Plantation and Agroforestry Research Directorate

Working Paper Series 03/2019

Addis Ababa, December 2019

Early growth performance of *Cordia africana* Lam. in provenance and progeny tests at Tepi, south-western Ethiopia

Abayneh Derero[1], Ashenafi Manaye[2], Fekadu Hailu[3], Gemedo Furo[4] and Melkamu Terefe[3]

1 Ethiopian Environment and Forest Research Institute, Addis Ababa, P.O.Box 24536 code 1000, Ethiopia; abaynehdd2009@gmail.com; 2 Mekelle Environment and Forest Research Center; 3 Jimma Environment and Forest Research Center; 4 Hawassa Environment and Forest Research Center

Report summary

Provenance and progeny trials were conducted on *Cordia africana*, which is a widely planted native tree in Ethiopia. The study aimed at quantifying the differences in growth and genetic parameters among *Cordia africana* provenances and families at Tepi in the humid lowlands of south-western Ethiopia. The provenance trial consisted of 12 provenances that were planted in RCBD design (12 tree plots and five replications), and the progeny trial had 39 open-pollinated families in single-tree plots and twenty replications. Data were analysed employing logistic regression and linear mixed model. Heritability values were also estimated for the different traits. The survival and tree forking incidence did not reveal significant differences among the provenances. Growth had significant differences among the families tested. The narrow-sense heritability both for the tendency to form multiple stems and the first forking height at the age of one was about 0.1, and the mean heritability over 5 ages for DBH and height was 0.29 and 0.46, respectively. We conclude that local provenance is not necessarily the best and genetic gain can be realized by early selection of families with focus in traits related to growth performances.

1. Introduction

Forest development and tree planting in agricultural and other landscapes are essential for sustainable production of wood and non-wood products and for a range of ecosystem services. The Climate Resilient Green Economy strategy implemented in Ethiopia sets ambitious afforestation and reforestation goals with the aim of re-establishing forests for their economic and ecosystem services (FDRE 2011).

Due consideration needs to be given to matching of species to planting sites as well as using well adapted and productive provenances of the plantation species during planning and implementation of afforestation and reforestation programmes (Evans 1987; Hawe and Short 2012). Specifically, provenance research is essential to identify well growing and sufficiently adapted tree populations that can be used as seed sources for afforestation and reforestation (König 2005), to defining seed zones (Ying and Yanchuk 2006) and to observe adaptive genetic variation across provenances under specific climate conditions (Sáenz-Romero et al. 2011; Schueler et al. 2013). In addition, progeny trials either separate or coupled with provenance trials can be used to evaluate growth, heritability, and expected genetic gain from selections (Moura and Dvorak 2001).

The tree species under investigation, *Cordia africana* Lam. (Boraginaceae), is a tree species native to 17 different countries in tropical Africa and tropical Arabia (Friis 1992; Warfa 1988). The species is widespread in montane forests, in riverine forests as well as in the western lowlands in Ethiopia (Derero et al. 2011). Generally, the species grows in areas with altitudes between 550 and 2600 m a.s.l. and annual rainfall of 700 to 2000 mm (Friis 1992). It is an early colonizer in forest re-growth and is often found along forest margins, regenerates in clearings and forest gaps (Derero et al. 2003; Fichtl and Adi 1994). The species is one of the tree species exploited commercially for timber (Abebe and Holm 2003) in several parts of Ethiopia for furniture, doors, windows and several other utilities. It is also valued as an agroforestry tree species as coffee shade and honey bee flora and the heavily shade leaves contribute to the nutrient cycling through decomposition (Fichtl and Adi 1994; Negash 1995; Teklay and Malmer 2004; Yadessa et al. 2009). Hence, the tree is commonly found in agricultural landscapes (Samuel et al. 2019) as a scattered tree system and contributes in soil improvement (Gindaba et al. 2005; Yadessa et al. 2009). Thus, the species is one of the commonly planted (but in small quantities) broadleaf tree species in Ethiopia owing to its wide adaptation to the different climatic and edaphic conditions in Ethiopia and its multiple uses and services. A recent study showed that the share of *C. africana* was only 0.22% of seedlings produced in Ethiopian tree nurseries (Lillesø and Derero 2019).

