EFFECT OF VARIOUS IN-ROW PLANT SPACING OF MILLET (*Panicum miliaceun)* INTERCROP WITH MUNGBEAN *(Vigna Radiata)*

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INTRODUCTION

Nature and Importance of the study

Kabog millet is the name in Cebuano dialect for what is called paniki in the rest of the Philippines "Bird seeds." It is a small-seeded cereal plant known as millet in other countries. It is cultivated in Cebu, one of the central Visayas Islands of the Philippines, from locally acquired seeds. It has a short growing season under dry, high temperature conditions. Kabog was a native cereal staple food of Cebuanos long before the Spanish colonizers came into the Philippines.("Cebu Kabog Millet - Arca Del Gusto," n.d.)

Mungbean (Vigna radiata L. Wilczek) is the economically most important crop of the Vigna group. It is also known as green gram, golden gram, moong, Chickasaw, Oregon pea, and chop suey bean and this legume have a strategic position in Southeast Asian countries for nutritional security and sustainable crop production.(Mehandi et al., 2019)

Intercropping could serve as a new cereal/legume planting pattern to increase crop production. These two crop species compete for resources by stimulating root development and water uptake is unknown. Owing to their efficient use of land, light, water, and soil nutrients, scientifically sound and rational intercropping combinations have contributed to increased grain yields and have helped improve environmental quality.(Chamkhi et al., 2022)

To assess the competition between cereal and legume intercrops and the benefits of intercropping as row cropping, a number of indices have been proposed, including land equivalent ratio, crop equivalent yield, relative crowding coefficient, competition ratio, aggressivity, actual yield loss, etc. Although there are some obstacles to the widespread use of cereal-legume intercropping systems, such as the scarcity of high-quality seeds, biofertilizers, and technical and scientific expertise for the complex intercropping system, there is still great potential to boost agricultural systems with limited resources in terms of productivity and profitability.(Layek et al., 2018)

Objective of the Study

The main objective of this is to determine the intercropping of cereals and legumes to obtain the higher yield or providing a significant of economic impact for the farmers,

1. To determine the growth performance of kabog millet intercrop with mung bean.
2. To identify the yield of plant spacing between millet and mung bean.
3. To assess the economic performance of millet and mung bean based on in-row spacing.

Scope and Limitations

This study will focus on the effect of various in-row plant spacing of kabog millet intercrop with mung bean on the yield. A field experiment is conducted to study the effect of row spacing between the intercrop kabog millet and mung bean.

Time and Place of the Study

This experiment will be conducted in the Csu main Ampayon Butuan City during the wet and dry season. The date will be conducted in September 2023.

REVIEW OF RELATED LITERATURE

Intercropping Practices of millet

Intercropping cereals with legumes may achieve high crop yields at reduced input levels. There were some limitations in the samples used in this study, namely, the kabog millet, the reference millet, and the rice samples were not cultivated under similar conditions or in the same country. Kabog millet samples were also grown within the same year but in different agro-climatic conditions. The kabog millet used in the study cannot be cultivated outside the Philippines under the existing Material Transfer Agreement (MTA).However, the consequences of facilitation of P uptake are not necessarily clear-cut because plant species are competing for other resources at the same time, particularly light, water, and nutrients. Also, facilitation due to release of P mobilizing chemicals by the roots of one of the species is likely to be unapparent if the soil has high P availability.(Tang et al., 2021)

Advantages of millet-legume intercropping.

Intercropping cereals with legume is a very common combination and it provides more advantages in terms of efficient use of available resources, soil fertility improvement, less use of chemical fertilizers (Chalk et al., 2014; Chavanet al., 2017;Jensen et al., 2020), controlling erosion andrun-off of water and enhancing diversity (Maitra et al., 2019)and ultimately total productivity of crops (Jan et al., 2016). Seran and Brintha (2010) attributed that, cereal +legume intercropping system being popularized as insurance against crop failure for monocropping under rainfed conditions, the chief goal of intercropping is to ensure improved and sustainable production.The intercropping system of cereals + legumes were tested and found to be profitable systems(Francis, 1985; Ahlawat et al., 2005), legume-cereal intercropping increase the fixation of nitrogen by legumes(Hardarson and Atkins, 2003). Vesterager et al. (2008) found millet and cowpea intercropping is beneficial on nitrogen poor soils.With the increasing global demand for food, the relationship between crop production and food security should be determined and natural resources must be preserved (Banik and Sharma, 2009). Although industrial agriculture is directly beneficial to improving labor efficiency and crop production, intense fertilizer use has led to a series of ecological environmental problems, such as loss of diversity in ecosystems, decreases in soil fertility and aggravation of environmental pollution (Boardman et al., 2003; Jacobsen et al., 2013). Intercropping is a useful agricultural practice that permits the simultaneous growth of two or more crops in the same field, thereby improving the land use efficiency (Yu et al., 2017).

