PERFORMANCE ASSESSMENT OF TECHNICALLY SPECIFIED AND NON-SPECIFIED SPRINKLER IRRIGATION SYSTEMS IN RUBBER NURSERIES IN THE INTERMEDIATE ZONE OF SRI LANKA

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INTRODUCTION

The demand for natural rubber in Sri Lanka is increasing further, particularly with increasing consumption of rubber in the world. The total rubber extent of the country is about 128,100 ha while the total mature extent in the country is 101,700 ha in year 2011. National productivity level of rubber is 1,552 kg/ha in year 2011(MPI, 2011). In the year 2006 it was forecasted that the NR production has to be increased up to 200,000 MT by the year 2016 with a continuous production increase rate of 5% annually.

Therefore there is a need for the country to increase NR production through improving genetic composition of *Hevea brasiliensis* for high yields and the area of planting rubber. However, further expansion of rubber in traditionally growing wet areas is limited largely due to urbanization and industrialization (Iqbal et al., 2010). As a solution the Government of Sri Lanka is exploring the possibility of planting rubber in non-traditional areas such as Moneragala and Ampara Districts in the Intermediate zone and some areas in the Northern Province of the country. For those planting programmes, it requires large planting material production to reach the demand with expected level.

Therefore large scale nurseries should be maintained under the government, Regional Plantation Companies (RPCs) and private sector in those intermediate and dry zones to produce required plants. Planting material production, nursery management and bud grafting demand proper planning, timing and high quality seedlings and bud wood (Senevirathne P, 2005). The Nursery period of currently recommended planting materials is about nine months. These budded plants are raised in young budding nurseries and transplanted to the fields with the onset of monsoon rains.

But low available soil moisture, high evaporation, high temperature and wind velocity are constraints in establishing good rubber nurseries. Therefore irrigation is necessary especially in the rubber nursery management in drier areas to ensure high quality plants and high productivity and sprinkler irrigation is a convenient and efficient method of supplying water to crops for producing large and steady crop yield when compared to the other micro irrigation methods (Nakandala et al. 2008).

There are two types of sprinkler irrigation systems (*i.e.* technically specified or impact and technically non-specified) now available in the country. All these types have their own advantages and disadvantages according to their system design on operational characteristics. This paper mainly discusses the irrigation system performance on their operational characteristics as the part of this study.

Materials and Methods

Young budding rubber nursery at Monaragala Sub Station of Rubber Research Institute of Sri Lanka was selected for the study. It was located in Latitudes - $06^0\,50^/\,06^{//}$N and Longitudes – $081^0\,18^/\,55^{//}$E. The annual rainfall of the district ranges from 1250 mm to 2623 mm with the average annual rainfall of 1623 mm. The ideal rain fall for growing rubber is within the range of 1650 – 3000 mm and should be uniformly distributed throughout the year. Rainfall, less than 500 mm is severely affect the growth of rubber in early stages of planting (Yogaratnam, 2001).

The midyear dry period extends from June to August in the intermediate zone areas of the Monaragala district. During this period the probability of occurrence of dry days is high. (Wijesuriya et al., 2005).

To evaluate the systems on operational characteristics, a bucket experiment was designed to test the water distribution pattern of each system at the beginning of study under nursery conditions. A 6m * 6m square was marked on the field and it was divided in to 36 squares which have $1m^2$. The sprinkler was centralized on the 6m * 6m square and 36 buckets were placed on centrally on each square. Sprinkler was operated and water was collected in the buckets for half an hour. Collected water was measured separately by using measuring cylinder and the diameter of the bucket was measured by using a measuring tape. The area of the bucket was then calculated. A conversion factor, based on the area of the bucket, was used to convert the volume in millilitres to depth in millimetres. The same procedure was carried out to measure the uniformity of spread of four sprinklers at four corners under the field condition. Direction and velocity of wind, temperature and humidity was also recorded during the testing period. Based on the bucket experiment uniformity coefficient, pattern efficiency was calculated.

