

Effect of Tree Hedgerow Pruning on Maize Yield in Santa, Cameroon

Neba Derick Akume, *Suh Christopher, Mbarga Amougou Manga, Ngome Ajebe Sone Francis, Fornkwa Victorine Yaya, Lenzemo Venasius

Institute of Agricultural Research for Development (IRAD),
Bambui Center P.O.Box 80 Bamenda, N.W.Region, Cameroon.

*Corresponding Author's Email: suhchristopher@yahoo.com

Abstract – Hedgerow intercropping or alley cropping is an agro forestry practice where perennial, preferably leguminous trees or shrubs are grown simultaneously with arable crops. Both crops and trees are continually changing due to environmental conditions and management techniques that affect both the trees and crops. The effectiveness of a such a system depends on the successful management of light competition, nutrients and water management between woody species and crops. The main objective of this study was to investigate the effect of tree hedgerow pruning on maize yield. The trial was conducted in Santa, Cameroon in a Randomized complete block design (RCBD) having four replications of five treatments each. The treatments were a control(without trees) and four multipurpose tree species viz: *Calliandra colothyrsus*, *Leucaena leucocephala*, *Acacia angustissima* and *Gliricidia sepum*. The maize variety used was COCA due to its adaptability to the Western Highlands of Cameroon. Tree performance and maize grain yield data were recorded in each plot and analyzed using ANOVA. The trial was monitored for four years. The first year involved the installation of the tree hedges while the subsequent years involved maize intercropping. Results showed that there was a significant increase at 5% level of students t test in maize yield due to soil improvement with pruning of all tree species compared to the control. Overall results showed that *Acacia angustissima* and *Calliandra calothyrsus* are suitable tree species for alley cropping in the Western Highlands of Cameroon, owing to their excellent performance in growth and biomass production as compared to *Leucaena leucocephala* and *Gliricidia sepum*.

Keywords – *Acacia Angustissima*, *Calliandra Colothyrsus*, *Gliricidia Sepum*, Hedgerow, *Leucaena Leucocephala*, Maize.

I. INTRODUCTION

Maize is planted throughout the N.W. region of Cameroon at the onset of the rainy season, between the second half of March and early April. Generally, local varieties of the flint type and dark yellow grain are commonly planted. However, because of breeding techniques, new high yielding varieties have been introduced by the Agricultural research institute, e.g. Coca and CHC. In the N.W. Region of Cameroon, maize is the single most important diet food. The Western Highland region of Cameroon accounts for about 60% of maize produced by the traditional sectors of Cameroon [4]. Cultivated in small plots of 0.4 to 0.6 ha, maize is usually intercropped with beans, potatoes, groundnuts and yams, according to locations.

Hedgerow intercropping or alley cropping is an agro forestry practice where perennial, preferably leguminous trees or shrubs are grown simultaneously with arable crops. Both crops and trees are continually changing in response to environmental conditions and management that affect both the trees and crops. The effectiveness of a such a system depends on the successful management of competition for light, nutrients and water between woody species and crops [9]. The trees, managed as hedgerows, are grown in wide rows and the crop is planted in the interspace or “alley” between the tree rows [12]. This cropping system has been widely practiced in many parts of the world, especially in the tropics. In the tropics, the trees are usually heavily pruned so that the leaves and small stems are applied to the soil as mulch, thus serving as a source of N and organic matter. Benefits of hedgerow intercropping include improvements in N fertility and other soil properties and maintenance of crop productivity over a period of time. On sloping terrains, hedgerows serve as a physical barrier to runoff and reduce soil erosion. Also, secondary products of alley cropping, such as forage, firewood and reduced use of chemical fertilizers and pesticides contribute to economic and environmental sustainability.

Competitive interactions for resources such as water, light, and nutrients between the tree component and crops in alley-cropping systems have been well documented [3, 2, and 21]. Plants require light, nutrients and water for their growth and survival; trees, crops and weeds have the same requirement in this regard. Thus, hedgerow trees, just like weeds, can compete with companion crops for available light, nutrients and water in an alley-cropping system. Tree-crop competition is often believed to be responsible for declining crop yields at the hedgerow-crop interface commonly observed in many alley-cropping trials [19, 6, and 15]. Studies on tree-crop competition in alley cropping have mostly focused on indirect competition through exploitation of shared resources [15]. Many trials report low yields of crops grown adjacent to hedgerows that negate the benefits from yield increases in the center of the alleys [9]. This usually is a sign that the pruning regime was not adequate to control competition from the hedgerows [9]. Reducing the interval between prunings during early crop growth may be all that is needed to reduce the competition at the tree-crop interface to a tolerable level [17, 13, and 22]. With alley cropping, timely hedgerow pruning is essential to reduce the