This agricultural practice is a technological method based on the ecological principles of facilitation and complementarity (Duchene et al., 2017). Thus, intercropping has not only been adopted by developing countries but also European countries (Martin-Guay et al., 2017). Among different intercropping combinations, cereal–legume intercropping systems have become sustainable farming models because these types of crops are not competing for the same niche (Li et al., 2001) and have different nitrogen (N) use abilities or obtain N via different pathways (e.g., by mineral or organic fertilizer in cereals and N fixation in legumes) (Ghosh et al., 2009).Legumes reduce N input requirements by biological N fixation, which meets 50–60% of the N demand (Salvagiotti et al., 2008). Several studies have shown that intercropped crops use soil nutrients more efficiently than monocultured crops because of the higher recovery of N, increased yields of dry matter, and lack of negative impacts on the environment (Inal et al., 2007; Luo et al., 2016). Efficient utilization of N in belowground plant parts can promote the optimal growth of aboveground plant parts. Thus, the roles of effective planting patterns as a means of maintaining N supplies are valuable in modern agriculture

Cereal/legume intercropping increases dry matter production and grain yield morethan their monocultures. When fertilizer N is limited, biological nitrogen fixation (BNF) is the major source of N in legume-cereal mixed cropping systems. The soil N use patterns of component crops depend on the N source and legume species. Nitrogen transfer from legume to cereal increases the cropping system's yield and efficiency of N use. The use of nitrate-tolerant legumes, whose BNF is thought to be little affected by application of combined N, may increase the quantity of N available for the cereal component. The distance between the cereal and legume root systems is important because N is transferred through the intermingling of root systems. Consequently, the most effective planting distance varies with type of legume and cereal. Mutual shading by component crops, especially the taller cereals, reduces BNF and yield of the associated legume(Fujita et al., 1992)

Two sole crop finger millets (planted in rows and broadcast) and two sole legume crops (haricot bean and lupine) were included as checks. The experiment comprised a randomized complete block design with three replications. Results indicated intercropped finger millet and total land output yield from finger millet-haricot bean row intercropping at a 100:50 planting ratio and sole finger millet planted in a row improved better yield stability. (Layek et al., 2018)

MATERIALS AND METHODS

Site Characteristics

The CARAGA region is composed of various soil types dominated by soil and clay loam. The climate type in the Caraga region is Type II and is pronounced wet and dry. During the month of September to December is good to conduct.

Soil Sampling/Analysis

Initial soil samples will be collected from the experimental area and the soil sample will collect 0-20 cm depth, and the lay-out of soil sampling is Zigzag type. After collected the soil will be sieve, air dry, and sent to Soil Testing laboratory (STL) located at Barangay Taguibo, Butuan city. The analysis will be the Soil Ph, organic matter, Total N, Available P and exchangeable K. The same soil sampling and analysis will be collected after harvest for final soil analysis.

Experimental Design and Layout

The Experimental Plots will be Laid-out in a Randomized Complete Block Design (RCBD) with three Replications. The treatments are as follows:

T1- Millet (75cm x 25cm)