Uniformity coefficient

A measurable index of the degree of uniformity obtainable for any size of sprinkler, operating under given conditions has been adopted and is known as the Uniformity coefficient (Cu) (Michel. 1978)

$$Cu = \left(1 - \frac{\Sigma x}{mn}\right)$$

In which

x =Numerical deviation of individual observations from the average application rate (mm)

m = Average value of all observation (average application rate) (mm)

n = total no of observation points

Pattern efficiency

Pattern efficiency was determined by gauge records of the bucket experiment as follows.

$$\text{Pattern efficiency} = \frac{\text{Average minimum depth of catch}}{\text{Average depth of catch}} \times 100$$

$$\text{Average depth of catch} = \frac{\text{Sum of the depths water}}{\text{No of gauges}}$$

Minimum depth of catch = 25% of gauges having the least water depth

Soil Properties

Bulk density and Field Capacity were tested of potting media before commencing irrigation practices of each treatment

Soil moisture measurements

Soil moisture content was measured daily to compare the amount of water accumulate in the poly bag by each system. The available soil moisture content in 10cm and 20 cm depth of the poly bags was measured by using a *Theta probe* (Model DL 2x).

Results and Discussion

Uniformity co-efficient (Cu)

Uniformity co-efficient (Cu) is a measurable index of the degree of uniformity computed the depth of water collected in a bucket experiment. Table 1 shows the average values of Cu as percentages of sprinklers operated under various conditions. Cu of single sprinkler operation of technically specified or impact sprinkler and non specified sprinkler were 29.85% and 17.32% respectively.

Table1. Uniformity co-efficient of sprinkler testing

Test	**Cu %**
Technical Sprinkler (Single)	29.85
Non-Technical Sprinkler (Single)	17.32
Technical Sprinkler (four sprinklers)	92.22
Non-Technical Sprinkler (four sprinklers)	89.51

Higher the uniformity of distribution of water was obtained by a single technical sprinkler operated with a revolving type sprinkler head with two nozzles and slow rotating type (Michel. 1978). Technically non specified sprinkler contains only an orifice in the sprinkler head that was not technically designed. It has broken the rain drops in to very fine drops and with high windy conditions water droplet was moved from wetting area. Therefore low Uniformity (Cu) was observed under non-technical single sprinkler.

Therefore sprinkler laterals were placed in to 100% overlap of four sprinklers between two laterals. As shown in Table 1, both technical and non-technical sprinklers have shown more than 85% of Cu that was considered to be satisfactory under 100 % overlapping condition at system installation.

Pattern efficiency

In both systems (i.e.; technical and non-technical), the average pattern efficiencies of four sprinklers were 87% and 86% respectively which was satisfactory when the crops are lying below the riser height. But if plants were raised more than the riser height, radius of throw was interfered with plant height resulted low pattern efficiency of the system.

Table 2 Pattern efficiencies of sprinkler testing

Test	Pattern efficiency (%)
Technical Sprinkler (Single)	16.2
Non-Technical Sprinkler (Single)	12.0
Technical Sprinkler (four sprinklers)	87.0
Non-Technical Sprinkler (four sprinklers)	86.0

Soil properties

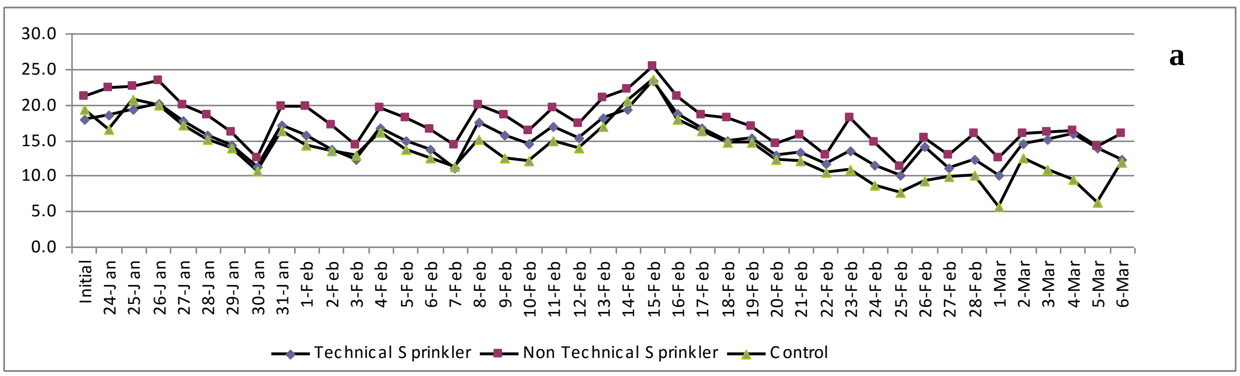
Bulk density and field capacity of the potting media of poly bag nursery was measured prior to commencement of the study. Table 3 shows the bulk densities of each soil sample take from each irrigation system. Accordingly field capacities of each potting media were varies between 21 – 25%

