Original Research Article

Standardization of nutrient requirement for enhancing yield and quality in grape (*Vitis vinifera* L.) var. Red Globe

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ABSTRACT

Grape is one of the important fruit crops grown for its refreshing and nutritious berries. Adequate nutrition is very important for grape cultivation as it directly reflects in the yield and quality of the crop. A field experiment was conducted in the College orchard, TNAU, Coimbatore to standardize the nutrient requirement for the grape variety Red Globe. The experiment consisted of thirteen treatments with varying levels of N (100, 150, 200 g/vine) and K (150, 300, 450, 600 g/ vine) without altering P levels and was laid out in randomized block design with three replications. The results revealed that application of 30 kg FYM + 100:150:150 g NPK/vine (T_2) improved the yield/vine (17.25 and 15.51 kg) by increasing the number of bunches per vine (23.00 and 20.13) with optimal bunch weight (750.0 and 770.3 g) in summer and winter season crops respectively. However, the application of 30 kg FYM + 150:150:450 g NPK/vine (T_9) improved the quality parameters *viz.,* total soluble solids (17.84 and 17.59 °Brix), reducing sugars (15.65% and 15.55%) and total sugars (17.22% and 17.76%) along with a decrease in acidity (0.48 and 0.49%). The application of 100:150:150 g NPK/vine and 150:150:450 g NPK/vine along with 30 kg FYM were found beneficial for yield and quality of grapes var. Red Globe respectively.

Keywords: Grapes, Red Globe, yield, quality, attributes

1. INTRODUCTION

Grape (*Vitis vinifera L.*) is one of the important fruit crops cultivated in India. The fruits are appreciated for its appeal, taste and nutritional values. Grapes serve as good source of carbohydrates, sugars, vitamins (C, A, K, B complex), minerals and antioxidants and other polyphenols. Grape has originated from temperate region nearer to Black Caspian Sea, however it has acclimatized to sub-tropical and tropical agro climatic conditions prevailing in the Indian sub-continent [1].Commercial grape cultivation in India has been taken up in a wide range of soil and climatic conditions under three distinct regions *i.e.,* temperate (Jammu & Kashmir and Himachal Pradesh), sub-tropical (Punjab, Haryana, Rajasthan and Western Uttar Pradesh) and tropical regions (Maharashtra, Karnataka, Tamil Nadu and Andhra Pradesh) of which nearly 94% of the area is contributed by tropical region. Presently the area under grape cultivation in India is estimated at about 1.63 lakh ha with an annual production 34.00 lakh MT and productivity of 20.81 MT/ha. In Tamil Nadu, the annual production stands at 0.49 lakh MT from an area of 2000 ha and the productivity is 24.60 MT/ha [2]. India exported 2.68 lakh MT of grapes to the world for the worth of Rs.2543.42 crores during the year 2022-23 [3].

Nutrition is a key component of vineyard management, as it has the potential to influence fruit set and fruit quality. Combining organic manures and inorganic fertilizers proved to be more effective for a positive plant response than discrete application of either source alone. In grapevines, nitrogen is essential for vegetative growth, phosphorus in fruit bud differentiation and root growth and potassium for cane maturity, bunch quality and shelf-life of bunches [4]. Low levels of N and $P_2O_5$with medium of K_2O are applied during the growth cycle; while high N and K_2O with medium P_2O_5 are applied during the fruiting season. Vine nutritional status, bud fertility and berry quality have strong correlation in grapes[5]. Like any other crop, grapevines also require essentially nitrogen, phosphorus, potassium, calcium, magnesium, sulphur, iron, manganese, zinc, copper, molybdenum and boron for their growth and production. The relative importance of these nutrients depends upon their role in vine growth and productivity, and availability in the soil. It is not nitrogen, phosphorus and potassium concentration, which individually affect bud differentiation but a proper balance between them induces the bud either to develop into a fruitful bunch or a non-productive tendril [6].

Majority of the grape production in India is for fresh consumption. The seeded varieties *viz*., Anab-e-Shahi, Dilkush, Bangalore Blue and Muscat of Hamburg and the seedless varieties *viz*., Thompson Seedless, Tas-A-Ganesh, Sonaka, Manik Chaman, Black Seedless (Sharad Seedless), Beauty Seedless and Perlette are the major cultivars cultivated in large scale for fresh consumption in India. Recently, there is a growing demand in the market for the variety 'Red Globe' with very bold spherical berries (22-25 mm dia) with few seeds; firm and fleshy pulp; light red and thick skin. It was introduced from the University of California, USA and has been evaluated on Dog Ridge rootstock in heavy soils and on own root in light soils. Production of high quality grapes are determined by berry size and quality attributes which are influenced by genotype, climate, and horticultural practices especially training and pruning, nutrition management and growth regulator application [1]. Under Coimbatore condition, for the variety Red Globe, pruning at 5-6 bud level enhanced the productivity [7] and spraying GA_3 (10 or 20 ppm) in combination with Brassinosteroid (2 ppm) at berry diameter stage of 8-10 mm enhanced bunch development and quality [8]. Though nutrient requirement for var. Red Globe, has been studied under Maharashtra conditions, the nutrient requirement and their influence on the productivity and quality attributes of var. Red Globe under Tamil Nadu condition has not been experimented so far. In this background, the present investigation was carried out to standardize fertilizer recommendation for grape var. Red Globe (*Vitis vinifera* L.) to enhance yield and quality under Coimbatore conditions.

