits. Foliar spray in the form of SOP could be economically integrated into banana nutrition strategies.

Banana requires large amounts of nutrients for proper growth and production. Its nutritional requirement is estimated to be around 320 kg N, 32 kg P_2O_5, and 925 kg K_2O/ha per year (Lahav and Turner, 1983). Neypoovan is one of the leading banana cultivars of southern India. Yet, poor filling and development of fruits is often reported with this cultivar, which might be related to inadequate nutrients or non-availability just prior to the shooting stage occurring 7 months after planting. High nutrient availability is important at that stage to support plant requirements until harvest since large quantities of photosynthates are beginning to move from the source to the sink—developing fruit bunches. Any limitation in the supply of nutrients at this time will negatively affect bunch size and quality. However, it has not been wise to apply fertilizers basally at finger development stage, since the uptake is slow and low (Veerannah et al., 1976; Buragohain and Shanmugavelu, 1986).

Many reports have indicated usefulness for a post-shoot stage spray of various nutrients in influencing fruit yield, shelf life, and quality (Kannan, 1980; Swietlik and Faust, 1984). Banana responds well to foliar spray supplied through KCl or KH_2PO_4 (Yoharathnam et al., 1981; Mahalakshmi and Sathiyamoorthy, 1999). However, the effect of foliar SOP spray has not been assessed. An investigation was carried out at Tamil Nadu Agricultural University (TNAU), Coimbatore, with the objectives of: 1) evaluating the effect of post-shooting stage spray of SOP on bunch yield and quality of banana, and 2) integrating SOP into the nutrient management practices of regional banana farms.

The experiment was conducted with Neypoovan banana, using a randomized block design with four treatments (**Table 1**). Plants were sprayed twice, initially after the opening of the last hand (i.e. 7th month after planting), and 30 days later. The entire plant canopy was sprayed including the developing bunches. Due to the waxy nature of the leaf surface, a wetting agent (APSA 80) was included at 2 ml per 10 L of spray solution.

Banana plant in bearing stage, sprayed with SOP.

Study parameters included: the total number of leaves retained at harvest, total leaf chlorophyll content, days to maturity, bunch weight, and the total number of hands and fingers per bunch. The middle fingers in the top and bottom rows of the second hand were selected to record average finger weight, girth, and length. Fully ripened fruit were selected to record fruit pulp:peel weight ratios. Quality parameters included TSS, total, reducing and non-reducing sugars, titrable acidity (expressed as malic acid equivalents), sugar:acid ratio, and the PLW of fruits. The cost of cultivation accounted for various inputs during the entire experimental period. Net returns were also determined for each treatment.

Foliar SOP spray significantly increased the number of leaves at harvest, with leaf number being highest in the 1.5% SOP treatment (**Table 1**). Lahav, 1972; Mustaffa, 1987; and Baruah and Mohan, 1991, indicate that reduced longevity of banana leaves can be due to high mobility of K from old leaves to other plant parts, and as a result, leaf duration can be severely hampered by low K content. In the present investigation, the relative decrease in leaf number at harvest was low in plants

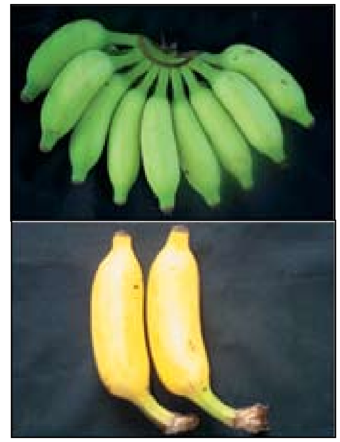
Table 1. Effect of SOP foliar spray on number of leaves at harvest, total chlorophyll, and bunch traits of banana.

