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Effect of Pot Sizes and Coffee Cultivars on Emergence and Subsequent Seedling Growth of Coffee (Coffea Arabica L.), South Western Ethiopia

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ABSTRACT
Currently, due to lack of technology based information the same polythene bag size (pot size) are used to raise Arabica coffee cultivars seedlings at different coffee nursery site, so it requires sound study at coffee nursery and field transplanting for improved productivity. Therefore, an experiment was conducted at Bonga in 2011/13 period to determine the effect of different pot sizes (11cm diameter by 23 cm height, 6cm diameter by 12 cm height and 8cm diameter by 20 cm height) on the growth performance of Coffea arabica cultivars (75227, 741, 7440, Dessu, 74110 and 74112). The experimental design was randomized complete block design with three replications. Analysis of variance revealed that there was significant ($p<0.05$) difference among pot sizes in seedling vigor index, plant height, internode length, leaf area index, leaf dry weight, stem dry weight, root volume, total dry weight, shoot mass ratio, tap root length, relative growth rate, specific leaf area and leaf area ratio. However, mean day of emergence, percent emergence, emergence rate, number of internodes per plant, girth, leaf number per plant, lateral root number, lateral root length, root to shoot ratio and field survival percentage after transplanting were not significantly ($p<0.05$) affected by the main effect of pot sizes. In general all the parameters were significantly ($p<0.05$) affected by the main effect of variety. Arabica coffee cultivars 74110, 74112, 7440 and Dessue were revealed the highest field survival percentage 97.94%, 93.83%, 97.20% and 94.43% after field transplanting, respectively. On the other hand open Arabica coffee cultivars 741 and 75227 showed lower field survival (70.89%) and (71.78%), respectively. Generally, a great contribution for the highest field survival percentage of Arabica coffee after field transplanting was obtained from the three pot sizes that undertaken for this study, however there was no significance different among pot sizes. Finally, coffee seedling grown under smaller pot size (6 cm X 12cm) preferred for field transplanting, because coffee producing farmers would able to transport a large number coffee seedlings grown under smaller pot size for field transplanting than larger pot size. Therefore, application of smaller pot size could be recommended as a practically approved choice-for-the-study-area.
Keywords: coffee, cultivar, pot size, relative growth rate, survival rate, transplanting,

1. Introduction

Coffee (Coffea arabica L.), a perennial crop of high genetic diversity is originated in the forest ecosystem of the south and south-western Ethiopia (Seyoum, 2003). On the whole, coffee is considered as the most important single commodity of the country since it contributes 60 - 70% towards foreign exchange earnings and 30% to direct governmental revenue (CSA, 2010). Yet, despite its decisive role in the national economy and given the wealth of genetic diversity and climatic suitability, the national yield average is 600 kg ha^{-1} of clean coffee (MoARD, 2010). According to the reports of BoAD (2010), the South Nation Nationality and People Regional State (SNNPR) is one of the major coffee producing regions in Ethiopia, it has a great potential for coffee production due to its suitable agro-climatic conditions. Generally, Sidama, Gedio and Kafa are the major coffee producing zones in the region. More than 92% of the coffee is produced by small scale farmers, the remaining produced by private investors and government state farms (BoAD, 2010). South west Ethiopian high lands has a major potential area for coffee production in SNNPR, it has suitable agro-climatic zonation and land forms for coffee production and it is also believed to be the center of diversity for *Coffea arabica*. Currently, among the problems identified in the production of Arabica coffee at Kafa is low survival rate of coffee seedlings after field transplanting (Endale *et al*., 2008).

This was, due to lack of useful resent information and coffee technologies generated by the Jimma research centre, which still remain not adequately accessed around the study area where forest coffee production system with low crop productivity is predominantly practiced (Francis *et al.,* 2000). KZDoA (2010) reported that farmers are using polythene bag having 11cm diameter by 23cm height, but they have failed to hold and transport large number of seedlings to plantation area due to its larger pot sizes and soil volume. Optimization of pot size according to the Arabica coffee varieties helps to increase area to be planted at field condition (Antenhe *et al.*, 2008). Furthermore, it enhances the survival rate of coffee seedling after transplanting (Francis et al., 2000

and KZDoA, 2010). Various sizes of polythene bags that pertinent to rising coffee cultivars seedling at nursery level were identified under ideal agronomic practices (Whitcomb, 2002). So using acceptable range of pot size could have a great contribution for coffee seedling production and coffee production as well as far as it had got a better field survival rate (Francis et al., 2000). Therefore, this study was proposed with the objective to examine the effects of different pot sizes on the emergence and subsequent growth of Arabica coffee cultivars. .

