Natural Rubber Research, **25**(1): 68-76, 2012

POLYHOUSE TECHNOLOGY FOR PRODUCTION OF HEALTHY PLANTING MATERIALS OF RUBBER

V.C. Mercykutty, Kavitha K. Mydin, Shammi Raj, C. Bindu Roy and P.M. Priyadarshan*

Rubber Research Institute of India, Kottayam - 686 009, Kerala, India

*Central Experiment Station, Rubber Board, Chethackal, Ranni-689 676, Kerala, India

Received : 21 March 2011 Accepted : 13 July 2011

Mercykutty, V.C., Mydin, K.K., Raj, S., Roy, C.B. and Priyadarshan, P.M. (2012). Polyhouse technology for production of healthy planting materials of rubber. *Natural Rubber Research*, **25**(1): 68-76.

Two polybag nursery experiments were conducted at the Central Experiment Station of the Rubber Research Institute of India, Chethackal to compare sprouting and growth of green and brown-budded stumps of rubber *(Hevea brasiliensis)* planted in polybags kept in polyhouse and outdoors. Budded stumps generated from both green and brown budding techniques recorded early emergence of buds and better and uniform growth of scion in polyhouse conditions. Plants raised in polyhouse were better in terms of height of scion, diameter of stem, number of whorls, number of lateral roots and total biomass content. The study showed that the quality of plants improved when grown inside a polyhouse.

Growing plants in polyhouse enabled to overcome intra-clonal variability in growth of bud-grafted plants to certain extent. It protected the grafts from diseases, reduced mortality due to adverse weather conditions and ensured production of healthy plants. The environmental conditions in the polyhouse had no adverse effect on further growth and development in the field and thereby ensuring rapid production of healthy planting materials in large-scale cultivation. In addition to saving manpower, this modern technology is an eco- friendly approach by limiting the use of fungicides inside the polyhouse condition.

Keywords: Budgrafted plants, *Hevea*, Polyhouse, Polyvinyl sheets

INTRODUCTION

Bud-grafted plants in the rubber nursery need extreme care during the early stages of their development. During adverse climatic conditions like heavy rainfall and high/low temperature, nursery plants are affected by diseases and pests resulting in low and delayed bud break followed by uneven growth of scion that leads to shortage of planting materials in rubber nurseries.

It is worthwhile to examine the growth and development of bud-grafted plants under controlled conditions, especially in polyhouse, that can be reused year after year. A polyhouse is a framed structure of UV-stabilized rigid transparent polythene sheets (200 micron thickness) covered from all sides in which plants can be grown under sufficiently controlled environmental conditions. The sheet is inserted 8-10 cm under soil for proper sealing of the polyhouse. The structure is supported with vertical iron rods and the use of HDPE pipes helps to form a semi-circular design. The covering of nursery areas with polyvinyl

Correspondence: V.C. Mercykutty (Email: mercykuttyvc@rubberboard.org.in)

sheets overhead protects young plants from pest and disease attacks to a great extent and provides protection from heavy rain, drought and cold weather, ensuring the production of healthy plants. Hence, polyhouse technique is widely adopted to grow seasonal and off- seasonal vegetables like tomato, brinjal, cucumber, *etc*. For production of any agriculture crop in adverse climatic condition and to get monetary benefit throughout the year, conducive natural conditions like micro-climate, soil type, air and water can be maintained in polyhouse. Adverse problems including pathogen can be overcome with adoption of polyhouse technique (Maikhuri *et al*., 2007). Kavitha *et al.* (2003) reported 96% increase in shoot length and 27% increase in yield of tomato inside the polyhouse as compared to control. Firake *et al*. (1990) studied the effects of plastic tunnel and mulches and reported 48% increased yield of tomato over the control.

Very few attempts have so far been made to systematically study the benefits of growing rubber plants in a polyhouse. A report from India that gave indications an increase of CO_2 concentrations, RH and temperature inside polyhouse led to a significant increase in total leaf area and dry matter per plant (Devakumar, 1996). Krishna Das *et al.* (2009) and Datta *et al.* (2010) reported that sprouting percentage of budded stumps inside the polyhouse was significantly high compared to open field conditions during winter season in the North East region of India. The present study was undertaken to explore the potential of polyhouse technology for production of uniform and healthy planting materials in rubber.

