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The effect of different node number cuttings on nursery performance of Vanilla (*Vanilla planifolia syn. Vanilla fragrans*) in south western Ethiopia

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Abstract

An experiment was conducted for three years (2007 to 2009) to determine optimum node numbers of *Vanilla fragrans* for production of quality planting materials in South Western Ethiopia. Different node numbers (one, two, three, four and five) of vanilla cuttings were used as treatment to select optimum node number and treatments were arranged in randomized complete block design with five replications. All nursery growth data and quality parameters (leaf, stem and root) were recorded and analyzed using SAS software with GLM procedure. Statistical results stated that most planting materials parameters were significantly affected by number of nodes used ($P \leq 0.05$). There was also an increasing trend in mean values of most planting materials growth parameters as the node number per original cutting was increased. Mean leaf, shoot and root parameters values were consistently increasing from node number one (1) to four (4) and declined with node number five (5) in similar pattern. Numbers of leaves (9.22, 6.85), length of vine (35.94, 28.88 cm) and root dry weight (4.49, 3.94 g) were obtained from four-node and five-node number cuttings, respectively. Four-node cuttings resulted in vigorous and quality planting materials and recommended for mass propagation in commercial and small scale farming.

Keywords: Vanilla, nodal cutting, propagation, cutting economy, root.

INTRODUCTION

Vanilla (*Vanilla fragrans*) is the only edible fruit of 35,000 species in the family *Orchidaceae* (Kaczynski, 2002). Vanilla is a tropical vine orchid requiring a warm climate with an annual rainfall of 1500-3000 mm (KAU, 2002) similar to other spices and essential oil crops (Kaczynski, 2002; Purseglove *et al*., 1981). It is native to Central America, southeastern Mexico, the West Indies and northern South America (Kaczynski, 2002; KAU, 2002; Njoroge *et al*., 2005). The major producing country of vanilla are Madagascar, Malagasy Republic, Indonesia, Comoros and Uganda. There is also export from Seychelles, Reunion, Mexico and Dominica in the West Indies (Bianchessi, 2004; Geetha and Shetty, 2000; Masefield *et al*., 1985). Vanilla is the most popular flavor in the world and second most expensive spice next to saffron. The pods (beans), the commercial product of vanilla, are the source of the popular flavoring substance called vanillin which is mainly used in flavoring cakes, ice creams, sweets, chocolate, beverages, cosmetics and perfume industry (Goodenough, 1982; Kaczynski 2002; Purseglove *et al*., 1981).

Vanilla fragrans and black pepper (*Piper nigrum* L.) prefer virgin natural forest areas to establish the plantation and recommended to retain the natural shade of the lofty trees for vanilla (KAU, 2002; Purseglove *et al*., 1981). Superficial root nature of vanilla (*V. fragrans*) also requires leave the soil and rich humus layer on top undisturbed (KAU, 2002). Vanilla is cultivated on varied type of soils from sandy loam to laterites. It requires filtered sun light and in the absence of natural shade, trees should be grown artificially for this purpose (KAU, 2002).

The major support and shade trees for Vanilla are *Jatropha curcas*, *Casuarina equisetifolia*, *Coffee liberica*, *Gliricidia sepium*, *Albizzia lebbeck*, *Erythrina brucei and Gravellia robusta* (Bianchessi, 2004) and in Tepi National Spices Research Center (TNSRC) *Erythrina brucei and Gravellia robusta* are very suitable trees for support and shade (Girma *et al*., 2008). *Vanilla fragrans* bears pods on its third year after planting and in its native places such as Mexico and Central America, pollination of vanilla is done by bees and humming birds while outside its original place performed artificially by hand. The rostellum is bent upwards using a pin, so that the pollinia can be pressed with a finger on to the stigma (Bianchessi, 2004; Rehm and Gustav, 1991; Weiss, 2002).

Agro-ecology of south western Ethiopia; Sheka, Bench-Maji, Mejenger and Kaffa zones are potential areas of vanilla expansion (MoARD, 2005). Being a new crop to more countries, the cultivation of *Vanilla fragrans* faces a number of constraints such as a narrow germplasm base, inadequate research, developing package of practices, diseases etc. for sustainable development (Shanmugavelu *et al*., 2002).

Such facts urge to build up suitable production recommendations like suitable propagation technique. Vanilla is propagated by stem cutting like most of the perennial vine spices (Carlos and Balakrishnan, 1991; KAU, 2002; Purseglove *et al*., 1981; Purseglove, 1973; Sengupta, 2003; Sujatha and Bhat (2010) and, different propagation experiences are available in various countries.

