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Influence of growth hormones and plant growth promoting rhizo microorganisms on root and shoot growth of plageotropic cuttings of black pepper (*Piper nigrum* L.)

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Abstract
Black pepper (*Piper nigrum* L.) is the major spice crop of India finds wide application in traditional medicine and modern pharmaceutical industry. The fruits are reported to have stimulant, expectorant, carminative, anthelmintic and other properties. Pepper is highly exacting in its soil and climatic requirements, which limits its cultivation in nontraditional areas. Cultivation of pepper in pots as bush pepper can overcome the above limitation. Plageotropic cuttings are difficult to root than runners. The present study was conducted to evaluate the effects of different growth hormones and plant growth promoting rhizo-microorganisms on root and shoot growth of cuttings. Out of nineteen treatments tried, treatment T_8 (IBA 1000 ppm) proved to be the best by recording highest primary (8.83), secondary (71.17) roots and maximum root length (18.88 cm) followed by T_5. Maximum shoot length (5.99 cm) and number of leaves per shoot (2.33) were recorded in treatment T_5 (*Azospirillum lipoferum* 10ml/cutting).

Keywords: black pepper, plageotropic, hormones, rhizo microorganisms, *Azospirillum*

Introduction
Black pepper (*Piper nigrum* L., Family: Piperaceae) popularly known as `king of spices' and `black gold' (Parthasarathy *et al*., 2008) [1] is used for flavouring or seasoning of food and also for medicinal purpose worldwide. It is the oldest and most important spice crop grown in India where it is mainly grown in Southern states like Kerala, Karnataka, Tamil Nadu and also in Assam.The berries are known to possess stimulant, expectorant, carminative, anthelmintic properties.In traditional medicine it is used against fever, neurological, Broncho pulmonary and gastrointestinal disorders (Majeed and Prakash, 2000) [2]. During 2016-17, India produced 57000 tons of black pepper from 1, 31, 230 ha area with a productivity of 3.66t/ha. (Anonymous, 2016-17) [3].
Black pepperis a perennial vine requiring support for its growth.Bush pepper is a miniature pepper in the shape of a bush grown as a potted plant with decorative and economic value. It is raised from fruiting branches of yielding vines. It goes on producing spikes from all its branches yielding berries throughout the year. They can be grown in the urban areas where land is a limiting factor in places like verandah, terrace or balcony and also innontraditional areas where black pepper is not cultivated. Besides, it may be planted in the field as inter or mixed crop with tall growing plants like in coconut, arecanut, cashew etc. As compared to runner shoots, the rooting percentage of laterals was found to be far less that is less than 30 % (Sujatha *et al*., 2004) [4]. Hence the study was conducted to know the effect of growth hormones and plant growth promoting rhizo microorganisms on shoot and root growth of bush pepper/ plageotropic cuttings.

Materials and methods
The experiment was carried out in naturally ventilated polyhouse at College of Horticulture, Mudigere. The healthy plageotropic cuttings of Panniyur-1variety were collected and the cuttings of 10-15 cm length with three nodes were prepared by giving a slant cut at the bottom. The cuttings were planted in polybags of 15 cm X 10 cm size filled with jungle soil, sand and

FYM in the ratio of 2:1:1.

The experiment was laid out with completely randomized design in a naturally ventilated polyhouse. There were nineteen treatments including control in which several growth hormones and plant growth promoting rhizo microorganisms formulations were used at different concentrations. Each treatment was replicated thrice. The treatment details are as follows,T_1-Control, T_2-*Pseudomonas fluorescens* 5ml, T3-*Pseudomonasfluorescens* 10ml, T_4-*Azospirillum lipoferum* 5ml, T_5-*Azospirillumlipoferum* 10ml, T_6-Keradix powder, T_7-IBA 1000 ppm, T_8-IBA 750 ppm, T_9-IBA 1250 ppm, T_{10}-NAA 200 ppm, T_{11}-NAA 400 ppm, T_{12}-NAA 600 ppm, T_{13}-2,4 D 100 ppm, T_{14}-2,4 D 200 ppm, T_{15}-2,4 D 300 ppm, T_{16}-Cow dung slurry 1:1, T_{17}-Cow dung slurry 1:2, T_{18}-Tender Coconut water@ 50%dilution, T_{19}-Tender Coconut water concentrated.