However, the knowledge on provenance differences on the species is not adequate. A provenance research carried out in southwestern Ethiopia involving 19 provenances of *Cordia africana* reported significant height differences at the age of six (Abate and Mihretu 1994). Another study carried out in Sudan compared three provenances for their responses to soil drying, but reported no significant variations (Khalil and Abdelgadir 2003).

The objectives of the current study were (1) to quantify differences in growth performances of *Cordia africana* among 12 provenances coming from the geographical range of 6.49° -11.41° N and 35.14° - 42.07° E in a provenance test, and (2) to quantify differences in growth performances of families and genetic parameters of selected traits in a progeny test. The study was done at Tepi (7°10'46"N and 35° 25'16.5E), which is in a humid south-western lowland of Ethiopia.

2. Methods

2.1. Mother tree selection and seed collection

Seeds were collected in 12 various natural populations (Figure 1).

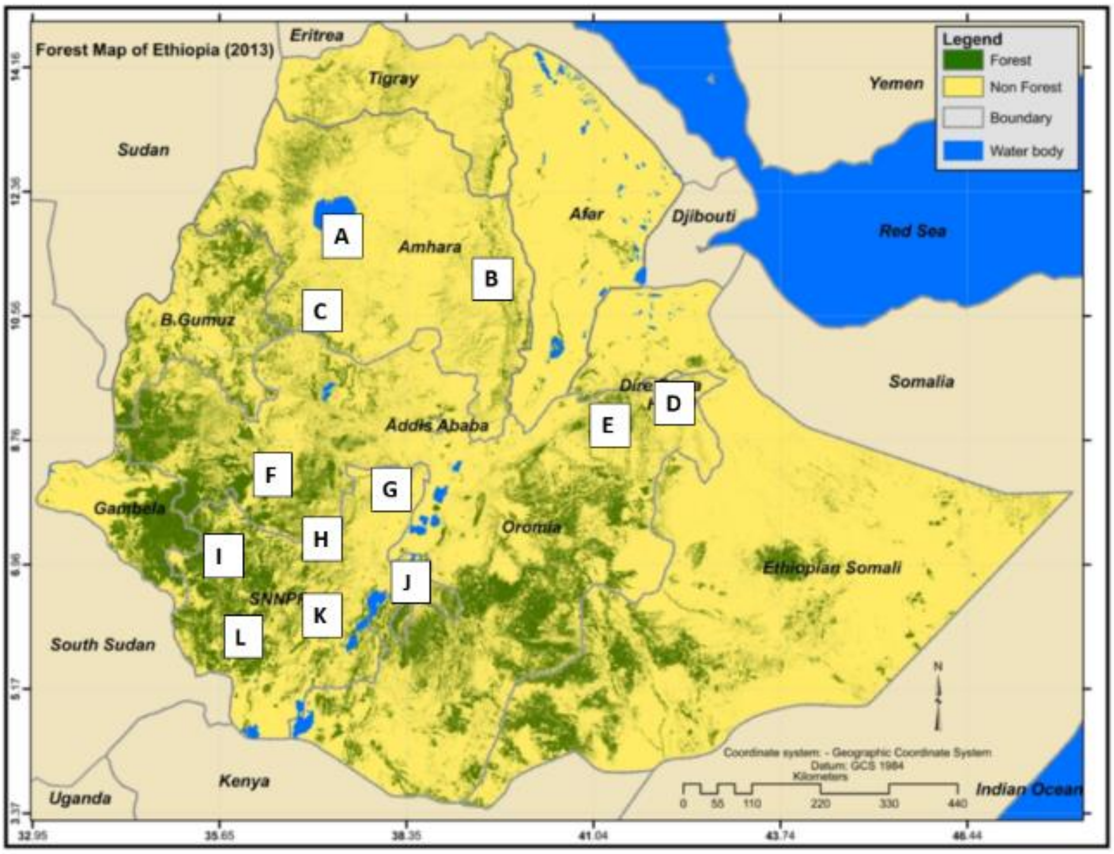

Figure 1 Approximate location of the sampled provenances of Cordia africana in Ethiopia (*A* Zeghie, *B* Kemisse, *C* Finoteselam, *D* Harar, *E* Hirna, *F* Didessa, *G* Butajira, *H* Sokoru, *I* Meti, *J* Wondogenet, *K* Boditi, *L* Guraferda)

Table 1 Growth characters, number of seed trees and environmental variables across the sampled provenances of *Cordia africana*