2. Materials and Methods

2.1. Site description

The study was conducted from October 2011 to January 2013 in Southern Nations Nationality Peoples Region (SNNPR) at the Bonga Agricultural Research Center. The area is located at latitude of 7°18' North and longitude of 36°14' East with an elevation of 1860 m.a.s.l. It is found at 446 km from Addis Ababa in southwestern Ethiopia. According to the Ethio-Agri-CEFT (2011) report, the average annual rainfall ranges from 1800 to 2200 mm, April-September are peak rainy months with a longer growing period. The mean maximum and minimum air temperatures 12.4 ^{o}C and 26.1 ^{o}C, respectively. The soils are characterized as deep, red, brown-grey and brown-clay soils (Bazira *et al*., 2002).

2.2. Treatments and Design

The treatments consisted of three pot sizes (11cm x23 cm, 6cm x 12 cm and 8 cm x 20 cm), and six Arabica coffee varieties (75227, 741, 7440, Dessu, 74110 and 74112). The experimental design was randomized complete block design in a factorial combination with three replications. The numbers of seedlings per plot were 25 and a total of 1350 coffee seedlings were used for the study. In these experiments the polythene bags were prepared as per the sizes and firmly filled with a growing media consists of purely forest soil.

To ensure maximum germination, two coffee seeds were sown directly on three sized polythene bags (potted) seed beds at a depth of 1.00 cm. One of the seedlings was removed at 90 days after sowing when all normal viable seedlings were expected to emerge. All other routine nursery management practices, including mulching, watering, shading, weeding and other nursery activities were carried out as per the recommendation (IAR, 1996).

Description of varieties

Six Arabica coffee varieties released by Inistitute of Agricultural Research were used for the study which have different canopy classes and recommended for different areas (IAR, 1996). The full description of the varieties and other information are described on Table 1.

2.3. Data collection

Seedling emergence

Emergency count was made from each experimental unit when just it was commenced (30 days after sowing) in seven days interval. This count was extended up to 90 days after sowing. Then, the number of seedlings that emerged above the soil surface and attained the soldier stage of growth were counted and recorded every 7 days till complete emergence. Then percentage of emerged seedlings (% E) was determined. Days required to 50% emergence (MDE) and the rate of seedling emergence (ER) were calculated using the formulae described below (Eq 1 and 2).

$$Mean\ days\ to\ Emergence(MDE) = \frac{\sum(nt)}{\sum n} \qquad \textit{(Eqn. 1)}$$

$$Emergence\ Rate(ER) = \sum(\frac{n}{t}) \qquad \textit{(Eqn. 2)}$$

Where, n = number of newly germinated seeds at time t, t = days from sowing.

Table 1. Coffee (*Coffea arabica)* Varieties Description

Varieties	Year of released	Yield (q/ha)		Canopy class	Recommended areas		
		On- Station	On-Farm		High altitude (1750-2100m)	Mid. altitude (1550-1750m)	Low altitude (1000-1550m)
741	1977/78	12.2	6-7	Open	S	S	S
75227	1980/81	17.9	8-9	Open	HS	S	S
7440	1979/80	16.2	8-9	Mid.Open	S	S	S
Dessue	1980	15.2	5-6	Mid.Open	S	HS	US
74110	1978/79	19.1	9-10	Compact	HS	S	US
74112	1978/80	18.1	9-10	Compact	HS	S	US

Key: *HS = highly suitable, S = suitable, US = Unsuitable*

An attempt was made to establish some vigor indices for the young coffee plants at an early stage of growth following the techniques by IAR (1996). Then seedling vigor indices (SVI) of the young coffee plants were determined by the following linear model sited by Wondyifraw (1994).

$$SVI-2 = GD \times (SH + RL) \times \%E/MDFTL) \qquad \textit{(Eqn.3)}$$

$$SVI-4 = (GD \times (SH + RL) \times \%E \qquad \textit{(Eqn.4)}$$

Where: SVI = seedling vigor index, GD= girth diameter (cm), SH = stem height (cm), RL = tap root length (cm), %E = percentage field emergence, and MDFTL = mean days to first true leaf growth stage.

