

## Original Research Article

# Performance of *Leucaena* Seedlings in two agro-climatic regions of Kenya

### ABSTRACT

**Aims:** To determine the *Leucaena* seedlings planted in two variant agro-climatic regions, Chepkoilel Campus and Maseno in Kenya.

**Study design:** The experiment was a 2-factor (provenance – lime) split plot design with five replications. Three provenances were randomly assigned to the sub-plots. A block measuring 60 m by 30 m was divided into two plots, which were separated by a 1m strip of land.

**Place and Duration of Study:** Study was conducted at Chepkoilel College Campus and Maseno farms in Kenya.

**Methodology:** Farm experiments were conducted. Soil samples were amended with lime at the rate of 6.6ton/ha. Three genotypes of *Leucaena* were planted. At 60 DAP and 120 DAP, seedlings were subjected to analysis to determine seedling height, root length, root collar diameter, leaf number and seedling biomass at both sites.

**Results:** Variation in the performance of each provenance based on all the growth parameters assessed was also observed between the two sites. KIT2724 recorded the highest means in all the growth attributes followed by K136, and the lowest means was recorded by K156 at Maseno. However, in Chepkoilel, K136 recorded the best performance in all the growth attributes followed by KIT2724 and lastly by K156. The general appearance of one the *L. leucocephala* provenances (K136) seedling growing in the field at Chepkoilel bore flowers and pods at the age of 6 months.

**Conclusion:** Seedlings of *L. leucocephala* grew faster at Maseno than at Chepkoilel. With liming, KIT2724 and K136 could be grown in acid soils especially in both Maseno and Uasin Gishu districts where agroforestry practice is being promoted. However, K156 seems to be more tolerant to soil acidity and the genetic basis of this tolerance should be further established.

**Keywords:** pH tolerance; provenances; biomass; root collar; lime.

### 1. INTRODUCTION

*Leucaena leucocephala*, being a tropical plant species, requires warm temperatures of between 20<sup>0</sup> and 30<sup>0</sup>C (Brewbaker and Sorensson, 1987; Williams, 1987). It can grow well in humid to semi-arid ecological zones (Lascano *et al.*, 1995). It also grows in a variety of soils, including heavy clay, coral, sandy neutral and alkaline soils. The plant grows at altitudes of about 1600 m above sea level, and requires an annual rainfall of between 500 mm and 1700 mm. The genus *Leucaena* has over 50 species, most of which are viewed as synonyms. Twelve species have been described in detail (Brewbaker *et al.*, 1972), and were differentiated by flower colour, leaflet size, growth habit, ecology, distribution and other traits (Brewbaker, 1983). Chromosome counts of the 12 species indicate that diploid number of chromosomes is 104 (2n =104). This ploidy level is different for the 2n = 26 or 2n = 28, that has been recorded for most mimosoids. The existence of polyploidy is thus implicit in the high basic number of chromosomes of the genus, which has long been recognized as a polyploid. Repeated efforts to identify segregating monogenes via isozymes in this genus, have not been successful (Sorensson, 1987).

Many species of *Leucaena* that have high self-compatibility include *L. leucocephala* and *L. retusa* (Brewbaker, 1983), a fact underlying their early use as food. This permit a rapid seed

28 multiplication, but also gives the species an undesirable property of weediness. However  
29 some species are self-incompatible, and thus are completely outcrossing (Hutton, 1981).  
30 Significant outcrossing occurs with *L. shannoni* and *L. esculenta*. It is probable that *L.*  
31 *diversifolia* and *L. esculenta*, which have the same chromosome number ( $2n = 52$ ), will cross  
32 with each other and with *L. leucocephala*, which has the double number of chromosomes  
33 ( $2n = 104$ ).  
34