Provenance	No of seed trees	Growth characters: DBH (cm) Mean	DBH (cm) SD	Total Height (m) Mean	Total Height (m) SD	Clear bole length (m) Mean	Clear bole length (m) SD	Average altitude (m a.s.l.)	Latitude (N)	Longitude (E)
Boditi	16	36.9	11	11.4	1.79	4.4	1.94	2050	6.57	37.52
Butajira	15	34.2	11	13.5	2.36	4.6	0.91	2070	8.07	38.23
Didessa	17	37.2	9.1	13.7	3.02	3.8	1.23	1475	8.40	36.21
Finoteselam	24	29.8	5.8	12.5	2.51	6.0	1.68	1875	10.41	37.11
Guraferda	15	40.1	11	19.0	2.49	6.1	2.05	1050	6.49	38.18
Harar	16	29.4	7.3	14.4	2.35	5.7	1.14	1900	9.18	42.07
Hirna	16	31.4	7.9	15.2	2.79	5.3	1.36	1850	9.12	41.05
Kemisse	15	36.1	8.7	8.7	2.40	5.2	1.23	1500	10.43	39.52
Meti	25	61.8	15	22.8	3.10	7.6	2.60	1250	7.17	35.14
Sekoru	18	39.7	8.9	18.4	3.04	7.2	2.47	1900	7.55	37.25
Wondogenet	17	43.0	17	15.8	2.65	6.7	1.75	1800	7.06	38.37
Zeghie	26	30.7	9.2	14.5	0.71	6.7	2.20	1850	11.41	37.19

In each population, seeds were collected from 15 to 26 trees with good growth and shape for timber production, keeping a minimum distance of 50 m between any trees to capture the genetic variation within the population. The populations have an altitudinal range of 1050 to 2070 m a.s.l. and represent well the diverse physiognomic features of the country. Details of the tree parameters, location and seed characteristics of the populations where seeds were collected for the provenance and progeny research are given in Table 1.

2.2. Site description

The experimental site is located at Tepi (7˚10'46"N and 35˚ 25'16.5E, at altitude of 1200 m asl, Figure 2), which is a representative site for luxurious growth of the species in Ethiopia. The site is in Yeki woreda (district) where two Afromontane forest types are dominant: the moist transitional forest and the rain forest and the experimental site is located within the geographical range of former type. Coffee and spices are grown in the area, The annual rainfall at the experimental site is 1415 mm, well distributed over eight months (March to October), the maximum average annual temperature is 21.4 °C (https://en.climate-data.org, accessed on 26 Feb. 2020). The soil types in the area are dominated by Nitisols. red coffee soils, and fertile loam soils (eiar.gov.et accessed on 27 Feb. 2020).

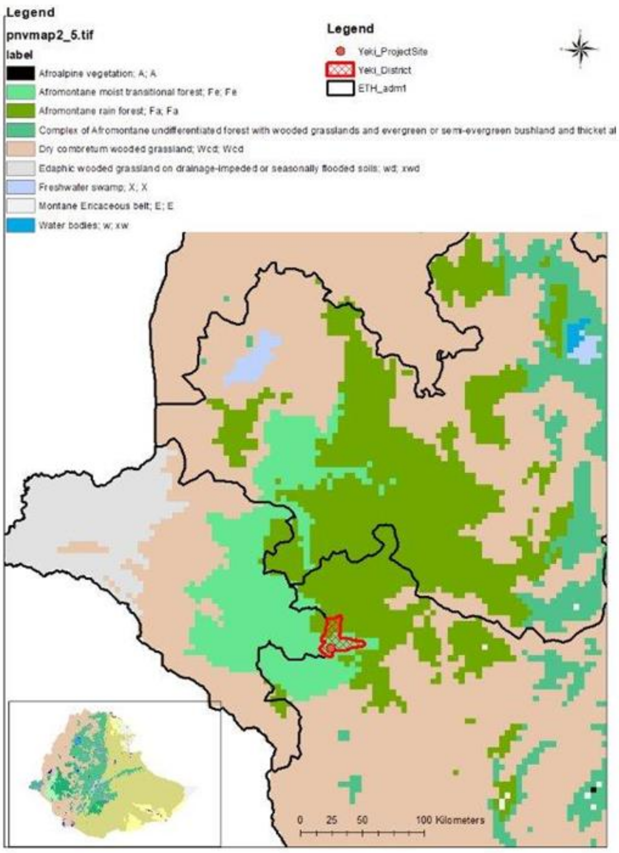

Figure 2 Location of the experimental site (Yeki woreda) shown on the potential natural vegetation map of Ethiopia

2.3. Experimental establishment and data collection

In this study, a provenance trial and a progeny trial were investigated.

