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Comparative study on performance of grafted black pepper v/s conventional black pepper vine

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Abstract
Black pepper (*Piper nigrum* L.) is a perennial vine native to Western ghats of India. It is one of the major spice crops and is cultivated in about 26 countries of the World. There are many constraints faced by farmers for its successful cultivation *Phytophthora* foot rot is one of the major diseases contributing to losses incurred by farmers and the grafting method of propagation is one of the means to overcome this. The present study was conducted at farmer's field in Sirsi from 2017 to 2019 wherein the vines propagated through cuttings of runner shoots (Conventional vines) and grafting were compared for their performance. The result showed that both the methods of propagations had no significant influence on growth and yield of black pepper. Therefore, grafting method may be adapted for getting equal yield with an added advantage of tolerance to foot rot disease incidence.

Keywords: Compatible, conventional vine, *Phytophthora* foot rot

1. Introduction
Black pepper (*Piper nigrum* L.) is a perennial vine belonging to family Piperaceae. It is one of the major spice crops cultivated in the world. It is commercially cultivated in 26 countries of the world. Besides India, Vietnam, Brazil, Indonesia, China and Thailand are major cultivating countries. India has about 2.59 lakhs ha under cultivation with production of 61,000 MT. Karnataka is the major producer of black pepper in India where it is cultivated both as sole crop and as mixed crop. India also exports black pepper worth Rs. 57,370.94 lakh (Spices Board, 2019). Black pepper is commercially propagated using cuttings from runner shoots. There are several constraints faced by farmers for successful cultivation of black pepper which includes climate change, biotic stresses like disease and pests, inadequate water availability, etc. Foot rot disease caused by the fungus *Phytophthora* is one of the major threats in black pepper cultivation. The crop loss in Karnataka alone is estimated to be up to 20-30 per cent due to this (Thomas and Naik, 2017) [13]. This spreads rapidly and is also difficult to control or manage. The plants affected by this pathogen is observed to die within 2-3 weeks during rains and adjacent plants may be infected within one or two months (Anh *et al.*, 2018) [2]. One of the most common methods of controlling this is using chemical control strategies. However, this may lead to increased cost of cultivation, reduction in soil fertility, environmental pollution and health hazards. To overcome this constraint, use of grafted vines is one of the options apart from the other control measures. *Piper colubrinum* (Brazilian black pepper) is found to be resistant rootstock to this disease and root-knot nematode infestation which is also graft compatible with *P. nigrum*. In order to control the foot rot disease of black pepper farmers are opting grafted black pepper plants using Brazilian pepper (*P. colubrinum*) as root-stock for re-establishing the plantations. But there is meagre scientific information on the yield efficiency of grafted vines in comparison to that of normally propagated plants through cuttings. Thus, there is a need for research on the yield efficiency of grafted black pepper vines in order to understand the economic feasibility of this method of propagation.

2. Material and Methods
The experiment was conducted in farmer's field near Sirsi (Uttara Kannada dist., Karnataka) from 2017 to 2019. The experimental design adopted was 't' test to compare the performance of grafted and vines from rooted cuttings (conventional) of black pepper. A total of 20 middle aged vines at bearing stage were taken per treatment. The variety Panniyur-1 was chosen for this study, which was grafted on *Piper colubrinum* (root-stock).

The treatment details were as follows:

- Treatment 1: Conventional black pepper (rooted cuttings)
- Treatment 2: Grafted black pepper

Following were the observations recorded to compare the performance of the crop:

2.1. Number of leaves
The number of leaves was counted in one-meter column at 1.25m above ground level at two months interval in black pepper vines. In case of grafted vines, the number of leaves was calculated in one-meter column above graft union at a height of about 1.25 m from ground level. Mean number of leaves of 20 vines each in case of grafted and conventional vines was calculated.

2.2. Leaf length (cm)
The length of three fully opened leaves in each vine was measured in centimetres using meter scale at two months interval in vines. Mean leaf length of 20 vines was expressed in centimetres both in grafted and conventional vines.

2.3. Leaf breadth (cm)
The breadth of three fully opened leaves in each black pepper vine was measured in centimetres using meter scale at two months interval. Mean leaf breadth of 20 vines each in both grafted and conventional vines was expressed in terms of centimetres.

2.4. Leaf area (cm^2)
The length and breadth of the three leaves of each vine was multiplied with the leaf area constant (0.68). Mean leaf area of 20 vines per treatment was calculated and expressed in square centimetre.