## 35 2. MATERIAL AND METHODS

### 36 2.1 Experimental site

37 Site of Study: The study was carried out in the fields at Chepkoilel Campus of Moi University,  
38 in Uasin Gishu district, and at the International Center for Research in Agroforestry (ICRAF)/  
39 Kenya Forestry Research Institute (KEFRI) sub-station at Maseno in Kisumu district with  
40 contrasting soil characteristics (Table 1). Chepkoilel campus, Moi University: Chepkoilel  
41 campus site is situated in Uasin Gishu district of Rift Valley province. It is located on  
42 longitude  $36^{\circ}$  E and latitude  $30^{\circ}$  N and at an altitude of 2180 m. The annual temperatures lie  
43 between a mean maximum of  $23^{\circ}$  C and a mean minimum of  $10^{\circ}$  C. The annual rainfall  
44 ranges between 900 mm and 1100 mm and is bimodally distributed, with the first peak in  
45 April and second peak in August (Jaetzold and Schmidt, 1983). The soils at this site are  
46 acidic (pH <5), dark red, friable, rhodic ferralsols (Jaetzold and Schmidt, 1983). The farms  
47 around Chepkoilel Campus, which were originally used for commercial large-scale maize  
48 and wheat farming, have undergone considerable subdivision and subsistence farming is  
49 slowly gaining prominence (Muok, 1997).  
50

51 The government and non-governmental organizations have vigorously promoted  
52 agroforestry as a viable form of land use in this region. Planting of leguminous “agroforestry  
53 trees” is now being adopted in this district and *L. leucocephala* has also been recommended  
54 as one of the agroforestry tree species for use in this region (Muok, 1997). The site was  
55 selected for this study because of its low pH soils and the fact that Uasin Gishu district has  
56 been recommended for agroforestry intervention.

57  
58 **Maseno ICRAF/KEFRI sub-station:** Maseno ICRAF/KEFRI sub-station is situated at the  
59 boundary between Western and Nyanza provinces, however administratively the station is  
60 under Kisumu district. The site is located on longitude  $34^{\circ} 35'$  and latitude  $0^{\circ}$  N and at an  
61 altitude of about 1500 m. It receives an average rainfall of about 1736 mm, which is  
62 bimodally distributed, with the first peak (long rains) between March/April and June/July, and  
63 the second peak (short rains) between September and November. The annual temperatures  
64 lie between a mean maximum of  $29^{\circ}$  C and a mean minimum of  $21^{\circ}$  C. Soils in this region  
65 are classified as acidic nitisols pH < 5 (Jaetzold and Schmidt, 1982).  
66

67 The main land use system is subsistence crop production. Major crops grown in this area  
68 include maize, beans, cassava, sweet potatoes, sorghum and millet. Planting of leguminous  
69 agroforestry trees like leucaena in the crop fields is practised by many farmers (Muok, 1997).  
70 The site was selected because it not only contains acid soils, but represent one of the  
71 regions in Kenya where agroforestry is actively practiced.  
72

73 Table 1. Selected chemical properties of soils at Maseno and Chepkoilel experimental sites  
74 at the time of planting.

| Soil properties | Mean values |                 |
|-----------------|-------------|-----------------|
|                 | Maseno site | Chepkoilel site |

|                            |                   |                   |
|----------------------------|-------------------|-------------------|
| pH (1 soil: 2.5 water)     | 4.8 <sup>b</sup>  | 5.0 <sup>a</sup>  |
| CEC (Cmol/kg)              | 8.9 <sup>b</sup>  | 11.6 <sup>a</sup> |
| Organic Carbon (%)         | 1.9 <sup>a</sup>  | 2.0 <sup>a</sup>  |
| Calcium (me/100g)          | 2.0 <sup>a</sup>  | 2.0 <sup>a</sup>  |
| Exch. aluminium (me/100g)  | 0.2 <sup>b</sup>  | 0.9 <sup>a</sup>  |
| Aluminium saturation (%)   | 16.7 <sup>a</sup> | 7.1 <sup>b</sup>  |
| Available Phosphorus (ppm) | 2.6 <sup>b</sup>  | 4.9 <sup>a</sup>  |
| Nitrogen (%)               | 1.1 <sup>a</sup>  | 0.2 <sup>b</sup>  |

75 **Key:** - Means followed by the same letter in each row are not significantly different (p  
76 ≤ 0.05) from each other according to Tukey HSD test.  
77 Source: Kodiago et. al. (2015)

78 **Source and Type of Leucana Seeds:** Seeds of three randomly selected *L. leucocephala*  
79 provenances were obtained from KEFRI seed bank in Muguga, Kenya. They comprised  
80 bulked local seed collections from Gede (Kilifi District), Kitale (Trans Nzoia District) and  
81 Kibwezi (Makweni District), which have been designated as K156, KIT2724 and K136,  
82 respectively. The accession name for the seeds that were collected from Kitale could not be  
83 established hence the shortened form (KIT) for Kitale and test number (2724) has been used  
84 in this study as KIT2724 to represent the accession from Kitale.