The provenance trial (ST1) was established as a completely randomised block design RCBD with five blocks, and 12 plots per block. Each plot contained twelve seedlings of each of the 12 provenances were planted per each plot. There was one row of border tree around the experiment with the same spacing. Seedlings were planted in 2 x 2 m spacing. The total number of seedlings including the border trees was 898 and the total area was 0.36 ha.

Progeny trial (ST2): The experimental design of the progeny trial was RCBD with single tree plots and 20 replications and with uniform spacing (between seedlings, between plots, between blocks) of 2 m. A total of 39 half-sib families from three provenances (13 families from Butajira, 11 families from Harar and 15 families from Hirna) with 20 progenies each were planted randomly in single tree plots in each block. An additional tree was planted so that each block consists of 40 single-tree plots, but from which data was not collected. One row of trees was planted around the families to avoid boundary effects. The total number of seedlings was 920 and the total area was 0.37 ha.

The seedlings for both the both trials were produced at the Tepi nursery and planted in the experiments in August 2013. Six months after planting, data on survival (dead/alive), collar diameter and height were collected for each tree in the experiment. Each year, data on survival rate, total height and diameter at breast height (DBH) were collected. Trees forking below 1.3 m height were considered as separate stems for dbh measurement. Forking conditions (first forking height) and number of stems per individual tree were also assessed.

2.4. Statistical analysis on ST1

Descriptive statistics (mean and standard deviations) were computed for survival, collar diameter, diameter, total height and first forking height. Separate binary logistic regressions were computed on survival data at the different ages by treating both provenance and block as covariates in the model. Analysis of variance in a linear mixed model for growth data were conducted in a restricted maximum likelihood (REML) method by considering provenance as a fixed effect, block as random effect and age as a repeated effect. In addition, stem form was evaluated based on the data at 1 year of age: the number of stems per plant and forking height in a univariate general linear model, and differences in the existence of forking among all the provenances in a binary logistic regression. All statistical analysis was conducted in SPSS 20. Mean values of dbh and height of each provenance over the five years were plotted in R.

2.5. Statistical analysis on ST2

The growth data from the progeny trial was analysed in a linear mixed model employing a restricted maximum likelihood (REML) method by considering family as a fixed effect, block as random effect and age as a repeated effect. Similarly, a separate analysis of the performance of the three provenances in the progeny trial was conducted in a linear mixed model employing a restricted maximum likelihood (REML) method by considering provenance as a fixed effect, block as random effect and age as a repeated effect. In addition, the tendency to form multiple stems (number of stems per tree) and the first forking height was evaluated based on year 1 data. Family and provenance effects were evaluated in separate analysis by taking each of them as fixed factor and block as random factor in a univariate general linear model.

In addition, variance components for random effects (family, family-block interactions) were computed employing the restricted maximum likelihood (REML) method in the general linear model. Then narrow-sense heritability (dbh, total height, stem number and first forking height) was computed as the ratio of the additive genetic variance to the total phenotypic variance, and equation 1-3 adapted from (White et al. 2007) were employed. Furthermore, coefficient of additive genetic variation was computed using equation 4 adapted from Garcia-Gonzalez et al. (2012):

$$\sigma^2_A = 3*\sigma^2_f \quad (1)$$

$$\sigma^2_p = \sigma^2_f + \sigma^2_{fb} + \sigma^2_e \quad (2)$$

$$h^2 = (3*\sigma^2_f) / (\sigma^2_f + \sigma^2_{fb} + \sigma^2_e) \quad (3)$$

$$C\sigma^2_A = \sqrt{\sigma^2_A} / \bar{X} \quad (4)$$

where

σ^2_A is the additive genetic variance

$C\sigma^2_A$ is the coefficient of additive genetic variance

σ^2_p is the phenotypic variance among individual trees

h^2 is heritability (narrow-sense)

σ^2_f isthe variance among the half-sib family effects

σ^2_{fb} isthe variance due to the family block interaction effects

σ^2_e isthe residual variance

$C\sigma^2_A$ is the coefficient of additive genetic variance

$\bar{X}$ is the phenotypic mean of the trait under consideration

3. Results

3.1. Survival

The overall survival in the ST1 varied from 73 (±44) % on sixth month to 68 % at 4.5 (±47) year after planting. While the mean survival of the local provenance Meti (located near Tepi) over the years varied between 58-62%, the provenances such as Hirna exhibited higher survival of 78-85% over the five years (Table 2). Logistic regression did not reveal significant difference in survival among the provenances at any of the periods.