MATERIALS AND METHODS

Two polybag nursery experiments were conducted at the Central Experimental Station of the Rubber Research Institute of India, Chethackal, Central Kerala, India.

Experiment No. I: Green budding was carried out during January by bud-grafting scale buds collected from 6-8 week old scion shoots on vigorously growing 5-6 month old root-stock plants. Budded stumps were prepared following the standard method and planted in polybags placed inside the polyhouse during February.

Experiment No. II: Root-stock of almost uniform girth of about 7.5 cm at the root collar region was selected and was grafted with brown-coloured leaf buds during June. Budded stumps were prepared and planted in polybag nursery established inside the polyhouse in October.

For both the nursery experiments, polybags with 55 x 25 cm lay flat dimensions which could hold about 11 kg of soil were used. One hundred budded stumps each of brown and green-budded plants were planted in Completely Randomized Design. Control plants (100 each) for both the experiments were pulled out from the ground nursery, stumped and planted in the polybag nursery established outside the polyhouse. Plants inside the polyhouse were maintained by irrigating alternate daily using a cup, whereas plants in outdoor conditions were irrigated daily using a hose. Plants grown in the outdoor condition were maintained by giving all agromanagement practices recommended for the same (Marattukalam *et al*., 1980; Potty, 1980). In addition to this, outdoor plants were protected, maintaining optimum soil moisture and providing 50% shade with agro-shade net that saved the plants from extreme summer temperatures. Effective disease control measures were carried out in the outdoor plants by repeated spraying with the recommended dose of fungicides, *viz*. Bordeaux mixture 1%, mancozeb 0.2% or carbendazim 0.02% was undertaken.

Observations on bud break were made over two months. Growth parameters such as height of scion, diameter of the scion at a height of 5 cm above the bud union, number of whorls, number of lateral roots and biomass content were recorded at monthly intervals for seven months. Number of lateral roots and biomass were recorded from randomly selected five plants per treatment. Evaluation of polyhouse- grown plants for the incidence of nursery diseases namely *Colletotrichum* leaf disease, powdery mildew disease and Bird's eye spot disease was carried out and compared with plants grown outdoors.

Impact of environmental conditions on further growth and development in the field was also studied. Twelve uniform brown-budded polybag plants of 2-3 whorls from polyhouse and outdoor were planted at a spacing of 1 x 1m in a clonal nursery at the Central Experiment Station during the planting season of 2010 and were maintained with standard cultural operations. Height of plants, diameter of scion and number of whorls were recorded six months after planting in the field. Analysis using 't' test was carried out to compare the plants grown inside and outside the polyhouse.

Meteorological data such as daily maximum and minimum temperature, sunshine hours and relative humidity (twice daily) were collected inside the polyhouse during the October-November period.

RESULTS AND DISCUSSIONS

The time taken for the emergence of bud for the two types of budded plants grown inside the polyhouse was significantly better in both the experiments. Buds from stumps grown inside the polyhouse emerged faster than that of the outdoor (Fig. 1). Weekly