2.5. Number of spikes per vine
The total number of spikes produced per vine was observed at two months interval in one metre column length. The mean number of spikes obtained in 20 vines of each treatment was recorded.

2.6. Fresh yield of spikes (kg/vine)
The total weight of the spikes was recorded immediately after harvest. Mean fresh yield of spikes from 20 vines in each treatment was calculated and expressed in kilograms per vine.

2.7. Dry yield of berries (kg/vine)
The freshly harvested spikes were de-spiked on the next day of harvesting and then sun dried. The berries were filled in polythene bags and dried under sun for 6hr (for blanching). Later on, the berries were directly sun dried until the moisture level of berries is in the range of 10-12%. The weight of these berries was recorded and mean dry weight of the berries from 20 vines both in grafted and conventional vines was calculated and expressed in kilograms per vine.

2.8. Recovery (%)
The weight of processed berries obtained from the fresh berries was considered as the recovery of black pepper berries.

$$\text{Recovery (\%)}: \frac{\text{Dry weight of berries (kg)}}{\text{fresh weight of berries (kg)}} \text{ x } 100$$

The mean dry berry recovery percentage from 20 vines in each treatment was recorded and expressed in percentage.

3. Results and Discussion
The grafted and conventional black pepper vine did not show significant difference in number of leaves throughout the study period. However, the grafted vines recorded more mean number of leaves (43.55 nos. to 46.35 nos.) when compared to conventional black pepper vines (36.35 nos. to 37.20) when recorded from November 2017 to January 2019 (Fig.1). This may be because of increase in the photosynthetic rate caused by high rootstock and scion combination (Malasi *et al.*, 2017) [8]. Increased number of leaves on grafting were also recorded in apple (Marini *et al*., 2000; Rana and Bhatia, 2004; Tworkosi and Millar, 2007 and Malasi *et al.*, 2017) [9, 11, 8].

Similarly, the difference in mean leaf length of grafted and conventional black pepper vines was not significant during the study period. Also, maximum leaf length was observed in grafted vines which increased from16.80 cm to16.92 cm during the study period. The leaf length of non-grafted black pepper was recorded to be 15.91 cm which increased to 16.06 cm by end of study period (Fig. 2).

In case of leaf breadth, grafted vines showed significant difference in mean leaf breadth when compared to conventional vines. The maximum leaf breadth was recorded in grafted black pepper vines which increased from 12.02 cm in November 2017 to 12.15 cm in January 2019. While, the conventional vines showed less leaf breadth which was recorded 10.80 cm in November 2017 increasing to 10.96 cm by end of study period (Fig.3). This is in agreement with Singh *et al.* (2014) in mango. This might be because of compatibility between the rootstock and scion (Suzuki and Morishita 2002) [12] which influenced scion yield, quality and vigour by regulating the amount of minerals reaching the scion thus affecting the growth of leaves (Cline *et al.*, 2001) [4].

The grafted and conventional black pepper vine showed significant difference in leaf area throughout the study period (Fig. 4). The mean leaf area was observed to be more in grafted black pepper vines (137.92 cm^2 to 140.85 cm^2) when compared to non-grafted vines (117.26 cm^2 to 120.05 cm^2).

The differences in yield characters *viz.*, number of spikes, fresh yield and per cent recovery in one-meter column of grafted and conventional vines were also not significant during the study period (Table 1). However, maximum mean number of spikes was observed in grafted vines 17.20 nos. during both the years while non-grafted black pepper recorded 9.40 number of spikes during 2017-18 and 7.80 during 2018-19.

The grafted vines recorded maximum fresh (3.70 kg/vine, 3.32 kg/vine) and dry yield (1.124 kg/vine, 0.945 kg/vine) during both the years respectively, when compared to conventional vines which recorded lesser fresh yield (3.59 kg/vine, 2.53 kg/vine) and dry yield (1.044 kg/ vine, 0.695 kg/vine). Although there was no significant difference in dry yield during 2017-18, significant difference was observed during 2018-19 was observed. The recovery percentage in grafted black pepper recorded maximum recovery of black pepper berries during both the years (30.31%, 28.49%) and conventional black pepper vines recorded 29.18% and 21.91% recovery of black pepper respectively.

