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Assessment of microenvironment under hardening shed on mango and cashew grafts

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Abstract
Crop grown in open condition gets affected from various pests and diseases. Nets are commonly used to protect agricultural crops from excessive solar radiations, extreme temperature and pests. Hardening shed creates an appropriate micro climate conducive to plant growth. It was found that outside hardening shed the temperature was 1.9 °C more than inside temperature. The height, diameter of stem and number of leaves of mango and cashew seedlings were found to be higher in the hardening shed as compare to outside the shed. The effect of green shade net cladding over hardening shed posses positive impact on growth of mango and cashew seedlings.

Keywords: Microenvironment, hardening, mango, cashew, radiations

Introduction
Nursery is a managed site, designed to produce seedlings grown under favorable conditions until they are ready for planting. All nurseries primarily aim to produce sufficient quantities of high quality seedlings to satisfy the needs of uses. At present 30-40% demand for planting material is being met by the existing infrastructure. Nurseries may supply plants for gardens, agriculture, forestry and conservation biology.

Crop grown in open condition gets affected from various pests and diseases. Nets are commonly used to protect agricultural crops from excessive solar radiations, extreme temperature and pests. In the recent period, nets are used for reducing thermal load, improving micro-environment and providing physical protection, colour nets represent new agro-technological concept, which aims combining physical protection with different filtration of solar radiation, promoting desired physiological response. Plants rose indoors or in a greenhouse need to be acclimatised to cooler temperatures, lower humidity and increased air movement for about two to three weeks before they are planted outdoors. This ‘toughening up’ process is known as hardening off.

Hardiness of plants describes their ability to survive adverse growing conditions. It is usually limited to discussions of climatic adversity. Thus a plant's ability to tolerate cold, heat, drought, flooding, or wind are typically considered measurements of hardiness. Hardiness of plants is defined by their native extent's geographic location: longitude, latitude and elevation. These attributes are often simplified to a hardiness zone. In temperate latitudes, the term most often describes resistance to cold, or "cold-hardiness", and is generally measured by the lowest temperature a plant can withstand. Plants vary greatly in their tolerance of growing conditions, and are capable of adaptation to changes in climate on their own to some extent. The selective breeding of varieties capable of withstanding particular climates forms an important part of agriculture and horticulture. Part of the work of nursery growers of plants consists of cold hardening, or hardening off their plants, to prepare them for likely conditions in later life.

Hardening Shed is used to harden off the plants. Hardening off is a simple process of gradually exposing tender plants to sunlight, wind and uneven temperature. When plants are almost ready for the garden, take them outside for short amounts of time each day. On chilly nights, move plants into a shed, garage or back indoors. Hardening is the process of exposing transplants (seedlings) gradually to outdoor conditions. It enables your transplants to withstand the changes in environmental conditions they will face when planted outside in the garden. Seedlings vary in their susceptibility to injury from frost. Damage can be catastrophic if "unhardened" seedlings are exposed to frost. Frost hardiness may be defined as the minimum temperature at which a certain percentage of a random seedling population will survive or will sustain a given level of damage.

The acquisition by plants of resistance to unfavorable conditions, such as frost, cold, drought or salinization. The effects of hardening are caused by changes in metabolism. Plant resistance to frost develops in the fall when plants have ceased to grow owing to the short days and become dormant and also in winter when frosts are mild or moderate. That is why trees that can withstand frosts as low as −60 °C (larch, spruce, pine) may die in summer at temperatures of −7° to −8 °C. The first phase of hardening takes place at a temperature of about 0 °C during exposure to light, when plants accumulate carbohydrates because of a decrease in the rate of respiration. The second phase takes place during mild or moderate frosts and is accompanied by the loss of water in the cells owing to the formation of ice. At this time the protoplast becomes isolated and lipid-protein layers form on its surface. The plasmodesmata are drawn into the cells, and the living cellular contents become insensitive to the pressure of ice in the interstices.

Hardening off allows plants to adapt from being in a protected, stable environment to changeable, harsher outdoor conditions. If suddenly placed outside, the shock can severely check a plant's growth. Although plants usually recover eventually, hardening off is thought to be preferable to a sudden shock. The effect of hardening off is to thicken and alter the plant's leaf structure and increase leaf waxiness. It ensures new growth is sturdy although growth will be much slower than in the greenhouse. But be warned: hardening off does not make frost-sensitive plants hardy.