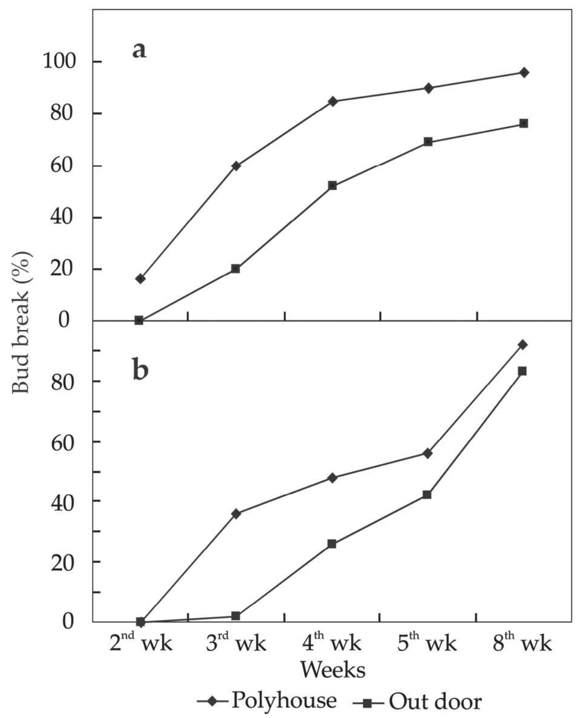

Fig. 1. Emergence of buds (%) in (a) brown budded and (b) green budded plants

observation on bud emergence showed that maximum difference in bud break compared to control was 40% for green-budded stumps and 34% for brown- budded stumps during the fourth and third weeks respectively after planting in the polybags. After a period of two months total bud emergence was 96 and 92% inside the polyhouse as against 76 and 83% in the outdoor in green-and brown-

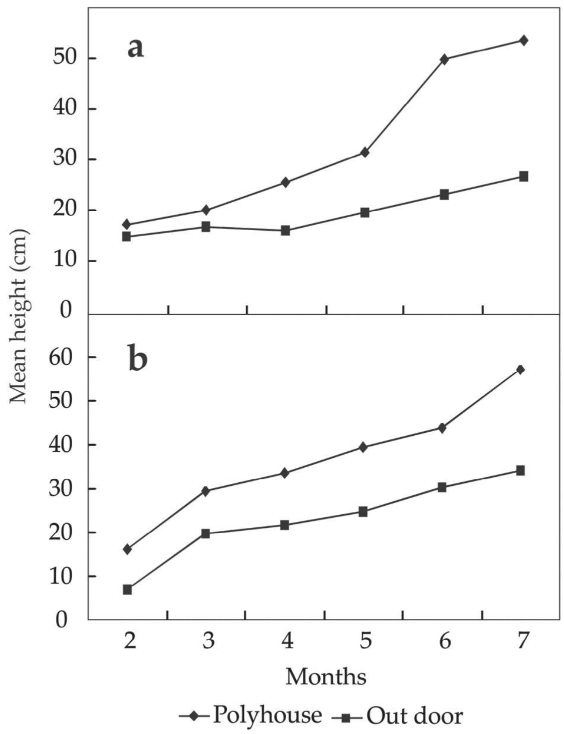

Fig. 2. Mean height of scion at different stages of growth in (a) brown budded and (b) green budded plants

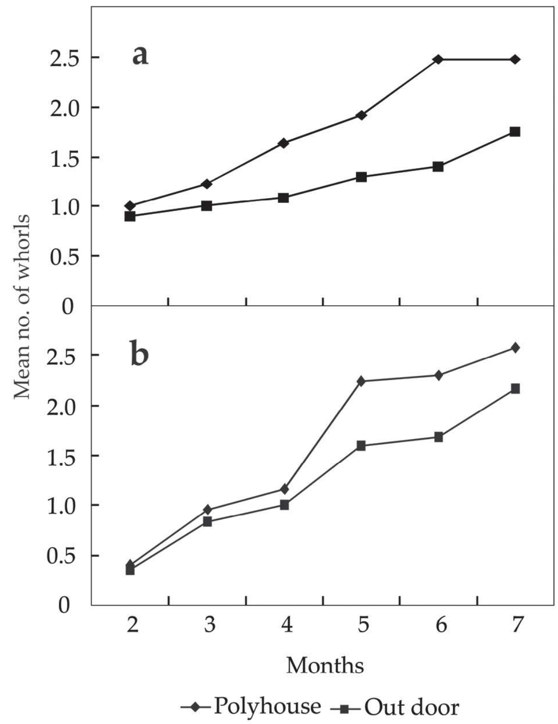

Fig. 4. Mean stem diameter at different stage of growth in (a) brown budded and (b) green budded plants