Table 2. Rate of seedling survival (%), growth, stem number and stem form at various ages after establishment.

Provenance	Mean survival 6 month	Mean survival 4.5 year	Mean DBH (cm) 4.5 year	Mean Height (m) 4.5 year	Mean number of stems per plant 1 year	Forked trees (%) 1 year	First forking height (cm) 1 year
Bodity	73	68	7.31	9.39	2.9	95.5	61.9
Butajira	67	57	6.35	7.38	2.5	95	42.9
Didessa	83	80	7.02	8.22	2.8	98	62.6
Finoteselam	77	75	7.01	7.89	2.9	100	58.5
Guraferda	75	70	6.29	7.14	2.6	95.6	64
Harar	52	45	6.67	7.70	2.5	100	58.1
Hirna	85	78	5.82	6.39	2.7	96.1	44.2
Kemisse	75	67	6.95	8.21	3	100	41.2
Meti	62	58	5.16	6.17	2.6	94.6	50.2

Sekoru	77	72	6.05	7.22	2.8	100	41
Wondogenet	82	73	6.27	7.99	2.8	95.8	42.5
Zeghie	73	68	6.73	7.37	2.8	100	55.5
Mean	73	68	6.45	7.56	2.8	97.5	51.7
SD	44	47	2.74	2.81	1	15.5	49.9

3.2. Growth differences

The analysis of growth evaluated from the ST1 revealed that *Cordia africana* on average attained a mean dbh of 6.45 (±2.74) cm and a mean height of 7.56 (±2.81) m in the fifth year after planting. The mean growth at the fifth year is given in Table 2, and the pattern of growth of the different provenances is shown in Figures 3 and 4. The analysis of variation in growth among the provenances in the general linear mixed model did not reveal significant differences among the provenances.

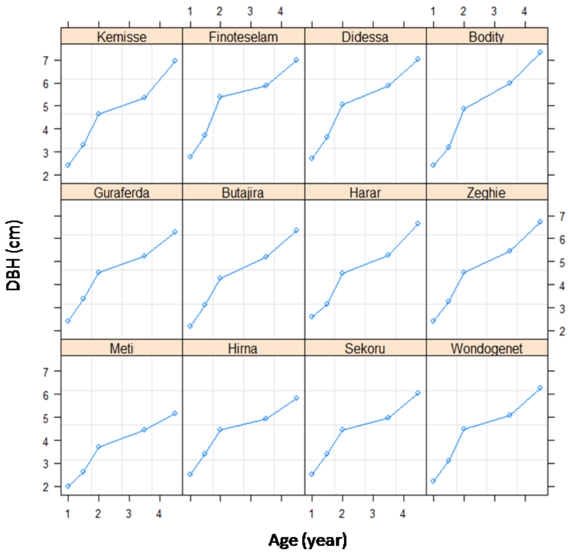

Figure 3 Diameter at breast height (cm) of 12 provenances at five different ages at Tepi in south-western Ethiopia

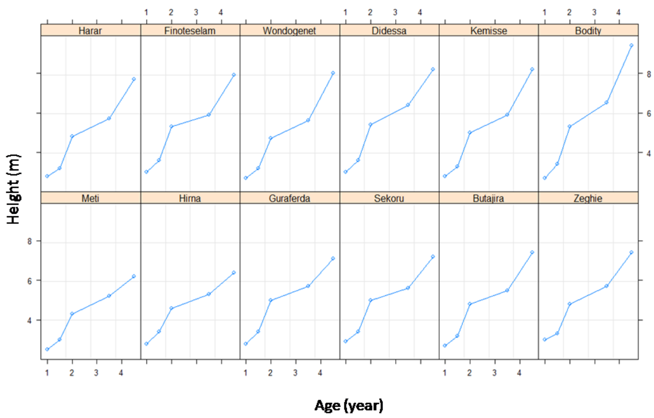

Figure 4 Height (m) of 12 provenances at five different ages at Tepi in south-western Ethiopia

3.3. Stem form

Analysis of stem form in the ST1 at 1 year of age revealed that, almost all (97.5%) of the trees forked with 2.8 stems per plant on average (Table 2). The mean forking height was 51.7 (±49.9) cm. There was no significant difference among the 12 provenances neither for number of stems per plant nor for forking height. In addition, logistic regression didn't reveal significant differences in forking conditions (forking, not forking) among the provenances.

