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Effect of Seed Treatment and Nursery Potting Media on Emergence and Seedling Growth of Korarima (*Aframomumcororima* (Braun) P.C.M.Jansen)

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ABSTRACT

*Korarima (Aframomum corrorima) is native crop to Ethiopia, tropical herbaceous, perennial and aromatic spice and medicinal crop widely used in traditional dishes, and sold at higher prices. Research has comparatively been less in korarima although these plants promising economic value. Korarima can be propagated by seed and vegetative parts. Germination of seeds has problem of seed dormancy, which may be associated with the hard seed coat and impermeable. Improved varieties, agronomic practices like seed propagation techniques among the production constraints have not been well studied and documented. Thus, the current study was conducted with the objective of determining the effect of different seed treatment method and media composition on seed emergence and subsequent seedling growth. **E**xperiment has two factors**.** Soil media **(**Forest, Top , Forest : Top , Forest : compost , Top : compost , Forest : Top soil : compost, Top : compost (0.75:0.25)), & Seed treatment (,0 hrs,24 hrs , 48 hrs , 72 hrs , & 50% sulfuric acid soaking for 60 minutes) factorial arrangement using RCBD with three replications. Analysis of Variance using statistical analysis system version 9.2 software. Treatment means were separated using LSD at 0.05 probability level. The results of these experiments of the ANOVA indicated that there were interaction effect of between the factor was highly significant (P<0.1) in respect of emergence and seedling parameters. The interaction effect of seed treatment by soil media was highly significant (p<0.01) for mean days to emergence and emergence %. Korarima seeds sown in mixed forest and top soil. The highest score of emergence percentage for Korarima seeds sown in mixed forest and top soil (85.63).. In general, treatments showed Highly significant (p<0.01) variation in terms of shoot height, root length, stem girth, leaf area ,leaf number, total dry weight.*

Keywords: *Aframomum corrorima, Korarima Emergence, Korarima seedling, Soil Media, Seed treatment*

INTRODUCTION

Korarima (*Aframomum corrorima* (Braun) P.C.M. Jansen) is a perennial tropical aromatic herb, often of large size, bearing flowers and capsules, and grows usually with strong fibrous subterranean scaly rhizomes and leafy stems reaching 1–2 m height. Korarima is usually self-pollinated and occasionally cross-pollination by insects is possible due to the presence of large nectar at the top of the ovaries (Jansen, 2002), indigenous to Ethiopia, high genetic diversity in the country (Girma *et al.*, 2008)..Hence, it is economically important aromatic species used as traditional medicine and food preservative, to flavor coffee and bread, as source of income from local and export markets, for soil conservation and as substitute of Indian cardamom (Eyob *et al.*, 2007).In Ethiopia, korarima grows naturally at 1,700–2,000 m.a.s.l., annual rainfall varying from 1300 mm to 2000 mm, and annual average temperature of about 20^0C. It is a shade loving plant that grows in almost the same habitats as wild Arabica coffee in high rain forests of southern and south western Ethiopia (Jansen, 2002).

On the other hand, although propagation by seeds seems more advantageous, germination of korarima seeds is often poor and irregular, thus, has certain problems. Seed dormancy, which may be associated with hard and impermeable nature of the seed coat, had been reported to be the major problem of korarima germination (Eyob *et al.*, 2009). To make hard seed coats permeable to water or gases and hasten germination and subsequent growth of seedlings, some sort of seed treatments is commonly used in different crops (Bhattacharya and Khuspe, 2001). Pre sowing treatment by

soaking in water or other chemicals for certain period can reduce the time required for germination. However, information on the use of such practices in korarima is very scarce.

Growth medium has been found to be the most critical factor determining seedling quality in the nursery, acting as a reservoir for nutrients, moisture and oxygen supply to the growing plant (Baiyeri and Mbah, 2006) .

In line with this, in Ethiopia, information on korarima propagation by seed and optimum nursery management practices is lacking. Although the crop is important in the spice industry in general, and in the national economy of the country in particular its seed treatment method to hasten germination seed treatment and media composition for improved seedling growth have not been well studied and documented. Therefore, the objective of this study was the effect of different seed treatment methods and nursery media compositions on seed emergence and to produce subsequent early growth of korarima seedlings for farmers and customer to improve food security and income generation.

MATERIALS AND METHODS

Description of Study Area

The experiment was performed at Jimma Agricultural Research Center (JARC)nursery site from May to September 2012; and located at 365 km Southwest of Addis Ababa, altitude of 1750 m.*a.s.l.,* at latitude of 7^0, 46" N, and longitude of 30^0, 50 "E in the sub humid tropical belt of south western Ethiopia. Mean total annual rain fall of the area 1530 mm, average relative humidity 66%, and mean minimum and maximum temperatures of 11.6^{0}C and 26.3^{0}C, respectively ((Appendix Table 1).The soil of the area is characterized by reddish to reddish brown clay with pH range of 5-6.The experiment comprised two factors, seed treatments and media. So far there is no released variety of korarima in the country, along with the few accessions which have been collected and maintained at Tepi and Jimma Research Centers, Jimma local landrace was used for the experiments.