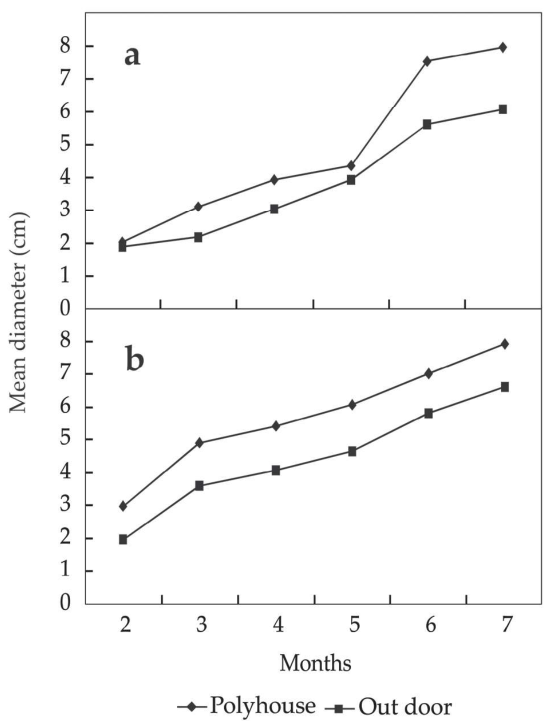

Fig. 3. Mean stem diameter at different stages of growth in (a) brown budded and (b) green budded plants

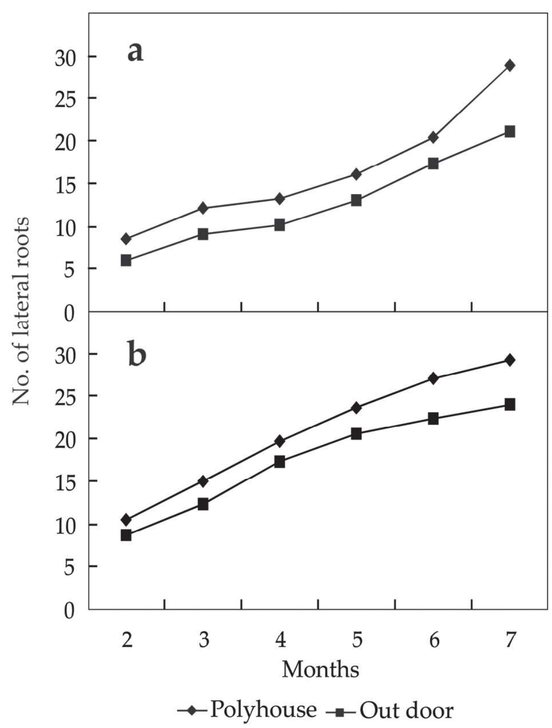

Fig. 5. Mean number of whorls at different stages of growth in (a) brown budded and (b) green budded plants

budded plants respectively. This showed that micro-environment inside the polyhouse facilitated uniform and better sprouting of stumps.

Plants grown inside the polyhouse, in general, performed better in growth than those in the outdoors throughout the period. The scion height (a measure of growth), indicated faster growth under the polyhouse condition than under outdoor conditions. Scion height of green-budded plants inside the polyhouse was two times more than the control plants. Similarly, brown-budded plants recorded an increase in scion height of 68% over the control after seven months (Fig. 2). An increase of 21% and 7.5% in stem diameter was recorded by green and brown-budded plants, respectively compared to the control plants (Fig. 3). Similarly, the percentage increase in the number of leaf whorls was about 35% and 19%, respectively (Fig. 4).

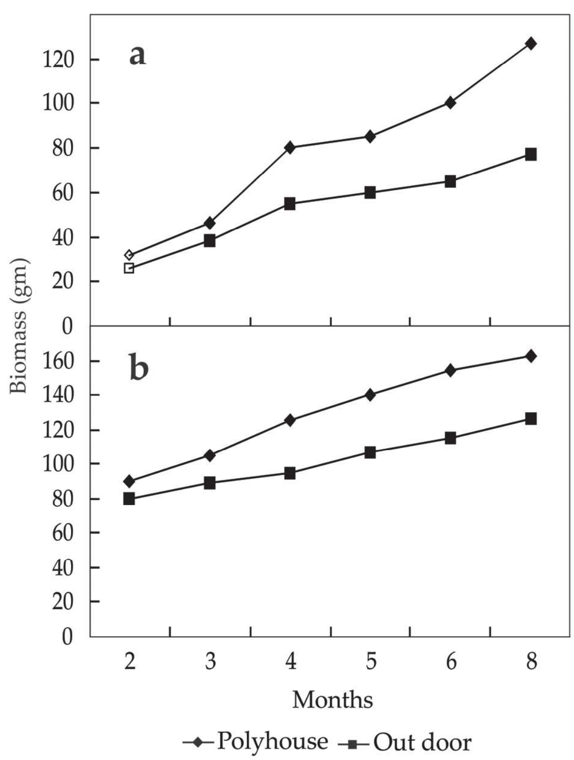

Fig. 6. Number of lateral roots at different stages of growth in (a) brown budded and (b) green budded plants

