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Evaluation of Dry Nursery Management in Semi-arid and Arid Areas of Daro Labu and Habro Districts, West Hararghe Zone, Oromia, Ethiopia

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Abstract
The success of plantation program depends to a great extent on success of nursery. Nursery usually, depending on weather condition and bed type. Beds can be made of three types (raised bed, sunken bed and level bed. To this end, we have been undertaken the experiment on evaluation of dry nursery management at arid and semi-arid areas in Daro Labu and Habro districts in randomized complete block design with six replications (PAs as replication) in 2013/14 and 2014/15 cropping seasons. Coffee (Mehara-1) variety was sown as test crop in sunken bed with different treatments (bare root without plastic sheet, bare root with plastic sheet, polythene tube without plastic sheet and polythene tube with plastic sheet) and normal bed (level bed) as control. Two years data of survival rate, root-shoot ratio, and seedling height and germination percentage were collected and analyzed. The result revealed that there was significant difference ($P<0.05$) in survival rate during first and second years in which bare root without plastic sheet, polythene tube without plastic sheet and control shown higher performance than bare root with plastic sheet and polythene tube with plastic sheet. Bare root without plastic sheet and polythene tube without plastic sheet offers much promise for nursery management for future use in arid and semi-arid areas of the study areas and similar agro-ecologies.
Keywords: Dry Nursery**,** Percentage, Survival Rate, Root-shoot ratio

1. Introduction

The most extensive dry woodland types in eastern Africa are in the semi-arid zone, covering 1.6 million km2 (Timberlake *et al.* 2010). Climate Change will further exacerbate the situation in the region, and species that will be more vulnerable are those with: limited geographical range and drought/heat intolerant; low germination rates; low survival rate of seedlings; and limited seed dispersal/migration capabilities (Chidumayo 2008, Chidumayo *et al.* 2011).

Despite the existence of enormous genetic diversity of coffee and its importance in the national economy of Ethiopia, the per unit area national average yield of the crop is hardly exceeds 0.7 ton ha-1 clean coffee (Central Statistical Authority, 2012). This low productivity of the crop stems from a sundry of reasons. *Inter alia,* use of twisted, forked and whippy seedlings with undesirable shoot and root growth for field planting and erroneous management of the plant during the nursery period are the major constraints which accounts for low coffee yield in the country. These emanate from use of growing media not suitable for germination and seedling growth, improper depth of seed sowing and inadequate or excessive shading and watering during the nursery period (Anteneh *et al*., 2008).

Arid and semi-arid environments are generally very fragile. These lands are associated with low and unreliable rainfall and relatively high temperature. The best example is districts found in west Hararghe zone where about 70% of land lies in these environments (Farming system of Daro Labu and Boke districts, Mechara agricultural research center (unpublished)); thus resulting in limited water resources and difficulty for establishment of seedling and other farming system.

Nursery practices must be consistent and the various techniques closely integrated. If one element in the chain is lacking there will be a negative impact on seedling quality. Good quality seedlings cannot be produced and sustain without care. Nursery plants need to be protected from extremes of environmental conditions until they are strong enough to withstand.

The nursery industry continues to develop new production methods that encourage the growth of more fibrous roots, preserve more roots at transplanting time, improving root circling in production beds, and prevent root mortality due to thermal heat loading (Appleton, 1995, 1994 and 1993). Nurseries usually depend on weather condition and bed type. Beds can be made of three types (raised bed, sunken bed and level bed). Based on irrigation facility and in the nursery, raised beds are used in areas with high water tables, sunken ones are used in semi-arid and arid areas while flat beds are used in intermediate areas(Anonymous,1996).

Dry nursery is a nursery maintained without any irrigation or artificial watering like in underground seed bed (sunken bed). Such beds can easily resist the drought with its underground moisture conservation, during dry season. It is also in dry regions, especially on sandy soils with low water-holding capacity, vegetables can be planted in sunken beds. Sunken beds were laid out 30 to 50cm deep from the ground level in order to collect run-off water from adjoining areas and reduce evaporation loss from the sides and conserve water much more effectively than raised beds for two reasons. First, it don't have the exposed sides as raised beds from where considerable moisture can be lost by evaporation, and second none of the applied water is lost by runoff (Luna, 2006).

