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Effect of potassium mobilizing bacteria on growth, yield, quality and nutrient uptake in grapes cv. Nanasaheb Purple (*Vitis vinifera* L.)

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Abstract
The field experiment was conducted to study the effect of potassium mobilizing bacteria (KMB) on growth, yield, quality and nutrient uptake in Nanasaheb Purple grapes during 2018-19. The KMB product "Jaiv Shakti K" (Embio Ltd.) was applied through soil application at 60th, 75th, 90thdays after fruit pruning at a different concentration of 0.5, 1, 1.5, 2 and 2.5 ml/vine and different characters like growth, yield, quality and nutrient uptake were studied at different stages of development. Growth parameters, quality parameters, berry biochemical parameters and petiole nutrient content showed significant difference to the various concentration levels of KMB application. It is also observed that there is positive correlation between applied KMB concentration and growth, yield, quality and nutrient uptake.

Keywords: KMB, grapevines, berry biochemical, yield, petiole nutrient content

Introduction

Grape is one of the widely grown fruit crop in the world. Basically, it is a temperate crop but well acclimatized in tropical and subtropical climatic conditions. In India, the area under grapes during 2017-18 was 1.39 lakh hectares with the production of 2920 million tonnes (Anonymous, 2018) [3]. The major green seedless varieties under cultivation are Thompson Seedless and its clones, while among the coloured seedless, Sharad Seedless and its clones are grown on larger area. Among the colour seedless, Nanasaheb Purple is a black seedless cultivar having a bold berries and attractive black-purple colour. The demand for this variety has high demand in domestic market due to its berry size and attractive colour. The variety is being commonly grown in four states *viz*. Maharashtra, Andhra Pradesh, Madhya Pradesh and Karnataka covering more than 21,000 hectares area (Anonymous, 2019) [4]. To harvest good quality grapes, nutrient plays an important role. Potassium is considered an important macronutrient in grapes as it performs various physiological processes and directly related to quality. It is being available in soil in abundant quantity. Total potassium content in soil ranges between 3000-10,000 kg/ha in the upper 0.2 m of soil profile, out of total 98% is bound in the mineral form whereas, 2% is in soil solution and exchangeable phases (Schroeder, 1979) [22]. After nitrogen and phosphorus, potassium is the most important plant nutrient which perform a key role in the growth, metabolism and development of plants. In addition to increasing plant resistance to diseases, pests, and abiotic stresses, potash is required to activate over 80 different enzymes responsible for plant and animal processes such as energy metabolism, starch synthesis, nitrate reduction, photosynthesis, and sugar degradation (Almeida *et al*., 2015; Cecilio-Filho *et. al*., 2015; Gallegos-Cedillo *et. al*., 2016; Hussain *et al*., 2016; White and Karley, 2010; Yang *et al*., 2015) [2, 8, 11, 14, 31, 33].
Potassium is a mineral and most of this is unavailable for plant uptake (Sparks and Huang, 1985) [27]. Minerals containing K are feldspar (orthoclase and microcline) and mica (biotite and muscovite). The non-exchangeable form of K makes up approximately 1 to 10% of soil K and is trapped between the layers or sheets of certain kinds of clay minerals (Sparks, 1987) [26]. In addition, this form is most subject to leaching in soils. The concentration of soil solution K varies from 2 to 5 mg/l for normal agricultural soils (Sparks and Huang, 1985) [27]. The major amount of K in the soil is present as a fixed form (non-available to plant indirectly). As a result, K deficiency has been reported in most of the crop plants (Meena *et. al*., 2014; Xiao *et al*., 2017) [18, 32]. Since the cost of K-fertilizers is increasing every year and also use of these fertilizers has harmful effects on the environment, it is necessary to find an alternative indigenous source of K and maintain K level in soils for sustainable crop production.