Other growth parameters such as number of lateral roots and total biomass of the plants were found to be significantly more in plants grown inside the polyhouse. Number of lateral roots, an indicator of healthy plants, inside the polyhouse showed 37% and 21% improvement over outdoor plants in green and brown-budded plants, respectively (Fig. 5). A magnitude of 67% increase in biomass was obtained, in green-budded plants inside the polyhouse than the control, whereas in case of brown-budded plants, 28% of increase in biomass was noted inside the polyhouse (Fig. 6). Thus the plants grown inside the polyhouse were healthier than those grown in outdoor conditions. Better growth of plants raised in polyhouse conditions compared to outdoor might be attributed to better sprouting, plant height, number of leaves and roots as also noted in crops like tomato and brinjal (Firake *et al.*, 2003; Kavitha *et al.*, 2003). Polyhouse technology is used for enhancing the production of quality vegetables, flowers, ornamental plants, *etc.* as it provides protection to crops from severe effect of frost and cold as well as diseases. Growth rate of plants grown in polyhouse in terms of height of plants, diameter of scion and numbers of whorls were statistically on par with the conventional types in the field conditions. Moreover, plants grown inside the polyhouse have a soil core well bounded with active roots, which is less disturbed on planting.

In general, polyhouse is more advantageous in enhancing growth of young rubber plants. Polythene sheet prevents the entry of UV rays and conserve greenhouse

Table 1. **Comparison of seven months growth in polyhouse and outdoor**

Particulars	Types	Experiment No. 1			Experiment No. II		
		Mean	CV	SE	Mean	CV	SE
Height of scion (cm)	Polyhouse	53.1 **	23.13	3.55	57.20 **	17.48	3.16
	Outdoor	26.75	36.13	2.77	34.10	36.10	3.61
Diameter of scion(mm)	Polyhouse	7.45	22.38	0.48	8.04	25.77	0.60
	Outdoor	6.16	38.16	0.68	7.48	30.28	0.66
No. of whorls/plant	Polyhouse	2.47 *	26.56	0.19	2.58	19.93	0.15
	Outdoor	1.83	39.15	0.21	2.17	33.13	0.22
No. of lateral roots/plant	Polyhouse	29.04 **	15.02	1.24	29.70 **	8.41	0.79
	Outdoor	21.17	27.70	1.69	23.41	13.44	0.98
Total biomass (g plant)	Polyhouse	126.38 **	24.39	8.91	162.08 *	22.80	10.67
	Outdoor	75.83	31.05	6.80	126.67	28.48	10.41

* Significant at P= 0.05
** Significant at P= 0.1

gases which enhances the efficiency of plant growth and development (Maikhuri *et al.*, 2007and 2010). Generally, the temperature and moisture inside the polyhouse are higher than outside environment which enhance the rate of photosynthesis and help in better and uniform growth of plants (Palni, 1996; Palni and Rawat, 2000). A polyhouse system protects plants from sudden change in weather and regulates the environment inside. This helps the plants to grow without any external obstruction. The tight enclosure of the polyhouse prevents inoculum build up for various diseases incidence in nursery plants.

It has been noted that performance of green-budded plants was better in terms of sprouting and growth attributes compared to brown budded plants inside the polyhouse. Tender and young green-budded stumps when raised in polybags often showed higher percentage of casualty due to poor sprouting, die-back of scion and incidence of diseases than hardy brown-budded stumps (Marattukalam and Varghese, 2000; Mercykutty and Gireesh, 2010). Stable and controlled environmental conditions inside the polyhouse help better sprouting and growth of green-budded plants. The improved technique resolves the main problems associated with the establishment of green budgrafts due to small stock with little starch reserve where severe die-back of sprouted shoots is encountered.

