Proceedings of 12th Agricultural Research Symposium (2013) 185-189

Effect of Cultivar and Humid Chamber Opening Time on Growth of Black Pepper (*Piper nigrum* L.) during Nursery Stage at Low Country Intermediate Zone (IL_{1a})

A.A.B. KUMARASINGHE[1], H.A. SUMANASENA[2], S.I.C. SILVA[2], K.G.A.P.K. AMARASINGHE[1] and M.N.D. FERNANDOPULLE[1]

[1]*Department of Plantation Management, Faculty of Agriculture and Plantation Management, Wayamba University of Sri Lanka, Makandura, Gonawila (NWP)*

[2]*Intercropping and Betel Research Station, Dampelessa, Narmmala*

ABSTRACT

Black pepper (*Piper nigrum L.*) is an important spice crop which is widely used in the processing of foods and is medicinally important. The current propagation techniques are based on experimental findings carried out at Matale, located in IM_{3a}. However, there are some discrepancies when rooting at other agro-climatic zones. Therefore, this study was carried out to investigate effect of humid chamber opening time on nursery level performance of different black pepper cultivars in low country intermediate zone (IL_{1a}). The survival rate, shoot length, root length, root mean diameter and root and shoot dry weight were measured on five pepper cultivars in three polythene humid chambers which were opened at three, four and five weeks after planting of pepper cuttings. Highest survival rate (95.56 %) and shoot length were observed in the humid chamber which was opened at three weeks after planting. Cultivar Panniyur-1 showed the best performance when considering the survival rate (99.26 %) and other growth parameters. Root mean diameter and root shoot ratio observation suggest that further studies are warranted for exploitation of beneficial values of local cultivars as well as effect of opening time of humid chamber for post nursery field establishment.

KEYWORDS: Black pepper, Humid chamber, Nursery, Root growth, Shoot growth

INTRODUCTION

Pepper (*Piper nigrum* L.), known as the "King of Spices" and it belongs to genus piper of the family piperaceae. It is the most widely used spice all over the world. It has extensive uses for flavouring and preserving processed foods and is important medicinally. Black pepper is native to south India, and is extensively cultivated there and in tropical regions. Currently Vietnam is the world's largest producer and exporter of pepper, producing 90,000 mt as of 2010 (Anon, 2010a).

In Sri Lanka pepper is mainly cultivated in Low and Mid Country Wet and Intermediate agro-climatic zones and total extent of pepper in Sri Lanka is about 32,800 ha. Matale, Kandy, Kegalle, Kurunegala and Nuwara Eliya are the major districts of pepper growing (Anon, 2010b). In 2011, Sri Lanka produced 26,500 tons of pepper and earned US$ 30.7 million as pepper export revenue (Anon, 2011). High yielding ten local pepper selections (IW5, MB12, MW18, MW21, GK49, KW30, KW31, KW33, MB21 and PNMI) have been identified by the Department of Export Agriculture of Sri Lanka. Other than local selections the two commercial varieties Panniyur – 1 of India and Kuching of Malaysia have been introduced to Sri Lanka in 1970 (Anon, 2010b).

The most important input in any crop is the planting materials. Pepper is usually propagated through stem cuttings. For commercial cultivations, cuttings are selected from orthotropic or from basal runners. The selected mother vine should be high yielding, healthy and having good rooting ability (Anon, 2010b). One of the main problems faced by the pepper farmers is receiving low quality rooted cuttings for field establishment. Getting of high quality of rooted cuttings depends on the propagation techniques and nursery practices.

The current propagation techniques are based on experimental findings carried out at the Central Research Station, Department of Minor Export Agriculture, Matale, located in IM_{3a} (Anon, 2002; Bavappa and Gurusinghe, 1978). However, there are some discrepancies when rooting at other agro-climatic zones (Priyadarshani *et al.*, 2012) and this may be attributed with recent frequent occurrence of extreme weather conditions in unexpected time. On the other hand, opening time of humid chamber is about 3 weeks for Matale condition (Bavappa and Gurusinghe, 1978) and it is not clearly mentioned in the current pepper bulletin (Anon, 2002). Therefore this experiment was carried out to investigate effect of humid chamber opening time on nursery level performance of different black

pepper cultivars in low country intermediate zone (IL_{1a}).