Seed Treatment

Fresh capsules were split open and seeds were extracted from the capsules and immediately washed with tap water to remove mucilage. Then, uniform and healthy seeds were subjected to one of the following treatments: Control (un-soaked), soaked in tap water for 24 hrs, for 48 hrs, for 72 hrs; and soaked in 50% sulfuric acid (H_2SO_4) for 60 minutes (Eyob *et al.*, 2009).

Growth Media Preparation

Soil from forest land was dug to 5- 10 cm depth, top soil depth 15 cm was also collected from continuously cultivated land. Compost was prepared from decomposed grass, coffee pulp, top soil and cow dung, which were collected from the research center, and was air dried manually crashed and passed through 2mm sieve to remove clods and other foreign materials. The growth medium was prepared from forest soil and top soil alone and mixture of forest and top soil in 1:1 ratio, forest soil and compost in 1:1 ratio, top soil and compost in 1:1, forest soil, top soil and compost in 1:1:1 ratio , and top soil and compost in 3:1 ratio. Each medium ingredient (treatment) was filled in to black polythene bag of 16cm wide and 22cm length. Pre sowing soil analysis result **(**Appendix table 2**).**

Treatments and Experimental Design

A single experimental unit (plot) consisted of 12 pots. These were arranged in rectangle fashion (3x4) on nursery bed with 15 cm spacing between experimental units and 20cm between replications. Three seeds were sown at a depth of about one-and half cm in each pot (polythene bag) to minimize the risk of germination failure and were thinly covered with fine soil. The beds were mulched to about five cm depth with straw mulch all other routine nursery management practices, including, shading, weeding and other activities were based on nursery recommendations of Jimma Agricultural Research Center (IAR, 1996). For experiment I the seed pots were watered every other day in the conventional way until emergence.. The beds were constantly checked for emerging seedlings starting from the 5th day after sowing. Once emergence was observed, the mulch was removed and the seedlings were protected from direct sunlight by providing a moderate level of overhead shade, which was constructed at 1.5 m height using the elephant grass. Two months (at two leaf sage) and four months after sowing, both non-destructive and destructive parameters were measured.

Experimental Design

The experiment was carried out in a 7x5 factorial using RCBD with three replications. A total of 35 treatments were studied. This experiment involved two factors (Factor A= Soil

media (seven levels) and Factor B = Seed treatment (five levels)) and their combination as described below. The media compositions were selected based on coffee and cardamom nursery media (Yakob *et al*., 1998; Spices Board of India, 2009). Seed treatments were arranged based on the experience of Eyob *et al*,.(2008) and Bhattacharya and Khuspe (2001).

Soil Media Levels

Forest soil alone (M_1), Top soil alone (M_2), Forest soil and Top soil in 1: 1 ratio (M_3), Forest soil and compost in 1:1 ratio (M_4), Top soil and compost in 1:1 ratio (M_5), Forest soil, Top soil and compost in 1: 1: 1 ratio (M_6), Top soil and compost in 3: 1 ratio (control) (M_7).

Seed Treatment Levels

Non-soaked (control) (T_1), 24 hours soaking in pure water (T_2), 48 hours soaking in pure water (T_3), 72 hours soaking in pure water (T_4), Soaking in 50% sulphuric acid (H_2SO_4) for 60 minutes (T_5). Growth soil media from forest land was dug up to 10 cm depth, top soil depth 15 cm was also collected from continuously cultivated land. Compost was prepared from decomposed grass, coffee pulp, top soil and cow dung, which were collected from the research center, and was air dried manually crashed and passed through 2mm sieve to remove clods and other foreign materials. The sieved soil was filled in to black polythene bag of 16cm wide and 22cm length.

Every routine nursery management practices, was practiced uniformly to all experimental units as per the nursery recommendations of JARC (IAR, 1996). Emergency count was made from each experimental unit when just it was commenced (5 days after sowing) in three days interval. This count was extended up to 28 days after sowing. Four months after sowing plant height (cm), leaf number, leaf area (cm2), root length (cm) and biomass (g) production were measured by taking four seedlings from randomly selected inner rows of each experimental unit. The collected data were processed and analyzed using SAS computer software Version 9.2 (SAS, 2008). The analysis of variance (ANOVA) was employed for each parameter in order to identify the difference among the factors of soil media and watering frequency and Significant differences among the treatments were compared using Fisher's Least Significance Difference (LSD) at < 5 % probability level.

RESULTS AND DISCUSSION

Mean Days to Seedling Emergence

Days to 50% emergence was significantly affected by the interaction of seed pre-sowing treatments and soil media (Appendix Table 3). The highest days to 50% emergence (32.67) was obtained from seeds treated with 50% sulphuric acid (soaking for 60 minutes) and sown in forest soil (T_5M_1) or in forest soil and compost mixture at 1:1 ratio (T_5M_4). Seeds treated with 50% sulphuric acid and sown in forest and top soil mixture at 1:1 ratio ($T_5M_{3)}$ gave higher days to 50% emergence (32.00). The minimum days to 50% emergence were 14 days for 24 hours soaking in pure water and sowing in mixture of forest and top soil ($T2M_3$), 48 hours soaking in pure water and sowing in top soil ($T3M_2$), 72 hours soaking in pure water and sowing in mixture of forest and top soil (T4M3) or for Korarima seeds soaked for 60 minutes in 50% sulfuric acid and sown in a blend of forest soil, top soil and compost in 1:1:1 ratio (T_5M6) (Table 1). The result may be due to the growth medium physical properties can also have a profound effect on the supply of water and air to the growing seedling emergence, besides seed soaking. This is similar to the report of Taye (2008) the effect of the various organic source and proportions on percent germination of coffee seeds was highly significant.

