Effect Of Zinc Application To Mothervines Of Dog Ridge Rootstock On Rooting Success And Establishment Under Nursery Condition

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Abstract: Grape (Vitisvinifera L.) is one of the important fruit crop. Zinc is a micronutrient which plays important role in various metabolic processes in plants. Zinc works as auxin precursor in plants. The effect of zinc application to mothervine of Dog Ridge rootstock was studied in the present experiment. Zinc was applied in concentration of 0, 5.0, 10.0, 15.0 and 20.0 g/ mothervine and its effects were studied on rooting success and establishment. It was found that application of zinc resulted in early bud sprout as well as increase in rooting success in cuttings. It also resulted in better plant growth as well as increased leaf area.

Key words: Zinc, Auxin, Rooting, Mothervine, Shoot growth, leaf area

1 INTRODUCTION

Grape (Vitis vinifera L.) is one of the major important fruit crops of the country grown in an area of 1, 11,000 ha with an annual production of 12, 35,000 tonnes [1]. An increasing occurrence of soil salinity, drought and declining productivity of grape varieties in India has made use of a suitable rootstocks imperative [2]. Owing to the conditions of salinity and drought and reduced fruitfulness as a major reason, establishment of grape vineyards on rootstock became mandatory. The health of vine plays an important role in achieving higher and quality yield. In addition to the irrigation, nutrition and sunlight to achieve the fruitfulness of vines, different means are followed by the grape growers. The physiological and metabolic processes involved with grapevine growth and production are influenced by key macro or micro-nutrients such as nitrogen, phosphorous, potassium, magnesium, boron, zinc, manganese, iron and copper. These elements play an important role in vine functioning, growth, yield and/or quality. Nutrients involved in development of grapevines, photosynthetic functioning and metabolic pathways are required in certain quantities to ensure healthy growth and performance. If a required element is not available in adequate amounts, the vine performance is limited by the supply of that single element. Mineral nutrients have essential and specific functions in plant metabolism: such as constituents of organic structures, as activators of enzymatic reactions, or as charge carriers and osmoregulators [3]. Nutrition is a key factor determining root morphogenesis [4]. Rootstocks vary in their ability to root, based on biochemical constituents of mother vines and also IBA (Indole-3-Butyric Acid) concentration used for treatment of cutting [5]. Rootstocks may have different absorption capabilities for some specific microelements; especially zinc [6].

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Zinc (Zn) is a micronutrient whose normal concentration range is 25 to 150 ppm in plants [7], whereas the deficiencies are usually associated with concentrations of less than 20 ppm, and toxicities will occur when the zinc concentration in leaf exceeds 400 ppm [8]. It plays an important role in several plant metabolic processes; it activates enzymes and is involved in protein synthesis and carbohydrate, nucleic acid and lipid metabolism [9, 10]. Zinc is required for the synthesis of auxin (a growth regulating compound (Indole acetic acid, IAA). Stunted growth and small leaves are the most distinct visible symptoms of zinc deficiency and are the result of disturbances in the metabolism of auxins, especially IAA. Research evidence suggests that auxins play a central role in the determination of rooting capacity, by enabling the faster production of rooted cutting material which is essential for vegetative propagation [11].Tryptophan is the most likely precursor for the biosynthesis of IAA. There are some evidences that zinc is required for the synthesis of tryptophan. Auxins are also known to increase rooting percentage and rooting time together with uniformity of rooting [12]. Considering this an experiment was conducted to study the effects of application of zinc to the mothervine of Dog Ridge rootstock for rooting success and establishment under nursery conditions.