According to Carlos and Balakrishnan (1991), cuttings of vanilla (90-100 cm) length with at least 12 nodes taken from healthy vigorous part of the vine are preferred for planting. It is usual to remove 2 to 3 leaves from the base which is inserted into the humic layer and mulch. On the other hand, KAU (2002) discussed that vanilla is propagated by planting shoot cuttings in situ and rooted cuttings of 60 cm. The author added that longer cuttings bear fruit earlier than shorter cuttings and rooted cuttings as well as tissue culture derived plants can also be used for planting. Moreover, Purseglove (1973) discussed that cuttings of about 1 m long can be used for propagation in direct field planting of un-rooted cuttings. According to Verheij (2004), planting of rooted cuttings is practiced for plants/wildings and need high care and favorable growing conditions. On the other hand direct planting out of cuttings in trees like *Gliricidia sepium*, *Euphorbia species*, *Lantana camara* is practiced in hedge round garden and others around cattle pen, shade trees for cocoa or coffee e.g. *Albizia procera*, *Erythrina species*, *Commiphora species* (Verheij, 2004). In the research center (TNSRC) cuttings with two, three and more number of nodes can be used, but the question is what number of node/length of cutting will be optimum for economical propagation?

It is obvious that as the length of cutting increased the rooting, nursery and field establishment will be much better but this requires investing of more planting materials. All available information show that it should be checked for the blanket recommendation. Therefore, the objective of this experiment was to identify the suitable number of nodes on vanilla cutting for efficient propagation.

MATERIALS AND METHODS

Description of the study area

The experiment was conducted in South Western Ethiopia,Tepi National Spices Research Center (location indicated in Figure 1) from (2007-2009). The site is located with latitude of 7°3' N and longitude of 35°0' E with an altitude of 1200 m a.s.l and receives a mean annual rain fall of 1688 mm. The mean maximum and minimum temperature of the area (ºC) is 29.5 and 15.3 ºC, respectively (Edossa, 1998; Girma and Kindie, 2008). The soil type of the study area is Dystric Nitisols, Eutric Vertisols and Vertic Gleysols dominated with forest soil (Abayneh and Ashenafi, 2005). Precipitation (mm), minimum and maximum temperature (ºC) of the experimental periods are presented in (Figure 2).

Cutting source and preparation

Cuttings were prepared from four year old vanilla accession (Van.1/93) planted in the research center garden. The cutting tools (pruning shear) were disinfected by alcohol to avoid contamination. The experiment consisted of five different node numbers (one, two, three, four and five) treatments of cuttings arranged in randomized complete block design (RCBD) with five replications.

Methodology

In 2007, 2008 and 2009 cuttings were taken and planted in nursery in the 1st week of March. Then stayed in the nursery until regular planting season (August). Forest soil having enough humus was collected from the natural forest, sieved with a 2 mm diameter mesh wire, mixed and moistened. Then filled into polyethylene bags having a height of 21 cm and layflat diameter of 11 cm (standard coffee poly bag). The pots were kept under a 2 m height and 50-60% shade. Healthy cuttings of vanilla from the semi hard wood (middle part of the shoot) were prepared using pruning shear with node numbers (one, two, three, four and five). Cuttings of each treatment group were pulled or mixed for random distribution and planted. Weeding and watering practices applied equally for all the planted cuttings as necessary. Data on number of

