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Arunkumar K Kambl
Department of Fruit Science, College of Horticulture, UHS, Bagalkot, Karnataka, India

Mukunda GK
Professor of Horticulture, Department of Horticulture, UAS, Bangalore, Karnataka, India

Namita B Raut
Department of vegetable science, College of Horticulture, UHS, Bagalkot, Karnataka, India

Nachegowda V
Professor of Fruit science, Directorate of research, UHS Bagalkot, Karnataka, India

Murthy BNS
Senior Scientist, Division of fruit science, IIHR Bangalore, Karnataka, India

Nagarajaiah
Professor of Botany, UAS, Bangalore, Karnataka, India

K Seenappa
Professor of Statistics, UAS Bangalore, Karnataka, India

Correspondence
Arunkumar K Kambl
Department of Fruit Science, College of Horticulture, UHS, Bagalkot, Karnataka, India

Role of bio inoculants on production of primary, secondary and tertiary roots in grapes cuttings (*Vitis vinefera* L.) with special reference to wine varieties

Arunkumar K Kambl, Mukunda GK, Namita B Raut, Nachegowda V, Murthy BNS, Nagarajaiah and K Seenappa

Abstract
The experiment was conducted at Division of Horticulture, Gandhi Krishi Vignana Kendra, University of Agricultural Sciences, Bangalore, There were five varieties viz. Arka Kanchan, Arka Soma, Arka Thrishna, Bangalore Blue and Queen of Vine Yard, consisting of ten treatments and the treatments consisting of *Trichoderma harzianum*, *Glomus mossae*, PSB and IBA, replicated in five and tested in a factorial completely randomized design. The results revealed that among the treatmetns, maximum number of primary, secondary and tertiary roots was recorded in treatment T8 (30.65, 84.37 and 37.05 respectively). Whereas, lowest number of primary, secondary and tertiary roots was noticed in the treatment T10 (15.34, 56.51 and 25.69 respectively). Among the varieties maximum number of primary and secondary roots was recorded in Bangalore Blue (25.15 and 79.14), Whereas incase of tertiary roots were observed in Arka Thrishna (33.28). However, least number of primary and tertiary roots was noticed in Queen of Vine Yard (19.38 and 27.61), Where as incase of secondary roots were observed in Arka Soma (59.12). Interaction effect between the treatments and varieties maximum number of primary roots was noticed in variety Bangalore Blue with treatment T8 (33.86), Where as lowest number of primary roots were recorded in Queen of Vine Yard with treatment T10 (12.64). Maximum number of Secondary roots was noticed in variety Arka Krishna with treatment T8 (95.84), Where as lowest number of secondary roots were recorded in Arka Soma with treatment T10 (49.52). Maximum number of tertiary roots was noticed in variety Arka Thrishna with treatment T8 (41.56), Where as lowest number of tertiary roots were recorded in Queen of Vine Yard with treatment T10 (23.65).

Keywords: grape varieties, biofertilisers, IBA, primary, secondary and tertiary roots

Introduction
Propagation is one of the most important aspects in horticulture. Vegetative propagation methods like cuttings, air layering, grafting and budding are being widely followed to raise plants of desired genetic constitution and to maintain their purity for commercial exploitation.
Grape (*Vitis vinifera* L.) is one of the most important fruit crop of tropical and sub-tropical regions. It has been cultivated from time immemorial. Globally it occupies an area of 6976108 ha with an annual production of 68412467 MT. In India it has been cultivated in 1187000 ha with an annual production of 2585.3 MT (Anonymous, 2015) [5]. Propagation by stem cuttings is the commercial method followed in grapes root stock.... etc. Further, growth substances applied exogenously to cuttings are found to enhance early and good root formation.
Soil microorganisms have been differentiated according to their functions by soil microbiologists and microbial ecologists, as benefial and harmful. Benificial microorganisms are those that can stimulate plant growth by fixing atmospheric nitrogen, decomposing organic wastes and residues, enhance nutrient cycling, detoxifying pesticides, suppressing plant dieses and soil borne pathogens by producing bioactive compounds such as vitamins, hormones and enzymes. Using some of these beneficial microorganisms, various microbial inoculants have been prepared for use in crop propagation and production to reduce the cost on synthetic chemicals and to minimize environmental pollution. Since with use of synthetic chemicals and pesticides, they are now widely applied in eco technology. Microorganisms like *Trichoderma* spp, *Glomus* spp and some bacteria are reported to produce phytohormones (Constracerta and Vandelyden, 1995) [2] which induce rooting of different plant species.

These microorganisms can be employed in propagation of horticulture species (Amy *et al*., 1995) [3].