85  
86 The parent trees were in stands that were established by KEFRI purposely for seed  
87 collection, and all the seed batches comprised crown collection. The seeds from Gede were  
88 collected in September 1994 from about 42 parent trees located 5 m apart. Seeds from  
89 Kitale were collected in February 1997 from 10 parent trees that were located 10 m apart.  
90 Seeds from Kibwezi were collected in May 1995 from 100 parent trees that were located 3 m  
91 apart. In each case, equal quantities of seeds were bulked together to provide bulked seeds  
92 for each provenance (Information obtained from the KEFRI sub-stations where these  
93 accessions were planted).

94  
95 **Sample collection and preparation:** Soil analysis for selected attributes was done for each  
96 experimental site before the experiment. Soil samples were collected at a depth of 20-cm  
97 (using a soil auger) from the fields at Chepkoilel Campus farm, Moi University and Maseno  
98 ICRAF/KEFRI centre. Five soil samples were collected from each of the 30 sub-plots and  
99 bulked forming a composite sample, and then five representative sub-samples were  
100 withdrawn from the composite sample after thorough mixing.

101  
102 **Germination of *L. leucocephala* Seeds:** All the seedlings for pot or field experiments were  
103 pre-germination in the laboratory as described by Muok et al., (1998). Seeds of the three  
104 provenances were surface sterilized in 2% sodium hypochlorite for 10 minutes and  
105 thoroughly washed with deionized water. They were nipped and soaked in distilled water for  
106 45 minutes to imbibe. Imbibed seeds were placed on trays of moist filter paper and  
107 incubated at 26°C - 28°C for two days to germinate. Successful germination was determined  
108 as emergence of the radicle. Uniform pre-germinated seedlings were selected and used in  
109 the experiments. It was assumed that the seeds derived from individual maternal parent that  
110 formed the “bulk seeds”, had equal germination capacity and thus represented the  
111 provenance (population) germination ability.

112  
113 **Lime Application on Field Grown *L. leucocephala*:** Field experiments were set up at  
114 Chepkoilel campus, Moi University and Maseno ICRAF/KEFRI center sites. The experiment  
115 was a 2-factor (provenance – lime) split plot design with five replications. The three  
116 provenances were randomly assigned to the sub-plots as shown in the layout. A block  
117 measuring 60 m by 30 m was divided into two plots, which were separated by a 1m strip of

land. One plot was limed at 6.8 t/ha ( $L_1$ ) but the other was not limed ( $L_0$ ). The lime was uniformly spread on the soil surface and then manually mixed into the top-soil. Each plot was then sub-divided into 15 sub-plots (measuring  $2.9 \times 3.5$  m), which were numbered and randomly allocated to provenances. The spacing used was 1 m between and 0.8 m within the rows. Two pre-germinated seedlings were planted per hole, and thinned to one seedling, two weeks after planting. Four randomly selected plants per sub-plot were tagged and used in assessing growth and development of the seedlings. Number of leaves, plant height and root collar diameter were recorded at 60, and 120 DAP. The plants dry weight (biomass) was assessed at 60, and 120 DAP.

### 3. RESULTS

**The effect of Site on Growth Response of Potted *L. leucocephala* at Maseno and Chepkoilel:** Combined means (limed, unlimed and aluminum treatments) of seedling growth attributes are used to compare the effect due to site on growth and development of leucaena between Maseno and Chepkoilel (Figures 1 – 5).

**Number of leaves:** The number of leaves per seedling for both sites is presented in Figure 1. Most seedlings had significantly more leaves in Maseno than in Chepkoilel except provenance K136 which had more leaves in Chepkoilel than in Maseno and provenance KIT2724 that had equal number of leaves per seedling in both sites at 60 DAP.

**Seedling height:** The seedlings height at both Maseno and Chepkoilel at various stages of growth is presented in Figure 2. The seedlings were significantly taller at Maseno than Chepkoilel at all stages of growth however, inter-provenance differences were not significant statistically at either site.

**Seedling root length:** Root length of the seedlings is presented in figure 3. Maseno seedlings had longer roots than the ones at Chepkoilel at all stages of growth.