Potassium Mobilizing Bacteria (KMB) are the microorganisms which helps to make available the unavailable potash. The institute of Microbial technology (IMTECH), Chandigarh find *Frateuria aurentia* as potassium Mobilizing Bacteria (KMB) which belongs to pseudomonaceae family (Chandra and Greep, 2006) [9]. Potassium Solubilizing Bacteria can transform the insoluble potassium to soluble forms by acidification, chelation, exchange reactions and polymeric substances formation (Bhattacharyya and Jha, 2012) [6]. It also increases the uptake of N and P and other micronutrient which directly affect growth of plant and quality of fruits.It has been reported that inoculation with KMB produced beneficial effect on growth, quality and yield of different plants (Etesami *et. al.*, 2017) [10]. Considering the importance of KMB in producing quality grapes, the experiment was conducted to study the effect of potassium mobilizing bacteria on growth, yield, quality and nutrient uptake in Nanasaheb Purple grapes grown under semi-arid conditions.

Materials and Methods

The trial was conducted at the farmer field during 2018-19. The experimental site is situated in Mid-West Maharashtra at an altitude of 527 m above mean sea level. The trial was conducted on three-year-old vineyard of Nanasaheb Purple grapes grafted on Dogridge rootstock and trained to bower system. The vines were spaced at 9 feet between two rows while 5 feet between two vines thus accommodating 2400 vines per hectare. The ready prepared KMB product (Jaiv Shakti K) developed by Embio Ltd. was applied through soil at 60th, 75thand 90thdays after fruit pruning at a concentration of 0.5, 1.0, 1.5, 2.0 and 2.5 ml/vine.

Growth parameters

The observations on growth parameters were recorded at 90 days after fruit pruning. Shoot length (cm) was measured with the help of measuring tape from base of shoot to the top, shoot diameter (mm) was measured with the help of digital Vernier calliper. Total chlorophyll and leaf area (cm^2) were measured using leaf area meter (CIB, Inc).

Yield parameters

The bunches per vine were counted after berry setting and mean was recorded. Average bunch weight (g) was estimated by weighing three bunch and mean of three was recorded. Number of berries per bunch was counted and mean was recorded. Fifty berry weight (g) was counted with the help of weighing balance and yield per vine (kg) were recorded at time of harvesting.

Quality parameters

The quality parameters were recorded after harvesting. Berry length (mm) and berry diameter (mm) was recorded with help of digital Vernier calliper. The juice was extracted from berries using muslin cloth and TSS and acidity were measured. Total soluble solids (°B) were measured using hand-held temperature-compensated digital refractometer (ERMA, Japan), while titratable acidity (g/lit) was measured by titrating a known volume of juice with 0.1 NaOH using phenolphthalein as indicator (Ryan and Dupont, 1973) [21].

Biochemical parameters

Samples were prepared after harvesting by crushing whole berry and stored at -20 º C for further analysis. Total phenolic content (mg/g) was estimated using Folin-Ciocalteu reagent and by measuring the absorbance of the reaction mixture at 650 nm (Singleton and Rossi, 1965) [25]. Same samples were used for estimation of tannin (mg/g) and colour intensity (%). The results obtained were expressed as catechol equivalent. Reducing sugars (mg/g) were estimated by using Dinitrosalicylic Acid (DNSA) method (Miller, 1972) [19]. Estimation of carbohydrate (mg/g) was done using Anthrone method (Hedge and Hofreiter, 1962) [12]. The anthocyanin (mg/lit) contents of the plant samples were analysed according to the method of Ticconi *et al*., (2001) [30]. Proline content (µmoles) was colorimetrically according to the method of Bates *et al*., (1973) [5] was protein (mg/g) estimation was carried out using colorimetric method as described by Lowry *et al.*, (1951) [17]. Total chlorophyll was estimated by DMSO calorimetric method described by Blanke (1992) [7].