The basal portions of the cuttings (about 2.5-3 cm) were dipped in growth hormone solution at three different concentrations of IBA (750ppm, 1000ppm, 1250ppm), NAA (200 ppm, 400 ppm, 600ppm) 2,4-D (100ppm, 200ppm, 300ppm) for ten seconds and air dried. Liquid cultures of *Pseudomonas* and *Azospirillum* were applied to potting media at two different concentrations i.e., 5ml/polybag and 10 ml/polybag. For keradix treatment, the basal end of the cuttings (2.5-3 cm) was dipped in water and the cuttings were tapped to the brim of the container to remove the excess water and later dipped in keradix powder taken in a beaker. The cuttings were dipped in cow dung slurry and tender coconut water at different dilution levels for 10 minutes.

Observations were made on various roots and shoot parameters such as length of new sprout per cutting, number of leaves on sprout per cutting, number of primary and secondary roots per rooted cutting and length of longest root per rooted cutting were recorded at monthly intervals. Destructive sampling was done for recording root parameters. Data pertaining to various shoot and root parameters were tabulated and statistically analyzed using Completely Randomized Design (CRD). The inference was drawn after comparing the calculated F values with the table F values at 1% (P= 0.01) level of significance.

Result and discussion

Influence of growth hormones and PGPRs on length of new shoot per cutting at 30, 60, 90 and 120 days after planting are represented in figure 1. Shoot length was found to be maximum in cuttings treated with *Azospirillum* 10 ml (5.99 cm) followed by IBA 1000 ppm (5.62 cm) during the course of the study as shown in figure 1.

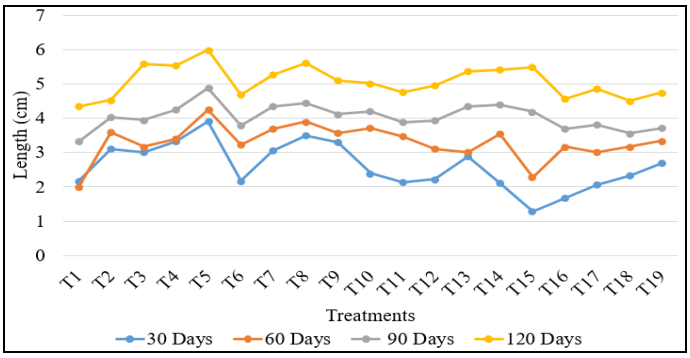

Fig 1: Effect of different treatments on length of new shoot per cutting in plageotropic cuttings.

The data pertaining to number of leaves per cutting as influenced by growth hormones and PGPRs at 30, 60, 90 and 120 days after planting are represented in figure 2. Cuttings applied with *Azospirillum* 10 ml/polybag (T_5) recorded maximum number of leaves (2.34) followed by IBA 1000 ppm (1.84).

Azospirillum reported to produce plant growth promoting substances like IAA and gibberlins (Bashan *et al.*, 2004) [5], which in turn might have resulted in maximum number of leaves and increased shoot length in plageotropic cuttings. The results are in agreement with the findings of Verma *et al.* (2011) [6], Ramtin *et al.* (2011) [7], Rahman and Naggar, (2012) [8], who also reported the beneficial effects of *Azospirillum* on shoot growth in cuttings.