According to Anonymous (1996), the nature of the bed affects the conditions for survival rate and other growth parameters. Preparation of sunken bed could be with plastic sheet under the floor base of beds; this system could be used for controlling root growth penetrating in to the ground and save water for seedlings, if moisture availability was good at the first sowing time. This mechanism assumes that water intake of plant/day was saved as compared to normal earthen bed and water requirement of seedlings could be reduced. The objective of conducting this field trial is, therefore, to select the best seed bed type that can sustain seedling in dry period during summer, especially for arid and semi-arid areas of districts in West Hararghe Zone and other similar agro-ecologies

2. Materials and Method

2.1. Description of the study area

The study was undertaken in West Hararge zone, Habro and Daro Labu districts that are located to South of Chiro town, the capital of the zone, at a distance of 70 and 110 km respectively. The altitude range for Daro Labu is 1350 to 2450 m.a.s.l with area coverage of 434,280 ha whereas that of Habro district varied between 1464 to 2450 m.a.s.l with total area of 730.32 square kilometers (CSA, 2005). Their latitudinal and longitudinal positions are $40^0$19.114 East and $08^0$35.589 N for Daro Labu district and 8^o36.06'North latitude and 40^o20'.76''East longitude for that of Habro district. Both districts have bimodal type of rain fall distribution with average annual rainfall of 1094mm and mean annual temperature 20^{o}C summarized from Mechara metrological station for Daro Labu district and that of Habro district is 1,010mm annual rainfall with mean annual temperature of 18.5^{o}C.

The nature of rainfall in the area is very erratic and often unpredictable causing tremendous erosion. The predominant production systems in the districts are mixed crop-livestock production. The crops grown in the area includes food crops like teff, maize, sorghum, pulses as well cash crops such as coffee and chat. Mango, Avocado and Citruses are also grown to some extent. The major soil type of the area is Nitisol and its texture is sandy loam clay which is reddish in color particularly in Daro Labu district (Report on farming system of Daro Labu and Boke districts, Mechara agricultural research center (unpublished)). Nitisol in lowland part and Vertisol in mid-land is the major soil type found in Habro district. Exactly three Peasant associations that were more or less found at the same level of altitude from each district were selected to conduct the trial (Table 1).

Table 1. Peasant associations where nursery is established in DaroLabu and Habro districts in 2013 & 2014

SN	District	Peasant associations	Distance from capital town	Altitude
1	DaroLabu	Burakisa	14 km from Mechara town	1633 m.a.s.l
		Haroresa-qile	23 km ,,	1635 ,,
		Sakina	25 km ,,	1668 ,,
2	Habro	Gerbigoba	3 km from Gelemso town	1703 ,,
		Lagabera	5 km ,,	1707 ,,
		Ibsa	15 km ,,	1701 ,,

The monthly rainfall pattern in 2013/14 and 2014/15 cropping season taken at Mechara (Daro Labu) and Gelemso (Habro) stations is depicted in Figure 1 & 2 below. The rainfall amount in the second year (2014/15) is recorded low as compared to the first one which has impact on seedling survival and other growth indicators.

