Original Research Article

# Effect of Spacing and Pruning Methods on Root Yield and Yield Parameters of Cassava (*Mahinot esculenta* Crantz ) in Fedis District, East Harerghe Zone, Ethiopia


*Abstract*

*Because of the long duration of cassava roots maturity, drought and disease problems, intercropping grain and legumes in cassava should be developed. To intercrop component crops, it is important to reduce cassavas' canopy through the evaluation of the pruning effect on root yields. The study was aimed to determine the effects of different plant spacing and pruning methods on root yield and root yield parameters of cassava grown in Eastern part of Ethiopia. Cassava variety 'Kello' was used for the experiment as a test crop. Five cassava plant intra-row spacing (0.60, 0.80, 1.00, 1.20 and 1.40 m) were assigned to main plots while pruning methods (cutback, debranching and no pruning) were assigned to sub plots. The experiment was laid out in randomized complete block design (RCBD) in a factorial arrangement with three replications. The result revealed that there were highly significant differences for number of roots per plant, root length, average root weight and unmarketable due to the effect of pruning, while significant differences was observed for total root yields due to intra-row spacing. There was also highly significant interaction effects for marketable and total root yields due to the effects of intra-row spacing and pruning. Cassava with no pruning recorded about, 21.9 and 25.7%, 10 and 26.4%, 17.2 and 19.9%, 43.5 and 58.7% over cassava with debranching and cutback for number of roots per plant, root diameter, root length and root weights, respectively. Cassava pruning and intra-row spacing also interacted and the highest root yield was recorded at 80cm with cassava no pruning. Averagely, cassava with no pruning provided the highest marketable and total root yield by about 39.3 and 44.7%, 35.8 and 41.6% over cassava with debranching and cutback, respectively. Therefore, considering the land scarcity of the area intra-row plant spacing of 80cm and cassava with no pruning was recommended for the study area and similar agro-ecology for land economy in eastern Harerghe zone.*



**Keywords**: Cassava, Cutback, Debrancing, Pruning and Spacing


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**Comment [i2]:** Of what? Intra spacing?

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## 1. Introduction

Cassava is a perennial crop native to tropical America with its center of origin in north-eastern and central Brazil [2]. It is cultivated mainly for its enlarged starchy roots and one of the most important food staples in the tropics, where it is the fourth most important energy source. Given the crop's tolerance to poor soil and harsh climatic conditions, it is generally cultivated by small-scale farmers as a subsistence crop in a diverse range of agricultural and food systems [3]. Roots can be left in the ground without harvesting for a long period of time, making it a useful crop as security against famine.

The success of cassava production in Africa, as food security crop, is largely because of its ability and capacity to yield well in drought prone, marginal wasteland under poor management conditions where other crops would fail. Cassava is a tropical root crop, requiring at least eight months of warm weather to produce a crop. It takes 18 or more months to produce a crop under adverse conditions such as cool or dry weather. Cassava does not tolerate freezing conditions. It tolerates a wide range of soil pH 4.0 to 8.0 and is most productive in full sun.

In Ethiopia, cassava grows in some areas of southern regions including Amaro, Gamogofa, Sidama, Wolaita, Gedeo and Konso. Cassava was introduced to drought prone areas of Southern part of the country primarily to fill food gap for subsistence farmers due to the failure of other food crops as the result of drought [7]. The average total area planted to the crop and production of cassava per annum in Southern region of Ethiopia is 4,942 ha and 53,036.2 tones, with productivity of 10.73 tons per hectare, respectively [12]. In the report of [8] about 26.8 tons per hectare of cassava root yield was recorded around eastern part of Ethiopia.

As cassava plant develop large canopy, it can affect nearby or undergrown crops and may reduce the productivity of the undergrown crop as it covers and compete light interception. However, the available sunlight, water and nutrients between rows can be profitably utilized for short duration intercrops [10]. [9] stated that cassava-soybean intercropping

was increased cassava root yield by 41.7 and 21.3% as compared to cassava-cowpea and cassava-haricot bean, respectively.