MATERIALS AND METHODS

Experiment Location, Design and Treatments

This study was carried out at the Intercropping and Betel Research Station, Department of Export Agriculture, Dampelessa, Naramala located in the Low Country Intermediate Zone (IL_{1a}) and the laboratory of the Department of Plantation Management, Wayamba University, Makandura, Gonawila in Sri Lanka from January to April 2013.

The experiment was laid out in Complete Randomized Design (CRD) with three replicates using factorial combination. Factor 1 consisted of five black pepper cultivars, IW5, MB12, MW21, GK49 and Panniyur-1(PAN). Factor 2 consisted of three humid chambers opened at 3 weeks after planting (3WAP), 4 weeks after planting (4WAP) and 5 weeks after planting (5WAP).

Preparation of Polythene Bags and Plant Cuttings

Bottom sealed standard polythene bags (8" (20 cm) × 5" (12.5 cm), gauge 250, black) were used to plant the cuttings. Polythene bags were filled with standard potting mixture (Top soil 1: Coir dust 1: Sand 1: Cow dung 1) and the lower portion of each bag was perforated with few holes to maintain good drainage. Then bags were watered thoroughly and allowed for drain excess water for 24 hr (Nasli *et al.*, 2007). Two nodal orthotropic cuttings were prepared and dripped in a copper base fungicide solution as a measure of preventing possible fungal attacks. Basal end of each cuttings were dripped in a commercial rooting powder. One thousand two hundred and twenty six cuttings were used for this experiment. Immediately after preparation, each cutting was planted in polythene bags and allowed to root in transparent polythene humid chambers under nursery shade environment (Sanjeewani *et al.*, 2011).

Measurements

Humid chambers were opened twenty one days (3 WAP), twenty eight days (4 WAP) and thirty five days (5 WAP) after planting. Survival rate of the cultivars were recorded at the time of opening. Hardening was done in each humid chamber for one week. Eight, nine, ten and eleven weeks after planting, three cuttings were uprooted randomly from each cultivar grown in each humid chamber.

Non destructive and destructive measurements were made for each cultivar as follows.

Non Destructive Observation

Shoot Length

Destructive Observations

Root Length

Root length measurements were made by counting the number of observations of roots overlying intersections between 1 cm grid lines (Tennat, 1975).

Root length = $\frac{\pi}{4}$ × No. of intercepts × Grid unit

Root Volume

After the root length was measured, the volume of each sample was measured by using pycnometer (Sumanasena, 2003).

Root Mean Diameter (RMD)

RMD = 10 (4×Root Volume/ π×Root Length)^{½} (Sumanasena, 2003).

Root and Shoot Dry Weight

Each root and shoot samples were oven dried at 70 ^{0}C for 24 hr, and weight was taken separately.

Statistical Analysis

Data were analyzed by Analysis of variance with general linear model (GLM) procedure of SAS, followed by t test (LSD) and Duncan's multiple-range test (SAS, 1999).

RESULTS AND DISCUSSION

Survival Rate at the Time of Opening

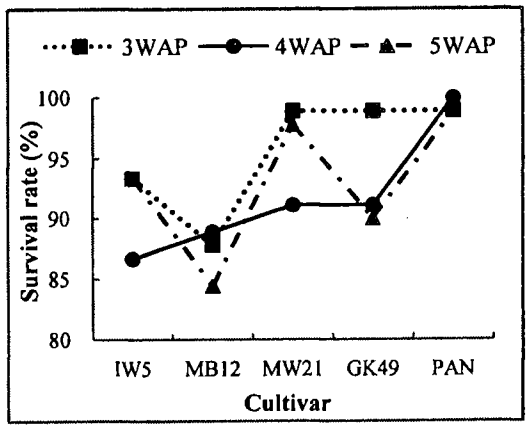

Figure 1. Mean survival rate and treatment combinations

Mean survival percentages of cultivars at the time of humid chambers opening are shown in Figure 1. The survival rates of more than 80% were observed for all cultivars. The

highest survival rate was observed in the humid chamber which was opened at 3 WAP irrespective of cultivar effect. Cultivar MB12 had the lowest survival rate (84 %) when opening at 5 WAP ($P<0.05$). Cultivar PAN was shown the highest survival rate (99 %) at all humid chamber opening times. Survival rate of GK49 at 3 WAP was significantly higher than that of each 4 WAP and 5 WAP humid chamber opening times (Figure. 1). Bavappa and Gurusinghe (1978) suggested that about 3 weeks after planting in humid chamber as appropriate for opening the humid chamber for pepper at Matale in IM_{3a}.