effect of shading on performance and yield of the companion crops. The optimum pruning regime is not a fixed interval throughout the year. Pruning should be timed to minimize competition for moisture, nutrients, and light during the critical periods of crop growth, while maximizing conditions for hedgerow regrowth during crop senescence and the dry season to maximize biomass availability for the succeeding crop [9]. [7] found that 3 prunings per maize crop gave higher yields than 2 prunings.

Competition for solar radiation is the most prominent above ground competition between hedgerow trees and companion crops. [10] measured radiation incident on crop rows as a function of distance from the hedgerows to determine the extent of shading by shrubs. The maize rows adjacent to *Leucaena* (*Leucaena leucocephala*) received 51-69% of the available light compared with 75-81% received by mid-alley rows. [14] observed that maize yield decreased with increased total dry matter yield of pruning from the associated hedgerow species. Maize grain yield was positively correlated with light transmission incident on maize at cob height.

Hedgerow shoot pruning can alleviate shading of crops while providing biomass for mulch or green manure. [5] reported that less frequent pruning and higher pruning height increased hedgerow biomass yields, but also reduced the companion crop yield. Shading can be minimized by more frequent pruning and lower pruning height, but this also limits hedgerow capacity for biomass production and nutrient recycling [11]. Hedgerow tree roots can compete with crop roots for available water and nutrients in the topsoil. [19] reported that, In semi-arid areas such as India, significant water competition was observed between leucaena hedgerows and castor (*Ricinus communis*), cowpea (*Vigna unguiculata*), and sorghum (*Sorghum bicolor*). In southwestern Nigeria, [23], using root barriers and root pruning to assess competition between maize and coppiced teak trees (*Tectona grandis*) found that shading alone depressed maize yield by 40%, while shading and root competition combined depressed yield by more than 60%. At a drought prone site in Haiti, alley cropping gave significantly higher maize yields than the control without hedgerows when rainfall was adequate despite the reduced cropping area, but under extreme drought conditions, yields in the alleys differed little from the control [18]. In the Guinea savanna of Congo, yield depression in the drought-prone short rainy season was less in the alley plots than in control plots, suggesting that improved moisture and fertility conditions in alley plots were more important than the competitive effect of leucaena [17]. Under drought stress conditions, higher groundnut yields in *G. sepium* alleys than in control plots were attributed to shading that reduced evapotranspiration in the crop [16]. Shoot pruning also affect hedgerow root systems. [16] reported that shoot pruning of *G. sepium* during the cropping period shifted the peak for maximum root development to the dry season, thereby reducing the competitiveness of *G. sepium* in alley cropping.

Regular shoot pruning of the *Leucaena* hedgerows over 4 years significantly reduced both the fine root density (61%) and leucaena root diameter size as compared to unpruned hedgerows [1]. [13] reported that increasing the interval between prunings from 1 to 6 months resulted in increased moisture competition and decreased sorghum yield. In Ohio, black locust (*Robinia pseudoacacia*) hedgerows depleted the adjacent soil water after irrigation, but there was no evidence of competition from hedgerow roots on maize grain yield unless soil water content declined because of drought [20].

In the Western highlands of Cameroon, soil erosion and low soil fertility are some of the prominent causes of poor crop yield to rural farmers. The integration of ligneous multipurpose trees, fallowing, and the use of organic/inorganic fertilizers in farms to improve the soil fertility have been proposed by several authors. The International Centre for Research in Agro forestry (ICRAF) has provided several trees to enhance agro forestry and preserve genetic resources. Conversely most rural farmers are reluctant to adopt new technologies. Owing to the great diversity in crops and agro-ecological zones, the question is which innovation is appropriate for which crop and for what agro-ecological zone?

II. OBJECTIVES

The main objective of the study was to investigate the effect of tree hedgerow pruning on maize yield.

The specific objectives of the study were:

- 1) Improve maize yield at a relatively lower cost of production.
- 2) Identify tree species suitable for alley cropping in the Western Highlands agro-ecological zone of Cameroon.
- 3) Demonstrate alley cropping as an alternative to shifting cultivation.