3.4. Family growth differences and genetic parameters of selected traits

The analysis of the growth data from the ST2 in a mixed model revealed significant differences ($p < 0.001$) for dbh and height among the families. A separate analysis of the performance of the three provenances in the ST2 similarly revealed significant differences ($p < 0.001$) for dbh and height. The mean growth performance of each family at the fifth year is given in Appendix 1, and results show that most of the best performing families belong to the Butajira provenance. In addition, the analysis of year 1 data on tendency to form multiple stems revealed significant differences among the families ($p = 0.001$) and among the three provenances ($p = 0.001$). There was also significant difference for the first forking height among families ($p = 0.018$) and among provenances ($p = 0.003$). Almost all (98.7%) individuals forked, and logistic regression didn't reveal significant differences among families and among provenances.

The additive genetic coefficient of variation ranged from 15.6 to 25.2% for dbh, 14.7 to 26.2% for height at different ages, and it was 36.7% for first forking height and 10.8% for number of stems per plant evaluated at the age of 1 year (Table 3). Heritability at age one for the first forking height and the number of stems per plant was about 0.1, and the heritability of the dbh ranged from 0.195 at age 1 to 0.407 at age 3.5, and that of height ranged from 0.427 at age 1.5 to 0.499 at age of 4.5 (Table 3).

Table 3. Phenotypic mean, heritability and additive genetic coefficient of variation (CV_A) of selected traits at different ages assessed from *Cordia africana* progeny trial at Tepi, south-west Ethiopia

Trait	Mean	Heritability	CV_A
DBH1 (cm)	3.1	0.2	15.6
DBH1.5 (cm)	4	0.22	18.6
DBH2.5 (cm)	5.4	0.31	23.9
DBH3.5 (cm)	6.2	0.41	25.2
DBH4.5 (cm)	7.4	0.32	21.6
Height1 (m)	3.3	0.49	14.7
Height1.5 (m)	3.8	0.43	15.2
Height2.5 (m)	5.3	0.43	16
Height3.5 (m)	6.1	0.44	21.7
Height4.5 (m)	7.8	0.5	26.2
Year 1 first forking height (cm)	51.7	0.1	36.7
Year 1 number of stems per plant	2.8	0.11	10.8

4. Discussion

The maintenance of the initial survival percentage (73 %) over the five years with less mortality afterwards and the absence of significant differences among the provenances in survival percentage indicate that any of the provenances could be grown in the humid lowlands in south-western Ethiopia. Likewise, no significant difference was reported for survival among provenances of *Cordia alliodora* at five years of age in Brazil (Sebbenn et al. 2007). In addition, (Cundall et al. 2003) reported the absence of significant differences for survival among provenances of another broad-leaved species, *Fraxinus excelsior*, in five out of six experimental sites in England and Wales. In addition, no significant differences were reported for *Eucalyptus grandis* provenances for survival at the age of eight years at Wondo Genet, southern Ethiopia (Hunde et al. 2003a). However, this is not a generalization as significant differences, for example, were reported for other broad-leaved species such as *Eucalyptus saligna* provenances at Wondo Genet at the age of eight years (Hunde et al. 2003b)and for *Juglans nigra* at the age of 22 years old (Bresnan et al. 1992) in the Midwestern United States. A third category of results reported both significant and non-significant results for *Gmelina arborea* provenances at the age of five depending on experimental sites (Lauridsen and Kjaer 2002).

The heaviest mortality (27%) happened only before the seedlings reached six months old, and such mortalities are often taken care of by beating up plantings to ensure a better and uniform initial stocking. The markedly higher survival percentage of some of the provenances such as Hirna, which exhibited higher survival (85-78% of survival over the five years) as compared to the local provenance Meti (62-58% over the five years), indicates that the local provenance is not always the best. In fact, the notion of a 'local is best' sourcing practice is argued against strongly since such a practice may also mean encouraging the use of seed sources that do not have enough genetic variation and evolutionary potential or adaptive potential to the rapidly changing environmental conditions(Boshier et al. 2015; Breed et al. 2013; Sgro et al. 2011).