Shoot Length

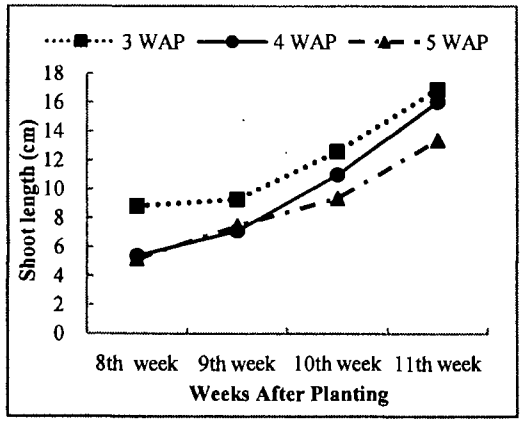

Figure 2. Mean shoot length and humid chambers opening time

Mean shoot length change with the time at three humid chambers are shown in Figure 2. The highest shoot length was observed in the humid chamber which was opened at 3 WAP at 8th week and the effect of WAP on shoot length of new shoots was disappeared towards 11th week.

Mean shoot length change with the time for different cultivars are shown Figure 3 and separate LSD ($P<0.05$) values are given for respective weeks. Effect of cultivar was significant for shoot length with time. In each and every week, the highest shoot length was observed in Panniyur-1 and the lowest shoot length was observed in IW5. In 8th, 9th and 10th weeks after planting, shoot lengths of local cultivars were significantly differ from Panniyur-1 ($P<0.05$). In 11th week after planting, shoot length of IW5 was significantly smaller than that of Panniyur-1. Other local selections were not significantly different from those two cultivars at eleven week after planting. According to literature cultivar Panniyur-1 has shown the highest morphological characteristic growth rate and yield than the other local selections (Anon, 2010b). When plants grow in humid chambers, water stress can be occurred. Water stress reduced the rate of leaf initiation, branching of the shoots and photosynthetic rate of the plant (Krizek and Dublk , 1987). Therefore, before seal the humid chambers and after opening of the humid chambers thoroughly watering is very vital factor for shoot growth.

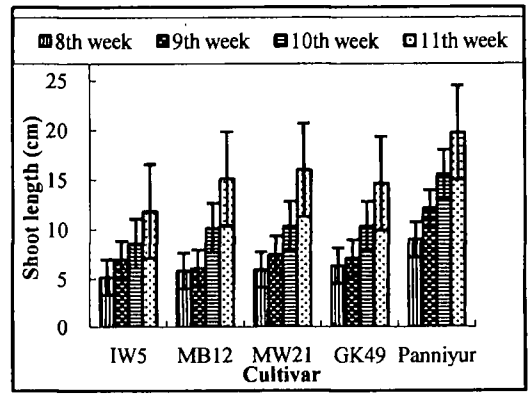

Figure 3. Mean shoot length and cultivars

Root Length

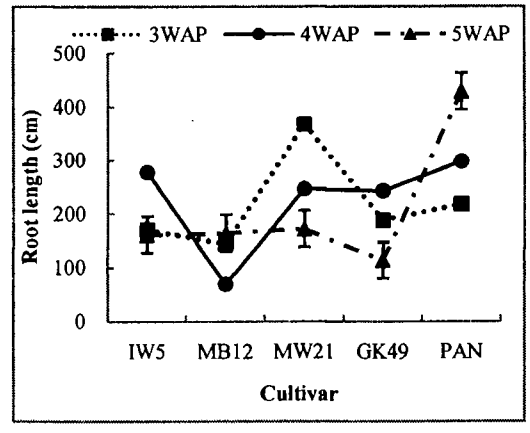

Figure 4. Mean root length and treatment combinations at eleven weeks after planting
Error bar indicates LSD at $P < 0.05$ = 68 cm