III. MATERIALS AND METHODS

The experiment was carried out in Santa, North West Region, Cameroon from 2008-2011. The site is located between Latitude 5.80292 and Longitude 10.22081. It is an upland area of about 1750 meters above sea level in altitude. The temperatures are generally cold, averaging about 25°C in the day and approximately 17°C at night.

Local rainfall is approximately 3,000 mm per annum and the soil is volcanic and ferrallitic. The rainy season begins in March and lasts until early November, but the months of greatest precipitation are generally from July to September.

The experiment was a Randomized complete block design (RCBD) having four replications of five treatments each. The plots representing each treatment measured 10m x 4m. The treatments were four multipurpose tree species with one control as indicated below.

S₀ = No tree (control)

S₁ = *Calliandra colothyrsus* pruning

S₂ = *Leucaena leucocephala* pruning

S₃ = *Acacia angustissima* pruning
 S₄ = *Gliricidia sepium* pruning

Tree performance and maize grain yield data were recorded in each plot and analyzed using analysis of variance (ANOVA).

The maize variety used was COCA due to its adaptability to the Western Highlands agro-ecological zone of Cameroon. The maize was grown on beds within the tree hedgerows at spacing of 40cm by 80cm giving a cropping density of 100 maize stems per plot. The tree hedgerows were 4m apart and the tree intra line spacing was 50cm giving a tree density of 40 per plot. The hedge height was maintained at 50cm to avoid interference with the maize. The tree prunings were applied twice for each cropping season and the pruning incorporated in the soil during bed preparation and mulching operations respectively.

The trial was monitored for four years. The first year involved the installation of the tree hedges. The performances of the various tree species were evaluated. Maize was then cropped during the three subsequent years and the yields due to the different treatments assessed.

IV. RESULTS AND DISCUSSIONS

Results of Hedgerow Pruning On Maize Yield

During the first year, the performance of the trees on the field was evaluated to know their growth, the survival rate as well as their contribution vis á vis the maize yield.

Table I: Maize Grain Yield Per Treatment (kg/ha)

Treatment	2009	2010	2011
No tree	1500 ^c	1475 ^d	1600 ^c
Calliandra	1950 ^b	2200 ^b	2000 ^b
Leucaena	1900 ^b	1875 ^c	1975 ^b
Acacia	2475 ^a	2450 ^a	2525 ^a
Gliricidia	1825 ^b	1750 ^c	1900 ^b

Levels not connected by same letter are significantly different.

After the first year i.e. in 2009, the yield of maize varied with the treatments (type of tree planted as hedgerow) as noticed in Table 1.

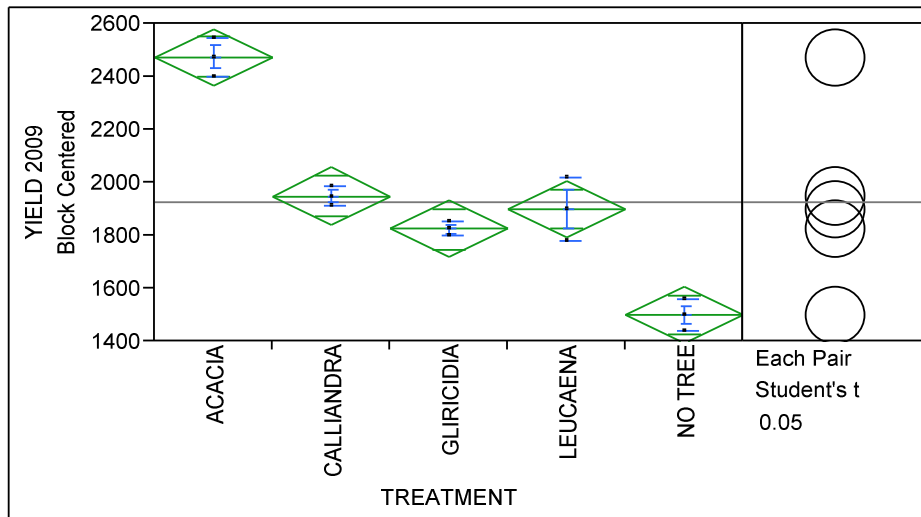


Fig.I. One-way analysis of maize yield in 2009 by treatment

Acacia plots gave a significantly higher yield of 2475kg/ha compared to the control (no tree as hedgerow) that gave 1500kg/ha. There was no significant difference in plots having *Calliandra*, *Gliricidia* and *Leucaena* in terms of maize yield but there was a significant difference compared with the control (fig 1).