Plant spacing is important agronomic factor in crop productivity and production that can limit yield and agronomic performance of plants. Plant spacing may depend on the soil type, moisture content of the soil, plant growing habit. Large/spread canopy plants need wider spacing than narrower/compact canopy plants. Cassava plant needs wider spacing as it is tree shrubs and large number of branches. According to [10], cassava is planted at intra and inter row spacing of 80-120 × 60-100 cm in the southern part of Ethiopia and takes more than 3 to 4 months to develop enough canopies. However, there is no literature review that state about the plant spacing of cassava in eastern part of Ethiopia including Harerghe area. As cassava is important root crop in tackling food insecurity in lowland areas, determination of plant spacing is important issue to optimize root yield and agronomic performance of the crop. Most studies have quantified the effect of plant spacing on the production of tuberous roots [1], but are lacking studies, especially in Eastern part of Ethiopia including Harerghe Zones, investigation of different spacing on growth and development, which are determinants of root yield in cassava.

Generally, determination of cassava plant spacing and effect of pruning on root yield and yield parameters has many advantages to cassava producing farmers. More than half of Harerghe farmers work on fattening of oxen in addition to crop production. Shortage of cattle feed is also the main problem of the area. In such case they can use cassava top prune to feed their cattle beside root production for their food. Pruning has many advantages to cassava producing farmers: cassava top prune is used for cattle feed beside root production, its canopy can also be pruned to open the space for the under growing and intercropping crops. Cassava plant need wider spacing because of its large canopy with a number of branches, so that it need to determine the spacing and pruning to reduce canopy for the under growing crops if it is not adversely affect root yields. In this context, the objective of this study was to determine the effects of different plant spacing and pruning methods on root yield and root yield parameters of cassava grown in Eastern part of Ethiopia.

**Comment [i4]:** To what exactly are these figures referring to cassava-soybean intercropping/cassava-cowpeas/cassava-harcort bean. Statement not clear

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## 2. Materials and Methods

### 2.1 Description of the Experimental Site

The study was conducted under rain fed conditions at Fedis Agricultural Research Center of Oromia Agricultural Research Institute (OARI) at Boko sub-site, which is located at the latitude of 9°07' north and longitude of 42°04' east, in the middle and lowland areas and at the altitude of 1702 meter above sea level, with a prevalence of lowlands. The soil of the experimental site is black with surface soil texture of sand clay loam that contains 8.20% organic matter; 0.13% total nitrogen, available phosphorus of 4.99 ppm, soil exchangeable potassium of 1.68 cmol(+)/kg and a pH value of 8.26. The experimental area is characterized as lowland climate. The mean rainfall is about 859.8 mm for the last ten years. The rainfall has a bimodal distribution pattern with heavy rains from April to June and long and erratic rains from August to October. The mean maximum and minimum annual temperature are 27.7 and 11.3°C, respectively, for the last five years (Fedis Agriculture Research Center Metrological Station, unpublished).

### 2.2 Treatments and Design

The experiment was conducted at Fedis research station in the main cropping season. Cassava variety 'Kello' was used for the experiment as a test crop. Five cassava plant intra-row spacing (60, 80, 100, 120 and 140 cm) were assigned to main plots while pruning methods (cutback, debranching and no pruning) were assigned to sub plots. The experiment was laid out in randomized complete block design (RCBD) in a factorial arrangement with three replications. Spacing between rows was 150 cm. For the spacing of 60, 80, 100, 120 and 140 cm, the plant population were 11111, 8333, 6667, 5556 and 4762 plants/ha, respectively. Pruning was carried out when cassava reached about 1m height from the ground. Cutback (all shoots and branches of cassava plant were removed), debranching (all branches were removed, except the main stem) and no pruning (no pruning was carried out from this treatment) were combined with spacing and assigned to experimental plots.

Table 1. Cassava plant spacing range and pruning methods as treatments

| Intra-row spacing | Pruning methods |
|---|---|
| S1 = 60 cm | CB = Cutback=removing all shoots |
| S2 = 80 cm | DB = De-branching=removing all branches, except main stem |
| S3 = 100 cm | NP = No pruning |
| S4 = 120 cm | |
| S5 = 140 cm | |

### 2.3 Data Management and Statistical Analysis

All quantitative data like root length, root diameter, number of root per plant, average root weight, marketable root yield, unmarketable root yield and total root yield will be collected. Root yield of cassava will be weighed using digital balance after harvest. The collected data will be subjected to ANOVA using GenSTAT computer software (GenSTAT Software 18th edition). Differences between means were compared using the least significance difference (LSD) test at $p \leq .05$.