Seedling Emergence Percentage

The interaction of seed treatment by soil media was highly significant ($P<0.01$) for emergence percentage (Appendix Table 3).The highest value of emergence percentage was observed for seeds soaked for 24 hrs in pure water and sown in top soil and compost in 3:1 ratio (T_2M_7) and for those soaked for 48 hrs in pure water and sown in top soil (T_3M_2) (90.67). While the lowest value (39.00) was recorded for Korarima seeds soaked for 60 minutes in 50% sulphuric acid and sown in top soil (T_5M_2) (Table 1). Reduction in emergence percentage was observed for all 72 hours soaking seeds in pure water and 50% sulphuric acid (H_2SO_4) soaking for 60 minutes combined with all soil media used. The result may be due to the presence of interaction of the pre sowing seed treatment and soil media. Based on the research result seeds soaked with water had higher value than other for all media types whereas seeds treated with H_2SO_4 had less seedling emergence percentage. This may be due to the effect of the reaction of H_2SO_4 with different media compositions. It

was contrary to Eyob *et al*,.(2009) who reported that H_2SO_4 pretreatments were more effective in breaking dormancy and stimulating emergence of korarima seed and increase significant effects on emergence percentage. This may be due to difference media used, environmental factor, seed material difference, the duration of sulphuric acid (H_2SO_4) in the store and concentration.

Table1. *Interaction effect of seed treatment by soil media on emergence of korarima seedlings*

Treatments	**Days to 50 %** emergence	Emergence **%**
T1M1	20.67^{ef}	75.67^{e-h}
T1M2	20.00^{f}	89.00^{ab}
T1M3	20.67^{ef}	78.67^{b-g}
T1M4	20.00^{f}	87.33^{a-d}
T1M5	20.67^{ef}	89.33^{ab}
T1M6	20.00^{f}	78.67^{b-g}
T1M7	21.33^{ef}	66.00^{h-j}
T2M1	20.67^{ef}	85.33^{a-e}
T2M2	21.33^{ef}	87.33^{a-d}
T2M3	14.00^{h}	85.67^{a-e}
T2M4	20.67^{ef}	86.33^{a-e}
T2M5	20.67^{ef}	87.67^{a-c}
T2M6	20.67^{ef}	79.33^{a-f}
T2M7	20.67^{ef}	90.67^{a}
T3M1	20.00^{f}	85.00^{a-e}
T3M2	14.00^{h}	90. 67 ^{a}
T3M3	20.00^{f}	68.00^{g-i}
T3M4	22.00^{e}	84.00^{a-e}
T3M5	20.00^{f}	76.00^{d-h}
T3M6	20.00^{f}	81.33^{a-e}
T3M7	20.00^{f}	77.00^{c-g}
T4M1	20.00^{f}	46.67^{mn}
T4M2	20.67^{fe}	68.67^{f-i}
T4M3	14.00^{h}	65.33^{h-j}
T4M4	20.67^{fe}	55.67^{j-m}
T4M5	20.00^{f}	46.67^{mn}
T4M6	30.00^{b}	53.67^{k-m}
T4M7	26.00^{c}	64.33^{i-k}
T5M1	32.67^{a}	48.00^{mn}
T5M2	17.00^{g}	39.00^{n}
T5M3	32.00^{a}	55.67^{j-m}
T5M4	32.67^{a}	59.33^{i-l}
T5M5	24.00^{d}	46.33^{mn}
T5M6	14.00^{h}	53.67^{k-m}
T5M7	24.00^{d}	49.67^{l-n}
CV%	3.14	8.26
LSD 5%	1.19	9.53

Mean values followed by the same letter(s) with in a column are not significantly different at P < 0.05

T_1 - Non-soaked,(T_2-: 24 hrs ,T_3-: 48 hrs T_4 -72hrs) soaking seeds in pure water) , T_5-:50% sulphuric acid soaking for 60 minutes, M_1- Forest soil , M_2- Top soil , M_3- Forest & Top soil (1:1), M_4- Forest & compost (1:1), M_5-: Top & compost (1:1), M_6- Forest l, Top & compost (1:1: 1), M_7: Top & compost (3:1)

Shoot Length

The interaction of seed treatment by soil media was highly significant (P<0.01) for Shoot Length (Appendix Table 3). The highest mean values of Shoot Length 10.88cm were recorded for Korarima seeds soaked for 24 hrs in pure water and sown in top soil and compost in 1:1 ratio (T_2M_5) at four months of growth stage after sowing (Table 2). The lowest value recorded for Shoot Length was 5.23cm for seeds soaked for 48 hrs in pure water and sown in forest soil media (T_3M_1). The vigorous and fast growth of seedlings may be attributed to better water holding capacity and availability of nutrients for plant growth in top soil and compost. While poor growth in Forest soil alone may be due to low nutritional status for plant growth offered

by the media. Similar results were reported by Conover *et al*. (1981) who reported better plant height in mixes and lowest in bark in considering single factor, the various proportion of organic source mixed with the same amount of top soil significantly affected shoot length Taye (2008),but with tow factor interaction the result may not similar.