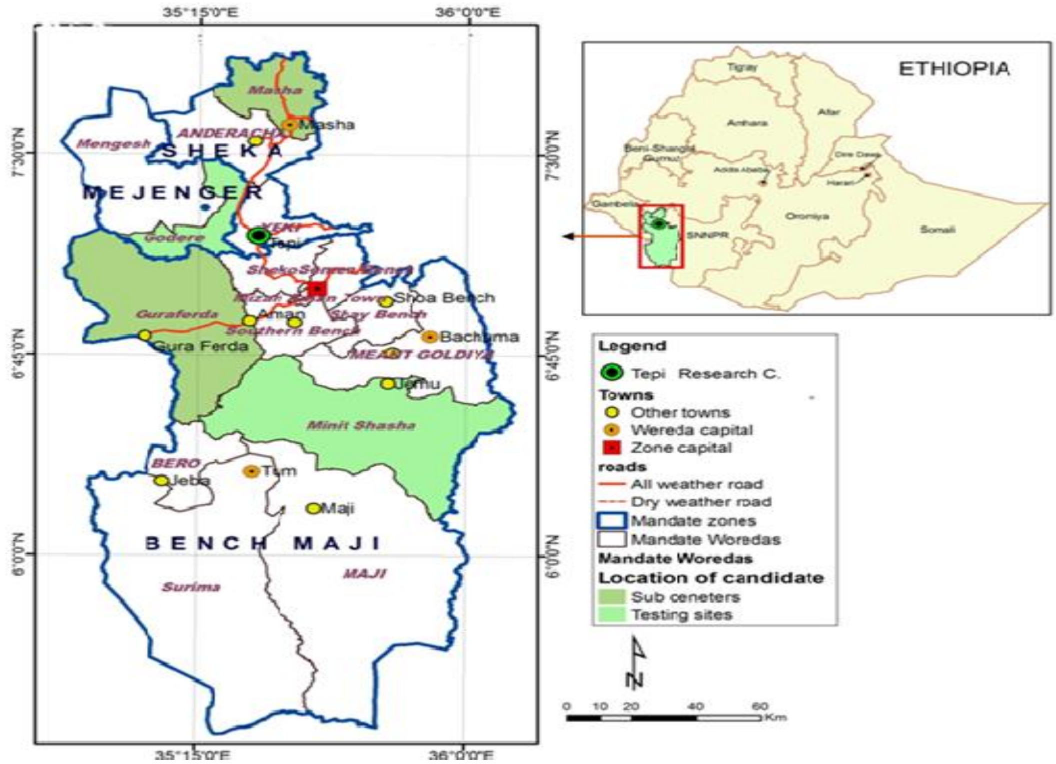

Figure 1. Location map of Tepi National Spices Research Center and suitable zones for Vanilla (*V. fragrans*) cultivation.

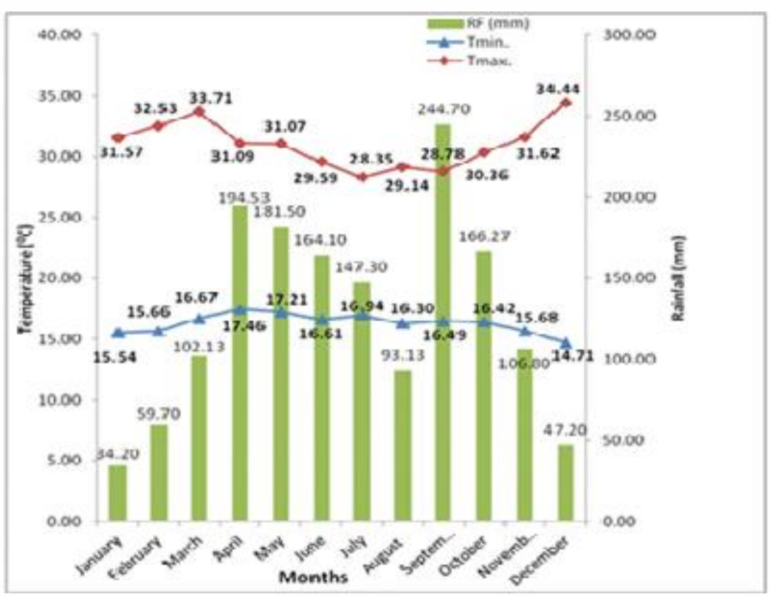

Figure 2. Mean of 3-years (2007-2009) total monthly rainfall and monthly maximum (T_{max}) and minimum (T_{min}) temperatures of the experimental years in Tepi National Spices Research Center.

leaves per vine, leaf length (cm), leaf width (cm), root length (cm), shoot (vine) length (cm), leaf fresh weight (g), leaf dry weight (g), shoot fresh weight (g), shoot dry weight (g), root fresh weight (g) and root dry weight (g) were recorded in August. Plant height, leaf length and width data were taken using pocket meter/plastic ruler.

Table 1. Effects of node number on leaf and shoot nursery performance of vanilla (*V. fragrans*) cuttings.

Node number of cutting	Number of leaves/vine	Leaf length (cm)	Leaf width (cm)	Leaf fresh weight (g)	Leaf Dry weight (g)	Length of vine (cm)
1	1.33[c]	1.54[c]	0.64	15.01[c]	1.73[c]	5.85[d]
2	5.39[b]	6.04[bc]	2.66	64.24[b]	6.09[c]	16.69[c]
3	6.89[b]	7.45[ab]	3.09	89.31[ab]	12.04[b]	23.80[b]
4	9.22[a]	8.70[a]	3.54	114.35[a]	12.42[b]	35.94[a]
5	6.85[b]	8.26[ab]	7.24	112.16[a]	18.38[a]	28.88[b]
Statistical significance	***	**	NS	***	**	**

*, **, *** Treatment effects significant at $p \le 0.05$, $p \le 0.01$ and $p \le 0.001$, respectively; ns: non-significant treatment effect ($p > 0.05$), means within a column having different letters are significantly different according to DMRT at $P \le 0.05$.