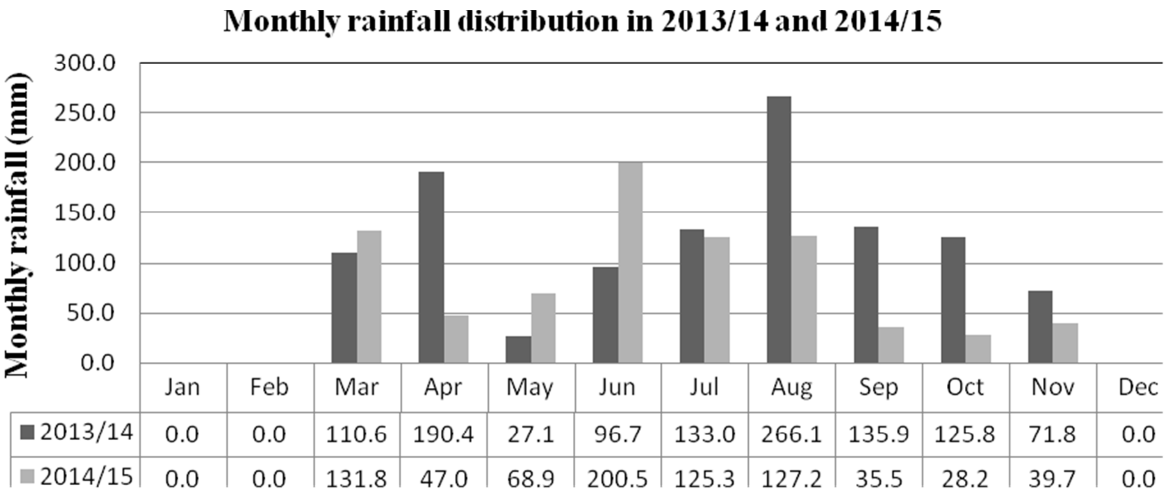

Figure 1. Monthly rainfall distribution in 2013/14 and 2014/15 at Mechara station

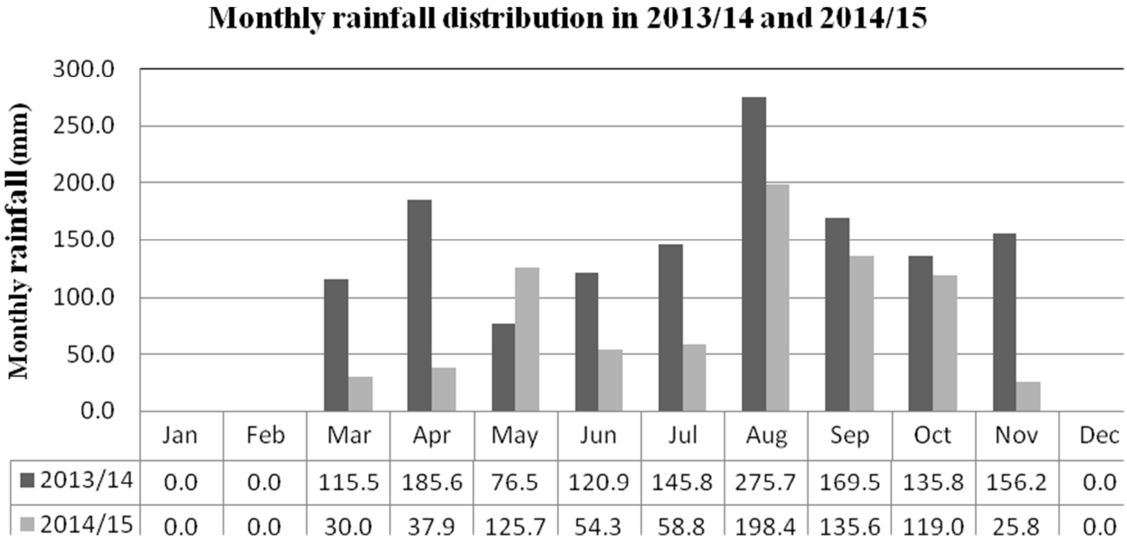

Figure 2. Monthly rainfall distribution in 2013/14 and 2014/15 at Gelemso station

2.2. Experimental design and layout

The experiment design was randomized complete block design with six replications (peasant associations were used as replication). **S**unken bed was prepared below the general level of the path, because the level path would facilitate underground moisture and it is beneficial in dry soil and well drained localities (Luna, 2006). The sizes of sunken beds were 6m length x1m width x 30 cm depth. The underground plastic sheet had the size of 80cm width and 2.6m length**.** For bare root, in both sunken beds with plastic sheet and without plastic sheet the soil was refilled to the length of polyethylene tube (22cm). As a control, Level bed of the same size as of sunken beds was laid in east west directions above ground. The seeds of coffee variety (Mechara-1) were direct sown on prepared seed bed in all treatments before on set of rainy season.