Mean root length of cultivars at eleven weeks after planting in three humid chambers are shown in Figure 4. There was no direct effect of humid chamber opening time (WAP) on root length. Nevertheless, highly significant effect can be seen for cultivar on root length ($P=0.0001$). Interaction effect of cultivars and humid chambers opening time were also significant on root length ($P=0.0001$). It is important to note that highest average root length was observed in PAN (314.7 cm) at 5 WAP and lowest average root length was observed in MB12 (126.21 cm) at 4 WAP and this is the reflection of slightly significant interaction effect of opening time and cultivar. As the ability of plants to absorb nutrients

depend on the root length. A high root length is an indication of Panniyur-1 for efficient resource utilization ability. Roots allow a plant to absorb nutrients from the soil, and hence a healthy root system is key to a healthy plant. Therefore root development is important for post nursery field establishment performances after transplanting in permanent field (Smit *et al.*, 2000) and this fact is applicable for black pepper of Sri lanka too.

Root Mean Diameter

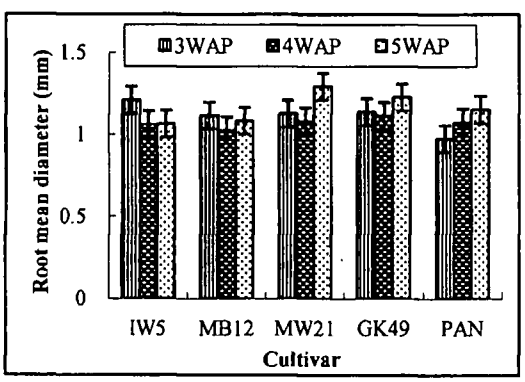

Figure 5. Root mean diameter and treatment combinations at eleven weeks after planting
Error bar indicates LSD at P < 0.05 = 0.164 mm

Root mean diameter of cultivars at eleven weeks after planting in three humid chambers are shown in Figure 5. The humid chamber opening time was effective on root mean diameter and the highest average root mean diameter was observed in humid chamber opening at 5 WAP (1.16493 mm). It is important note that root mean diameter of local cultivars of IW5 at 3 WAP was higher than that other opening dates. In contrast, cultivar MW21, GK49 and Panniyur-1 showed higher root mean diameter values at humid chamber opening of 5 WAP. Root mean diameter influences net ion arrival into the roots. Lower root mean diameter is an indication of more root branching with small diameter, hence resulting in more absorption area for water and nutrients. On the other hand litreature revealed that, large root mean diameter will promote interchanges and association of microbes with roots. Wide range of activities carried out by soil microbes such as stabilization of soil aggreates to nitrogen mineralization (Smit *et al.*, 2000).

Root Shoot Ratio

Root shoot ratio of cultivars at eleven weeks after planting in three humid chambers are shown in Figure 6. A highly significant effect can be seen at cultivar (P=0.0001) and humid chamber opening time (P=0.0005) on root shoot ratio. In cultivar IW5 at 4 and 5 WAP humid chamber openings show significantly high values of root shoot ratio (R:S>1). For cultivar MW21 at 5 WAP opening of humid chamber, root shoot ratio approached extremely close to equilibrium point and the R:S values at other two opening times for same cultivar was significantly lower (Figure. 5). Overall root shoot ratio was lower most for cultivar MB12 at all three humid chambers.

Root shoot ratio indicates changes in the adaptation of the plant to the environment in which it find itself. A high value of root shoot ratio indicates the movement of considerable amount of dry mater to below ground. Under conditions of low N supply, available resources were used to increase the size of the root. It results reduction of the shoot growth. An increase in the root shoot ratio would indicate that a plant was probably growing under less favorable conditions. Previous studies shown the concept of functional root-shoot equilibrium showed that, in situations of good supply of water and mineral nutrition. Any factor which improves growing conditions, such as favorable weather, fertilization, irrigation and aeration results in a reduced root shoot ratio (Smit *et al.*, 2000).