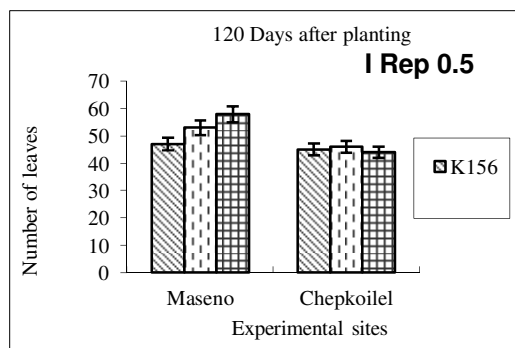
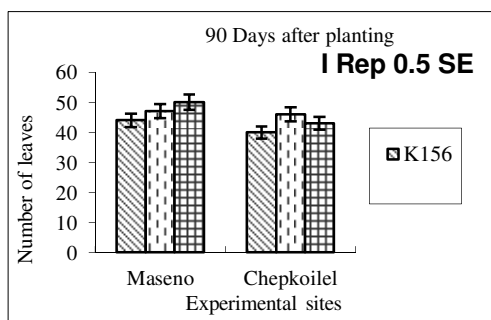
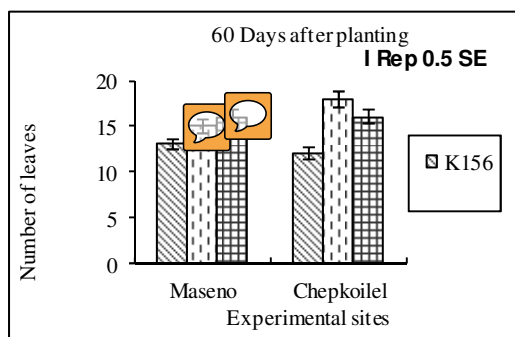


Figure 1. The effect of site on mean number of leaves per seedling of potted *Leucaena* at Maseno and Chepkoilel at 60, 90 and 120 days after planting.

**Seedling root collar diameter:** The root collar diameter of the seedlings is presented in Figure 4. Seedlings at Maseno had wider collar diameters than the ones at Chepkoilel 60 DAP. However the trend changed at 90 and 120 DAP whereby the seedlings at Chepkoilel had wider collar diameters than the ones at Maseno.

**Seedling biomass:** Seedling biomass is presented in Figure 5. Maseno seedlings had higher dry weights than the ones at Chepkoilel at all stages of growth.

**Inter-provenance variation:** Variation in the performance of each provenance based on all the growth parameters assessed ~~was also observed~~ between the two sites. KIT2724 recorded the highest means in all the growth attributes followed by K136, and the lowest means was recorded by K156 at Maseno. However, in Chepkoilel, K136 recorded the best performance in all the growth attributes followed by KIT2724 and lastly by K156. The general appearance of one the *L. leucocephala* provenances (K136) seedling growing in the field at Chepkoilel bore flowers and pods at the age of 6 months.