Hardening Shed creates an appropriate micro climate conducive to plant growth. It is used for hardening tissue culture plantlets. The shade structure should be planned taking into consideration the type of crop to be grown, locally available materials and local climatic conditions. Hardening off describes slowly exposing newly grown vegetables, fruits, and flowers to the elements-changing temperatures, varying levels of sunlight, wind-to enable healthy growth. While hardening off doesn't take a lot of time, it does involve some vigilance. Hardening is physiological process. Plants accumulate more carbohydrates reserves and produce additional cuticle on the leaves.

Typically hardening off takes two to three weeks, but the warmer the initial growing conditions, the longer the hardening off period. Hardy plants acclimatize faster than half-hardy or tender kinds. The work was carried out to assess microenvironment and seedling growth of Mango and Cashew seedlings under hardening shed.

Progressive farmers are adopting commercial protected cultivation of high valued vegetables and flowers and adopting commercial protected cultivation of high value vegetables and flowers (Maitra *et al*. 2020) [3]. The shading effect on crops resulted in various changes on both crop microenvironment and crop growth. The use of shade net for protecting various horticultural crops against various abiotic factors like scorching insolation, excess of wind speed, bird and rodent damage along with improvement in the micro environment and insect-transmitted virus diseases (Kittas *et al*. 2009) [2]. The difference in reduction of light intensity is obvious in shade net structures over normal field condition and the ability to modify various spectral properties which changes quality of the light has serious impacts on plant growth and development. The spectral manipulation is aimed at promoting photo orpho-genetic-physiological responses. The colored shade net approach was researched in various fruit trees, ornamentals (Nissim-Levi *et al*. 2008) [4], vegetables (Fallik *et al*. 2010) [1], and vineyards. Color-shade nets improved productivity by moderating climatic extremes compared with black shade nets of the same shading factor, the Red and Yellow shade nets were found to particularly stimulate the rate of vegetative growth and vigor, the Blue net resulted in severe dwarfing, and the Grey net specifically improved the branching and bushy character, and also reduced leaf size. (Oren-Shamir *et al*. 2001) [5]. Shahak *et al*. (2004) [6] found that coloured Shade nets not only exhibit special optical properties that allow the control of light, but also have the advantage of influencing the microclimate to which the plant is exposed and offer physical protection against excessive radiation, insect pests and environmental changes.

Material and Methods

The study was conducted at Nursery in Khed, Ratnagiri to assess microenvironment and seedling growth of Mango and Cashew seedlings**.** The dimension of Hardening Shed (Fig. 1) was 30 m x 15 m. The hardening shed structure was planned as per the type of crop to be grown, locally available construction materials and local climatic conditions. The hardening shed structure composed of two basic components that is frame and cladding material.

The percentage reflectance as well as value of different spectral indices such as normalized difference vegetation index and ratio vegetation index was found to be more in green followed by red, black, white and control. Hence, green shade net was used over frame. The total area of hardening shed is 30mx15m. Plinth of foundation was 1 m high and made up of laterite stone.

Fig 1: Grafts arrangement inside the shed

The environmental data collected was temperature and relative Humidity inside and outside hardening shed. These parameters were measured by wet bulb and dry bulb hygrometer and by the use of psychometric chart. The 15 sample grafts were selected inside the hardening shed and 15 grafts outside the hardening shed. All the grafts were prepared on the same day. The growth of grafts *viz.* seedling height, stem diameter and number of leaves were observed weekly for hardening period of three months. The vernier caliper was used for measurement.

Results and Discussion

Table 1 showed the temperature measured inside the hardening shed as well as outside the shed. It was observed that on an average 2 °C temperature difference was due green shade net over hardening shed.

Table 1: Temperature observations (°C)

S. N.	Inside the shed	Outside the shed	Difference
1	36	37	1
2	31	33	2
3	35	36	1
4	36	38	2
5	36	38	2
6	34	36	2
7	30	33	3
8	32	34	2
9	31	33	2
10	30	32	2
		Average	1.9

Table 2: Observations of growth parameters of mango and cashew grafts inside and outside the hardening shed