Petiole nutrient content

After fruit pruning the petiole samples were collected at full bloom and near version. The collected petiole first washed with tap water fallowed by distilled water then dried in oven. After drying, a fine powder was prepared and used for further nutrient analysis. The sample was dried at 70ºC wet digested and analyzed for N by Kjeldahl method. Another part of the sample was digested with HNO_3:$HClO_4$ (9:4 v/v) and P was estimated by vanado-molybdate method. Potassium and sodium were determined by flame photometer. An atomic absorption spectrophotometer was used for determining Ca, Mg and Zn in the absorption mode (Sharma *et al.*, 2005) [24].

Statistical analysis

The experiment was carried in Randomized Block Design. Data were analyzed by using Minitab software, version 16.0. Comparison of means was made by Duncan's multiple range test (P-0.05). The data represented in figures are expressed as means of three biological replicates ± standard deviation (SD).

Result and Discussion

Growth parameters

Soil application of potassium mobilizing bacteria (KMB) showed significant effect on Nanasaheb Purple grapes for growth parameters such as shoot length, shoot diameter, total chlorophyll and leaf area. Maximum shoot length (116.53 cm), shoot diameter (8.77 mm), total chlorophyll (2.73mg/g) and leaf area (141.67 cm^2) were recorded in KMB application of 2.5ml/vine treatment at 90 days after fruit pruning while minimum shoot length (79.70 cm), shoot diameter (7.63 mm), total chlorophyll (1.63 mg/g) and leaf area (124.10 cm^2) in control. The maximum shoot growth was recorded in T_6 (2.5 ml KMB/vine at 60, 75 and 90 days after fruit pruning) treatment followed by T_5 (2.0 ml KMB/vine at 60, 75 and 90 days after fruit pruning)whereas, minimum growth was noted in control treatment. It is observed that the growth showed positive response to KMB application and as the concentration of KMB increased, the growth also increased. From the above results it can be concluded that application of KMB positively changed the growth of vine and higher concentration resulted into better growth of a vine. Potassium has important role in the improvement of leaf area and dry matter production within the plant which ultimately resulted in leaf expansion. The results of the present study are in accordance with the findings of Hussain *et al.*, (2015).

Shaheen *et al.,* (2013) [13, 23] indicated that treated vines with microbiota(B. *megaterium*, B. *subtilis*, A. *lipoferum*) had a positive effect on vegetative growth parameters in comparison to untreated vines of Superior Seedless grapes. Swaminathan *et al*., (2020) [29] reported that application of bio fertilizer had positive effect in growth parameter of Nanasaheb Purple grapevines.

Bunch and yield parameters

The yield parameters such as average bunch weight, number of berries per bunch, 50 berry weight and yield/vine showed significant effect on soil application of KMB while bunches/ vine showed non significant effect on KMB application as number of bunches were kept constant for all treatments. The higher average bunch weight of 592.33 g and number of berries/bunch (78.30) were recorded in T_6while 50 berries weight (379.00 g) and yield (16.41 kg) were recorded in T_5 whereas, lowest average bunch weight (448.66 g), number of berries/bunch (66.86), 50 berries weight (334.66 kg) and yield (12.54 kg) were recorded in T_1(Control). From the above results it is observed that higher dose of KMB showed positive effect on yield parameters as concentration (0.5, 1.0, 1.5, 2.0 and 2.5 ml/vine) of KMB increased, the yield of vine also increased. The higher uptake of K resulted into the higher accumulation of sugars into the berries which ultimately increases the berry weight, average bunch weight and yield/vine. Stino *et al.,* (2017) [28] reported that foliar application of bio-stimulants especially at its highest doses increased yield, cluster parameters and physiological parameters of berries of Flame Seedless grape vines. Swaminathan *et al*., (2020) [29] reported that there was positive correlation between bio fertilizer application and yield/vine.