Non-destructive extension growth parameters were collected on the central three seedlings at an interval of one week, between October and July, 2011/2013, that was beginning from the start points of the experiments up to the end of the experiment. From each experimental plot data was taken every seven days starting from 45th days after sowing till all potentially capable seedlings in each plot developed their false leaves. Non-destructive plant growth parameters such as emergence rate, emergence percentage, plant height per unit time (cm), girth diameter, number of true leaf, number of nodes, and internodes length (cm) and estimated leaf area (cm^2) were recorded at a month intervals, by using the procedure adapted by Yakob *et al*., (1993) as follows:

$$\mathbf{Y = K \times L \times B}$$

Where, Y is estimated leaf area; K is constant specific to cultivars and canopy classes; L is leaf length (cm) and B is maximum leaf breadth (cm).

Shoot extension growth

Shoot growth parameters were measured from three seedlings taken randomly from the central rows and measurement of plant height (cm) and internode length were taken. Leaf area per leaf was calculated using the procedure adapted by (Yakob *et al*., 1993). Stem diameter (girth) was measured starting from first true leaf at the surface of the soil by using a caliper in order to develop some vigor indices.

These three seedlings also subjected to destructive sampling after removing above ground part at collar point by scissor, then shoot parts were separated to leaves and stems and fresh weight of each weighed using sensitive balance. The polythene bag containing the roots of the seedlings then, were immersed in running tap water and roots were separated carefully from the soil still being in water. The roots were subsequently washed with clean water, dried with water adsorbent cloth and fresh weight of roots (g), leaves (g), stems (g) and total fresh biomass yield (g) were measured by using sensitive balance. Square paper was put under clean glass to count the total number of squares covered by lateral roots and its length was calculated. Other growth parameters such as lateral root number and length (cm), tap root length (cm) and seedling vigor index were taken from the three randomly selected coffee seedlings from central row of a plot. Volume of fresh root was recorded by using water displacement methods in graduate cylinder at the field. After drying separately at 70-80^{0}C for 48 hr in paper bags in a hot air oven until a constant weight attained as described by Adjet-Twum and Solomon (1992). Finally, shoot and root dry matter yields were weighted using a sensitive balance and the derivatives leaf mass ratio (LMR = leaf dry weight/total dry matter), shoot mass ratio (SMR = shoot dry weight/total dry matter), root mass ratio (RMR = root dry weight/total dry matter) and root to shoot ratio (RSR = root dry weight/shoot dry weight) were calculated to assess the effect of transplanting techniques and Arabica cultivars on dry matter partitioning at their early growth stage.

The mean relative growth rate (RGR) and specific leaf area (SLA= leaf area/leaf dry mass) of seedlings were the methods used to compare growth differences that arise from experimental treatments due to differing genotypes, growing media (Lambers and Poorter, 2008).

The mean relative growth rate (RGR) was calculated by taking plant growth at two points in time. The times were five months (T1) to nine month (T2) after sowing of Arabica coffee seeds at nursery. The equations used for calculating the RGR and SLA were written as:

$$RGR = \frac{lnW_2 - lnW_1}{T2 - T1} \quad \textbf{(Eqn. 5)}$$

$$SLA = \frac{LA}{LW} \quad \textbf{(Eqn.6)}$$

Where: W_1 and W_2 are the dry biomass at the beginning (T_1) and end (T_2) of the sampling period, and ln is the natural logarithm. SLA =Specific leaf area, LA= leaf area, LW= leaf dry mass, LAR= leaf area ratio, TDW = total plant dry weight.

In addition to these, linear measurements of girth diameter, shoot and root length at the first true leaf growth stage of the seedlings from each plot were also taken and used to develop vigor indices (Sited by Wondyifraw, 1994). Therefore, based on the records of viability test, the mean days to emergence and the rate of emergence of each treatment were computed following the procedure by Scott *et al*. (1994) as indicated in **Eqn.1** and **Eqn. 2**. At the end of the experiment field survival rate was computed according to the measurement procedure of Wintegens (2004) within a month interval after transplanting to the field continuously for six months.