Material and Methods

The present investigation on propagation of grapes (*Vitis vinefera* L.) using biofertilisers with special reference to wine varieties was carried out at Division of Horticulture, Gandhi Krishi Vignana Kendra, University of Agricultural Sciences, Bangalore, which was situated at an elevation of 930 meters from mean sea level. Studies on the suitability of the microbial inoculants for multiplication of grapes through hard wood cutting were conducted in open field. There were five varieties consisting of ten treatments, replicated in five and tested in a factorial completely randomized design. The varieties are Arka Kanchan, Arka Soma, Arka Thrishna, Bangalore Blue and Queen of Vine Yard were selected. The cuttings were prepared after the vines were back pruned during the month of April. After discarding the basal portion, lateral branches and leaves, medium thickness cuttings were prepared by giving a slant cut at lower end immediately below the bud, while the upper end was cut 0.75 to 2.0 cm above the bud. These cuttings were ready for the treatments and planted in the polybags.

The cuttings were uprooted carefully from the poly bag on 60th day after planting, washed thoroughly under running water and adhering sand particles were removed with a fine camel hair brush and following observations were recorded.

a. Number of primary roots per cutting
b. Number of secondary roots per cutting
c. Number of tertiary roots per cutting

Treatment details

T_1: *Trichoderma harzianum* @ 10g/ kg of potting mixture
T_2: *Glomus mossae* @ 10g/ kg of potting mixture
T_3: PSB @ 10g/ kg of potting mixture
T_4: *Trichoderma harzianum*+ *Glomus mossae* each @ 05g/ kg of potting mixture
T_5: *Trichoderma harzianum* @ 05g/ kg of potting mixture+ IBA @1000 ppm.
T_6: *Glomus mossae*+ PSB each @ 05g/ kg of potting mixture
T_7: *Trichoderma harzianum*+ *Glomus mossae* + PSB each @ 05g/ kg of potting mixture
T_8: *Trichoderma harzianum*+ *Glomus mossae* + PSB each @ 2.5g/ kg of potting mixture + IBA @1000 ppm.
T_9: Control IBA @ 1000 ppm
T_{10}:Absolute control (No IBA and no microbial inoculants)

Result and Discussion

a. Number of primary roots

The data pertaining to the number of primary roots per cutting as influenced by microbial inoculants are presented in table 1. Which revealed the significant difference between among the treatments and varieties. Maximum number of primary roots was recorded in treatment *Trichoderma harzianum*+ *Glomus mossae* + PSB each @ 2.5g/kg of potting mixture+1000 ppm IBA (T8) (30.65), which was followed by treatment *Trichoderma harzianum*+ *Glomus mossae*+ PSB each @ 5.0g/kg of potting mixture (T7) (28.06) and treatment control @1000 ppm IBA (T9) (26.47). While least number of primary roots was noticed in the treatment absolute control (T10) (15.34). Among the varieties maximum number of primary roots was recorded in Bangalore Blue (25.15), followed by Arka Trishna (23.34) and Arka Kanchan (21.96). However least number of primary roots was noticed in Queen of Vine Yard (19.38).

Interaction effect between the treatments and varieties were also found to be significant. The variety Bangalore Blue with treatment *Trichoderma harzianum*+ *Glomus mossae* + PSB each @2.5g/kg of potting mixture+1000 ppm IBA (T8) recorded highest number of primary roots (33.86). Whereas, the least number of primary roots were noticed in variety Queen of Vine Yard with treatment absolute control (T10) (12.64).

Table 1: Production of number of primary roots in grape cuttings as influenced by microbial inoculants

Treatments	Varieties					Mean
	Arka Soma	Bangalore Blue	Queen of Vine Yard	Arka Thrishna	Arka Kanchan	
T1	18.68	22.13	17.30	19.46	18.35	19.18
T2	17.72	20.23	16.45	18.61	17.21	18.04
T3	16.37	19.69	15.42	18.21	17.14	17.37
T4	20.31	25.17	19.22	23.25	22.64	22.12
T5	24.39	28.43	20.68	25.28	24.07	24.57
T6	19.59	23.48	17.24	20.36	20.53	20.24
T7	26.07	31.44	24.42	30.79	27.56	28.06
T8	29.57	33.86	26.98	32.52	30.30	30.65
T9	25.42	29.64	23.47	28.22	25.63	26.47
T10	13.68	17.46	12.64	16.68	16.23	15.34
Mean	21.18	25.15	19.38	23.34	21.69	

	Varieties	Treatments	Interaction
F-test	*	*	*
S.E m±	0.120	0.170	0.381
C.D. at 5%	0.334	0.472	1.056

b. Number of secondary roots

The data pertaining to the number of Secondary roots per cutting as influenced by microbial inoculants are presented in table 2. Which revealed the significant difference between among the treatments and varieties Maximum number of secondary roots was recorded in treatment *Trichoderma harzianum*+ *Glomus mossae* + PSB each @ 2.5g/kg of potting mixture+1000 ppm IBA (T8) (84.37), which was followed by treatment *Trichoderma harzianum*+ *Glomus mossae*+ PSB each @ 5.0g/kg of potting mixture (T7) (80.96) and treatment control @1000 ppm IBA (T9) (78.76). However, least number of secondary roots was noticed in the treatment absolute control (T10) (56.15). Among the varieties maximum number of secondary roots was recorded in Bangalore Blue (79.14). which, was on par with Arka Trishna (78.78) and followed by

Arka Kanchan (78.42). However least number of secondary roots was noticed in Arka Soma (59.12).