The mean growth attained in the fifth year (dbh of 6.45 and height of 7.56) is comparable or superior to growth of abroad-leaved species of the same genus, *Cordia alliodora*, under tropical climatic conditions elsewhere: it grew to about 6 cm in dbh but could attain mean height of only below 6 m (Sebbenn et al. 2007).A much slower growth is reported for *Cordia africana* (a mean height of < 4 m) in the highland Vertisols of Ethiopia (Mekonnen et al. 2006).

The absence of significant differences among the provenances evaluated also shows that there is no as such superior or inferior provenance in terms of growth, and thus any provenance of the species could be used in afforestation and reforestation activities in the humid lowlands of the south-western Ethiopia. Evaluation of the performance of 13 provenances of *E. grandis* at Wondo Genet at the age of eight years revealed significant differences for stem and branch diameters (Hunde et al. 2003a) whereas study conducted on ten provenances and one land race at Wondo Genet on *Eucalyptus saligna* revealed no significant differences in tree height, diameter, volume and stem form at eight years of age (Hunde et al. 2003b).

The marked difference in growth between the highest performing Bodity provenance and the local provenance Meti again indicates that the local provenance is not necessarily the best in terms of growth. Another study reported that among 20 *Acacia nilotica* provenances planted in India, the local source performed very poor and ranked fourth-last in respect of height growth at six years of age (Ginwal and Mandal 2004).Similarly, (Cundall et al. 2003)noted that there was no as such height growth superiority of the local provenance in their common ash provenance trials.

The forking incidence, which was observed on almost all the trees, could be due to insect attack(Kerr and Boswell 2001; Ofori et al. 2007) or it could also be under a large degree of genetic control (Callister 2013). But our data didn't reveal genetic control at provenance level as there was no statistically significant differences among the provenances.

The existence of significant differences for growth parameters (dbh and height), first forking height and the tendency to form multiple stems among the families indicates that genetic gain through selection of plus trees from existing stands is feasible, and as such removing inferior families would increase the gain. Similarly (Mwase et al. 2008) reported significant differences for height, dbh, straightness and forking among 36 families of *Fraxinus excelsior* at the age of 3 to 8 years. However, the fact that almost all individuals (98.7%) did fork entails the need for intensive management and protection of *Cordia* stands to greatly minimize the incidence.

The three provenances in the ST2 similarly differed significantly for the growth parameters and stem form (first forking height, number of stems per plant) and this is essentially in agreement with several other findings on broad-leaved species (e.g. (Kien et al. 2009; Sudrajat et al. 2016), but could not be conclusive as the provenances compared here are two few to make valid comparisons.

The highly comparable additive genetic coefficient of variation (15.6-26.2%) of the growth parameters (dbh, height) indicates both are highly variable and merit equal attention during selections, and a tree volume-based selection might generally give better results. Reported results of additive genetic coefficient of variation for *Fraxinus excelsior* was much higher for height (10.2-12.7%) than for dbh (1.5-2.1%) (Mwase et al. 2008). However, the highest coefficient was coming from the first forking height (36.7%), hence selection and management should aim at minimum forking incidence and a lower forking height as much as possible.

The heritability values were generally the highest for height, medium for dbh and lowest for stem form (the first forking height and the number of stems per plant) indicating that intensive management may be needed to increase heritability of the stem form. A study on heritability of ash (*Fraxinus excelsior*) also reported similar patterns: height most heritable trait followed by dbh whereas stem form to be not under strong genetic control (Mwase et al. 2008).Similarly, higher heritability values for diameter and height and lower values for stem form were reported for open-pollinated single tree families of the broad-leaved mahogany (*Swietenia macrophylla*) in Costa Rica(Navarro and Hernández 2004).

5. Conclusion

The research has investigated on growth performances of 12 provenances and 39 families (from three of the provenances) of *Cordia africana* in sites located in the south-western humid lowlands of Ethiopia. A few provenances and families were included in the trial than planned due to the lack of uniform and enough germination to represent each genetic entry in a single provenance/progeny trial.