Root Length

The highest mean value of root length at the growth stage of four months after sowing the maximum value of root length (18.44cm) was recorded for Korarima seeds not pre treated and sown in mixed forest and top soil media of ratio 1:1 (T_1M_3) (Table 2). Wheras the lowest root length were recorded for Korarima seeds soaked for 72 hrs in pure water and sown in forest soil, top soil and compost in 1:1:1 ratio (T_4M_6) (8.71cm) at four months of growth stage after sowing. The results indicate that the seeds soaked not significant for root length as soil media, and media has different soil nutrient for seedling root length growth. The highest root length root growth of korarima seedlings grown on those potting media containing of forest and top soil media at four months growth stage of seedling after sowing. This could be attributed largely to the improved physical conditions and promoted the penetration with profound growth and development of the root system. The lowest value observed may be due to low combination ratio of the nutrient soil medium This finding corroborates those of Taye Kufa (1998).

Stem Girth

The interaction of seed treatment by soil media was highly significant (P<0.01) for seedling stem girth (Appendix Table 3). The highest mean values of seedling girth 0.67cm was recorded for korarima seeds soaked 24 hrs in pure water and sown in soil media of top and compost ratio of 1:1 (T_2 M_5)at four months of growth stages after sowing (Table 2). The lowest value recorded for plant girth at four months of growth stage after sowing was 0.37cm for Korarima seeds soaked for 24 hrs in pure water and sown in forest soil alone (T_2M_1). The best performance of treatments might be attributed to its richer nutritional status specially nitrogen and phosphorus nutrient which enhanced increasing seedling girth growth. The adverse effect of sulphuric acid treated seeds and the limited nutrient content of medium might be restricting the girth growth.

Table2. *Interaction **e**ffect of seed treatment by media on shoot height, root length, girth and leaf*

Treatment	Shoot height (cm)	Root length(cm)	Girth(cm)
T1M1	7.61^{h-k}	15.91^{b-d}	0.46^{d-h}
T1M2	9.24^{c-e}	15.76^{b-e}	0.49^{c-h}
T1M3	7.78^{g-jk}	18.44^{a}	0.42^{hi}
T1M4	9.43^{b-e}	16.57^{a-c}	0.59^{b}
T1M5	10.48^{ab}	13.74^{d-l}	0.57bc
T1M6	9.71^{b-d}	15.46^{b-f}	0.49^{c-h}
T1M7	9.07^{c-f}	12.48^{g-n}	0.46^{d-h}
T2M1	8.68^{d-h}	14.60^{c-j}	0.37^{i}
T2M2	7.94^{f-j}	15.92^{b-d}	0.51^{b-h}
T2M3	8.58d-i	15.25^{b-f}	0.49^{c-h}
T2M4	9.94a-c	15.55^{b-f}	0.54^{b-d}
T2M5	10.88^{a}	13.34^{d-m}	0.67^{a}
T2M6	8.98^{c-g}	12.18^{i-n}	0.54^{b-e}
T2M7	8.38^{e-i}	17.57^{ab}	0.53^{b-f}
T3M1	5.23^{l}	11.00^{m-p}	0.48^{h-g}
T3M2	7.56^{h-k}	13.15^{e-m}	0.48^{c-h}
T3M3	8.91^{c-g}	15.12^{b-g}	0.45^{d-i}
T3M4	8.43^{e-i}	13.73^{d-l}	0.53^{b-e}
T3M5	8.85^{c-g}	13.68^{d-l}	0.49^{c-h}
T3M6	9.39^{b-e}	11.95^{j-n}	0.54^{b-e}
T3M7	8.56^{d-i}	14.25^{c-k}	0.46^{d-i}
T4M1	6.94^{jk}	14.79^{c-i}	0.47d-i
T4M2	7.60^{h-k}	11.67^{k-o}	0.44f-i
T4M3	7.56^{i-k}	10.47^{n-p}	0.48^{c-h}
T4M4	7.44^{i-k}	9.34^{op}	0.53b-e
T4M5	8.73^{d-h}	9.23^{op}	0.59^{b}

T4M6	6.72^{k}	8.71^{p}	0.52^{b-g}
T4M7	7.64^{h-k}	13.07^{f-n}	0.45^{e-i}
T5M1	7.44^{i-k}	14.78^{c-i}	0.53^{b-e}
T5M2	8.39^{e-i}	12.38^{h-n}	0.47^{c-h}
T5M3	7.56^{h-k}	15.00^{b-h}	0.43^{g-i}
T5M4	7.53^{h-k}	11.35^{l-o}	0.46^{d-i}
T5M5	8.66^{d-i}	11.67^{k-o}	0.52^{b-g}
T5M6	9.20^{c-e}	13.82^{d-l}	0.47^{d-h}
T5M7	8.74^{d-h}	15.68^{b-f}	0.54^{b-e}
Cv%	7.32	9.94	9.56
LSD 5%	1.00	2.21	0.08

Mean values followed by the same letter(s) with in a column are not significantly different at P < 0.05

T_1 - Non-soaked,(T_2-: 24 hrs ,T_3-: 48 hrs T_4 -72hrs) soaking seeds in pure water) , T_5-:50% sulphuric acid soaking for 60 minutes, M_1- Forest soil , M_2- Top soil , M_3- Forest & Top soil (1:1), M_4- Forest & compost (1:1), M_5-: Top & compost (1:1), M_6- Forest l, Top & compost (1:1: 1), M_7: Top & compost (3:1)