In 2010 during the second year of maize cultivation, *Calliandra* gave a yield of 2200kg/ha significantly different from *Leucaena* and *Gliricidia* that had yields of 1875 and 1750 kg/ha respectively. Just like in 2009, Acacia gave a significantly higher yield than the other treatments (fig 2).

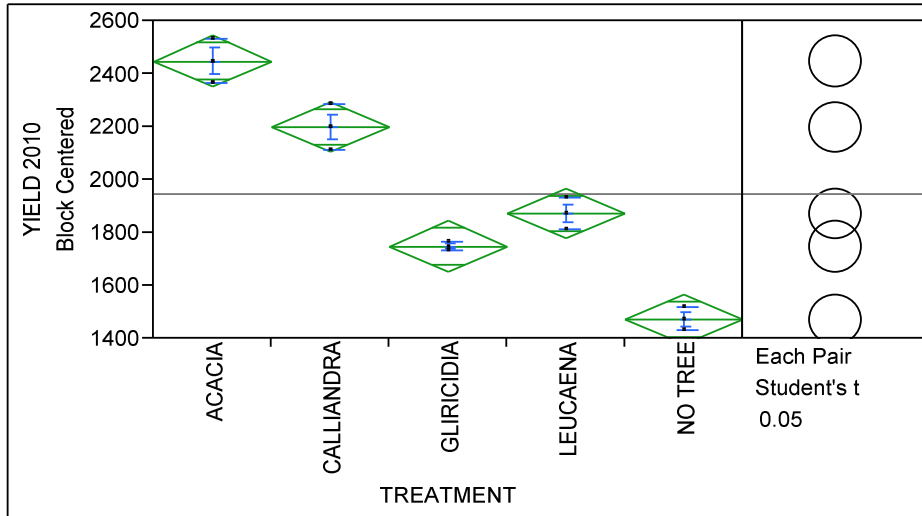


Fig.II. One-way analysis of maize yield in 2010 by treatment

In 2011, during the third planting season of the maize plant, *Acacia* gave the highest yield of 2525kg/ha which was significantly different from the other treatments. *Calliandra*,

Gliricidia and *Leucaena* had no significant difference in terms of maize yield though they were significantly different from the control (1600kg/ha) as seen in fig 3.