2.4. Statistical analysis

Finally, the data collected were subjected to analysis of variance using SAS software (SAS Institute, 2002). Comparisons among treatment means with significant differences for the measured and counted parameters were done based on the LSD test.

3. Result and Discussion

3.1. Germination and Emergence

Analysis of variance showed that none of the parameters were affected by the interaction effect, however mean days to emergence, percent emergence, emergence rate and seedling indices at 2 true leaves stage were significantly ($p<0.05$) affected only by the main effect of variety (Table 2). Whereas, seedling vigor index (SVI-4) was affected by the main effects of pot size and variety (Table 2). The 11 cm diameter by 23 cm height pot gave the highest (41.35) SVI-4 index followed by 6 cm diameter by 12 cm height pot size, which inturn outsmarted the 8 cm diameter by 20 cm height pot size (Table 2). The 11 cm diameter by 23 cm height pot superiority might have been due to the large sized volume which favoured good aerated condition, which ultimately led to good early growth.

The genotypes were found to have difference in the different indices studied (Table 2). The presence of variation among *Coffea arabica* related with larger reserves of nutritive substances for open cultivars followed with intermediate and compacted cultivars, this favored water imbibitions and subsequent physiological process. These results are in agreement with the finding of Tripathi & Khan (1990) and Worku and Astatkie (2008).

Table 2. Emergence and vigor indices as influenced by *Coffea arabica* Cultivars and Various pot Sizes Coffee (*Coffea arabica*) Varieties

Treatments	**MDE**	**E (%)**	**ER at 45th date**	**SVI-2**	**SVI-4**	MDBF
Pot size						
11cm x 23cm	58.5	90.89	1.31	0.29	41.35[a]	107.11
6cmx 12cm	58.22	90.44	1.29	0.29	39.23[b]	106.67
8cm x 20cm	58	90.44	1.3	0.28	36.63[c]	106.5
LSD	Ns	Ns	Ns	Ns	1.48	Ns
Varieties						
75227	52.11[c]	99.11[a]	1.44[a]	0.37[a]	47.55[a]	99.33[c]
741	52.00[c]	98.67[a]	1.44[a]	0.38[a]	51.06[a]	99.00c
7440	59.00[b]	91.56[b]	1.27[b]	0.28[b]	37.89[c]	107.11[b]
Dessue	59.00[b]	91.11[b]	1.27[b]	0.29[b]	38.49[c]	106.89[b]
74110	63.78[a]	81.78[c]	1.18[c]	0.21[c]	30.25[d]	114.33[a]
74112	63.56[a]	81.33[c]	1.18[c]	0.21[c]	29.18[d]	113.89[b]
LSD (5%)	0.88	1.91	0.02	0.022	2.09	1.17
CV (%)	**1.64**	**2.19**	**1.62**	**7.84**	**5.59**	**1.14**

Means followed by the same letter within a column are not significantly different at P≤ 0.05; MDE= Mean days of emergence; E= Emergence percentage; ER = Emergence rate; SVI-2= Vigor indices at Emergence, SVI-4 = Vigor indices at first true leaves.

Extension Growth

Plant height was, internode length, and leaf area index were significantly ($p<0.05$) affected by the main effects of pot size and variety, while number of internodes per plant, girth and number of leaves per plant were affected only by the main effect of variety; however, none of the parameters were affected by the interaction of pot size and variety main effects (Table 3).

Pot size of 11 cm x 23 cm showed a significantly ($p<0.05$) higher plant height, internode length and leaf area index than the remaining pot sizes which were in statistical parity each other (Table 3). This was due to the fact that the large volume of the pot size (11 cm x 23 cm) created well flexible condition for accessibility of adequate plant nutrients and moistures for vigorous growth of the root system resulted in increased total biomass of the crop (Chane, 1991; Carlson and Miller, 2002).