Table 3 Bulk density and Field capacity of potting media

Location	***Bulk Density g/cm*** ^{3}	**FC**
Technical Sprinkler (T)	1,74	22.99
Non Technical Sprinkler (N)	1.76	25.42
Control (C)	1.72	21.51

Moisture pattern

The available soil moisture content in the potting media of poly bag plants in the depths of 10 cm and 20 cm was plotted in figures 1 a and b. Moisture curves were drawn for total irrigation cycles of each irrigation system including manual watering.



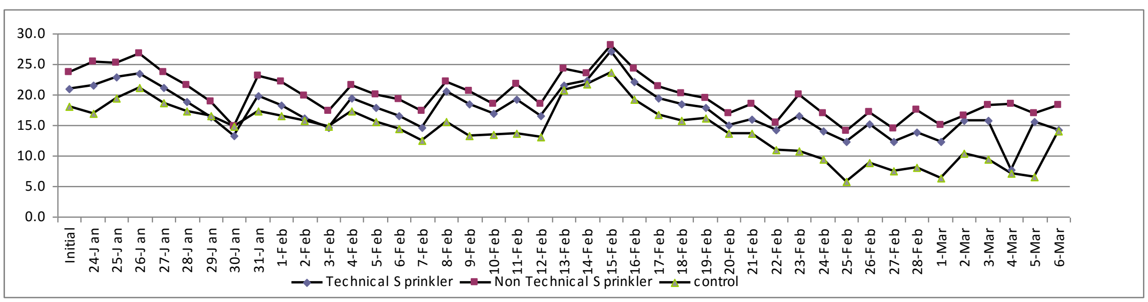


Figure 1. Moisture curves a – at 10 cm depth soil in poly bag plant and b – at 20 cm depth soil in poly bag plant

b

As in the figures (a) and (b), irrigation was done until field capacity was reached. Irrigation was done at the 50% depletion level was reached. Peaks in mid January and February in Figure 1 were the heavy rains occurred resulting saturated conditions in the potting media. According to the Figure 1 moisture retention in the manual watering system was comparatively low, resulting high moisture depletion level. Higher water retention was shown in non technical sprinkler irrigation system for both depths. Low discharge rate of non technical sprinkler (600 l/hr) minimize the surface runoff and maximize the infiltration rate in to the potting media of poly bag plants regardless of technical and manual watering systems.

The study was conducted to evaluate two types of sprinkler systems ie; technically specified and non-specified sprinkler systems on their operational characteristics under nursery conditions.

The operational characteristics such as uniformity co-efficient, pattern efficiency, discharge rate would directly affect the performance of the sprinkler irrigation systems. Uniformity co-efficient of technical and non-technical sprinkler systems were 92.22% and 89.51% respectively and pattern efficiencies were 87% and 86% respectively which was satisfactory for the nurseries in the intermediate zone in Sri Lanka.

Conclusion

This study highlights the operational characteristics of technically specified and non-specified sprinkler systems that directly affected the performance of the system. Maintenance of relatively high uniformity coefficient in technical irrigation system positively affected the growth of rubber nursery plants which would be important to achieve high irrigation efficiency of the system. Low discharge rate of non technical sprinkler system increases the system efficiency by minimizing the surface runoff and maximize the infiltration rate of poly bag plants which can be considered as an advantage.

Further irrigation systems are to be evaluated not only for their operational performance but also for the uniform growth of plants when selecting a proper sprinkler irrigation system.

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