2. MATERIAL AND METHODS

The study was conducted at the vineyard in the College Orchard, Horticultural College and Research Institute, TNAU, Coimbatore during 2019-20. The experiment was taken up in fifteen years old grafted grape vines of cv. Red Globe trained on bower system with Dog Ridge as root stock and spaced at 4.0 X 2.0 m. Soil type of the experimental vine yard was sandy loam with pH, EC, available N, P and K of 7.57, 0.08 dS/m, 347 kg/ha, 32 kg/ha and 815 kg/ha respectively. The grape vines of mean girth 12±0.9 cm was selected for the study and the experiment was laid out in Randomized Block Design, consisting of thirteen treatments with three replications. The fertilizer dose recommended by TNAU, Coimbatore and NRCG, Pune for Muscat and Red Globe respectively were fixed as T_1 and T_2. The remaining treatments *viz*., T_3 to T_{13} were fixed by varying N levels (100, 150, 200 g/vine) and K levels (150, 300, 450, 600 g/ vine) and without varying P levels so that the treatments are intended to supply nutrients in between nutrient levels as recommended by TNAU, Coimbatore and NRCG, Pune. The treatment details are mentioned below,

T_1 : 100 kg FYM +200 : 160 : 600 g NPK/ vine

T_2 : 30 kg FYM + 100 : 150 : 150 g NPK/ vine

T_3 : 30 kg FYM + 150 : 150 : 150 g NPK/ vine

T_4 : 30 kg FYM + 200 : 150 : 150 g NPK/ vine

T_5 : 30 kg FYM + 100 : 150 : 300 g NPK/ vine

T_6 : 30 kg FYM + 150 : 150 : 300 g NPK/ vine

T_7 : 30 kg FYM + 200 : 150 : 300 g NPK/ vine

T_8 : 30 kg FYM + 100 : 150 : 450 g NPK/ vine

T_9 : 30 kg FYM + 150 : 150 : 450 g NPK/ vine

T_{10} : 30 kg FYM + 200 : 150 : 450 g NPK/ vine

T_{11} : 30 kg FYM + 100 : 150 : 600 g NPK/vine

T_{12} : 30 kg FYM + 150 : 150 : 600 g NPK/vine

T_{13} : 30 kg FYM + 200 : 150 : 600 g NPK/vine

The grapevines were pruned for summer season crop (second fortnight of January, 2019) and winter season crop (second fortnight of August, 2019). In the selected vines, during both the seasons, 50% of the shoots were pruned for forward pruning (5 bud level) and remaining 50% of the shoots were pruned for backward pruning (2 bud level).The bunches were harvested during May, 2019 and January, 2020 respectively for summer and winter season crop. Immediately after pruning of the grapevines, well decomposed farmyard manure along with full dose of recommended nitrogen and phosphorus and half the dose of recommended potassium were applied as per the treatments. The remaining half of the recommended quantity of potassium was applied 60 days after pruning as top dressing.

Observations on yield and quality attributes *viz*., number of bunches per vine, bunch weight, yield per vine, TSS, acidity, reducing sugars and total sugars were recorded. The number of bunches per vine was counted on each vine and the mean value was worked out. Bunches collected from the randomly tagged vines were weighed and computed for mean bunch weight and expressed in grams. The total bunch yield per vine was computed by multiplying number of bunches from vines with mean bunch weight. The TSS content in the pulp was determined by using the juice squeezed from the pulp and the reading was noted by using ERMA hand refractometer. Acidity was estimated by titrating the fresh juice extracted from pulp against 0.1 N NaOH added with phenolphthalein indicator [9] and the value expressed as percent tartaric acid equivalents. The total sugars, reducing sugars and non-reducing sugars were estimated by the method suggested by [10]. The data were subjected to statistical analysis as outlined by Panse and Sukhatme [11]. The various comparisons were made after working out the standard errors and critical difference at 5 per cent level of significance