The genotypes differed significantly ($p<0.05$) in plant height, number of internodes per plant, internode length, girth, leaf numbers per plant and leaf area index (Table 3). This was due to the diversified growth habits of *Coffea arabica* genotypes influence LAI and efficient utilization of available above and below ground external resources enhanced the growth of adventitious and feeder roots that would enable maximum exploitation of soil moisture and nutrients (Sobrado, 2005). Furthermore, the difference of leaf morphologies among cultivars might be the basic reason for differences in leaf area index and stem girth, this difference also a determinant factor in radiation interception, photosynthesis, biomass accumulation, transpiration and energy transfer by crop canopies. This is associated with the report of Jonckheere *et al* (2004).

Table 3. Effects of *Coffea arabica* cultivars and Various Pot Sizes on extension Growth at Bonga in 2013-14.

Treatments	Plant height (cm)	Number of internodes per plant	Internode length (cm)	Girth (mm)	Leaf Number per plant	Leaf Area Index
Pot size						
11cm x 23cm	22.59[a]	7.52	3.01[a]	12.38	3.06	2.16[a]
6cmx 12cm	**22.32**[ba]	7.46	2.89[b]	12.37	3.05	2.05 [b]
8cm x 20cm	22.31[b]	7.48	2.88[b]	12.31	2.98	1.99[b]
LSD	0.27	NS	0.05	NS	NS	0.04
Varieties						
75227	24.39[a]	7.83[a]	3.15[a]	13.45[a]	3.33[a]	2.20[a]
741	24.34[a]	7.79[a]	3.17[a]	13.31[a]	3.36[a]	2.19[a]
7440	22.32[b]	7.48[b]	2.95[cb]	12.51[b]	3.08[b]	2.07[b]
Dessue	22.38[b]	7.38[b]	2.99[b]	12.57[b]	3.12[b]	2.06[b]
74110	20.50[c]	7.07[c]	2.75[cb]	12.04[c]	2.66[c]	1.93[c]
74112	20.51[c]	7.04[c]	2.82[c]	12.01[c]	2.65[c]	1.95[c]
LSD (5%)	0.48	0.3	0.15	0.31	0.15	0.05
CV (%)	1.508	3.29	3.57	1.9	3.44	2.53

Means followed by the same letter within a column are not significantly different at P≤ 0.05.

Shoot- root growth and Field survival

Dry weight of leaf, stem, root and total dry weight, root volume and shoot mass ratio were significantly ($p<0.05$) affected by the main effects of pot size and variety (Table 4), however, the interaction effects were not significant (Data not presented). Tap root length, relative growth rate, specific leaf area ratio and leaf area ratio were significantly ($p<0.05$) affected by the main effects of method of transplanting and variety; however, lateral root number, lateral root length and root to shoot ratio were affected only by the main effect of variety (Table 5).

The 11 cm x 23 cm size pot was superior in leaf dry weight, stem dry weight, root volume and total dry weight than the remaining pot sizes which were equal statistically; however, root dry weight showed no significant result at 6 cm x 12 cm pot size (Table 4). This was due to the volume size which favoured root growth due to the presence of adequate moisture, nutrients for optimum growth (Chane, 1991; Carlson and Miller, 2002).

A significantly ($p<0.05$) higher relative growth rate, specific leaf are (SLA) and leaf area ratio was found in the 8 x 20 cm pot size, while the lowest value was observed under 11 cm x 23 cm pot size. However, there was no significant ($p<0.05$) difference was observed between 8 cm by 20 cm and 6 cm by 12 cm pot sizes (Table 5). This result could be probably due to the larger growing media offers larger plant nutrient and increase vegetative growth at their early growth stage, the net assimilation rate in plant basis also increased at increasing rate, so it resulted for non-assimilatory tissue accumulation, as a result plant grown under larger pot size recorded lower RGR and SLA. This is consistent with the work of Armstrong and Westoby (2001) who reported the relationships between biomass and relative growth rate. The coffee varieties showed a clear difference in the various parameters considered (Table 4 and 5). This is in line with the work of Wintegens (2004) and Taye and Jurgen (2008).