Interaction effect between the treatments and varieties were also found to be significant. The variety Arka Kanchan with treatment *Trichoderma harzianum*+ *Glomus mossae* + PSB each @2.5g/kg of potting mixture+1000 ppm IBA (T8) recorded highest number of secondary roots (95.87). Whereas the least number of primary roots were noticed in variety Arka Soma with treatment absolute control (T10) (49.52).

Table 2: Production of number of secondary roots in grape cuttings as influenced by microbial inoculants

Treatments	Varieties					Mean
	Arka Soma	Bangalore Blue	Queen of Vine Yard	Arka Thrishna	Arka Kanchan	
T1	55.40	78.61	58.23	74.33	73.53	68.02
T2	52.23	70.53	56.35	69.69	68.33	63.43
T3	52.43	65.56	53.31	65.34	65.25	60.38
T4	60.42	83.18	63.68	80.29	83.50	74.21
T5	62.80	84.33	65.43	83.42	84.56	76.11
T6	58.41	78.29	60.36	79.43	75.33	70.36
T7	65.44	90.09	68.18	90.45	90.66	80.96
T8	69.14	92.61	69.01	95.26	95.87	84.37
T9	65.38	86.86	66.17	89.23	86.18	78.76
T10	49.52	61.31	50.31	60.37	61.03	56.51
Mean	59.12	79.14	61.10	78.78	78.42	

	Varieties	Treatments	Interaction
F-test	*	*	*
S.E m±	0.128	0.181	0.405
C.D. at 5%	0.355	0.502	1.123

c. Number of tertiary roots

The data pertaining to the number of tertiary roots per cutting as influenced by microbial inoculants are presented in table 3. Which revealed the significant difference between among the treatments and varieties Maximum number of secondary roots was recorded in treatment *Trichoderma harzianum*+ *Glomus mossae* + PSB each @ 2.5g/kg of potting mixture+1000 ppm IBA (T8) (37.05), which was followed by treatment *Trichoderma harzianum*+ *Glomus mossae*+ PSB each @ 5.0g/kg of potting mixture (T7) (35.89) and treatment control @1000 ppm IBA (T9) (34.59). However least number of tertiary roots was noticed in the treatment absolute control (T10) (25.69). Among the varieties maximum number of tertiary roots was recorded in Arka Thrishna (33.28). Which, was on par with Arka Soma (33.01) and followed by Bangalore Blue (32.80). However least number of tertiary roots was noticed in Queen of Vine Yard (27.61).

Interaction effect between the treatments and varieties were also found to be significant. The variety Arka Thrishna with treatment *Trichoderma harzianum*+ *Glomus mossae* + PSB each @2.5g/kg of potting mixture+1000 ppm IBA (T8) recorded highest number of tertiary roots (41.56). Whereas the least number of primary roots were noticed in variety Queen of Vine Yard with treatment absolute control (T10) (23.65).

Table 3: Production of number of tertiary roots in grape cuttings as influenced by microbial inoculants

Treatments	Varieties					Mean
	Arka Soma	Bangalore Blue	Queen of Vine Yard	Arka Thrishna	Arka Kanchan	
T1	31.54	30.41	26.56	29.24	26.58	28.86
T2	31.08	28.24	25.63	28.90	25.63	27.89
T3	30.08	27.22	25.45	27.56	24.92	27.05
T4	32.75	33.30	27.29	32.67	28.66	30.93
T5	33.24	35.36	28.63	36.21	29.80	32.65
T6	32.43	30.75	26.61	30.50	27.34	29.52
T7	36.36	39.38	30.52	41.90	32.54	35.98
T8	38.97	40.34	31.85	41.56	32.55	37.05
T9	34.98	37.61	29.93	38.69	31.77	34.59
T10	28.72	25.85	23.65	26.35	23.89	25.69
Mean	33.01	32.80	27.61	33.28	28.73	

	Varieties	Treatments	Interaction
F-test	*	*	*
S.E m±	0.105	0.149	0.333
C.D. at 5%	0.291	0.412	0.923

In the present investigation clearly revealed that grape hard cuttings respond very well to the combination of inoculants of *Trichoderma harzianum*+ *Glomus mossae* + PSB each @2.5g/kg of potting mixture+1000 ppm IBA for rooting character like number of primary, secondary and tertiary roots. This may be due to the production of rooting co factors, production of growth regulators, vitamins and biotins which helped in formation of primary, secondary and tertiary roots of cuttings. Similar views have been reported by Bose and Mandel (1972) [4], Nageswari *et al*. (1999) [8], Damar *et al.* (2014) [5], Ahmad (2016) [6] and Abhinav (2009) [7].

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