3. RESULTS AND DISCUSSION

In the present study, it was observed that the yield and quality parameters were significantly influenced by the different treatments in the grape variety Red Globe and the data are presented in Tables 1 & 2. Maximum number of bunches were recorded in T_2 (23.00 and 20.13), and significantly lower number of bunches were recorded in T_1 (9.33 and 7.89) in both summer and winter season crops, respectively. In terms of bunch weight, T_9 (820.1 and 814.6 g) recorded the maximum followed by T_8 (790.1 and 802.8 g) which was superior over T_3 (650.0 and 657.8 g) and T_4 (663.1 and 639.9). The fruit yield/vine of grapes ranged from 6.48 to 17.25 kg/vine and 5.60 to 15.51 kg/vine in summer season and winter season respectively. The highest fruit yield was recorded in T_2 (17.25 and 15.51 kg/vine) followed by T_9 (16.40 and 14.83 kg/vine) while the lowest fruit yield was recorded in T_1 (6.48 and 5.60 kg/vine). The application of nitrogen fertilizer may potentially influence the nitrogen content of the grapevines, which could result in the enlargement of leaf area and an overall boost in grape yield, mainly attributable to the increased cluster weight [12]. Excessive nitrogen supply leads to increased vegetative growth, which can, in turn, compete with the translocation and accumulation of sugars [13] causing a delay in berry ripening and an increased susceptibility to fungal diseases.These combined factors may contribute to a reduced yield as observed in T_1.

Phosphorus plays a vital role in all aspects of grapevine growth and development, influencing various physiological and biochemical processes, including photosynthesis [14]. Additionally, it plays an active role in root growth, cell expansion, the formation of flowers and seeds, crop maturation, crop quality, as well as in energy storage, transfer reactions, and in providing resistance against various plant diseases [14,15,16,17,18]. The presence of accessible phosphorus and its active involvement in both shoot and root growth significantly contributed to overall plant development, culminating in an improved yield [19]. The increase in berry weight might be the result of accumulations of increased soluble solids. Potassium promotes fruitfulness through activating the enzymes involved in the conversion of carbohydrates to ribose sugar and marked positive effect of potassium was found to increase the number of bunches per vine and thereby results in higher yields [5,20]. In addition, potassium has an additive effect with nitrogen in increasing the number of bunches.

The application of nutrients led to a considerable increase in total soluble solids (TSS). Among the treatments, T_9 exhibited the highest TSS (17.84 and 17.59 °Brix), however T_{13} recorded the lowest TSS (16.51 and 16.50 °Brix) while the other treatments showed the intermittent values. As for acidity percentage among the treatments, T_9 displayed the minimum acidity (0.48 and 0.49%), while T_1 had the maximum acidity (0.64 and 0.64%). In terms of sugars content, T_9 recorded the highest percentages for both reducing sugars (15.65% and 15.55%) and total sugars (17.22% and 17.76%), while T_{13} recorded the lowest percentages for both reducing sugars (13.23% and 13.28%) and total sugars (15.04% and 14.95%) in summer and winter season crop respectively.

Among the factors influencing grape quality, potassium plays a significant role, being involved in various metabolic processes, including carbohydrate and protein synthesis, enzyme activation, membrane transport, charge balance and generation of turgor pressure. In grape berries, potassium is the most abundant cation, contributing to charge balance and potentially involved in sugar transport [21]. Potassium interacts with tartaric acid to form potassium bitartrate, which has limited solubility, thereby reducing the acidity levels in berries [22]. Furthermore, according to Martin *et al*. [23], a higher supply of potassium leads to an increase in the total soluble solids content and a decrease in the overall acidity of berries. Similar findings were reported in Anab-e-Shahi and in Thompson Seedless [24], indicating that application of potassium effectively improved the total soluble solids (TSS) content.

4. CONCLUSION

Grapes, being a deep-rooted perennial crop benefits from nutrient application, resulting in increased annual yields, improved grape and wine quality, and enhanced biological and chemical properties of the soil. The present investigation clearly reflects that application of 30 kg FYM + 100:150:150 g NPK/vine (T_2) improved the yield by increasing the number of bunches per vine, each with optimal bunch weight. Regarding fruit quality, the application of 30 kg FYM + 150:150:450 g NPK/vine (T_9) led to improved total soluble solids (TSS) and sugar content, along with a decrease in acidity levels.