Treatment	Number of leaves	Total chlorophyll, mg/100g	Maturity days	Bunch weight, kg	Number of hands	Total number of fingers
Control (Water)	8.0	1.517	110.4	10.80	11.17	182.3
0.5% SOP spray	8.4	1.672	105.5	11.53	12.33	209.0
1.0% SOP spray	8.2	1.702	100.3	12.63	13.00	221.0
1.5% SOP spray	10.2	1.769	89.9	14.27	13.00	233.3
SEd	0.168	0.075	2.82	0.50	0.253	4.30
CD (p=0.05)	0.344	0.155	5.77	1.02	0.517	8.79

Abbreviations and notes for this article: SOP = sulfate of potash (potassium sulfate); KCl = potassium chloride; KH_2PO_4 = potassium di-hydrogen phosphate; TSS = total soluble solids; PLW = physiological loss in weight.

Table 2. Effect of SOP foliar spray on various finger traits of banana.

Treatment	Finger length, cm	Finger girth, cm	Finger weight, g	Pulp weight, g	Peel weight, g	Pulp:peel ratio
Control (Water)	10.33	9.50	55.7	49.7	7.2	6.90
0.5% SOP spray	10.97	10.33	67.7	59.5	8.2	7.26
1.0% SOP spray	12.83	12.07	71.4	62.4	8.5	7.33
1.5% SOP spray	14.37	13.77	75.1	65.7	8.9	7.38
SEd	0.57	0.41	4.58	3.67	0.67	0.097
CD (p=0.05)	1.17	0.83	9.36	7.50	1.37	0.198



Second hand from SOP-sprayed bunch at top. Below: Fingers from SOP-sprayed bunch.

receiving foliar spray. The synthesis and transport of plant assimilates to the developing banana fruit is greatly affected by the retention of green leaves after the flowering stage, especially when assimilate flow from other plant parts becomes limiting. Senescing leaves also contribute their own stored assimilates to developing fruit.

Neypoovan plants receiving foliar spray had significantly higher leaf chlorophyll content at harvest. Retention of chlorophyll pigment during the post-shooting growth stage helps fruit bunches accumulate photosynthates, thus contributing to fruit bunch size, days to maturity and yield. Potassium is a general metabolic activator, increasing the respiration and photosynthetic rate (Evans, 1971; Martin-Prevel, 1972).

Improvements in fruit bunch weight and yield are the culmination of all desirable traits that perform well under optimum conditions including balanced nutrition. Foliar spray concentration had a significant and positive impact on bunch weight. Fruit bunch components including: hand and finger number, finger length, girth, and weight, were positively impacted by treatment with foliar spray (**Table 2**). Perceptible differences among spray concentrations were also realized for the fruit pulp:peel ratio. Improvements in these finger characters have close bearing on general appeal and value of hands sent to market. In fact, in high value crops like banana, quality standards have become the most important factor influencing monetary yield and farmers' income. Any management system should aim to produce quality fruits, besides maximizing productivity.

In banana, fruit quality is mainly judged by the sugar content and acidity in the pulp. The foliar SOP sprays appeared to be effective at enhancing various quality parameters such as TSS, reducing, non-reducing and total sugars and acidity (**Table 3**). Venkatarayappa et al. (1979) also obtained better quality parameters with foliar K spray. Higher fruit quality, especially higher sugar content, can be explained by the role K plays in carbohydrate synthesis, breakdown and translocation and synthesis of protein, and neutralization of physiologically important organic acids (Tisdale and Nelson, 1966). 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 (Mengel and Kirkby, 1987). The timing of this study's foliar K application also favors the conversion of starch into simple sugars during ripening by activating the sucrose synthase enzyme. In plants well-supplied with K, the osmotic potential of the phloem sap and the volume flow rate are higher than in plants grown under low K fertility, and as a result, sucrose concentration in the phloem sap is increased (Marschner, 1995). Reduced acid content of fruits under low K regimes could be explained by an apparent shunting of phosphoenol pyruvate (PEP) into alternate pathways resulting in a shortage of acetyl CO-A (Pattee and Teel, 1967). Hence, oxaloacetate 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 a reduction in acidity (Tisdale and Nelson, 1966).