Quality parameters

The quality parameters showed significant effect of soil application of KMB on berry diameter, berry length, TSS and acidity. The highest berry diameter (23.00 mm), berry length (21.67 mm) and TSS (20.33 °B) were recorded in T_6 while acidity (5.55 g/l) in T_5 as compared to lowest berry diameter (20.33 mm), berry length (19.33 mm), TSS (15.90 °B) and acidity (5.39 g/l) were observed in T_1. The above results clearly indicated positive relation between KMB application and production of quality grapes at higher concentration.This is might be due to the effect of converting complex substances into simple sugar, which enhances themetabolic activity in fruits and resulted in increased TSS. Quality is an important parameter in grape production, application of KMB helps in uptake of potassium which favours higher accumulation of food materials and sugars to berry. This might results into increased in berry diameter and total soluble solids. Similarly, Abdel-Mawgoud *et al*., (2010) and Ismaeil *et al.*,(2003) [1, 15] also observed that application of bio-stimulants improved the TSS and acidity ratios in Red Roomy andThompson Seedless grapes.

Biochemical parameters

The biochemical parameters such as total phenol, total tannin, colour intensity, reducing sugar, carbohydrates, anthocyanin, proline and protein were recorded at harvest. Except anthocyanin, all parameters showed significant effect on soil application of KMB. Higher concentration of phenol (1.97 mg/g), total tannin (3.44 mg/g), colour intensity (2.07%), reducing sugar (393.86 mg/g), carbohydrates (79.85 mg/g) and protein (10.36 mg/g) were recorded in T_6 treatment while, higher concentration of proline (9.02 µmoles) was recorded in T_5 whereas, lower concentration of total phenol (1.07 mg/g), total tannin (2.47 mg/g), colour intensity (1.38%), reducing sugar (206.44 mg/g), carbohydrates (55.41 mg/g), proline (4.62 µmoles) and protein (7.14 mg/g) were recorded in T_1. Berry biochemical showed positive response to soil application of KMB. This might be due to the acceleration of uptake of nutrients especially potassium into xylem vessels of vines, which leads to higher accumulation of food material into the berries and alters the physiology of grape berries in a positive sense. The results obtained in the present study were also supported by findings of Patel *et al*., (2017) [20] the effect of different integrated nutrient management including KMB on biochemical parameters in fruits of Sapota (*Manilkaraachrus*).

Nutrient uptake

After fruit pruning the petiole samples were collected at full bloom and near version.

Petiole nutrient analysis was performed after fruit pruning at full bloom and near version. Petiole nutrient uptake showed positive effect to the soil application KMB. At 35 days after fruit pruning, maximum nutrient uptake of N (1.46%) in T_1 and T_2, P (0.73%) in $T_{2,}$ T_3 and T_5 while K (2.27%),Na (0.32%), Ca (0.68%), Mg (0.43%) and Zn (203.49 ppm) were recorded in T_2, T_5, $T_{6,}$ T_1 andT_4 respectively. Whereas, minimum N (1.12%), P (0.66%), K (1.71%), Na (0.12%), Ca (0.44%), Mg (0.25%) and Zn (161.22 ppm) were recorded in T_3, T_1, T_4, T1, T_1, T_3 and T_6 respectively. At 65 after fruit pruning, maximum nutrient uptake of N (0.98%), P (0.60%), K (4.45%) and Na (0.12%) were recorded T_5, T_2, T_6 and T_5 respectively while Ca (1.33%), Mg (0.80%) and Zn (56.48 ppm)were recorded in T_5.Whereas, minimum N (0.76%)were recorded in T_2, while P (0.44%) and K (2.72%) were recorded in T_1(control)whereas, Ca (0.89%), Mg (0.54%) and Zn (30.57 ppm) were recorded in T_2. The results clearly indicated that KMB application not only helps in K uptake but also helps in uptake of other nutrients which improves the growth, quality and yield of Nanasaheb Purple grapes. Lin *et al*., (2002) [16] demonstrated that bacterial inoculation resulted in growth promotion and higher nutrient contents of plant components.