Although there was no significant difference, grafted showed better results. The results are in line with results of Abdelaziz

and Abdeldaym (2019), Noor *et al.* (2019) and Gisbert-Mullor *et al.* (2020) [1, 10, 5] in tomato, capsicum and cucumber, respectively. Increase in yield was observed in all these crops indirectly expressing increased number of flowers. The present results also justify the reports of Bekhardi *et al.* (2011) [3] in watermelon wherein grafting showed no influence on fruit quality and yield. Higher yield in grafted plants might be due to improved water and nutrient uptake by vigorous rootstock (Khah *et al.*, 2006) [7].

Further, no stock-scion break up (incompatibility) is seen in the grafted vines against the general notion among the farmers. The profuse root formation, both anchoring and feeding types were found in grafted vines. This showed that the grafted vines can take up sufficient quantities of nutrients from the soil.

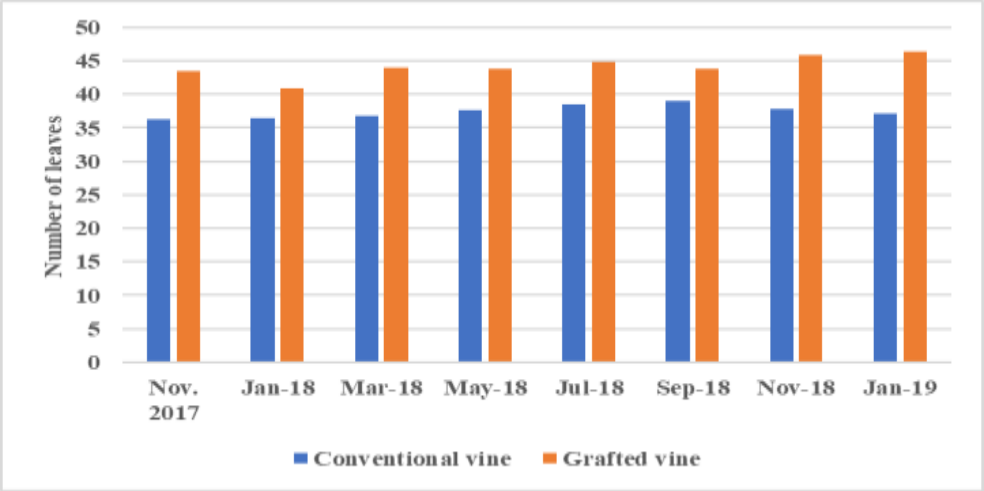

Fig 1: Comparison of number of leaves of grafted and conventional black pepper vines