The PLW from harvested fruits, especially under tropical conditions, causes severe economic losses. Several workers have tried nutrient treatments at post-shoot stage to reduce PLW (Swietlik and Faust, 1984). Neypoovan variety receiving foliar spray at either 1.0 or 1.5 % SOP had similar significant reductions in PLW.

This study demonstrated an extension of the fruit ripening period due to foliar SOP spray. The days to edible ripening were fewer in foliar spray treatments—an observation which could be related to the reduced PLW experienced in these treatments. Both the green-life and shelf-life of fruit were significantly lengthened by a maximum of 5.3 and 8.7 days past the control, respectively.

Foliar SOP spray improved final fruit yield and net income (**Table 4**). Steady increases were obtained as spray concentration increased. The 1.5% SOP treatment was most

Table 3. Effect of SOP foliar spray on quality traits and post-harvest life of banana.

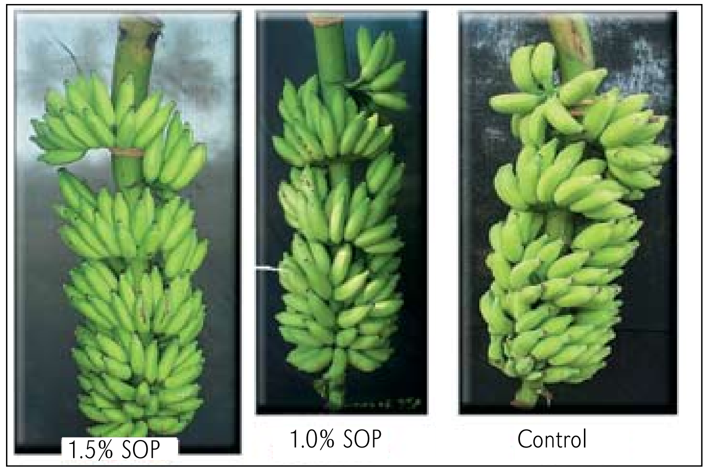
Treatment	TSS, %	Reducing sugars, %	Non-reducing sugars, %	Total sugars,%	Acidity, %	Sugar:acid ratio	PLW, %	Green-life, days	Shelf-life, days
Control (Water)	24.4	18.60	1.53	20.35	0.40	50.89	13.24	4.5	6.5
0.5% SOP spray	27.9	19.28	2.15	21.31	0.30	71.04	11.34	4.8	7.8
1.0% SOP spray	27.9	19.57	2.26	21.82	0.26	84.31	10.96	5.2	7.8
1.5% SOP spray	28.9	19.96	2.44	22.36	0.23	97.64	10.34	5.3	8.7
SEd	1.01	0.50	0.048	0.58	0.012	3.29	0.71	0.024	0.48
CD (p=0.05)	2.06	1.02	0.099	1.18	0.024	6.72	1.45	0.048	0.98

Table 4. Economics of SOP foliar spray on banana.

Treatment	Treatment cost, Rs./ha	Total cost, Rs./ha	Total yield, kg/ha	Gross income, Rs./ha	Net income, Rs./ha
Control (Water)	0	90,000	32,400	129,600	39,600
0.5% SOP spray	930	90,930	34,590	138,360	47,430
1.0% SOP spray	1,380	91,380	37,890	151,560	60,180
1.5% SOP spray	1,830	91,830	42,810	171,240	79,410

US$1 = RS.43.95

profitable and doubled net income compared to the control. Yield, quality, and economic traits all suggest significant advantages from foliar spray application during the post-shoot growth stage. It is recommended to integrate similar foliar spray techniques into banana nutrition, besides supplying recommended rates of fertilizers at 3, 5, and 7 months after planting. BC



Bunches of banana cultivar Neypoovan from post-shooting spray of nutrients.