T2- Mungbean between millet spaced at 125cm x 25cm

T3- Mungbean between millet spaced at 100cm x 25cm

T4- Mungbean between millet spaced at 75cm x 25cm

T5- Mungbean between millet spaced at 50cm x 25cm

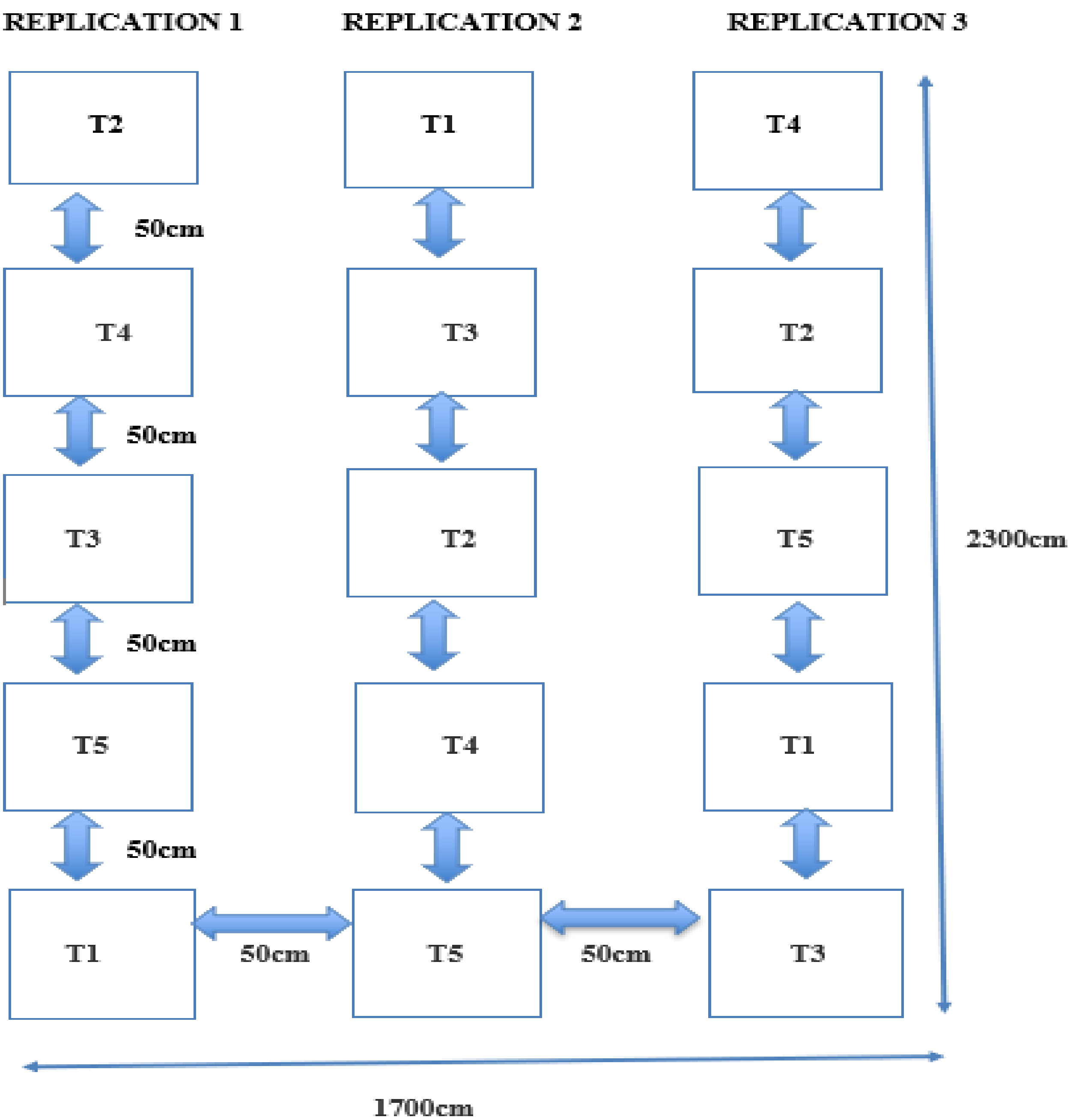
Area size: 2300cm x1700cm

Plot size: 5 x 4 m

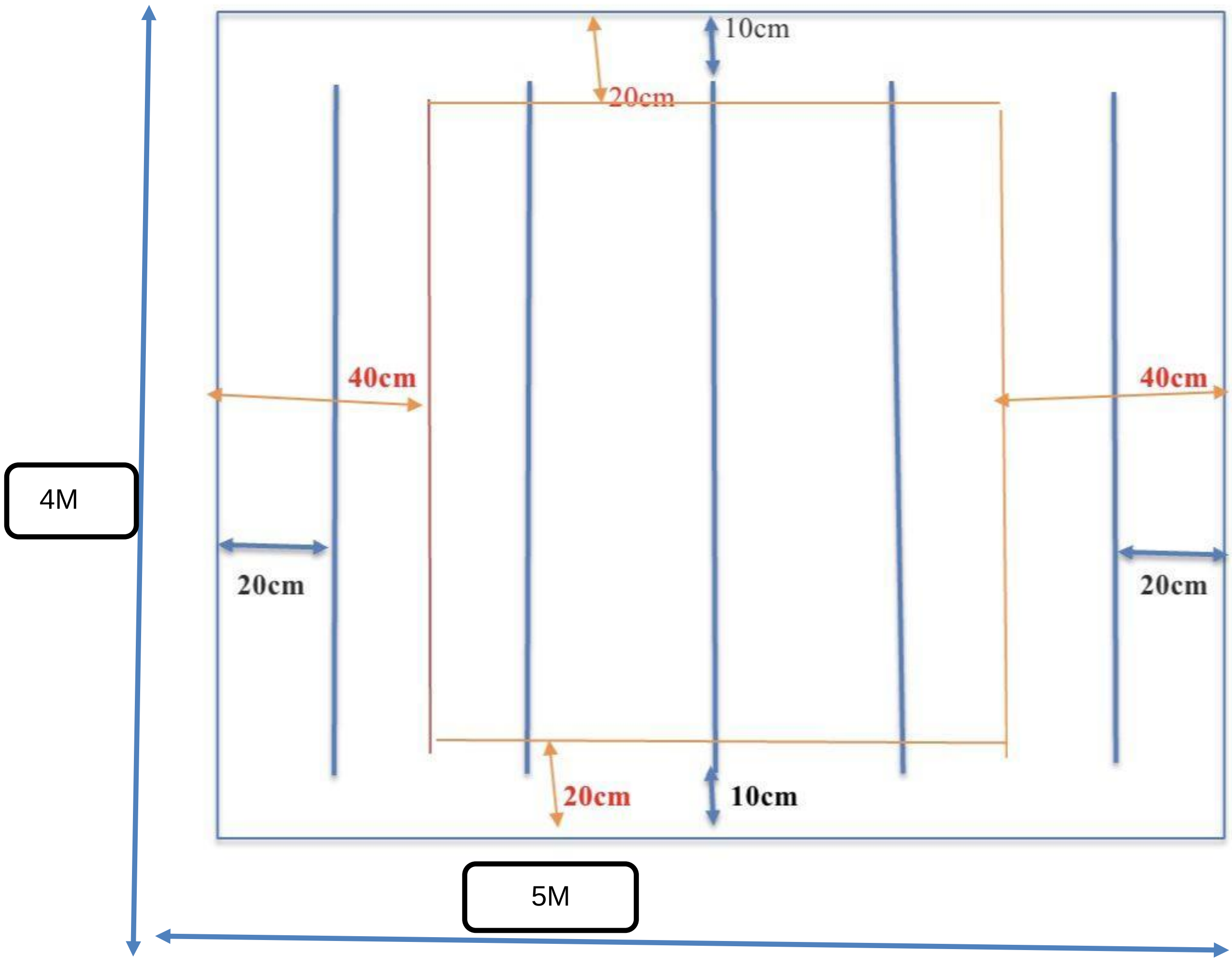
Spacing between replication: 50cm

Spacing between plots: 50cm