Treatments (Sunken bed had four treatments + Level bed as control):

1. Sunken bed with underground plastic sheet + polythene tube
2. Sunken bed with underground plastic sheet + bare root
3. Sunken bed without underground plastic sheet + polythene tube
4. Sunken bed without underground plastic sheet +bare root
5. Level bed (control)

Figure 3. Sunken bed preparation of dry nursery management at Daro Labu and Habro districts

2.3. Data collection and analysis

Data for germination percentage, survival rate, root-shoot ratio and seedling length were collected. Germination percentage was analysed as the proportion of germinated seeds to total number of sown seeds, where as survival rate was analysed as the proportion of surviving seedling to germinated seeds. Root-shoot ratio was analysed as the ratio of root to shoot and seedling length is the total length of surviving seedling.

Plot means for four variables were calculated to two decimal places and analysis of variance (ANOVA) was performed by stastical analysis (SAS in GLM). Treatment comparisons of means were made at alpha 0.05 siginificance level using Least Siginificant Difference (LSD) test .

3. Results and discussion

The statistical analysis reveal that there were no significant difference in germination percentage, root-shoot ratio and seedling length during 1stand 2nd years while, there were significant difference in survival rate in 1st and 2nd years in which bare root without plastic sheet, polythene tube without plastic sheet in sunken bed and level bed (control) shown higher performance over the other treatments.

The study revealed that during the first year all treatments give less than one root-shoot ratio which means shoot growth exceeds root growth and in the second year, root-shoot ratio greater than one for bare root without plastic sheet, polythene tube without plastic sheet and control signifying root growth exceeds shoot growth due to shortage of moisture occurred in that year. The result is in line with the study conducted by Niklas (1994) and Hunt and Nicholls (1986) that; root-shoot ratio increase in dry period (roots grow more as compared to shoot to search moisture to enhance survival of the seedlings). Besides, seedling length measured for level bed (15.67cm), bare root without plastic sheet (17.50cm) and polythene tube without plastic sheet (16.83cm) in sunken bed are in line with standard seedling length of 15-40cm for out-planting particularly in first planting year. But in the second year it didn't reach standard size due to drought (Table 2).

Table 2. Mean germination percentage, Survival rate, root-shoot ratio and seedling length at Habro and Daro Labu districts in 2013/14 and 2014/15 cropping seasons

Means in 2013/14 and 2014/15 cropping seasons								
Treatment	Germination %		Survival rate (%)		Root to shoot ratio (cm/cm)		Seedling length (cm)	
	2014	2015	2014	2015	2014	2015	2014	2015
Control	77.67b	49	71.91ab	44.79a	0.83	1.50	15.67	10.84
Bare root without plastic sheet in sunken bed	85.67ab	69	86.98a	77.25a	0.78	1.53	17.50	12.75
Polythene tube without plastic sheet in sunken bed	84.33ab	57.5	84.09a	66.27a	0.85	1.73	16.83	11.54
Bare root with plastic sheet in sunken bed	90.00a	54.5	50.64b	0b	0.54	-	13.00	-
Polythene tube with plastic sheet in sunken bed	88.00ab	53	49.75b	0b	0.56	-	12.50	-
CV (%)	10.79	32.79	36.62	69.99	50.67	34.47	35.24	11.20
LSD (5%)	11.07	28.59	30.29	40.616	0.43		6.41	
P-value	0.22	0.62	0.043	0.0027	0.4	0.53	0.39	0.49

4. Conclusion and Recommendations

Since survival and growth characteristics of seedlings at their early growth is highly affected by environmental conditions that are prevailing in arid and semi-arid areas like in most districts of West Hararghe zone, which results from low and erratic rain fall pattern and have limited/no irrigation water sources, use of appropriate nursery management is necessary. Dry nursery management is among available options in the area. The result from the study confirmed that use of sunken bed without lining with plastic sheet and sowing seed bare root or with polythene tube increased survival and other growth characteristics of coffee seedlings. Thus, bare root without plastic sheet and polythene tube without plastic sheet could be used to survive seedlings in dry areas.

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