Mean Leaf Area per Leaf

The response of Leaf area (cm^2)to seed treatment by soil media was highly significant ($p<0.01$) (Appendix Table 3). The leaf area of seeds soaked and sown in mixed forest and Top soil media in 1:1 ratio (T_2M_3) was found the highest during four months of growth stage after sowing, (Table 3) and their values was 15.03 cm^2. Korarima seeds soaked for 24 hrs in pure water and sown in forest soil, top soil and compost in 1:1:1 ratios (T_2M_6) (14.78) also seeds not treated and sown in forest soil and compost soil media in 1:1 ratio (T1M4)(14.37 cm^2) shown higher Leaf area at the four months of growth stage. On the other hand, the least leaf area was observed from seeds soaked for 72 hrs in pure water and sown in forest and compost soil media in 1:1 ratios (T_4M_4) (8.7cm^2)at four months of growth stages. The influence of the different proportions of media on leaf area at growth stage showed highly significant response. There were also non-significant leaf area growth variations within the proportions of each media source and seed pre treatment. However, the lowest value of leaf area was noted from those seedlings grown on the different proportions of media and seed pre treatment. This may be due to the age or early stage of seedling not used more compost blended of the media improve the soil condition in physical and nutrient availability. This contrary with the findings of Wosen et al., (2010) who reported growth parameters of leaf area has also increase with increasing soaking time

Leaf Number

The interaction of seed treatment by soil media was highly significant ($P<0.01$) for leaf number (Appendix Table 3).The highest Leaf number (8.17) was recorded for seeds soaked 24 hrs in pure water and sown in media ratio of 1:1 forest soil to top soil (T_2M_3) and seeds soaked for 60 minutes in 50% sulphuric acid sown in forest soil and compost in 3:1 ratio (T_5M_4). Even if T_2M_3 and T_5M_4 had higher values statically there were no different for most treatments (Table 3). The lowest value of leaf number (6.50) was recorded for seeds soaked for 48 hrs in pure water sown in top soil with compost ratio of 3:1 (T_3M_7) (Table 3). Different results recorded in leaf number may be due to the water holding capacity which is needed for plant growth that may be affected by seed treatment. Different seeds need seed treatments for germination as well as for growth. The increase in leaf number due to supplied of more nutrient from the media and this could be attributed to more number of leaves.

Largest Root Length

Even though korarima have fibrous roots the longest root was considered as tap root for this research. The highest largest root length was obtained from seeds not soaked and sown in top soil media (T_1M_2), seeds not soaked and sown in top soil and compost in1:1 ratios (T_1M_5), seeds soaked for 24 hrs in pure water and sown in forest soil media(T_2M_1), seeds soaked for 24 hrs in pure water and sown in top soil media(T_2M_2), seeds soaked for 48 hrs in pure water and sown in Top soil and compost media in 1:1:1atios (T_3M_5) and seeds soaked for 60 minutes in 50% sulfuric acid and sown in forest soil media (T_5M_1),its values were 30.60, 30.77, 30.37, 30.23, 30.8 and 30.40 cm at transplanting stage, respectively. The minimum value of largest root length (22.27 cm) was recorded when un soaked seeds sown in media composition of top soil and compost in 3:1 ratio (T_1M_7), at similar stage of transplanting (Table 3). This was due to the

application of soil media favor nutrient and water in most of the treatments for the growth of largest root length. Synergistic combination of both the factors in improving the physical conditions of the media and nutritional factors better plant seedling growth of largest root observed (Sahni *et al.*, 2008).

Table3. *Interaction effects of seed treatment and media on total leaf area, longest root length, leaf number,*

Treatment	Leaf area(cm^2)	Largest root length (cm)	Leaf number
T1M1	11.50^{m-o}	25.60^{hi}	7.00^{b-d}
T1M2	12.17^{j-m}	30.60^{a}	7.17^{b-d}
T1M3	10.73^{pq}	29.33^{b}	6.83^{cd}
T1M4	14.37^{a-c}	29.40^{b}	7.67^{a-c}
T1M5	10.54^{q}	30.77^{a}	7.500^{a-c}
T1M6	13.22^{e-g}	25.63^{hi}	7.33^{a-d}
T1M7	13.07^{e-h}	22.27^{m}	7.500^{a-c}
T2M1	13.44^{de}	30.37^{a}	7.67^{a-c}
T2M2	12.05^{k-n}	30.23^{a}	7.17^{b-d}
T2M3	15.03^{a}	23.47^{l}	8.17^{a}
T2M4	10.22^{q}	26.70^{fg}	7.17^{b-d}
T2M5	12.6^{f-k}	29.23^{bc}	7.50^{a-c}
T2M6	14.78^{ab}	25.27^{ij}	7.67^{a-c}
T2M7	10.95^{o-q}	27.43^{ef}	7.17^{b-d}
T3M1	13.45^{de}	28.37^{d}	7.50^{a-c}
T3M2	11.35^{n-p}	27.20^{ef}	7.50^{a-c}
T3M3	12.49^{g-k}	27.63^{e}	7.83^{ab}
T3M4	12.27^{i-m}	23.37^{l}	7.50^{a-c}
T3M5	13.01^{e-i}	30.80^{a}	7.33^{a-d}
T3M6	13.27^{e-g}	26.43^{g}	7.50^{a-c}
T3M7	10.40^{q}	27.30^{ef}	6.50^{d}
T4M1	14.14^{b-d}	28.57^{cd}	7.17^{b-d}
T4M2	10.64^{pq}	24.47^{k}	7.17^{b-d}
T4M3	11.87^{k-n}	25.47^{ij}	7.83^{ab}
T4M4	8.70^{r}	26.27^{gh}	6.83^{cd}
T4M5	14.16^{b-d}	24.77^{jk}	7.67^{a-c}
T4M6	10.43^{q}	24.37k	7.50^{a-c}
T4M7	10.63^{pq}	24.83jk	7.00^{b-d}
T5M1	13.72^{c-e}	30.40a	7.50^{a-c}
T5M2	11.66^{lo}	28.47d	7.50^{a-c}
T5M3	12.39^{h-l}	27.47ef	7.50^{a-c}
T5M4	12.97^{e-j}	27.40ef	8.17^{a}
T5M5	13.33^{f}	29.33b	7.00^{b-d}
T5M6	13.10^{e-h}	26.23gh	7.00^{b-d}
T5M7	13.48^{de}	28.47^{d}	7.50^{a-c}
Cv%	3.47	1.56	6.47
LSD 5%	0.70	0.69	0.78