## 3. Results and Discussion

### 3.1 Number of roots and root weight

The result also revealed that there were highly significant differences for number of roots per plant and average root weight due to the effect of pruning at *P<.01*. The highest number of roots per plant was recorded for cassava with no pruning plots as compared cassava with debranching and cutback. The number of roots per plant with no pruning cassava plant were obtained about 21.9 and 25.7% over the cassava plant debranching and cutback, respectively. In line with this study of [5] who reported that the highest average number of roots per plant were obtained from the unpruned plants, while no definite trend was observed under the two pruning methods. Moreover, increased number of storage roots per plant with wider root appeared to be responsible for good storage root yield per

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plant in cassava. Even though the intra-row spacing did not SHOW ANY significant differences, the number of roots per plant was advanced linear increase as intra-row spacing increased.

The highest root weight was also recorded for cassava with no pruning as compared to cassava with debranching and cutback. Averagely, cassava with no pruning recorded 43.5 and 58.7% root weights over cassava with debranching and cutback treatments, respectively. [5] were also stated that the biggest storage roots were recorded for unpruned cassava plants.

### 3.2 Root diameter and length

The result also revealed that there were highly significant differences for root length due to the effect of pruning at *P<.01*. Root diameter and length were significantly affected by pruning treatments regardless of the range of intra-row spacing. The highest root diameter was recorded for with no pruning among the three pruning treatments. Typically, cassava with no pruning was ~~provided~~ gave about 10 and 26.4% root diameter more than cassava with debranching and cutback, respectively. However, intra-row spacing ~~did~~ showed no significant differences on root diameter.

Root length was also significantly affected by pruning treatments. Cassava pruning treatments from cassava with no pruning, debranching and cutback were reduced root length accordingly. The longest root was recorded for cassava with no pruning among the three pruning treatments. Cassava with no pruning was ~~provided~~ gave about 17.3 and 19.9% root length over cassava with debranching and cutback, respectively. [6] were reported that control plants had higher storage root number, root length, root fresh and dry weights than 1-branch and 2-branch removal. However, the range of intra-row spacing ~~did~~ showed no significant differences for root diameter and length.

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### 3.3 Marketable, unmarketable and total root yields

The analysis of variance showed there were highly significant differences for unmarketable WHAT? root number? at *P<.01* and significant differences for total root yields due to intra-row spacing at *P<.05*. There was also highly significant interaction effects for marketable

and total root yields due to intra-row spacing and pruning at *P<.01*. Averagely, cassava with no pruning provided the highest marketable root yield by about 44.7 and 39.3% over cassava with cutback and debranching, respectively, while cassava with no pruning recorded total root yield by about 41.6 and 35.8% over cutback and debranching, respectively regardless of intra-row spacing. Cutback and de-branching were decreased root yield and were not economical as compared to no pruning. This study was supported with the findings of [6] who stated that storage root yield (both fresh and dry weights) decreased with increasing debranching.

Table 2: Analysis of variances for yield and yield parameters of cassava as influenced by intra-row spacing and pruning

| Agronomic and root yield parameters | Replication (2) | Intra-row Spacing(4) | Pruning (2) | Intra-row spacing * Pruning(8) | Error (73) |
|---|---|---|---|---|---|
| Number of roots per plant | 0.066 | 3.403 | 55.65** | 2.041 | 3.935 |
| Root diameter (mm) | 83.07 | 33.15 | 1974.79 | 83.09 | 65.5 |
| Root length(cm) | 72.34 | 36.84 | 938.87** | 52.66 | 66.11 |
| Average root weight(kg) | 0.51 | 0.02 | 5.40** | 0.10 | 0.06 |
| Marketable root yield (t $ha^{-1}$) | 2.89 | 57.84 | 3911.53** | 132.86** | 29.28 |
| Unmarketable root yield(t $ha^{-1}$) | 12.18 | 15.26** | 1.61 | 2.08 | 2.66 |
| Total root yield(t $ha^{-1}$) | 22.21 | 120.81* | 3829.87** | 136.16** | 34.58 |