So. No.	Height of mango grafts		Diameter of mango grafts		Number of leaves of mango grafts		Height of cashew grafts		Diameter of cashew grafts		Number of leaves of cashew grafts	
	Inside	Outside	Inside	Outside	Inside	Outside	Inside	Outside	Inside	Outside	Inside	Outside
1	36	28.66	0.85	0.48	14	8.66	30	27.88	0.80	0.79	14.88	11.87
2	31.77	34.22	0.51	0.64	7	11.66	23.44	32.33	0.82	0.54	15.33	10.88
3	36	34.55	0.61	0.65	9	9.33	36.77	35.88	0.91	0.71	12.77	8.55
4	55.33	37.77	0.70	1.06	13.77	11.44	23.77	36.22	0.86	0.92	13	10
5	47.22	46.33	0.61	0.50	10.77	11.55	21.66	48	0.95	0.94	13.77	13
6	47.11	48.11	1.00	0.95	19.11	10.55	35.33	46.77	0.77	0.90	9.888	12.44
7	32.88	42.22	0.66	0.88	8.88	14.33	25.44	19.88	0.91	0.99	14.66	13.11
8	40.77	53.55	0.81	0.70	11	19.11	23.66	34.33	1.00	0.85	12.77	10.44
9	61.66	39.77	0.99	0.63	17.88	10.33	27.11	27.55	0.95	0.62	10.77	9.77
10	41.88	41.88	0.81	0.79	18	11.11	27	33.88	0.86	0.93	11.66	12.55
11	44.89	33	1.06	1.32	18.44	6.88	29	21.55	0.72	0.84	9.33	9.88
12	61.88	55.33	1.10	0.59	20	13.44	27.66	31.77	1.07	0.90	12.22	11.88
13	61.77	54.88	0.98	1.26	13.44	12.66	29.66	17.88	0.85	0.93	10.44	12.55
14	29.77	46.11	1.02	0.79	13.77	14.33	27.77	23.77	0.94	1.15	11.33	11.11
15	49.88	37.11	0.94	0.62	10.88	7.33	37.66	23.11	1.16	0.94	13.88	11.77
SD	10.53	8.33	0.38	0.26	2.97	2.40	5.88	7.77	0.13	0.12	1.52	1.36

Height comparison

Inside the hardening shed, the temperature was less than outside the shed. Table 1, Fig. 2 and Fig. 3 showed height comparison of mango seedlings and cashew seedlings. The increase in height of seedlings kept outside the shed was less than the seedlings kept inside the hardening shed. The average increase in height of mango grafts is 2 cm. The average of increase in height of Cashew grafts is 3 cm inside the shed. Thus, the increase of cashew grafts outside the shed is minimum than the increase of cashew grafts inside the shed. As a result of the total observations, the height of cashew grafts inside the shed is maximum than the height of cashew grafts outside the shed.