Mean values followed by the same letter(s) with in a column are not significantly different at P < 0.05

T_1 - Non-soaked,(T_2: 24 hrs ,T_3: 48 hrs T_4 -72hrs) soaking seeds in pure water) , T_5:50% sulphuric acid soaking for 60 minutes, M_1- Forest soil , M_2- Top soil , M_3- Forest & Top soil (1:1), M_4- Forest & compost (1:1), M_5: Top & compost (1:1), M_6- Forest l, Top & compost (1:1: 1), M_7: Top & compost (3:1)

Leaf Dry Weight

The interaction of seed treatment by soil media was highly significant ($p<0.01$) for leaf dry weight (Appendix Table 3). The highest mean values of leaf weight (g) 0.786 and 0.787 wererecorded for seeds not soaked and sown in forest soil and compost in 1:1 ratio (T_1M_4) and seeds soaked for 24hrs in pure water and sown in mixed forest and compost soil media in 1:1 ratios (T_2M_4)at four months of growth stages after sowing,respectively (Table 4). The lowest value 0.373g and 0.376g were recorded for seeds soaked for 48 hrs in pure water sown in top soil (T_3M_2), and seeds soaked for 60 minutes in 50% sulfuric acid sown in top soil (T_3M_2), respectively. In respect to leaf dry weight, it was significantly influenced by the various seed treated and ratios of soil media with highly significant effects by sources and

proportion including their interactions (Table 4). As a result, the value for leaf dry weights ranged from 0.0039g to 0.786g was observed at different growth stage. In general, leaf growth responses indicate the influences of wide C: N ratio in the media and hence inadequate nitrogen nutrition due to limited mineralization.. This support the combined of the media of forest and compost soil combination Vineeta *et al* (2005) reported that soil structural stability increased due to straw addition with better aggregate size distribution and reduction in soil disturbance. He further added that soil organic matter acts as a reservoir for plant nutrients and prevents leaching of elements, necessary for seedling growth.

Stem Dry Weight

The highest mean values of stem weight (g) 0.513 were recorded seeds not soaked and sown in mixed forest and compost soil media in 1:1 ratio (T_1M_4) at four months of growth stages after sowing (Table 4). The lowest value recorded for stem weight(g) was 0.170, for seeds soaked for 24 hrs in pure water and sown in top soil and compost in 3:1 ratio (T_2M7). The result indicate un soaked seed (wihout seed treatment) and the equal combination of soil media improve the soil physical stracture and media nutrient, and this give high dry stem weight.On the other hand, less compost combination of the soil give less weight of stem dry weight(g).

Root Dry Weight

Interaction of seed treatment by soil media on root dry weight was highly significant ($p< 0.01$) (Appendix Table 3). Among the treatments tested, highest root weight per plant was recorded from seeds soaked for 24hrs in pure water and sown in mixed forest and compost soil media in 1:1 ratios (T_2M_4) treatments, which was 0.511 gat four months of growth stages. On the other hand, the seeds soaked for 48 hrs in pure water and sown in top soil media (T_3M_2) gave the lowest root weight during the growth stages four months and the values was 0.124 g (Table 4).This is may be due to combined effect of the soil improve the soil water holding capacity and nutrient uptake for growth. Hafeez-ur-Rahman *et al.*,(2007) reported that mixed soil media improve soil structure and texture, which, in turn, increases metabolic activity in germinating seeds, leading to better germination of seed and growth of seedling.