The analysis of the provenance test data at the five years of age revealed that the trees have attained a dbh of 6.45 (±2.74) cm and a height of 7.56 (±2.81) m on average. No statistically significant differences are reported for survival, growth and tree form (forking) among the provenances implying that all the tested provenances have comparable growth potential and adaptation in the humid lowlands of the south-western Ethiopia and local provenance is not necessarily the best. Generally, the evaluation of the trial in the fifth year gives indicative results, but provenance trials of broad-leaved species such as *Cordia africana* require longer observation periods than conifers to obtain conclusive results on growth and yield (König 2005).Therefore, more provenance trials at different locations should be initiated, and long-term data needs to be generated to get conclusive results. In fact, the trials on the species initially were established at three different locations in the country, but two of the sites had severe seedling survival problems and hence not included in this study.

ST2 revealed significant differences among the families. The study reports genetic parameters of selected traits for *Cordia africana* for the first time. The additive genetic coefficient of variation for dbh and height at the different ages was highly comparable, and it was the highest for the first forking height and the least for the number of stems per plant. Height has generally the highest narrow-sense heritability followed by dbh, and the heritability for the tendency to form multiple stems and the first forking height was generally low indicating that height is under stronger genetic control when compared with the other traits. We also conclude that significant genetic gain can be realized by early selection of families for growth performance than stem form.

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Appendix Table 4. Mean growth of 39 families from three provenances of *Cordia africana* at fifth year after planting in a progeny trial at Tepi, south-west Ethiopia, in decreasing order of family mean heights

No.	Provenance	Family code	Mean height (m)	Relative height	Mean DBH (cm)	Relative DBH
1	Butajira	Bj12	10.1	1.3	9.5	1.3
2	Butajira	Bj8	9.9	1.3	9.1	1.2
3	Butajira	Bj1	9.8	1.3	9.4	1.3
4	Butajira	Bj2	9.8	1.3	8.8	1.2
5	Harar	Ha3	9.4	1.2	9.2	1.2
6	Butajira	Bj5	9.2	1.2	8.3	1.1
7	Butajira	Bj3	9.2	1.2	8.4	1.1
8	Butajira	Bj7	9.2	1.2	8.9	1.2
9	Butajira	Bj10	9.1	1.2	8.4	1.1
10	Butajira	Bj13	9.1	1.2	9.3	1.3
11	Hirna	Hi15	9	1.2	7.9	1.1
12	Harar	Ha12	8.9	1.1	8.2	1.1
13	Butajira	Bj4	8.6	1.1	7.7	1.0
14	Butajira	Bj6	8.6	1.1	8.5	1.1
15	Butajira	Bj14	8.4	1.1	8.4	1.1
16	Harar	Ha7	8.4	1.1	8.3	1.1
17	Hirna	Hi13	8.1	1.0	7.6	1.0
18	Butajira	Bj9	8	1.0	7.4	1.0
19	Harar	Ha1	7.9	1.0	8	1.1
20	Harar	Ha6	7.6	1.0	8.1	1.1
21	Hirna	Hi7	7.6	1.0	6.8	0.9
22	Harar	Ha4	7.5	1.0	7.2	1.0
23	Harar	Ha8	7.3	0.9	7.5	1.0
24	Harar	Ha5	7.2	0.9	6.8	0.9
25	Harar	Ha9	7.2	0.9	7	0.9
26	Hirna	Hi6	7.2	0.9	7	0.9
27	Hirna	Hi3	6.8	0.9	6.2	0.8
28	Harar	Ha13	6.7	0.9	6.4	0.9
29	Hirna	Hi4	6.7	0.9	6.7	0.9
30	Hirna	Hi2	6.7	0.9	6.2	0.8
31	Harar	Ha15	6.6	0.8	6.7	0.9
32	Hirna	Hi1	6.5	0.8	6.8	0.9
33	Hirna	Hi12	6.5	0.8	6.9	0.9
34	Hirna	Hi10	6.4	0.8	6	0.8
35	Hirna	Hi5	6.3	0.8	6.2	0.8
36	Hirna	Hi9	5.8	0.7	5.5	0.7
37	Hirna	Hi11	5.5	0.7	6	0.8
38	Hirna	Hi14	5.5	0.7	5.6	0.8
39	Hirna	Hi8	5.2	0.7	5.2	0.7
		Total	7.8	1.0	7.4	1.0