Field survival percentage after field transplanting significantly ($p<0.05$) affected by Arabica coffee cultivars, however it was not affected by pot sized. The highest survival percentage mean value was recorded for 74110(97.94%), 7440(97.20%), Dessue(94.43%), and 74112(93.83%,, where as the lower mean value was obtained from 741(70.89%), and 75227(71.77%), Arabica coffee cultivars. This result could be probably due to the open growth habited Arabica coffee cultivars not able to perform well at higher altitude range, rather it could be suited at low land coffee growing area. This is in line with the work of (Endale *et al*.,2008) who reported that open Arabica coffee cultivars had revealed lower morphological and physiological performance at high land coffee producing area of the country.

Table 4. Dry matter partitioning as affected by *Coffea arabica* cultivars and different pot sizes

Treatments	Leaf Dry Weight (g)	Stem Dry Weight (g)	Root dry weight (g)	Root Volume (c^3)	Total Dry weight (g)	Shoot Mass Ratio
Pot size						
11cm x 23cm	0.80^{a}	1.38^{a}	1.18^{a}	5.06^{a}	3.56^{a}	0.68^{c}
6cmx 12cm	0.79^{b}	1.36^{b}	1.15^{ba}	5.03^{b}	3.51^{b}	0.73^{b}
8cm x 20cm	0.79^{b}	1.36^{b}	1.13^{b}	5.01^{b}	3.49^{b}	0.77^{a}
LSD	0.003	0.01	0.04	0.03	0.04	**0.03**
Varieties						
75227	0.96^{a}	1.67^{a}	1.19^{a}	5.70^{a}	4.02^{a}	0.78^{a}
741	0.97^{a}	1.68^{a}	1.18^{a}	5.56^{b}	4.03^{a}	0.77^{a}
7440	0.76^{b}	1.37^{b}	1.17^{ba}	5.27^{d}	3.49^{b}	0.76^{ba}
Dessue	0.76^{b}	1.36^{b}	1.15^{ba}	5.37^{c}	3.50^{b}	0.75^{b}
74110	0.66^{c}	1.07^{c}	1.11^{b}	4.17^{e}	3.05^{c}	0.67^{c}
74112	0.66^{c}	1.06^{c}	1.13^{ba}	4.14^{e}	3.04^{c}	0.64^{c}
LSD (5%)	0.02	0.03	0.06	0.04	0.04	0.02
CV (%)	0.66	1.71	3.88	1.42	1.37	**2.76**

Means followed by the same letter within a column are not significantly different at P≤ 0.05.

Table 5. Effects of *Coffea arabica* Cultivars and Various Pot sizes on Root and Shoot Growth

Treatments	Tap Root Length (cm)	Lateral Root Number	Lateral Root Length (cm)	Root to shoot ratio	Relative Growth rate (mg g^{-1} day^{-1})	Specific Leaf area (m^2 kg^{-1})	Field Survival Rate(%)
Pot size							
11cm x 23cm	20.02^{a}	48.77	161.74	0.15	62.50^{b}	3.36^{b}	89.574
6cmx 12cm	19.81^{ba}	48.66	161.82	0.15	63.60^{ba}	3.47^{ba}	86.379
8cm x 20cm	19.43^{b}	48.32	156.14	0.14	64.40^{a}	3.80^{a}	87.129
LSD	0.43	ns	ns	ns	1.3	0.27	NS
Varieties							
75227	21.26^{a}	50.86^{a}	150.63	0.10^{c}	59.30^{c}	2.68^{c}	71.778b
741	21.27^{a}	50.44^{a}	161.7	0.10^{c}	59.10^{c}	2.66^{c}	70.889b
7440	19.66^{b}	48.30^{b}	161.68	0.14^{b}	62.60^{b}	3.61^{b}	97.20a
Dessue	19.64^{b}	48.32^{b}	161.7	0.14^{b}	62.90^{b}	3.59^{b}	94.427a
74110	18.52^{c}	47.22^{cb}	162	0.19^{a}	68.70^{a}	4.33^{a}	97.94a
74112	18.17^{c}	46.35^{c}	161.67	0.19^{a}	68.50^{a}	4.37^{a}	93.833a
LSD (5%)	0.75	1.29	ns	0.08	2.3	0.47	9.04
CV (%)	2.68	**2.78**	**8.48**	3.37	**12.1**	**9.28**	**7.25**

Means followed by the same letter within a column are not significantly different at P≤ 0.05.