Table 1: Effect of KMB on growth parameters

Treatments	Shoot length (cm)	Shoot diameter (mm)	Total Chlorophyll (mg/g)	Leaf area (cm^2)
T1 (Control)	79.70	7.63	1.63	124.10
T2	82.57	7.80	1.99	125.43
T3	86.57	8.40	2.16	128.80
T4	108.60	8.63	2.58	135.17
T5	114.40	8.60	2.56	136.10
T6	116.53	8.77	2.73	141.67
S.Em ±	0.78	0.08	0.007	0.71
CD at 5%	2.48	0.11	0.022	2.24
Sig.	**	**	**	**

Table 2: Effect of KMB on bunch and yield parameters

Treatment	Bunches/vine	Average bunch weight (g)	No. of berries per bunch	50 berries weight (g)	Yield/vine (kg)
T1 (Control)	28.00	448.66	66.86	334.66	12.54
T2	28.00	469.00	67.00	350.33	13.13
T3	27.67	531.00	74.78	355.00	14.69
T4	28.00	562.33	74.73	376.23	15.75
T5	28.00	586.23	77.30	379.00	16.41
T6	27.33	592.33	78.30	378.00	16.19
S.Em ±	0.51	4.28	1.13	4.97	0.32
CD at 5%	1.62	13.50	3.57	15.67	1.01
Sig.	NS	**	**	**	**

Table 3: Effect of KMB on quality parameters

Treatment	Berry diameter (mm)	Berry length (mm)	TSS (^{0}Brix)	Acidity (g/lit.)
T1 (Control)	20.33	19.33	15.90	5.39
T2	20.67	20.67	17.30	5.46
T3	20.67	21.33	18.20	5.53
T4	22.00	21.00	18.50	5.54
T5	22.67	21.33	19.53	5.55
T6	23.00	21.67	20.33	5.54
S.Em ±	0.46	0.38	0.05	0.015
CD at 5%	1.47	1.22	0.18	0.048
Sig.	**	*	**	**

Table 4: Effect of KMB on berry biochemical parameters

Treatment	Total Phenol (mg/g)	Total Tannin (mg/g)	Colour intensity (%)	Reducing sugar (mg/g)	Carbohyd-rates (mg/g)	Anthocya-nin (mg/lit.)	Proline (μmoles)	Protein (mg/g)
T1 (Control)	1.07	2.47	1.38	206.44	55.41	371.48	4.62	7.14
T2	1.22	2.60	1.62	263.86	66.57	373.46	6.72	7.49
T3	1.25	2.78	1.71	287.11	68.39	372.54	4.80	7.80
T4	1.12	3.32	1.77	273.02	70.72	373.75	5.66	9.46
T5	1.24	3.36	1.81	323.75	73.54	374.81	9.02	10.02
T6	1.97	3.44	2.07	393.86	79.85	375.49	8.46	10.36
S.Em ±	0.11	0.19	0.11	0.65	0.57	1.27	0.45	0.58
CD at 5%	0.37	0.62	0.37	2.06	1.82	4.00	1.43	1.84
Sig.	**	*	*	**	**	NS	**	**

Table 5: Effect of KMB on petiole nutrient status at 35 days after fruit pruning

Treatment	N (%)	P (%)	K (%)	Na (%)	Ca (%)	Mg (%)	Zn (ppm)
T1 (control)	1.46	0.66	2.17	0.12	0.44	0.43	167.63
T2	1.46	0.73	2.27	0.15	0.67	0.30	186.31
T3	1.12	0.73	1.84	0.22	0.49	0.25	168.51
T4	1.18	0.71	1.71	0.24	0.54	0.32	203.49
T5	1.18	0.73	1.81	0.32	0.54	0.31	182.86
T6	1.23	0.77	2.13	0.17	0.68	0.29	161.22
S.Em ±	0.010	0.015	0.008	0.008	0.011	0.008	0.65
CD at 5%	0.030	0.04	0.02	0.02	0.03	0.002	1.96
Sig.	**	**	**	**	**	**	**