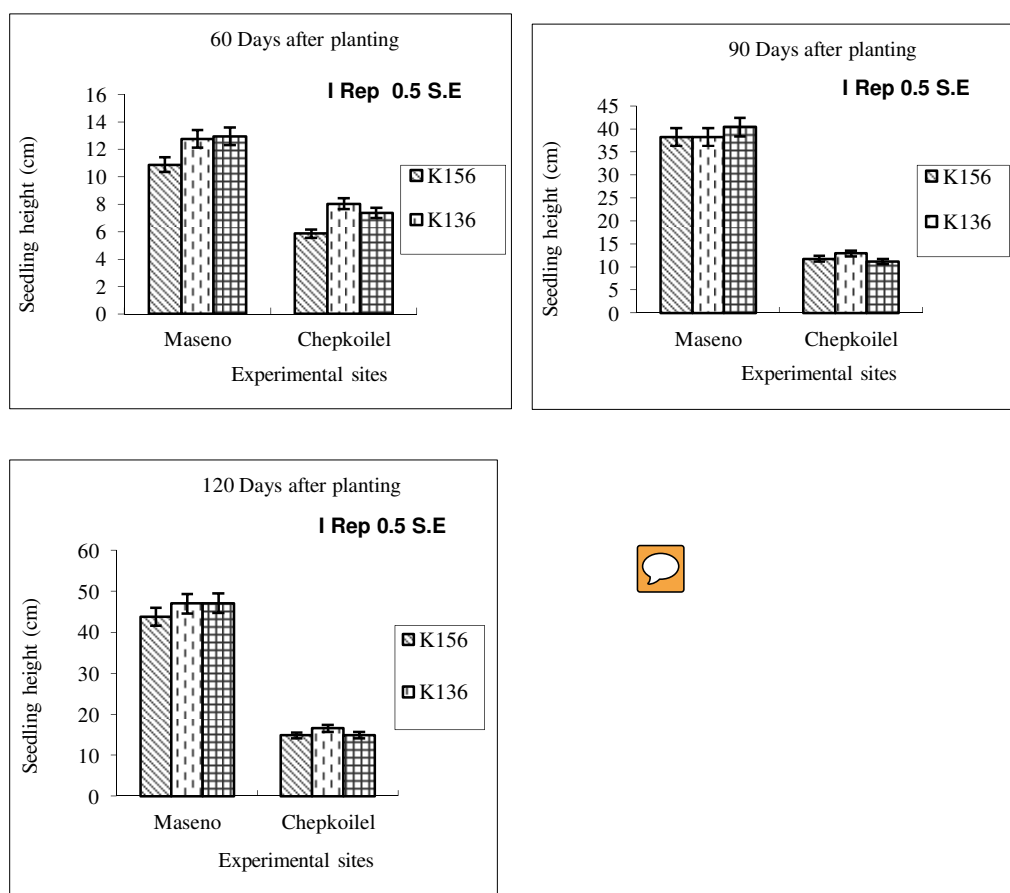


Figure 2. The effect of site on mean seedling height (cm) of potted leucaena at Maseno and Chepkoilel at 60, 90 and 120 days after planting.

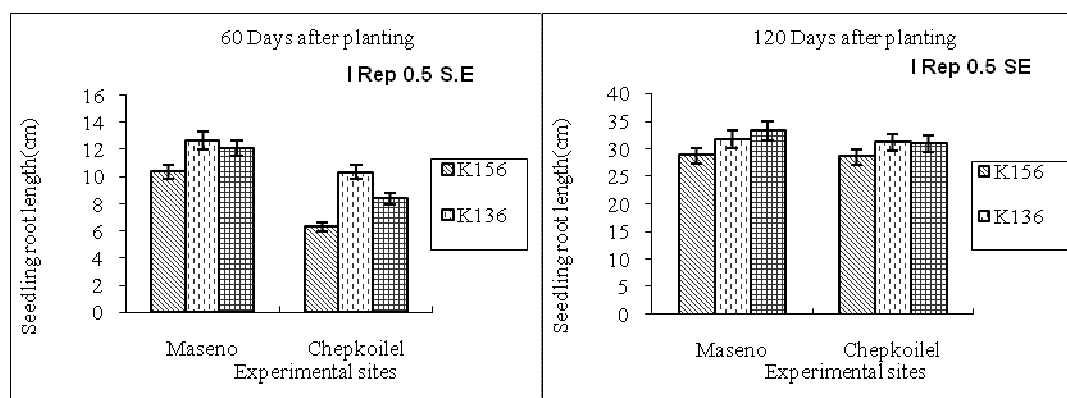


Figure 3. The effect of site on mean seedling root length (cm) of potted leucaena at Maseno and Chepkoilel at 60 and 120 days after planting.