SUMMARY AND CONCLUSION

Arabica coffee cultivars seedlings have been rising at different coffee nursery site and various polythene bag sizes (pot sizes) are used to raise coffee seedling. Pot size that had been agronomic acceptance, selected by coffee producing farmers of study area to transplant a lot of coffee seedling at a time, by this study. In this field experiment significantly the highes the longest plant height (22.59cm), the largest LAI (2.16), the heaviest TDW (3.56 g) and the largest RV (5.06cm^3) observed on normal pot sizes (11cm diameter by 23 cm height), where as the longer plant height (22.32 cm), the larger LAI (2.05), the heavier TDW (3.51 g) and the larger RV (5.03 cm^3) mean values were obtained from coffee seedling grown under smaller pot size (6cm diameter by 12 cm height). Similarly, Arabica coffee cultivars 74110, 74112, 7440 and Dessue were showed the highest field survival percentage 97.94%, 93.83%, 97.20% and 94.43% after field transplanting, respectively. Pot sizes exerted significant effects on most seedling growth parameters, but the highest and the lowest significant levels among growth parameters mean values were not brought significance difference on Arabica coffee seedling survival rate after field transplanting. Generally, a great contribution for the highest field survival percentage of Arabica coffee after field transplanting was obtained from the three pot sizes that undertaken for this study, however there was no significance different among pot sizes. Moreover, it is useful to undertake further research

across media type, years and locations to put the recommendation on a wider scale.

REFERENCES

Adjet-Twum, D. M. and L. Solomon. 1992. Some Research Methods in Agronomy and Crop Physiology. *Ethiopian Journal of Agricultural Sciences* 9 (1): 10-13.

Anteneh Netsere, Endale Taye, Tesfaye Shimber, Taye Kufa and Amamuale Aserat. 2008. Pre-planting Management of Arabica coffee In Ethiopia. In: Girma Adugna, Bayetta Belachew, Tesfaye Shimber, Endale Taye and TayeKufa (eds.). Coffee Diversity and Knowledge. Proceedings of a National Workshop Four Decades of Coffee Research and Development in Ethiopia, 14-17 August 2007, Addis Ababa, Ethiopia. Pp. 178-185.

Armstrong, D. P and M. Westoby. 2001. Seedlings from large seeds tolerate defoliation better: a test using phylogenetically independent contrasts. Ecology Journal.74:1092–1100.

Bazira, H., M.A. Bekunda and J. S. Tenywa. 2002. Soil fertility aspects and dry matter recycling in coffee-based cropping systems. In: M. Gichuru and P. Woomer (eds). The Biological Management of Soil Fertility. Proceedings of the fifth tropical soil biology and fertility program (TSBF). Uganda, 14-19 May. 1995. 32p.

BoARD (2010) Bureau of Agricultural and Rural Development Annual report. Crop Performance report for 2008/2009 cropping season. Crop production department, Hawassa. 68p.

Carlson, W. C. and D. E. Miller. 2002. Target Seedling Root and Shoot System size, Hydraulic Conductivity and Water use during seedling establishment. Paper presented at the Combined Meeting of the Western Forest Nursery Council and Intermountain Forest Nursery Association, Roseburg, OR, August 13-17, 2002. Pp.175-195.

Chane Abate, A.1991. Effect of Media composition, Volume and Nutrition on Coffee Arabica Seedlings. Haramaya University of Agriculture School of Graduate Studies. M.Sc.Thesis. Haramaya University, Haramaya. 85p.

Central Statistics Agency (CSA). 2010. Agricultural Sample survey: Report on area and Production of crops (private peasant holdings, meher season). Addis Ababa, Ethiopia. Bulletin 446. Volume. 4. pp58.

Endale, T. K. Taye, N. Anteneh, S. Tesfaye, Y. Alemseged, and A. Tesfaye. 2008. Research on Arabica Coffee field Management. In: Girma Adugna, Bayetta Belachew, Tesfaye Shimber, Endale Taye and TayeKufa (eds.). Coffee Diversity and Knowledge. Proceedings of a National Workshop Four Decades of Coffee Research and Development in Ethiopia, 14-17 August 2007, Addis Ababa, Ethiopia. Pp.187-194.