Leaf diseases caused by *Colletotrichum* spp., *Drechslera heveae* and *Oidium heveae* can be prevented due to better environmental conditions within the polyhouse ensuring uniformity in scion growth in polyhouse-grown plants as compared to those grown outdoors. Colletotrichum leaf disease caused by *C. gloeosporioides* and *C. acutatum* was absent in polybag plants inside the polyhouse, whereas the disease severity was high (50-60%) in polybag plants maintained outside the polyhouse. Bird's eye spot disease caused by *D. heveae*, damaging young rubber plants in the field and in nursery was also not observed in polyhouse-

Table 2. **Micro-climatic conditions inside the polyhouse and outdoor**

	Polyhouse					Outdoor				
Particular	Tmax.	Tmin.	RH1	RH2	Av. RH	Tmax.	Tmin.	RH1	RH2	Av. RH
Mean	36.6	22.9	90.0	68.0	79.0	31.1	22.0	90.6	67.3	78.9
S D	2.5	0.8	4.7	10.1	7.4	1.6	0.3	2.0	3.2	2.4

grown plants but was noticed in plants maintained outdoors (25-30%). Mild incidence (10-15%) of powdery mildew disease caused by *O. hevea* was observed on immature leaves of polybag grown plants maintained outside the polyhouse, whereas those plants maintained within the polyhouse escaped from the infection. This disease appeared as small necrotic spots with dark brown margins and pale centre on lamina.

Low magnitude of variability in various growth characters as judged from relatively lower coefficient of variation of plants grown inside the polyhouse than to outdoor plants (Table 2) indicated better uniformity in growth of plants under polyhouse conditions than to outdoor. Growth of scion shoot is better and uniform when sprouting started earlier and higher percentage of sprouting and uniformity in growth are equally important to the planter. Even though recommended agromanagement practices were adapted in plants grown in outdoor, they showed pronounced weaker growth followed by high mortality as the plants were exposed to heavy rain, excess solar radiation and high temperature. Lower incidence of disease under polyhouse condition helped the plants to have better establishment. The protected environment inside the polyhouse provided the scope for production of improved budded stumps profitably. The improved nursery practice under polyhouse condition is also important under present situation of climate change, rising labour costs and labour shortage.

The study found that polybag plants grown in the polyhouse showed no remarkable incidences of diseases during the study. Hence, total recovery and usage of polybag plants are significantly more in polyhouse than in outdoor conditions. Under this technology, less quantity of water is required for irrigation. Growing plants in polyhouse is eco-friendly as fungicide use is less.

Budded stumps of rubber need adequate light and temperature for sprouting and for better and uniform growth (Table 2). It was observed that inside the polyhouse the tight enclosure leads to longer duration of days with higher temperature compared to ambient temperature in the outdoor conditions. Drastic differences in humidity levels were not observed which indicates that inside the polyhouse, high humidity could not be maintained for a longer time. During the October-November period the outdoor polybags were exposed to a total of only 16 days sunshine with greater than 5.6 hours, considered optimum for rubber (Rao *et al*., 1998). Inside the polyhouse, plants were safer than outside as it cut 75% of ultraviolet (UV) and 50% of visible light. In the case of Brazil wood (Hendrickson *et al*., 2004) it was already seen that under greenhouse conditions when other limiting growth conditions are absent, increase of temperature in a tropical environment can contribute to higher plant productivity. This effect is enhanced when latitudinal temperature of the species is approached (Hendrickson *et al.*, 2004). Polyhouse prevents the entry of UV rays and maintains high temperature providing better conditions for plant growth and development.

A polyhouse can protect the crop from ill effects of environments and increase availability of good quality planting materials. Hence, for successful propagation of rubber, a propagation structure like polyhouse is very important. Due to higher cost involved in construction of iron supported shade in the first year, the net return may be negative. However, from the 2nd or 3rd year onwards the net monetary return goes higher. Low cost polytunnels and polytents made of wood and bamboo also offer good scope for clonal propagation of tree species like rubber.