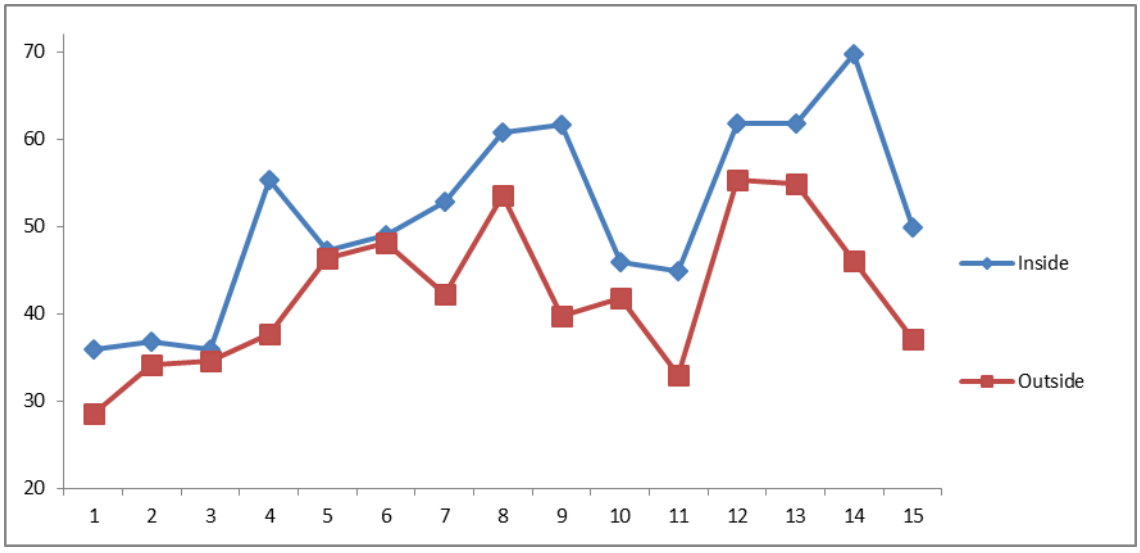

Fig 2: Height of mango grafts, cm

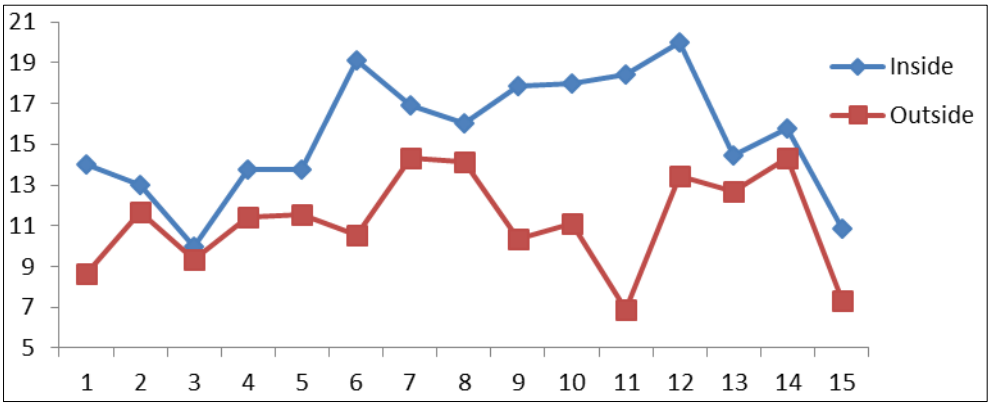

Fig 3: Height of cashew grafts, cm

Diameter Comparison

Table 1, Fig. 4 and Fig. 5 showed the average diameter comparison of mango grafts inside the shed during nine week hardening period. The diameters were taken average of 3 readings i.e. bottom, middle and upper side of grafts. The increase in diameter was observed every week. It was found that an average increase in diameter of mango seedlings in shed was 0.4 cm as compared to 0.3 cm for the seedlings kept outside the shed. Thus, increase in diameter inside the shed was found to be higher than the increase in diameter outside the shed. As we know that, the vegetative growth inside the shed is maximum than outside the shed. Also, the average increase of diameter of cashew grafts inside the shed was 0.15 cm as compared to 0.1 cm for cashew seedlings kept outside the shed.