The authors are with the Department of Fruit Crops, Horticultural College and Research Institute, TNAU, Coimbatore, 641 003, TN, India; e-mail: rameshort@yahoo.com.

References

Baruah, P.J. and N.K. Mohan. 1991. Banana News Letter, 14:21-22.

Buragohain, R. and K.G. Shanmugavelu. 1986. Banana News Letter, 9:19-23.

Evans, L.T. 1971. Ann. Rev. P1. Physiol., 22: 365-394.

Kannan, S. 1980. J. Plant Nutr., 2:717-735.

Lahav, E. 1972. Trop. Agric. Trinidad, 49:321-335.

Lahav, E. and D.W. Turner. 1983. IPI-Bulletin No.7. International Potash Institute, Bern, Switzerland, p.33.

Mahalakshmi, M. and S. Sathiyamoorthy. 1999. South Indian Horticulture, 47(1/6):155-157.

Marschner, H. 1995. Mineral nutrition of higher plants. 2nd Ed. Academic Press, London.

Martin-Prevel, P. 1972. In World Fertilizer Use Manual. Wichman, W. (ed.) International Fertilizer Industry Association, Paris, pp. 398-409.

Mengel, K and E.A. Kirkby. 1987. Principles of plant nutrition. International Potash Institute, Bern: 436-437.

Mustaffa, M.M. 1987. J. of Pot. Res., 3(3):129-132.

Pattee, H.E. and M.R. Teel. 1967. Agron. J., 59: 187-189.

Swietlik, D. and M. Faust. 1984. Hort. Rev., 6:287-355.

Tisdale, S.L. and W.L. Nelson. 1966. Soil fertility and fertilizers, Macmillan Co., London, pp. 81.

Veerannah, L., P. Selvaraj and R.S. Azhakiamanavalan. 1976. Indian J. Hort., 33:203-208.

Venkatarayappa, T., B. Narasimhan and C. Venkatesan. 1979. Mysore J. Agric. Sci., 13(4):428-432).

Yoharatnam, N., M. Ailen and D.W.P. Greenham. 1981. J. Hort. Sci., 56:255-260.

New Posters Feature Forages/ *Southern Forages* Book Now in Fourth Edition

Two new 24 x 30-inch posters, *Forages Legumes* and *Forage Grasses*, are now available from IPNI. Each poster features color photographs of 30 species of important forage plants, along with descriptive text on seeding/establishment, fertility needs, pest considerations, and other practical tips.

The posters were prepared by the authors of the popular book, *Southern Forages*. They are Dr. Don Ball, Auburn University; Dr. Carl Hoveland, University of Georgia; and Dr. Garry Lacefield, University of Kentucky. The book was first published in 1991 and has become a standard among farmers, educators, horse owners, individuals managing wildlife plots, and many others.

"The new posters provide one more level of information accessibility for the many people interested in forage grasses and legumes. We have seen the popularity and usefulness of the *Southern Forages* book for many types of audiences and believe the posters will effectively enhance understanding of forage production and management," noted IPNI President Dr. Terry Roberts. Many of the species included on the posters are grown across large areas of North America and some in other countries.

The posters would be appropriate for display in classrooms, seed outlets and farm stores, Extension and soil/water conservation meeting rooms, farm offices, and various other settings. A single poster is available for purchase at US$3.00 plus shipping. The cost for a set including one of each poster is US$8.00 sent folded or US$9.00 rolled in a mailing tube.

The Fourth Edition of the book *Southern Forages* was published by IPNI in early 2007 and is now available for US$30.00 plus US$4.00 shipping and handling for a single copy. Discounts are available on larger quantities.

For more information and cost details, contact: Circulation Department, IPNI, 655 Engineering Drive, Suite 110, Norcross GA 30092-2837; phone 770-825-8082; fax 770-448-0439; e-mail: circulation@ipni.net. Or check the website at: **>www.ipni.net<**. BC