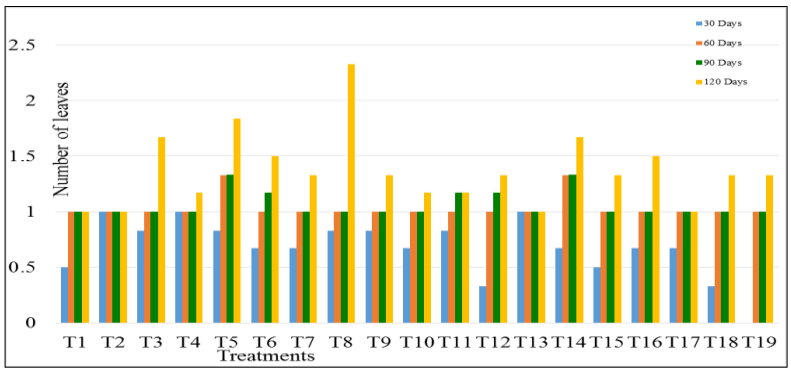

Fig 2: Effect of different treatments on number of leaves per cuttings.

The data pertaining to the mean number of primary roots, secondary roots and length of longest root per cutting asinfluenced by different growth regulator and PGPR treatments are presented in Table 1.Treatments T_8(IBA 1000 ppm) followed by T_5(*Azospirillum* 10 ml) recorded maximum number of primary roots (8.83 and 7.11respectively) and secondary roots (71.17 and 50.83respectively). The same trend also noticed for root length as maximum root length was

recoded in cuttings treated with IBA 1000 ppm (18.88 cm) followed by *Azospirillum* 10 ml (16.35 cm).

The length of the root increased with increase in the level of IBA. It is well known fact that auxin plays an important role in induction of roots in cuttings (Hartmann and Kester, 2004) [9]. The increase in the length of root over control might be due to the enhanced hydrolysis of carbohydrates, auxin induced accumulation of metabolites, synthesis of new proteins, cell enlargement and cell division caused by treatment with auxin. The results were in agreement with the findings of Susaj *et al*. (2012) [10], Younis (2005) [11]. Murty *et al*., (2010) [12] and Singh *et al.* (2009) [13]

Table 1: Effect of growth hormones and PGPRs on various root parameters in plageotropic cuttings of black pepper (*Piper nigrum* L.)

Treatments	Number of primary roots	Number of secondary roots	Length of longest root (cm)
T_1 - Control	2.00	4.60	2.12
T_2 - *P fluorescens* 5ml	3.95	18.17	10.25
T_3 - *P fluorescens* 10ml	6.00	24.17	10.12
T_4 - *Azospirillum* 5ml	5.83	23.50	12.07
T_5 - *Azospirillum* 10ml	7.11	50.83	16.35
T_6 - Keradix	6.00	36.17	14.61
T_7 - IBA 750 ppm	6.17	37.67	12.72
T_8 - IBA 1000 ppm	8.83	71.17	18.88
T_9 - IBA 1250 ppm	4.50	15.65	8.34
T_{10} - NAA 200 ppm	2.33	5.00	3.42
T_{11}-NAA 400 ppm	2.50	8.67	5.25
T_{12} - NAA 600 ppm	3.50	9.67	7.51
T_{13} - 2,4 D 100 ppm	2.17	8.67	4.09
T_{14} - 2,4 D 200 ppm	2.00	8.00	3.72
T_{15} - 2,4 D 300 ppm	2.00	7.17	2.58
T_{16} - Cow dung slurry 1:1	2.16	7.67	3.37
T_{17} - Cow dung slurry 1:2	2.06	5.00	3.12
T_{18} – Tender Coconut water@50% dilution	2.26	5.17	2.43
T_{19} - Tender Coconut water concentrated	2.37	4.67	2.17
S. Em. +/-	0.48	1.66	0.66
CD(0.01)	1.95	6.71	2.66
F test	**	**	**

*significant

Conclusion

The present study revealed that, treating the cuttings with IBA 1000 ppm results in better root and shoot growth of plageotropic cuttings of black pepper, followed by application of liquid culture of *Azospirillum* 10 ml per polybag.

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