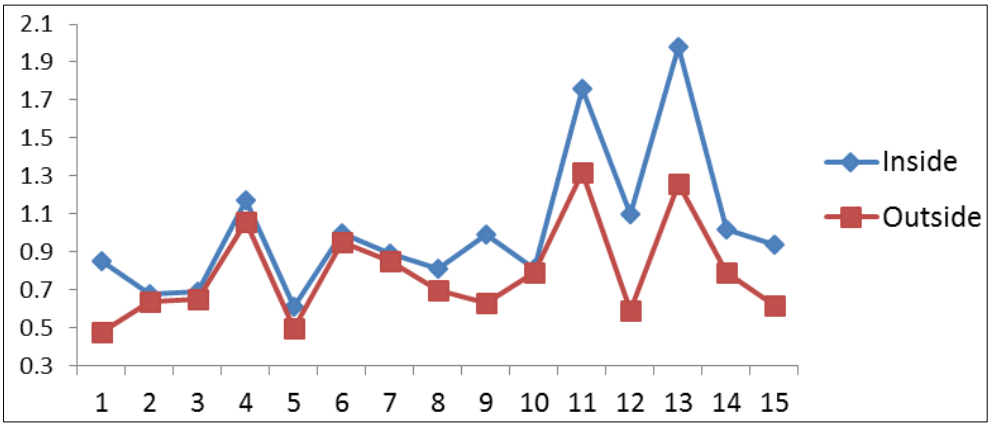

Fig 4: Diameter of mango grafts, cm

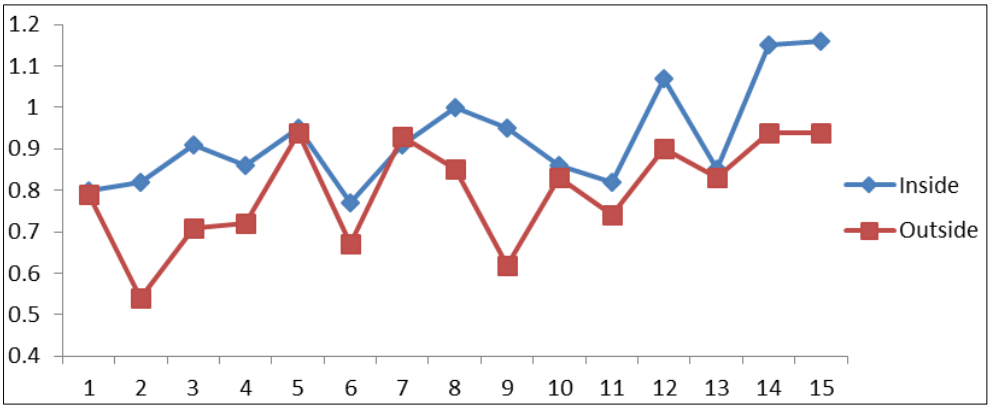

Fig 5: Diameter of cashew grafts, cm

Number of leaves comparison

Table 1, Fig. 6 and Fig. 7 showed the number of leaves data of mango and cashew seedlings for nine weeks period. As the height of a plant was increased, the number of leaves were also increased. The average of increase in number of leaves inside the shed of mango grafts is nothing but the four leaves. Above table shows the comparison of mango grafts outside the shed of each week. As per above graph, the average increase in no. of leaves outside the shed of mango grafts was 2 leaves per plant. Thus, the increase in number of leaves was higher inside the shed. The vegetative growth is higher under the shed than the outside of the shed.

Thus, it was found that hardening shed has better impact on growth parameters of mango and cashew seedlings as compare to open field seedlings.

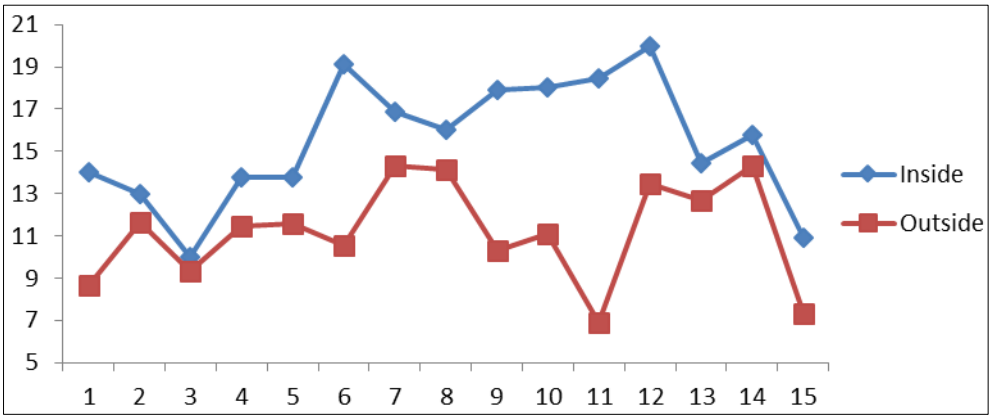

Fig 6: Number of leaves of mango grafts, Number

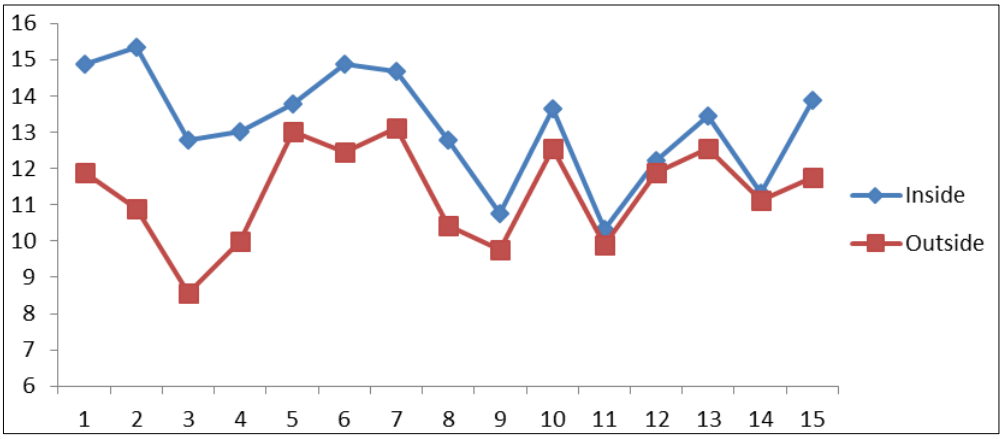

Fig 7: Number of leaves, number

Conclusions

It was found that outside temperature was 1.9 °C more than inside temperature. The height, diameter of stem and number of leaves of mango and cashew seedlings were found to higher in the hardening shed as compare to outside the shed. The effect of green shade net cladding over hardening shed showed positive impact on growth of mango and cashew seedlings. It can be concluded that shading can significantly enhance plant growth.

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