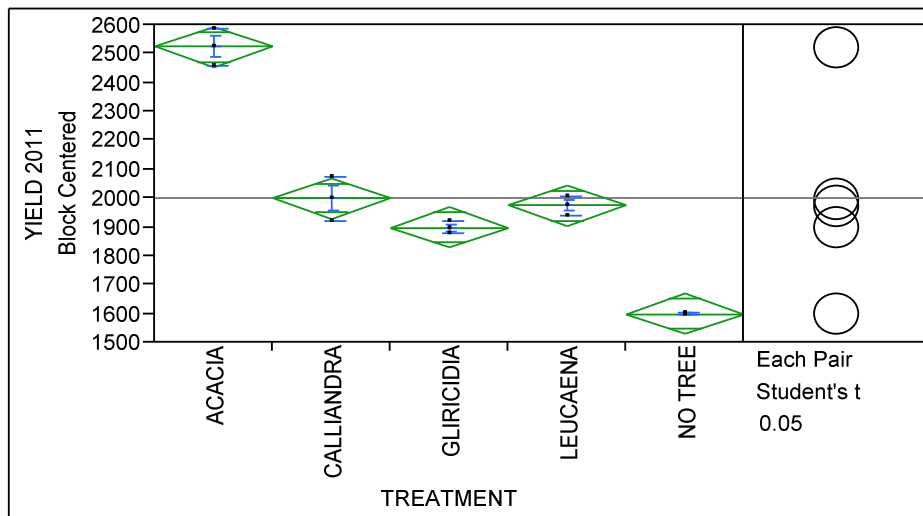


Fig.III. One-way Analysis of maize YIELD in 2011 By TREATMENT

Table II: Tree Performance In Alley Farming

Treatment	2008			2009			2010			2011		
	No. Trees	Survival Rate (%)	Average Height (CM)	No. Trees	Survival Rate (%)	Average Height (CM)	No. Trees	Survival Rate (%)	Average Height (CM)	No. Trees	Survival Rate (%)	Average Height (CM)
No tree	0c	0	0e	0b	0b	0e	0b	0b	0e	0b	0b	0e
<i>Calliandra</i>	38a	95.0a	30.3b	40a	100a	72.3b	40a	100a	73.2b	40a	100a	70.4b
<i>Leucaena</i>	37a	92.5a	11.9d	40a	100a	61.4c	40a	100a	62.1c	40a	100a	63.5c
<i>Acacia</i>	39a	97.5a	80.9a	40a	100a	151.5a	40a	100a	150.5a	40a	100a	149.6a
<i>Gliricidia</i>	20b	50b	16.0c	40a	100a	55.3d	40a	100a	60.2d	40a	100a	59.8d

Levels not connected by same letter are significantly different.

In 2008, there was a significant difference in tree establishment between *Gliricidia* and others. *Gliricidia* had 50% establishment against over 90% for the other species. However there was replacement before the maize cropping season to have all the treatments at same level of 100% (table 2). In terms of average height of trees, there was a significant difference among all the four species of hedgerow trees (fig 4, 5, 6, and 7). After pruning them, before the next planting season of 2009, 2010 and 2011, the

same trend in variation of height was observed in all the trees. This had an influential role in the yield obtained from maize since the pruning of different biomass levels were used to enrich the soil. However, the biomass used was insufficient for soil improvement and therefore part of the enrichment came from the level of the tree roots. [24]reported that hedgerows increased infiltration and reduced soil loss thereby contributing to soil improvement.