Table 2. Effects of node number on shoot and root nursery performance of vanilla (*V. fragrans*) cutting.

p	Shoot fresh weight (g)	Shoot dry weight (g)	Root Length (cm)	Number of roots per vine	Root fresh weight (g)	Root dry weight (g)
1	7.96[c]	1.15[d]	5.74[d]	0.92	5.07[d]	1.27[d]
2	21.41[bc]	3.11[c]	17.46[c]	1.29	14.09[c]	2.59[c]
3	32.46[b]	4.46[b]	24.12[b]	1.29	16.29[bc]	3.37[bc]
4	59.41[a]	6.21[a]	29.74[a]	3.68	23.59[a]	4.49[a]
5	50.82[a]	5.86[a]	26.64[ab]	1.31	20.83[b]	3.94[ab]
Statistical significance	***	***	**	NS	**	***

*, **, *** Treatment effects significant at $p \le 0.05$, $p \le 0.01$ and $p \le 0.001$, respectively; ns: non-significant treatment effect ($p > 0.05$), means within a column having different letters are significantly different according to DMRT at $P \le 0.05$.

The leaf, shoot and root parts of the planting materials were oven dried at 80 ºC for 72 hours for dry matter estimation and taken in the laboratory using sensitive mass balance. The collected data were analyzed using SAS software with GLM procedure (SAS Institute Inc. Cary NC, USA, version 2008).

RESULTS AND DISCUSSION

All planting materials growth and quality parameters were significantly influenced by the number of node cuttings used ($p \le 0.05$). However, leaf width (cm) and number of roots were not significant. Generally, there was an increasing trend in growth parameters as the node number per cutting increased. This might be due to the length/size of the cutting initially used.

The minimum (1.33) and maximum (9.22) number of leaves per vine was obtained from single and four node cutting, while 25% lower was recorded from five node cutting. Maximum leaf length (8.70 cm), leaf fresh weight (114.35 g) and length of vine (35.94 cm) were obtained from four node cutting. However, maximum leaf width (7.24 cm) and leaf dry weight (18.38 g) were obtained from five node cutting (Table 1). Consequently, increasing mean values were found until node number four and then declined slightly at five node cutting. Leaf width (7.24 cm) was statistically non significant across node number five and four, however numerically there was slight difference. Maximum leaf dry weight (18.38 g) was recorded for node number five followed by (12.42 g) for node number four. Current results on number of leaves per vine (9.22) and length of vine (35.94 cm) from four node cutting were supportive to a report by Umesha *et al*. (2011) from three to five node cuttings.

Mean maximum shoot fresh weight (59.41 g), shoot dry weight (6.21 g), root length (29.74 cm), root fresh weight (23.59 g) and root dry weight (4.49 g) were obtained from four node cutting. Increasing of mean values for all parameters were observed from node one to node four cutting. However, a decreasing trend was observed from node four to node five cutting (Table 2). On the other hand, number of roots per vine was not significantly affected by the number of node cuttings. However, an increasing pattern of number of roots per vine was obtained from one node to four node cutting while a decreasing order was recorded from four node to five node cutting. The performances of cuttings were not significant with four node or five node cutting. Thus, using four node cutting as planting material is preferable to economize the cutting source (Table 2).

Leaf, shoot/stem and root in fresh or dry state were consistently maximum at four node cutting. However, leaf width (7.24 cm) and number of roots per vine (3.68) were not significant (P≤ 0.05) (Table 1 and 2). Current research results of shoot dry weight (6.21 g) and root length (29.74 cm) were in support of the findings by Umesha *et al*. (2011). The results of using four (4) node number for vanilla planting material preparation was also supporting to a recommendation by Weiss (2002). The author also recommended using 30 cm length (approximately four node cutting) is economical as well as environmental. KA (2010); Umesha *et al*. (2011) reported that root initiation is faster and vigorous in three to five node cuttings.

Visual observation indicated that size and uniformity of planting materials from four node cutting were very promising similar to the report by Fajardo *et al*. (2010), that size and uniformity are important factors for vegetatively propagated crops. The shoot to root ratio 2.52 and 1.40 g/g in fresh and dry state, respectively (data not indicated here) was a supporting record by Bernier *et al*. (1995); Thompson (1985). The authors reported shoot to root ratio (1.5 to 2.5 g/g) is desirable quality of bare-root conifer seedlings.

CONCLUSION AND RECOMMENDATION

Full package recommendation such as suitable propagation is very important for sustainable expansion of vanilla (*V. fragrans*) technology. Most of the leaf, stem and root mean records in fresh or dry state were consistently higher at four node number of vanilla (*V. fragrans*). Mean values of number of leaves per vine (9.22, 6.85), length of vine (35.94, 28.88 cm), shoot fresh weight (59.41, 50.82 g), root length (29.74, 26.64 cm) and root dry weight (4.49, 3.94 g), were obtained from four and five node cuttings, respectively. Accordingly, four node vanilla (*V. fragrans*) cutting is recommended to raise nursery rooted planting materials in south western Ethiopia and this technology can be exercised by users easily.

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