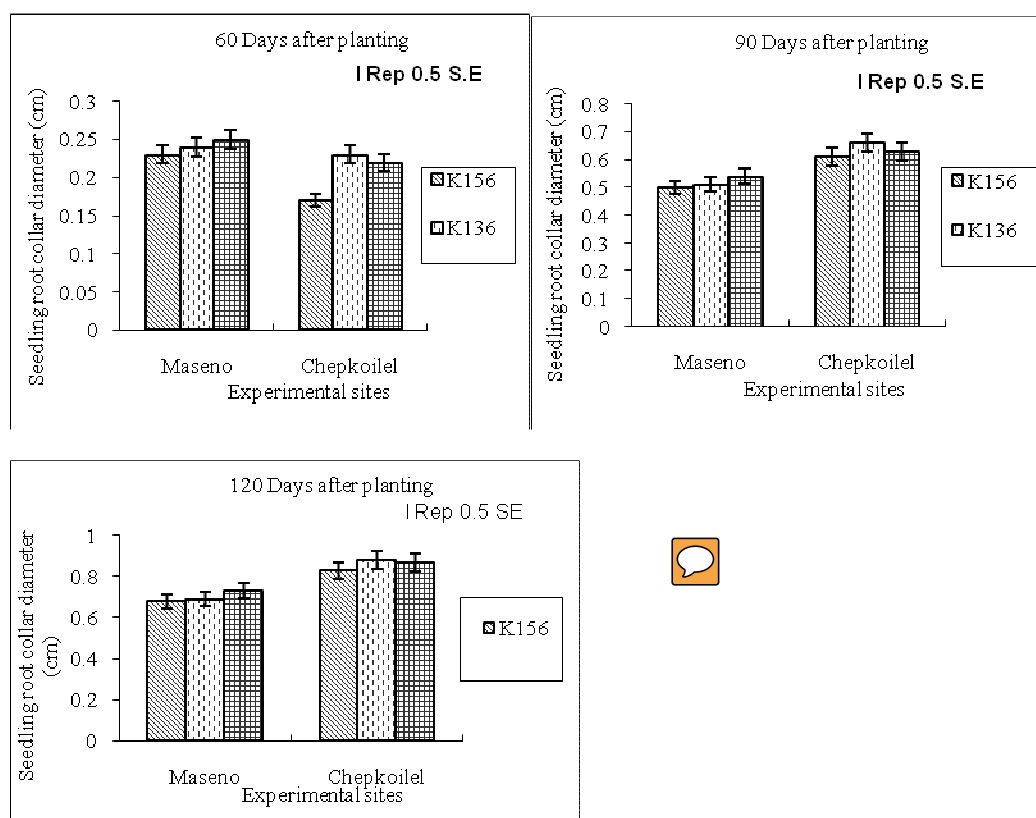


Figure 4. The effect of site on mean seedling root collar diameter (cm) of potted leucaena at Maseno and Chepkoilel at 60, 90 and 120 days after planting.

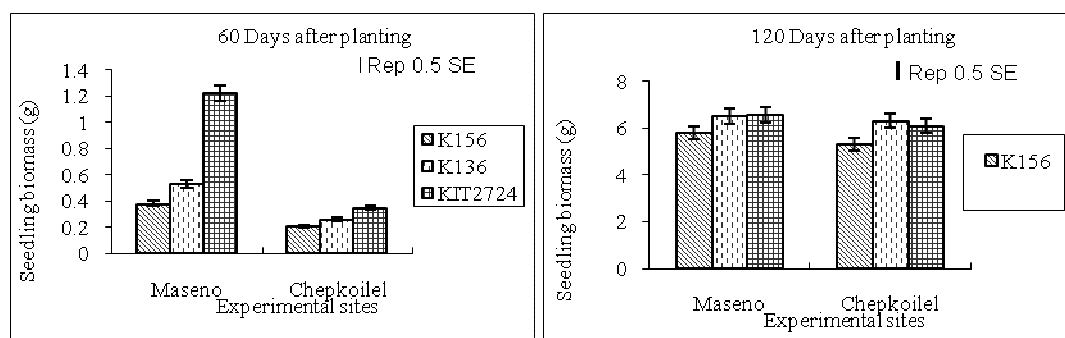


Figure 5. The effect of site on mean seedling biomass (g) of potted leucaena at Maseno and Chepkoilel at 60 and 120 days after planting.

#### 4. DISCUSSION

##### *The Effect of Site on Growth Response of L. leucocephala Genotypes at Maseno and Chepkoilel*

There was relatively better seedling growth at Maseno than Chepkoilel. The differences in environmental factors, such as higher mean temperatures (25°C) at Maseno could promote growth, resulting in higher plant height, root length and plant dry weight than in Chepkoilel, which had lower mean temperature 17°C, (Jaetzold and Schmidt 1982; Muok, 1997). However, although the Maseno plants were taller, they had smaller root collar diameters, especially after 90 days. The comparatively higher levels of nitrogen in the Maseno soils could also be responsible for the better growth. This was also reflected in the shoot tissues where the seedlings grown at Maseno had higher nitrogen content than those same genotypes grown at Chepkoilel site.

#### 5. CONCLUSION

Seedlings of *L. leucocephala* grew faster at Maseno than at Chepkoilel. With liming, KIT2724 and K136 could be grown in acid soils especially in both Maseno and Uasin Gishu districts where agroforestry practice is being promoted. However, K156 seems to be more tolerant to soil acidity and the genetic basis of this tolerance should be further established.

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