2 MATERIALS AND METHODS

The experiment was conducted in the Nursery at farms of National Research Centre for Grapes, Pune for two years (2008- 2010). Pune is situated in mid-west Maharashtra at an altitude of 559 m and lies on latitude 18.32^0 N, longitude 73.51^0 E. Four year old mothervine of Dog Ridge rootstock was selected for the study. All the standard recommended cultural practices were followed to maintain the rootstock mothervine in the nursery. Since zinc is considered an auxin precursor to activate rooting in the hardwood cuttings, while rooting different doses of zinc (0, 5, 10, 15 and 20 gm/ plant) in the form of ZnSO4 was applied to the mothervine. The micronutrient was applied two months before harvest (June) of cuttings for multiplication. The matured (lignified) shoots having 8-10 mm diameter with enough reserve food material were harvested from the mothervine during the month of September. These cuttings having 4 nodes were prepared, bundled and kept in running water for 24 hrs so as to leach out the inhibitors. After removal from water, a fresh slanting cut was given at basal portion of the cuttings so as to get maximum area for rooting. The basal portion was then applied in 2000 ppm IBA solution for about one minute and was then planted in the polybag (size 4" X 7"). These bags were placed in bed of 5' X 2'.6" size and were irrigated. The observation on days taken for bud sprout was recorded based on data of planting the cuttings and 50% bud sprout. Shoot length was recorded with the help of measuring scale and diameter with vernier calipers. Leaf area was recorded with Leaf area meter. The nutrient analysis was done as per the standard procedure followed. Among the nutrients, zinc was estimated using Atomic Absorption Spectrophotometer. Nitrogen was estimated using nitrogen auto analyzer by Kjeldahl method in Gerhardt Distillation Unit (Vasodest 30) after digesting the samples on a digestion system. Phosphorous content was estimated using UV- Visible Spectrophotometer, Evolution, 201, Thermo Scientific, USA and potash content in rootstock was estimated using Digital Flame Photometer, Jenway, UK. The nutrient content in shoots was expressed as % dry weight basis except zinc which was expressed in ppm. Statistical analysis The data was analyzed statistically by SAS 9.3.

3 RESULTS AND DISCUSSION

The data recorded for various parameters during two years of study (2008-10) is expressed in the result as average data.

3.1 Effect on rooting success and vegetative parameters

Significant differences were recorded for days to bud sprout. Application of Zn @ 5.0g/mother vine induced early sprouting (7.91 days) in the cuttings followed by 20.0g/mother vine (9.8 days), 10.0g/mother vine (10.76 days) and 15.0g/mother vine (11.74 days). In general, application of zinc resulted into early bud sprouts as compared to the control. The sprouting depends on carbohydrate reserves in the mothervine selected for preparing cuttings. More carbohydrate reserve in the mother vine might have broken down into sugars and acted as source of energy for bud sprout (unpublished data). Early sprouting with the application of zinc in the present study also supports the research results of Swietliek, 1999 [13], who also reported that zinc is involved in regulating the protein and carbohydrate metabolism. Variation for success percent of rooting in different treatments of Zn was observed with the application of zinc to the mothervine (Table 1). Maximum success percent was recorded in 5.0g/ mother vine (90.28 %) followed by 15.0g/ mother vine (85.55 %). All the treatments showed increased rooting success as compared to control (78.55%). Giernaszewska, 2003 [14], while working on ivy has reported that effect of zinc is plant species dependent. In juvenile form, it only increased the root length and did not improve the auxin efficiency when applied in mixtures. He could not see any such effect on cuttings of barberry (Berberissp.) or firethorn (Pyracantha sp.) too. On the other hand, in rockspray (Cotoneaster sp.) zinc acted as an auxin cofactor and improved rhizogenesis. Szydło and Pacholczak, 2007 [15], also cofirmed that zinc used together with an auxin improved almost all parameters of rooting of the cuttings in the difficult-to-root mature form of ivy. Significant differences were recorded among all the zinc applied treatments for shoot length. After 60 days, maximum shoot length was recorded in Zn @ 20.0 g/ mother vine (8.67cm) followed by 5.0g/ mother vine (8.52cm) as compared to control. After 120 days, maximum shoot length was recorded in zinc concentration of 20.0g/ mother vine (12.69cm) as compared to control (11.44cm).The early rooting due to the application of zinc might have resulted into faster shoot growth as indicated by increase in shoot length in the present study. Similar results were reported by Malik et al,2011 [7] in their experiments of effects of different level of zinc on growth and yield of Red Amaranth and Rice. Highest shoot diameter was recorded in zinc concentration of 5.0g/mother vine at 120 days after planting (2.37mm) while the maximum internodal length was recorded in zinc concentration of 20.0g/ mothervine (3.07cm). Application of zinc to the mothervine has resulted in the increase in shoot growth and also the shoot diameter as compared to the control treatment. However, under the control treatment rooting inhibitors might not have been leached out resulting into reduced percent success and also the reduced shoot growth (unpublished data). Sabir et al, 2004 [16] reported that 500 ppm IBA application promoted shoot length and shoot diameter. As Zinc is precursor of auxin it can be concluded that it also has positive effect on shoot growth parameters. Number of leaves/ shoot recorded highest in Zn @20.0 g/ mothervine (8.56). Application of Zn @ 20.0g/ mothervine resulted in highest leaf area followed by 5.0, 10.0 and 15.0g/ mothervine respectively. This was due to the effect of zinc on auxin production and increasing photosynthesis and growth rate. However it was found that with the increase in Zinc accumulation in root and shoot tissues, the decreased fresh mass and leaf area correlated with the inhibition of the net photosynthetic rate, transpiration, stomatal conductance, rate of apparent photosynthetic electron transport and isoprenoids accumulation [17].