Table 6: Effect of KMB on petiole nutrient status at 65 days after fruit pruning

Treatment	N (%)	P (%)	K (%)	Na (%)	Ca (%)	Mg (%)	Zn (ppm)
T1 (Control)	0.90	0.44	2.72	0.10	1.17	0.75	51.29
T2	0.76	0.60	3.42	0.07	0.89	0.54	30.57
T3	0.87	0.57	3.82	0.11	1.32	0.72	49.49
T4	0.92	0.52	4.02	0.08	1.29	0.75	51.30
T5	0.98	0.53	4.43	0.12	1.33	0.80	56.48
T6	0.92	0.55	4.45	0.11	1.26	0.68	44.77
S.Em ±	0.006	0.008	0.010	0.005	0.008	0.008	0.40
CD at 5%	0.02	0.002	0.03	0.016	0.002	0.024	1.21
Sig.	**	**	**	**	**	**	**

Conclusion

The application of KMB in Nanasaheb Purple grapes increased growth, berry quality and nutrient uptake as compared to control. Nanasaheb Purple grapes showed positive response to soil application of KMB (Jaiv Shakti K). Treatment T_6 (2.5 ml/vine) and T_5 (2.0 ml/vine) were at par with other. From the above investigation it can be concluded that KMB (Jaiv Shakti K) application at a concentration of

2ml/vine proved to be the best for Nanasaheb Purple grapes.