Total Dry Weight

Interaction of seed treatment and media on weight total dry matter per plant showed highly significant ($p< 0.01$) (Appendix Table 3). The highest total dry weight per plant of 2.386g and 2.219g were obtained from seeds soaked for 24hrs in pure water and sown in mixed forest and compost soil media in 1:1 ratio (T_2M_4) and seeds soaked for 60 minutes in 50% sulphuric acid and sown in top soil and compost in 1:1 ratio soil media (T_5M_5), respectively, followed by seeds not soaked and sown in forest soil and compost in 1:1 ratio (T_1M_4) (2.033g). On the other hand, seeds soaked for 48 hrs in pure water and sown in top soil media (T_3M_2) (0.846g) and seeds soaked for 60 minutes in 50% sulfuric acid and sown in top soil media (T_5M_2) (0.845g) showed the lowest values at the four after sowing months seedling growth stage (Table 4).Dry matter production in any crop depends upon the leaf area index (LAI), the structure of the canopy, photosynthetic rate per unit of leaf area, and the strength of the metabolic sinks in attracting assimilates, which is may be enhanced by seed treatment and blended media combination and this particularly important in sin seedling growth. This result is in agreement with previous finding of Wooton *et al.*,(1981)as reported that media blends with compost were to found be best for optimum seedling growth.

Table4. *Interaction effects of seed treatment and media on dry weight of leaf, stem, root and total dry weight*

Treatment	Leaf weight (g)	stem weight (g)	Root wt(g)	Total Dry weight (g)
T1M1	0.586^{e-h}	0.383^{c-g}	0.342^{c-f}	1.470^{gh}
T1M2	0.569^{f-j}	0.290^{j-n}	0.292^{d-h}	1.254^{i-k}
T1M3	0.600^{d-h}	0.324^{g-l}	0.296^{d-h}	1.618^{e-g}
T1M4	0.786^{a}	0.513^{a}	0.411^{bC}	2.033^{b}
T1M5	0.665^{b-f}	0.412^{b-f}	0.290^{e-i}	1.856^{b-d}
T1M6	0.701^{a-d}	0.366^{d-i}	0.358^{c-e}	1.675^{d-f}
T1M7	0.476^{i-n}	0.307^{h-m}	0.245^{g-k}	1.293^{h-k}
T2M1	0.600^{d-h}	0.371^{d-h}	0.371^{cd}	1.482^{gh}
T2M2	0.573^{f-i}	0.335^{g-k}	0.337^{c-f}	1.332^{h-j}
T2M3	0.527^{h-m}	0.324^{g-l}	0.298^{d-g}	1.297^{h-k}
T2M4	0.787^{a}	0.443^{bc}	0.511^{a}	2.386^{a}

T2M5	0.436^{mn}	0.422^{bcd}	0.286^{e-i}	1.576^{fg}
T2M6	0.422^{mn}	0.416^{b-e}	0.380^{bc}	1.680^{d-f}
T2M7	0.552^{g-l}	0.170^{q}	0.397^{bc}	1.282^{h-k}
T3M1	0.454^{k-n}	0.185^{pq}	0.280^{e-i}	1.035^{l-n}
T3M2	0.373^{n}	0.255^{l-o}	0.124^{n}	0.846^{n}
T3M3	0.496^{hm}	0.335^{g-k}	0.249^{g-j}	1.306^{h-j}
T3M4	0.560^{f-k}	0.345^{f-j}	0.286^{e-i}	1.441^{g-i}
T3M5	0.764^{ab}	0.372^{d-h}	0.449^{ab}	1.978^{bc}
T3M6	0.736^{a-c}	0.349^{e-j}	0.412^{bc}	1.810^{c-e}
T3M7	0.553^{g-k}	0.352^{e-j}	0.220^{g-m}	1.198^{j-l}
T4M1	0.463^{j-n}	0.199^{o-q}	0.180^{j-n}	1.004^{l-n}
T4M2	0.596^{d-h}	0.308^{h-m}	0.265^{f-i}	1.315^{h-j}
T4M3	0.446^{l-n}	0.268^{kl-n}	0.147^{mn}	0.994^{mn}
T4M4	0.467^{i-n}	0.250^{m-p}	0.222^{g-m}	1.101^{k-m}
T4M5	0.689^{a-e}	0.343^{f-ij}	0.215^{h-m}	1.593^{fg}
T4M6	0.433^{mn}	0.299^{i-m}	0.234^{g-l}	1.012^{l-n}
T4M7	0.549^{g-l}	0.343^{f-j}	0.209^{i-m}	1.375^{h-j}
T5M1	0.460^{k-n}	0.242^{m-p}	0.218^{g-m}	1.056^{lm}
T5M2	0.376^{n}	0.227^{n-q}	0.166^{k-n}	0.845^{n}
T5M3	0.426^{mn}	0.256^{l-o}	0.160^{l-n}	0.929^{mn}
T5M4	0.518^{h-l}	0.266^{k-o}	0.273^{f-i}	1.282^{h-k}
T5M5	0.653^{c-g}	0.479^{ab}	0.356^{c-e}	2.219^{a}
T5M6	0.643^{c-g}	0.366^{d-i}	0.225^{g-m}	1.697^{d-f}
T5M7	0.666^{b-f}	0.424^{b-d}	0.333^{c-f}	1.965^{bc}
Cv%	9.83	11.07	14.55	7.39
LSD 5%	0.09	0.06	0.07	0.17

Mean values followed by the same letter(s) with in a column are not significantly different at P < 0.05

T_1 - Non-soaked,(T_2-: 24 hrs ,T_3-: 48 hrs T_4 -72hrs) soaking seeds in pure water) , T_5-:50% sulphuric acid soaking for 60 minutes, M_1- Forest soil , M_2- Top soil , M_3- Forest & Top soil (1:1), M_4- Forest & compost (1:1), M_5-: Top & compost (1:1), M_6- Forest l, Top & compost (1:1: 1), M_7: Top & compost (3:1)