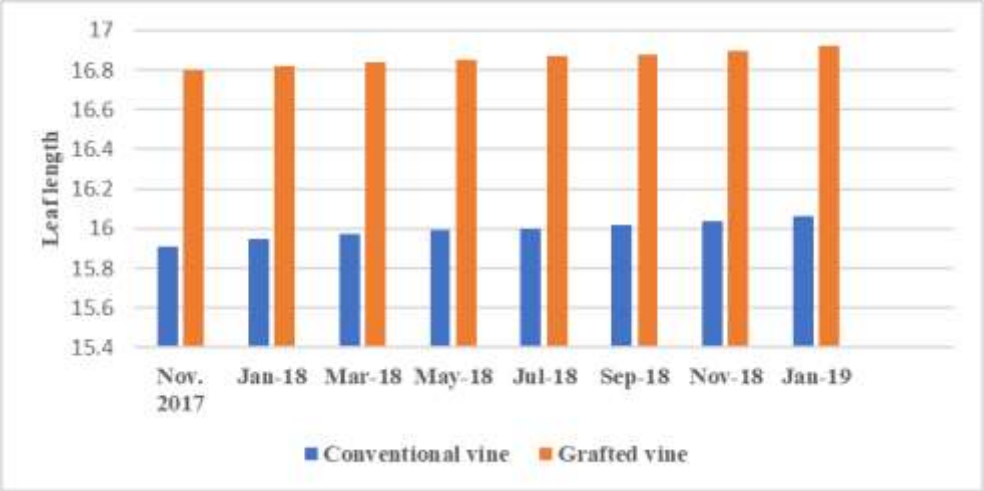

Fig 2: Comparison of leaf length of grafted and conventional black pepper vines

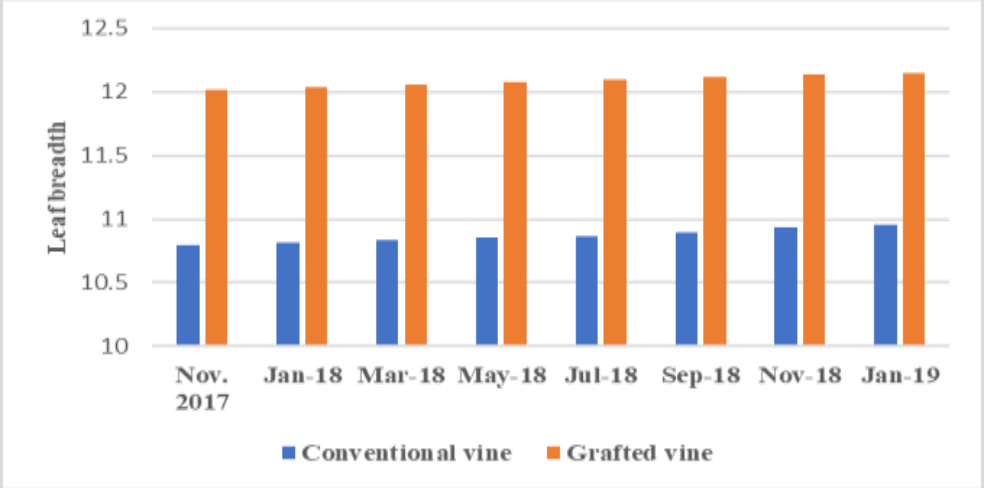

Fig 3: Comparison of leaf breadth of grafted and conventional black pepper vines

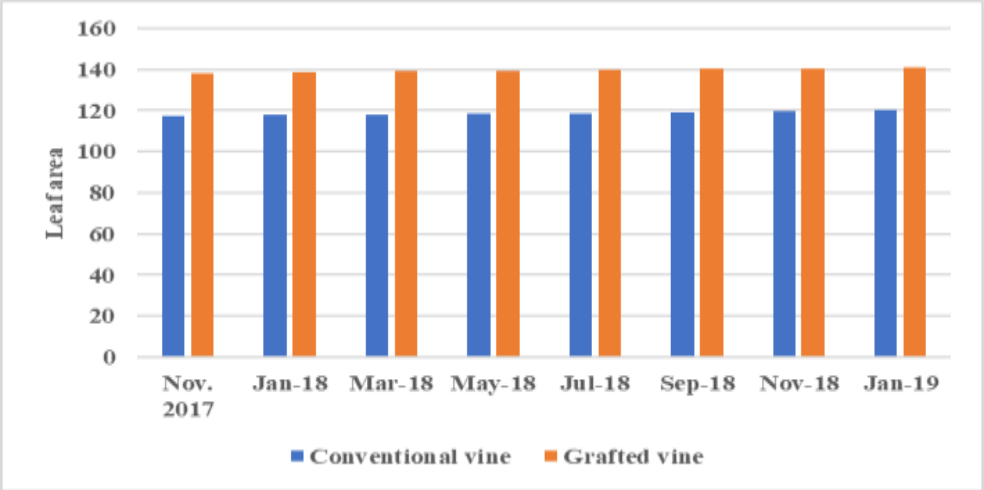

Fig 4: Comparison of leaf area of grafted and conventional black pepper vines

Table 1: Mean of yield characters of grafted and conventional black pepper vines

Treatment	Number of spikes		Fresh yield (kg/vine)		Dry yield (kg/vine)		Recovery (%)	
	2017-18	2018-19	2017-18	2018-19	2017-18	2018-19	2017-18	2018-19
T_1	9.40	7.80	3.59	2.53	1.044	0.695	29.18	21.91
T_2	17.20	17.20	3.70	3.32	1.124	0.945	30.31	28.49
't' value	-1.437	-2.173	-0.377	-2.268	-0.843	-2.506*	-1.220	-2.577

* Indicates significance at ρ value (0.05)
T_1: Non grafted black pepper (conventional)
T_2: Grafted black pepper

4. Conclusion

The study was conducted to compare the growth and yield performance of black pepper when two different methods of propagation was done. The grafting vines however are known to have tolerance to *Phytophtora* foot rot. The results of this study showed that as far as performance of crop is concerned there is no significant difference in whichever method of propagation adapted. No foot rot incidence and also graft incompatibility were seen in the grafted vines. Therefore, grafted vines may be a useful for successful cultivation of black pepper without compromising with the yield.

5. Acknowledgments

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