3.2 Effect on Nutrient Status

The data recorded on major nutrient status in the cutting of Dog Ridge rootstock is presented in Table 2. Significant variations were observed for major nutrients (N, P and K) in the shoots. Application of zinc @ 10g/ mothervine resulted in 0.49% Nitrogen, 28.3 ppm Zinc and 0.10% Phosphorous. Potassium in the cuttings was found maximum in 5.0g zinc/ mothervine (0.55%). The nitrogen content in the mothervine increased upto 10.0g zinc application but was decreased when the zinc was increased to 15.0g/ mothervine. Likewise, Phosphorous content was increased upto 10.0g/ mothervine and then decreased in 15.0g/ mothervine and 20.0g/ mothervine of zinc concentration. The variation in nitrogen and phosphorous status of a plant as it is influenced by application of different doses of zinc to the mothervine clearly indicates its requirement in appropriate quantity to the mothervine. It is known that at normal zinc concentrations in the nutrient medium the content of inorganic phosphorous decreases, whereas the organic (acid-soluble) form increases [18]. Potassium content in the mothervine continuously decreased with the increasing concentration of zinc. However, all the nutrients were found to be increased among all the treatments except P as compared to control. When zinc is accumulated excess in plants it is reported to have a negative effect on mineral nutrition [19].

4. Conclusion
Application of Zinc has resulted in increased rooting and early bud sprout in the cuttings. Zn might also acts as auxin precursor which helps in growth of plants. However, when the excess amount of Zinc accumulate in the cuttings it resulted in negative effects on the growth of cuttings.

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6. References

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Table 1: Effect of Zn application on Bud sprouting, Rooting success and Shoot and Leaf Parameters

	Days taken for bud sprouting	% Success	Shoot length (cm)		Shoot diameter (mm)	Inter nodal length	No. Of leaves/ shoot	Leaf area (cm2)
Treatment			60 DAP	120 DAP				
Zn@ 5.0g/ mother vine	7.91e	90.28a	8.52b	11.80b	2.37a	2.52d	7.41c	22.81b
Zn@ 10.0g/ mother vine	10.76c	81.12c	7.27c	10.56d	2.10d	2.70b	8.22b	22.25c
Zn@ 15.0g/ mother vine	11.74b	85.55 b	6.73e	9.85e	2.14c	2.41e	6.99d	20.24d
Zn@ 20.0g/ mother vine	9.8d	81.96 c	8.67a	12.69a	2.24b	3.07a	8.56a	24.52a
Control	13.1 a	78.55d	6.88d	11.44c	2.13cd	2.62c	7.41c	20.37d
CV %	2.35	1.569	1.044	1.204	1.44	1.27	1.285	1.206
LSD 5 %	0.336	1.756	0.106	0.182	0.042	0.045	0.133	0.356
Significances	**	**	**	**	**	**	**	**

Table 2: Effect of Zn application on nutrient status in Dog Ridge rootstock cuttings.

Treatment	N (%)	P (%)	K (%)	Zn (ppm)
Zn@ 5.0g/ mother vine	0.48b	0.08c	0.55a	23.4c
Zn@ 10.0g/ mother vine	0.49b	0.10a	0.51b	28.3a
Zn@ 15.0g/ mother vine	0.45c	0.09b	0.48c	25.3b
Zn@ 20.0g/ mother vine	0.42d	0.05e	0.43d	22.9c
Control	0.41e	0.07d	0.41e	19.2d
CV %	1.581	2.27	1.575	1.766
LSD 5 %	0.009	0.002	0.01	0.564
Significances	**	**	**	**