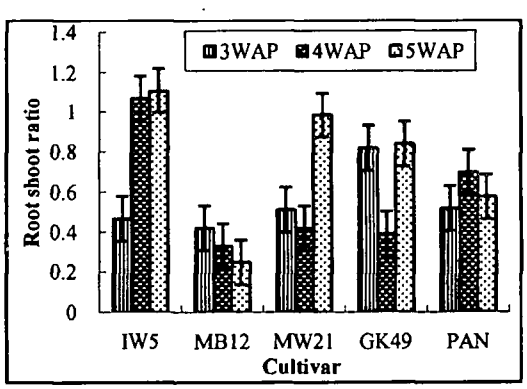

Figure 6. Root shoot ratio and treatment combinations at eleven weeks after planting
Error bar indicates LSD at P < 0.05 = 0.112

CONCLUSIONS

With reference to survival rates and some other growth performances at the time of opening humid chamber in this study, it indicates that humid chamber opening at 3 week after planting is acceptable for rooting of black pepper in low country intermediate zone (IL_{1a}) too.

Moreover, the Panniyur-1 (PAN) showed the great performance when considering the survival rate and growth parameters except root mean diameter. Root mean diameter and

root shoot ratio observation suggest that further studies are warranted for exploitation of beneficial values of local cultivars as well as effect of opening time of humid chamber for post nursery field establishment of black pepper.

ACKNOWLEDGEMENTS

Authors wish to express their gratitude to Dr. W.D.L. Gunarathne, Director, Department of Export Agriculture of Sri Lanka for giving permission for conducting the research. Also wish to acknowledge all staff and other members of Intercropping and Betel Research Station, Department of Export Agriculture, Naramala and Department of Plantation Management, Wayamba University of Sri Lanka.

REFERENCES

Anon. (2002). Technical bulleting of pepper cultivation, Department of Export Agriculture, Matale.

Anon. (2003). Revised map of Agro-ecological regions of Sri Lanka, Natural Resource Management Centre, Department of Agriculture.

Anon. (2010a). The Spice Council of Sri Lanka, Available online from www.srilankanspices.com/sl_spices_pepper.html. (Accessed 9 October 2012).

Anon. (2010b). Department of Export Agriculture, Available online at http:// www. exportagridept.gov.lk. (Accessed 20 October 2012).

Anon. (2011). Central Bank of Sri Lanka. Available from www.cbsl.gov.lk. (Accessed 17 October 2012).

Bavappa, K.V.A. and Gurusinghe, P.D.A. (1978). Rapid Multiplication of Black Pepper for Commercial Planting. Reprinted from the Journal of Plantation Crops **6** (2): 92-95.

Krizek, T. and Dubik, P. (1987). Influence of water stress and restricted root volume on growth and development of urban tress. Journal of Arboriculture, 13 (2), 47-55.

Nasli, A.M., Sumanasena, H.A. and Fernandopulle, M.N.D.C. (2007). Use of Partially Burnt Paddy Husk as a Component of Rooting Media for Cocoa (*Theobroma cacao L.*) Cuttings. In Proceedings of the 7th Agricultural Research Symposium, Makandura, Wayamba University of Sri Lanka, 106-110.

Priyadarshani, K.D.N., Subasinghe, H.M.P.A. and Sangakkara, U.R. (2012). Impact of Environmental Factors on Rooting of Different Types of Black Pepper (*Pipper nigrum L.*) cuttings. In proceedings of the Symposium on Minor Export Crops.16-17 August, 2012, Peradeniya, Sri Lanka, 60-64.

Sanjeewani, H.C., Rathnasoma, H.A., Gunathilaka, H.A.W.S. and Amarakoon, A.M.E.S. (2011). Root Promotion of Plagiotropic Branches of Betel (*Piper betle L.*) with Rooting Hormones and Different Types of Potting Mixtures. In Proceedings of the 11th Agricultural Research Symposium, Makandura, Wayamba University of Sri Lanka, 381-385.

Smit, A.L., Bengough, A.G., Engels, C., Van Noordwijik, M.V., Pellerin, S. and Van Geijn, S.C. (2000). Hand book root methods, Germany, SPIN Press.

Sumanasena, H. A. (2003). A Study of the Combined Effects of Irrigation Frequency and Phosphorous Fertility on Summer Pasture Production. Massey University, New Zealand, 214pp.

Tennant, D. (1975). Test of modified line intersect method of estimating root length, The Journal of Ecology. 63, 995.