Ethio. Agri- CEFT (Wushwush Tea production and processing Industry). 2011. Compiled Annual reports Climate data. SNNPRS. Kafa, Bonga. 35p.

Francis, B., Taye Kufa, S. Kumar, J. Okwadi, E. A. Pozo and Africa. Zeleke. 2000. Natural Resource Under Threat. An analysis of the farmers systems Gimbo Woreda, Kafa- shika zone. International centre for development Oriented Research in Agriculture (ICRA). Wageningen, The Netherlands. Pp 5-57.

Institute of Agricultural Research (IAR).1996. Recommended Production Technologies for Coffee and Associated Crops. Institute of Agricultural Research, Addis Ababa. 18p.

Jonckheere, I., S. Fleck, K. Nackaerts, B. Muys, P. Coppin, M. Weiss and F. Baret. 2004. Review on Cultivar Differences in Morphologies and Methods for in situ leaf areaindex and stem girth determination. In: Theories, sensors and hemispherical photography. Agric. For. Meteorol. Pp. 19-35.

Kafa Zone Departments Agriculture and Rural Development(KZDOA). 2010. Five Year Coffee Production Assessment Report. Crop Production Section, Bonga. 61p.

Lambers H. and B. Poorter. 2008. Inherent variation in growth rate between higher plants: a search for physiological causes and ecological consequences. Adv Ecol Res 23:187–261.

MoARD(Ministry of Agricultural and Rural Development) five year performance report. 2010.Crop performance report for 2008/2009 cropping season. Department of crop production Addis Abeba. 105p.

SAS Institute Inc. (2000). SAS OnlineDoc®, Version 9.2, Cary, NC: SAS Institute Inc.

Scott, S.J., R.A. Jones and W.A. Williams. 1994. Review of data analysis methods for seeds germination. Crop Sci.24:1192-1199.

Seyoum Seifu.2003. Genetic Divergence for Seedling Parameters and Associations amongAgronomic Traits in Ethiopia coffee (*Coffea arabica L.*) germplasm. An Msc. Thesis Presented to the school of Graduate Studies of Alemaya University.90p.

Sobrado, M.A. 2005. Leaf age effects on Photosynthetic rate, Transpiration Rate and Nitrogen Content in a Tropical Dry Forest. Physiol Plant 90:210–215

Taye Kufa, and B. Jurgen 2008. Ecophysiology of Wild *Coffea arabica* populations in Montane Rainforests of Ethiopia. In: Girma Adugna, Bayetta Belachew, Tesfaye Shimber, Endale Taye and TayeKufa (eds.). Coffee Diversity and Knowledge. Proceedings of a National Workshop Four Decades of Coffee

Research and Development in Ethiopia, 14-17 August 2007, Addis Ababa, Ethiopia. Pp. 140-148.

Tripathi, R.S. and M.L. Khan. 1990. Effects of seed weight and micro site characteristics ongermination and seedling fitness in two species of Quercus in a subtropical wet hill forest. Oikos 57: 289-296.

Whitcomb, C.E. 2002. Growing tree seedlings in containers. Okia. State University, Agri. Exp. Bull. Pp.14-18.

Wintegens, J. N. 2004. Coffee: Growing, Processing, Sustainable Production. WILEY-VCH Verlag GmbH &Co.KGaA, Weinheium.Pp 568-689.

Wondyifraw, T. 1994. The Influence of Duration of storage, Initial Moisture Content and Type of container on the Viability of Coffee (Coffea arabica) Seeds. M.Sc. Thesis. Haramaya University, Haramaya. 79p.

Worku. M. and T. Astatkie. 2008. Dry matter Partitioning and Physiological Responses of *Coffea arabica* Varieties to Soil Moisture Deficit Stress at the Seedling Stage in Southwestern *Coffee agronomy Journal*. Pp.2-15.

Yacob Edjamo, Mohammedur Abachebsa, Taye Kufa and Alemseged Yilma.1993. Leaf area estimation in CBD resistant Coffea arabica L. to design a prototype area meter. Paper presented on the 5th Annual Conference of Crop Sci. Soc. of Ethiopia, Addis Ababa, Ethiopia.Pp.45-49.

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