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References

1. Abdel-Mawgoud AMR, Tantaway AS, Hafez MM, Habib HAM. Seaweed extract improves growth, yield and quality of different watermelon hybrids. Res. J Agric. Biol. Sci 2010;6:161-168.
2. Almeida HJ, Pancelli MA, Prado RM, Cavalcante VS, Cruz FJR. Effect of potassium on nutritional status and productivity of peanuts in succession with sugar cane. J Soil Sci. Plant Nutr 2015;15:1-10.
3. Anonymous. Horticulture statistics at a glance 2018.
4. Anonymous. National innovation foundation Govt. of India 2019.
5. Bates LS, Waldren RP, Teare ID. Rapid determination of free proline for water-stress studies. Plant Soil 1973;39:205-207.
6. Bhattacharyya PN, Jha D. Plant growth-promoting rhizobacteria (PGPR): emergence in agriculture. World J of Micro. and Biotech 2012;28(4):1327-1350.
7. Blanke MM. Determination of Chlorophyll using DMSO. Vitis. Enol. Sci 1992;47:32-35.
8. CecilioFilho AB, Feltrim AL, Mendoza Cortez JW, Gonsalves MV, Pavani LC, Barbosa JC. Nitrogen and potassium application by fertigation at different watermelon planting densities. J. Soil Sci. Plant Nutr 2015;15:928-937.
9. Chandra K, Greep S. Potash Mobilizing Bacteria (*Frateuriaaurentia*). Published by Regional center of organic farming, Banglore 2006.
10. Etesami H, Emami S, Ali-Alikhani H. Potassium solubilizing bacteria(KSB): Mechanisms, promotion of plant growth, and future prospects - a review. J of Soil Sci. and Plant Nutri 2017;17(4):897-911.
11. Gallegos-Cedillo VM, Urrestarazu M, Álvaro JE. Influence of salinity on transport of Nitrates and Potassium by means of the xylem sap content between roots and shoots in young tomato plants. J. Soil Sci. Plant Nutr 2016;16(4):991-998.
12. Hedge JE, Hofreiter BT. In: Carbohydrate Chemistry 17. (Eds. Whistler RL and Be Miller JN), Academic Press, New York 1962.
13. Hussain SF, Naresh S, DorajeeRao AVD, Reddy MLN. The growth, yield and quality parameters of banana cultivar Grand Naine (AAA) as influenced by different organic amendments. Plant Archives 2015;15(2):723-727.
14. Hussain Z, Khattak RA, Irshad M, Mahmood Q, An P. Effect of saline irrigation water on the leachability of salts, growth and chemical study on their effects on tomato cultivation. Int. J. Innov. Applied Stud 2016;3:959-966.
15. Ismaeil FHM, Wahdan MT, El-Sheikh AF. Response of ‘Thompson seedless’ and ‘Roomy red’ grape cultivars to foliar sprays with yeast extract and GA. J. Agric. Sci., Mansoura Univ 2003;28(8):6321-6334.
16. Lin QM, Rao ZH, Sun YX, Yao J, Xing LJ. Identification and practical application of silicate dissolving bacteria. Agril. Sciences in China 2002;1(1):81-85.
17. Lowry OH, Rosenbrough NJ, Farr AL, Randall RJ. Protein measurement with the folin phenol reagent. J. Biol. Chem 1951;193(1):265–275.
18. Meena VS, Maurya BR, Verma JP. Does a rhizospheric microorganism enhance K+ availability in agricultural soils. Microbiol. Res 2014;169:337-347.
19. Miller GL. Use of dinitrosalicylic acid reagent for determination of reducing sugars. Anal. Chem 1972;31:426-428.
20. Patel M, Vihol NJ, Patel AD, Patel HC. Effect of integrated nutrient management on quality parameters of sapota [Manilkaraachrus (Mill) Forsberg] CV. Kalipatti. Int. J of Chem. Studies 2017;5(6):889-891.
21. Ryan JJ, Dupont JA. Identification and analysis of major acids fom fruit juices and wines. J Agr. Food Chem 1973;21(1):45-49.
22. Schroeder D. Structure and weathering of potassium containing mineral. Proc. Congr. Int. Potash inst 1979;11:43-63.
23. Shaheen MA, Abd El Wahab, Sahar M, El-Morsy FM, Ahmed ASS. Effect of organic and bio-fertilizers as a partial substitute for NPK mineral fertilizer on vegetative growth, leaf mineral content, yield and fruit quality of superior grapevine. J of Hort. Sci. & ornamental plants 2013;5(3):151-159.
24. Sharma J, Shikhamany SD, Singh RK, Raghupathi HB. Diagnosis of Nutrient Imbalance in Thompson Seedless Grape Grafted on Dog Ridge Rootstock by DRIS. Communications in Soil Science and Plant Analysis 2005;36:2823–2838.
25. Singleton VL, Rossi JA. Colorimetry of total phenolics with phosphomolybdicphosphotungsticcid reagents, American J. of Enol. and Viticul 1965;16(3):144-158.
26. Sparks DL. Potassium dynamics in soils, Advances in Soil Science. Springer 1987,1-63p.
27. Sparks DL, Huang PM. Physical chemistry of soil potassium. Potassium in agriculture 1985,201-276.
28. Stino RG, Ali MA, Abdel-Mohsen MA, Maksoud MA, Thabet AYI. Quality attributes of Flame seedless grapes as affected bysome bio-stimulants. J. of Chem. Tech. Research 2017;10(2):273-288.
29. Swaminathan AG, Hariprasad KP, Suryawanshi AV, Kadam GB, Ghule VS. Effect of Phosphorus Solubilizing Bacteria on Growth, Yield, Quality and Nutrient Uptake in Nanasaheb Purple Grapes Grown under Semi-Arid Condition. Int. J. Curr. Microbiol. App. Sci 2020;9(07):1274-1283.
30. Ticconi CA, Delatorre CA, Abel S. Attenuation of phosphate starvation responses by phosphite in Arabidopsis. Plant Physiol 2001;127(3):963-972.
31. White PJ, Karley AJ. Potassium, Plant Cell Monographs 2010,199-224p.
32. Xiao Y, Wang X, Chen W, Huang Q. Isolation and identification of three potassium-solubilizing bacteria from rape rhizospheric soil and their effects on ryegrass. Geomicrobiol. J 2017,1-8.
33. Yang BM, Yao LX, Li GL, He ZH, Zhou CM. Dynamic changes of nutrition in litchi foliar and effects of potassium-nitrogen fertilization ratio. J. Soil Sci. Plant Nutr 2015;15:98-110.