CONCLUSION

Significant variation among the different growth media and seed treatment of *Affframomum korarima seed regarding emergence and seedling growth gained.* Highly significant variation was obtained among the treatments in terms of plant height, root length, stem girth seedling, leaf area ,leaf number, leaf weight, root weight stem weight, total dry weight,. The interaction effect of seed treatment by soil media was significantly attained in respect of emergence percentage, mean days to emergence, The highest score of emergence percentage and early mean days to emergence for Korarima seeds soaked for 24 hrs in pure water and sown in top soil and compost in 3:1 ratios and Korarima seeds soaked for 48 hrs in pure water and sown in top soil media (90.67)(14,20), respectively. The highest value score of total dry weight (2.386g), total leaf area (201.09cm^2) was obtained from Korarima seeds soaked for 24hrs and 48hrs, in pure water and 60 minutes in sulphuric acid and sown in soil media of forest and compost, top and compost, forest and top and top and compost (3:1), respectively.

The experiments conducted so far in this area are not sufficient to draw a reliable conclusion. Since, the present study was done for the first time under Jimma conditions and further experiment needs to be conducted for korarima seed at different environmental conditions and agronomic practice techniques of seed treatment, sowing date, media, watering frequency and rate, mulch thickness, transplanting stage, viability, ranges of seed initial moisture content and storage temperatures.

Appendix Table1. *Monthly meteorological data for the experimental duration (2012) of Jimma Agricultural Research Center and experimental sites*

month	RF, NRD, and T and RH in the site experiment I						T and RH in the site experiment II			
	RF (mm)	NRD	T (^{O}C) 2012			RH(%)	T (^{O}C) 2012			RH(%)
	2012	2012	Max.	Min.	Mean	Mean	Max.	Min.	Mean	Mean
May	96.4	17	23.8	10.2	17	60	26.72	17.26	21.99	77
June	190.2	19	24.9	10.1	17.5	61	26	15.86	20.93	78

July	188.7	16	24.6	9.9	17.3	77	27.67	14.93	21.3	79
August	223.8	20	24.5	9.5	17	65	28.5	15.4	21.95	80
Septe.	131.3	15	24.7	9.8	17.2	60	27	14	20.5	80
Total	830.4	87	122.5	49.5	86	323	135.89	77.45	106.67	394
Mean	166.08	17.4	24.5	9.9	17.2	64.6	27.178	15.49	21.334	78.8

RF-Rainfall, NRD-Number of Rainy Days , T- Temperature, Max. –Maximum, Min.-Minimum

RH- Relative humidity, Septe.-September

Appendix Table2. *Pre sowing soil analysis*

Soil Media	P^H	ppm P	% OC	%OM	%N	Available K	C:N	Soil Type	WHC %	B.D(g/cm^3)
F	5.62	25.74	4.57	7.87	0.22	3.71	21:01	*S,C,L*	62	1.38
T	4.36	1.89	4.38	7.55	0.32	1.41	14:01	*S,C,L*	65	1.38
F :T (1:1)	5.64	71.28	4.91	8.47	0.25	6.65	21:01	*S,L*	56	1.48
F : C (1:1)	5.52	5.4	3.78	6.51	0.18	6.13	21:01	*S,C*	65	1.32
T : C(1:1)	5.52	151.92	6.64	11.44	0.49	6.9	14:01	*S,L*	72	1.47
F: T :C	5.03	66.33	5.57	9.6	0.36	3.45	15:01	*S,L*	73	1.46
T : C	5.31	60.03	5.25	9.05	0.33	3.58	16:01	*S,L*	69	1.47
F : T	5.62	25.74	4.57	7.87	0.22	3.71	21:01	*S,C,L*	62	1.38

B.D-Bulk Density S,C,L-Sand Clay Loam S,L- Sand Loam S,C- Sand Clay OC-Organic Carbon OM-Organic Matter N- Nitrogen F- Forest soil T- Top soil C- Compost F :T –Forest ratio toTop soil F :C –Fores soil ratio to Compost T:C- Top soil ratio to Compost F:T:C- Fores soil, Top soil and compost ratio W.H.O.- Water holding capacity

Appendix Table3. *Mean squares for Seed treatments and media of korarima emergence and seedling growth (at four month growth stage)*

Variables	Factors			CV%
	Seed treatment(T)	Soil Media(M)	Tx M	
DF	4	6	24	
Emergence Rate	213.319**	7.327**	7.930**	4.087
Emergence percentage	5435.729**	108.241**	174.912**	8.268
Mean Days of Emergence	113.610**	39.775**	63.410**	3.138
Shoot length cm	9.01**	7.73**	1.79**	6.74
Root length cm	62.79**	15.18**	8.82**	9.66
Stem girth cm	0.004*	0.026**	0.007**	8.18
Leaf area cm^2	6.37**	6.99**	6.60**	3.47
Leaf wt g	0.035**	0.053**	0.038**	9.88
stem wt g	0.023**	0.034**	0.015**	11.09
Root wt g	0.080**	0.027**	0.014**	14.23
Total dray wt g	0.560**	1.067**	0.288**	7.45
No. Leaf	0.18^{ns}	0.35^{ns}	0.43*	6.51

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