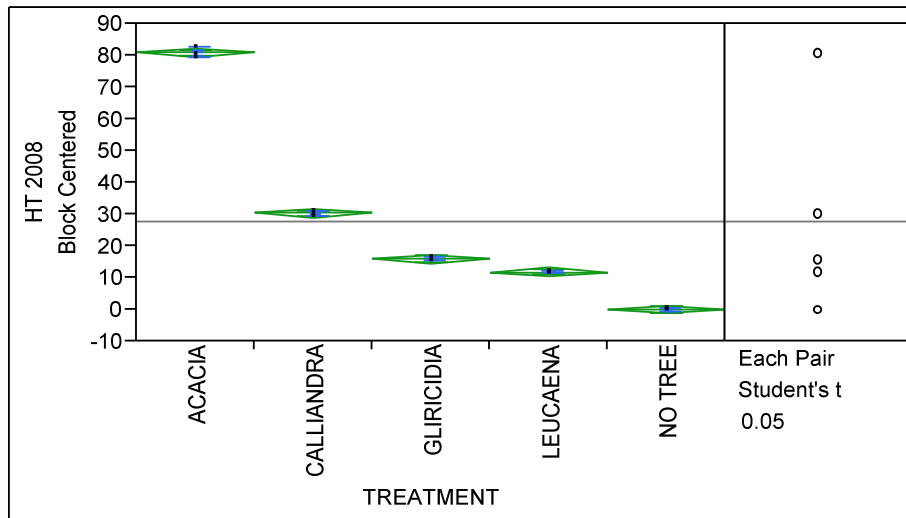


Fig.IV. One-way analysis of tree height in 2008 by treatment

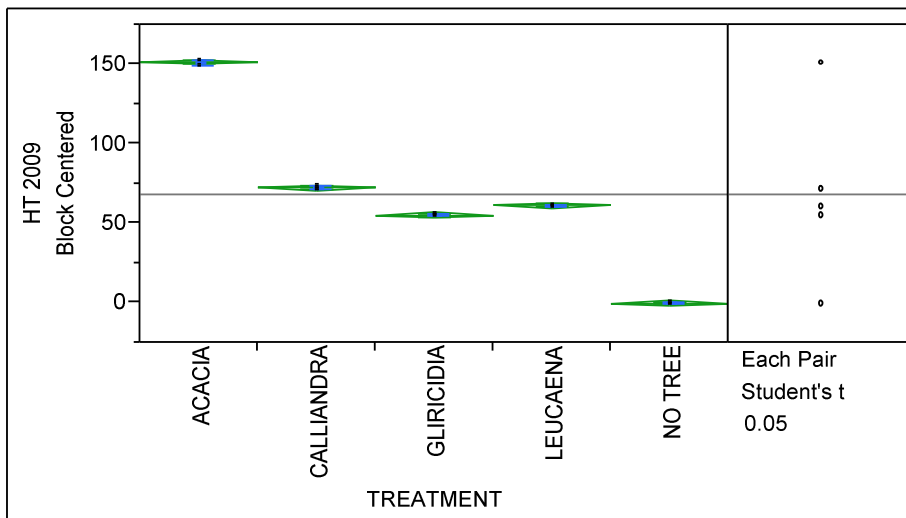


Fig.V. One-way analysis of tree height in 2009 by treatment

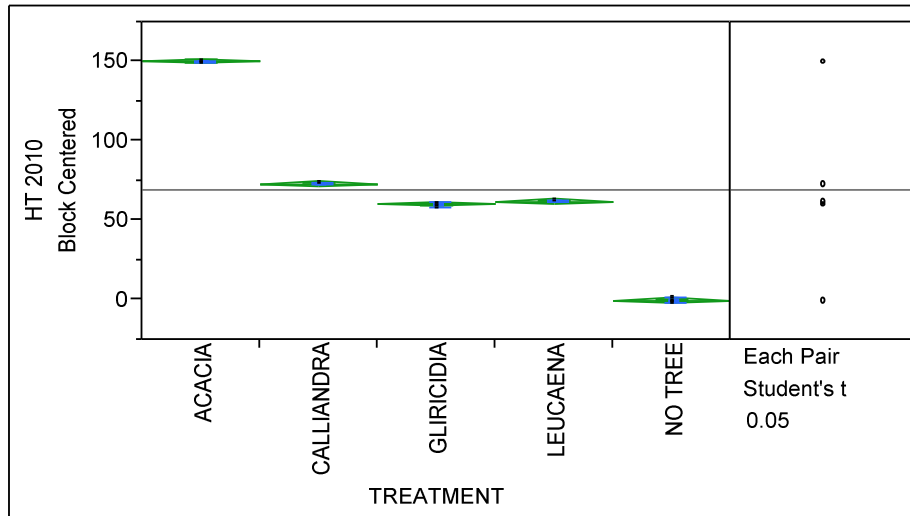


Fig.XI. One-way analysis of tree height in 2010 by treatment

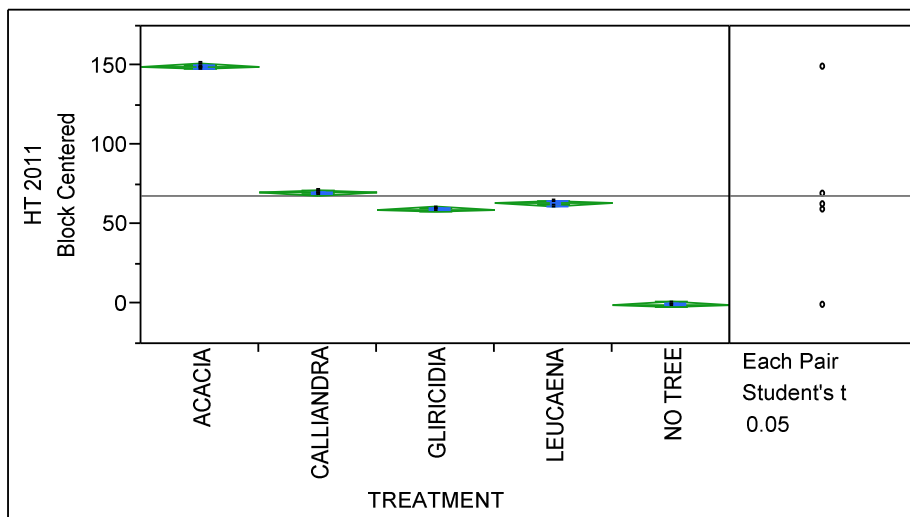


Fig.VII. One-way analysis of tree height in 2011 by treatment

V. CONCLUSION

- 1) There is a significant increase in maize yield due to pruning of *Acacia angustissima* and *Calliandra calothyrsus* in the Western highlands of Cameroon.
- 2) There is no significant increase in maize yield due to pruning of *Leucaena leucocephala* and *Gliricidia sepum* in the Western highlands of Cameroon.
- 3) *Acacia angustissima* and *Calliandra calothyrsus* are suitable tree species for alley cropping in the Western Highlands of Cameroon, owing to their excellent performance in growth and biomass production as compared to *Leucaena leucocephala* and *Gliricidia sepum*.

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