**highly significant, *significant

Table 3: Combined means of yield components of cassava as affected by intra-row spacing and pruning

| Intra-spacing (cm) | Root weight (kg) | Root diameter (mm) | Root length (cm) | Root per plant | Unmarketable root(t $ha^{-1}$) |
|---|---|---|---|---|---|
| 60 | 0.86 | 53.16 | 43.30 | 7.79 | 4.84a |
| 80 | 0.90 | 52.22 | 46.03 | 7.97 | 3.86ab |
| 100 | 0.93 | 53.58 | 46.73 | 8.15 | 3.06bc |
| 120 | 0.92 | 55.32 | 46.60 | 8.46 | 3.11bc |
| 140 | 0.94 | 51.88 | 44.92 | 8.89 | 2.44c |
| LSD (0.05) | NS | NS | NS | NS | 1.07 |
| Pruning methods | | | | | |
| Cutback | 0.57c | 44.54c | 41.61b | 7.29b | 3.37 |
| Debranching | 0.78b | 54.55b | 43.02b | 7.66b | 3.73 |
| No pruning | 1.38a | 60.61a | 51.93a | 9.81a | 3.30 |
| LSD (.05) | .13 | 4.16 | 4.09 | .99 | NS |
| CV (%) | 27.9 | 15.2 | 17.5 | 23.4 | 51.6 |

NS=Non-significant

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The reduction in root yield is due to the cassava plant consuming the reserves stored in the tuberous roots for recovering and leaf growth, always when the plant has environment conditions to develop [4, 11]. This might be due to cut away of cassava plant shoots that lead to limit sink capacity to feedback the photosynthetic process, reducing the photosynthetic rates.

Table 4: Interaction effect of intra-row spacing and pruning on marketable and total root yield.

| | Marketable root yield (t ha$^{-1}$) | | | Total root yield (t ha$^{-1}$) | | |
|---|---|---|---|---|---|---|
| | Pruning | | | Pruning | | |
| Spacing(m) | Cutback | De-branching | No pruning | Cutback | De-branching | No pruning |
| S1(0.6) | 25.70$^{c}$ | 39.71$^{b}$ | 43.27$^{ab}$ | 30.62$^{c}$ | 45.04$^{b}$ | 47.55$^{ab}$ |
| S2(0.8) | 29.29$^{c}$ | 24.96$^{c}$ | 49.19$^{a}$ | 32.56$^{c}$ | 29.40$^{c}$ | 53.07$^{a}$ |
| S3(1.0) | 25.60$^{c}$ | 28.25$^{c}$ | 46.11$^{ab}$ | 29.28$^{c}$ | 30.70$^{c}$ | 49.17$^{ab}$ |
| S4(1.2) | 22.45$^{c}$ | 23.45$^{c}$ | 48.19$^{a}$ | 24.94$^{c}$ | 27.47$^{c}$ | 51.02$^{ab}$ |
| S5(1.4) | 26.43$^{c}$ | 25.79$^{c}$ | 47.33$^{a}$ | 28.90$^{c}$ | 28.20$^{c}$ | 49.78$^{ab}$ |
| LSD (0.01) | 6.23 | | | 6.77 | | |
| CV (%) | 16.0 | | | 15.8 | | |

Pruning treatments were also interacted with intra-row spacing for marketable and total root yields. Intra-row spacing at 0.8, 1.2 and 1.4m ~~were provided~~gave the highest marketable root yield, while highest total root yield was recorded at intra-row spacing of 0.8m under cassava with no pruning. However, all intra-row spacing were statistically parity for marketable root and significantly different for total root yields with no pruning. It is important to consider the resources of the community around when presenting this study due to the scarcity of cultivation land in eastern Harerghe, so that 0.8m intra-row spacing is preferable.

## 4. Conclusion and Recommendation

Among pruning treatments, cassava with no pruning recorded the highest value in all parameters while pruning cassava with debranching and cutback adversely affected all parameters as compared to cassava with no pruning. Root yield and yield components of cassava reduced when it was pruned irrespective of pruning methods. The growth of unpruned cassava was never disturbed, while the pruned plots had to recover by

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developing new shoots. When the plant is pruned it needs some conversion process; use stored foods at an expense of root enlargement while it reduces marketable root yield. The general trend of cassava storage root yield under pruning treatments were cassava with no pruning > cassava with debranching > cassava with cutback. Pruning treatments and intra-row spacing were also interacted for marketable and total root yields. Intra-row spacing was also minimized from 100cm to 80cm without the influence of root yield that could advance about 0.2ha of land under cassava with no pruning. Therefore, the combination of intra-row plant spacing of 80cm and cassava with no pruning were recommended for the study area and similar agro-ecology for land economy as there is a land scarcity in east Harerghe zone.

**Comment [i10]:** The statement is not clear. Are trying to say that root yield was not impacted when intra-row spacing was reduced from 100 cm to 80 cm. Rephrased sentence

## 5. References


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**Comment [i12]:** Reference not cited