ACKNOWLEDGEMENT

The statistical analysis done by Mr. P. Aneesh is gratefully acknowledged. Technical advice given by Dr. K. Annamalainathan is also acknowledged.

REFERENCES

Das, K. Ray, D. and Dey, S.K. (2009). Enhancement of bud sprouting and growth of grafted rubber (*Hevea brasiliensis*) plants utilizing a Polyhouse during winter in Tripura. *Natural Rubber Research*, **22**(1&2): 163-167.

Datta, B., Thapliyal, A.P., Ravichandran, S., Singh, M. and Nair, N.U. (2010). Good agricultural practices for non traditional natural rubber growing areas experiencing extreme agroclimatic conditions. *International Workshop on Climate Change and Rubber Cultivation: R&D Priorities.* 28-30 July 2010, Kottayam, Kerala, India.

Devakumar, A.S., Jacob, J., and Sethuraj, M.R. (1996). A novel approach to obtain increased growth in the nursery seedlings of *Hevea brasiliensis* using CO_2 fertilization. *Symposium in Agronomy Aspects of the Cultivation of Natural Rubber* (*Hevea brasiliensis*), 5-6 November, Beruwela, Sri Lanka.

Firake, N.N., Bangal, G.B., Kenghe, R.N. and More, G.M. (2003). Plastic tunnel and mulches for water conservation. *Agricultural Engineering Today*, **14**: 35.

Hendrickson, L., Ball, M.C., Wood. J. T., Chow, W. S. and Furbank, R. T. (2004). Low temperature effects on photosynthesis and growth of grapewine. *Plant Cell Environment*, **27**: 795-809.

Kavitha, R., Vijayaraghavan, N.C. and Tajuddin, A. (2003). Response of vegetable crops in a solar aided polyhouse ecosystem. *JE (1) Journal* – AG **84**:52-55.

Maikhuri, R.K., Rawat, L.S., Vikram, S. N. and Purohit, V.K. (2007). Eco-friendly appropriate technologies for sustainable development of rural ecosystems in Central Himalaya. *G.B. Pant Institute of Himalayan Environment and Development*, p. 45.

Maikhuri, R.K., Rawat, L.S., Vikram, S. N., Abhay B., Sunil K. A., Faroouquee, N.A, Prakash, P. and Negi, C. S. (2010). Demonstration and dissemination of simple eco-friendly technologies for natural resource management in Central Himalaya. *Indian Journal of Science and Technology*, **3**(7): 822-830.

Marattukalam, J.G., Saraswathyamma, C.K. and Premakumari, D. (1980). Methods of propagation and materials for planting. *In: Handbook of Natural Rubber Production in India* (Ed.) P.N. Radhakrishna Pillai, RRII, pp. 63-81.

Marattukalam, J.G. and Varghese, Y.A. (2000). Bench grafting with green buds in *Hevea brasiliensis*. *Recent Advances in Plantation Crops Research*, pp. 65-68.

Mercykutty, V.C. and Gireesh, T. (2010). Methods to improve establishment success and growth of green budded stumps in polybags *Abstract 19th Biennial Symposium on Plantation Crops*. 7-10 December, 2010 Rubber Research Institute of India, Kottayam, p.52.

Palni L.M.S. (1996). Simple and environment friendly techniques for the well being of the Himalayan and its inhabitants. In: *Man, Culture and Society in the Kumaun Himalaya.* (Ed. C.M. Agarwal), Shree Almora Book Depot, Almora, pp. 270-290.

Palni, L.M.S. and Rawat, D.S. (2000). Simple technologies for capacity building and economic upliftment of women in mountains. *Indian Science Congress*, 3-7 January, 2000 Pune.

Potty, S.N. (1980). Nursery establishment and field planting. In: *Handbook of Natural Rubber Production in India* (Ed.) P.N. Radhakrishna Pillai, RRII, pp. 113-130.

Rao, P.S., Saraswathyamma, C.K. and Sethuraj, M.R. (1998). Studies on the relationship between yield and meteorological parameters of para rubber tree *(Hevea brasiliensis)*. *Agricultural and Forest Meteorology,* **90**: 235-245.

RRIM. (1964). Some notes on green budding. *Planters' Bulletin*, pp. 49-53.