Table 1. Effect of nutrient treatments on number of bunches, bunch weight and yield per vine in grapes var. Red Globe

Treatments	No. of bunches		Bunch weight (g)		Yield per vine (kg/vine)	
	Summer season crop	Winter season crop	Summer season crop	Winter season crop	Summer season crop	Winter season crop
T_1 - 100 kg FYM + 200 : 160 : 600 g NPK/ vine	9.33	7.89	695.3	709.2	6.48	5.60
T_2 - 30 kg FYM + 100 : 150 : 150 g NPK/ vine	23.00	20.13	750.0	770.3	17.25	15.51
T_3 - 30 kg FYM + 150 : 150 : 150 g NPK/ vine	14.00	11.55	650.0	657.8	9.10	7.60
T_4 - 30 kg FYM + 200 : 150 : 150 g NPK/ vine	14.33	11.92	663.1	639.9	9.50	7.63
T_5 - 30 kg FYM + 100 : 150 : 300 g NPK/ vine	19.33	16.39	690.3	675.2	13.32	11.06
T_6 - 30 kg FYM + 150 : 150 : 300 g NPK/ vine	12.00	10.05	675.2	662.0	8.10	6.65
T_7 - 30 kg FYM + 200 : 150 : 300 g NPK/ vine	10.33	8.68	680.1	690.3	7.03	5.99
T_8 - 30 kg FYM + 100 : 150 : 450 g NPK/ vine	16.67	14.92	790.1	802.8	13.17	11.98
T_9 - 30 kg FYM + 150 : 150 : 450 g NPK/ vine	20.00	18.20	820.1	814.6	16.40	14.83
T_{10} - 30 kg FYM + 200 : 150 : 450 g NPK/ vine	17.00	14.62	720.2	694.3	12.24	10.15
T_{11} - 30 kg FYM + 100 : 150 : 600 g NPK/ vine	13.67	11.34	659.0	674.3	9.01	7.65
T_{12} - 30 kg FYM + 150 : 150 : 600 g NPK/ vine	10.00	8.29	657.1	680.7	6.57	5.64
T_{13} - 30 kg FYM + 200 : 150 : 600 g NPK/ vine	9.67	8.04	663.2	630.7	6.41	5.07
SEd	1.67	1.28	12.8	16.43	0.40	0.21
CD (0.05%)	3.44	2.57	26.42	33.91	0.82	0.42

Table 2. Effect of nutrient treatments on TSS, titratable acidity, reducing sugars and total sugars in grapes var. Red Globe.

Treatments	TSS (°Brix)		Titratable acidity (%)		Reducing sugars (%)		Total sugars (%)	
	Summer season crop	Winter season crop	Summer season crop	Winter season crop	Summer season crop	Winter season crop	Summer season crop	Winter season crop
T_1 - 100 kg FYM + 200 : 160 : 600 g NPK/ vine	17.19	17.15	0.64	0.64	15.34	14.93	16.55	16.26
T_2 - 30 kg FYM + 100 : 150 : 150 g NPK/ vine	17.52	17.39	0.50	0.50	14.69	15.22	16.85	16.88
T_3 - 30 kg FYM + 150 : 150 : 150 g NPK/ vine	16.75	16.65	0.53	0.55	14.10	14.02	15.65	15.68
T_4 - 30 kg FYM + 200 : 150 : 150 g NPK/ vine	16.85	16.66	0.61	0.58	14.08	14.16	15.85	15.48
T_5 - 30 kg FYM + 100 : 150 : 300 g NPK/ vine	16.91	16.75	0.52	0.54	13.96	14.38	16.06	15.84
T_6 - 30 kg FYM + 150 : 150 : 300 g NPK/ vine	16.96	16.71	0.58	0.59	14.94	14.53	16.16	16.11
T_7 - 30 kg FYM + 200 : 150 : 300 g NPK/ vine	17.04	16.85	0.57	0.57	14.99	14.82	16.38	15.89
T_8 - 30 kg FYM + 100 : 150 : 450 g NPK/ vine	17.25	17.15	0.51	0.52	15.39	15.35	16.93	16.87
T_9 - 30 kg FYM + 150 : 150 : 450 g NPK/ vine	17.84	17.59	0.48	0.49	15.65	15.55	17.22	17.76
T_{10} - 30 kg FYM + 200 : 150 : 450 g NPK/ vine	17.16	17.02	0.56	0.55	15.02	15.07	16.23	15.89
T_{11} - 30 kg FYM + 100 : 150 : 600 g NPK/ vine	16.72	16.80	0.54	0.55	14.10	13.85	15.34	15.24
T_{12} - 30 kg FYM + 150 : 150 : 600 g NPK/ vine	16.65	16.57	0.50	0.48	13.69	13.52	15.17	15.19
T_{13} - 30 kg FYM + 200 : 150 : 600 g NPK/ vine	16.51	16.50	0.49	0.50	13.23	13.28	15.04	14.95
SEd	0.45	0.23	0.01	0.01	0.33	0.26	0.31	0.31
CD (0.05%)	NS	0.47	0.03	0.02	0.68	0.53	0.64	0.63

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