Burder effect per plot: 40cm x 20cm



Plot Lay out



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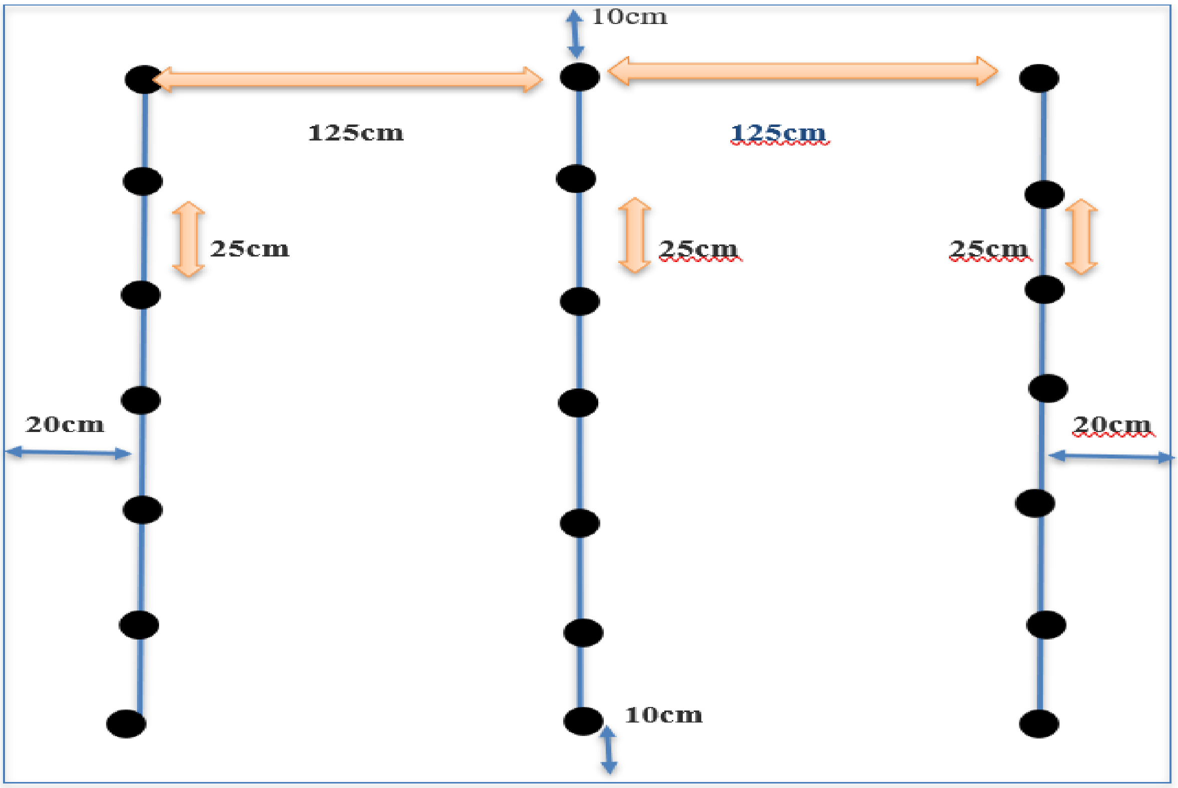
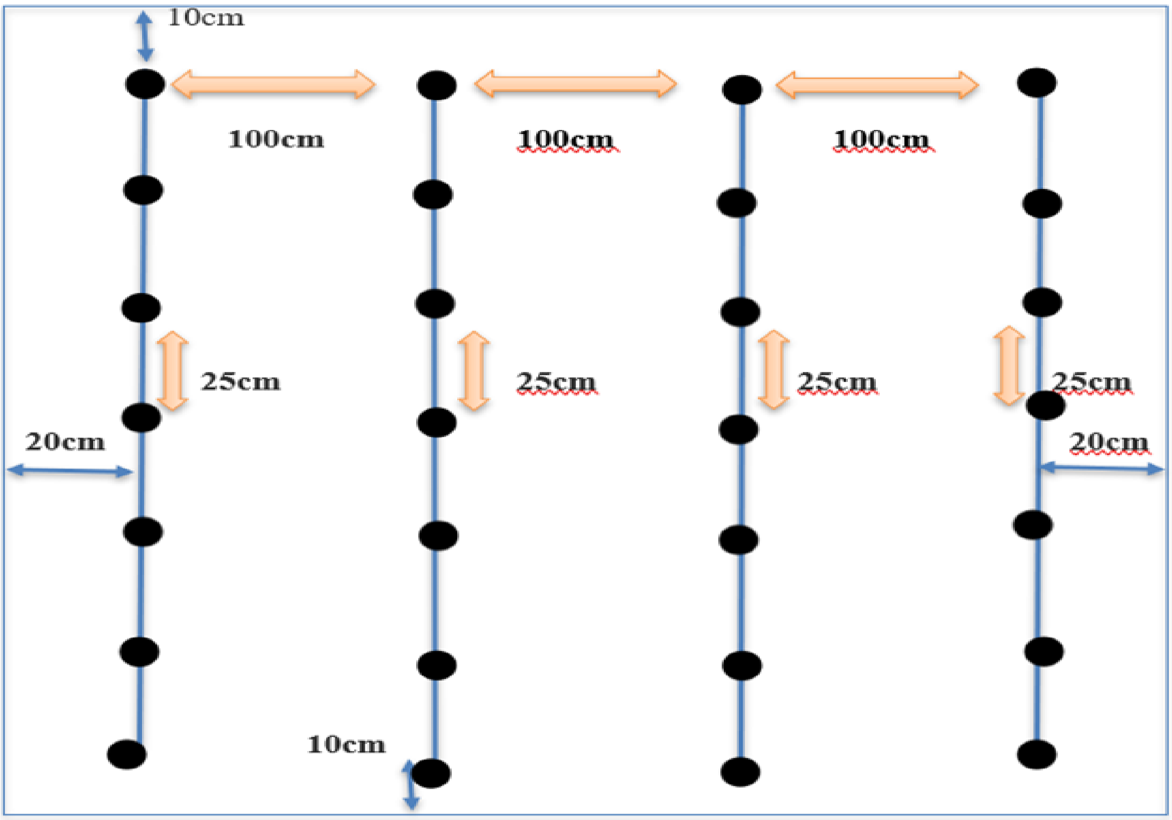
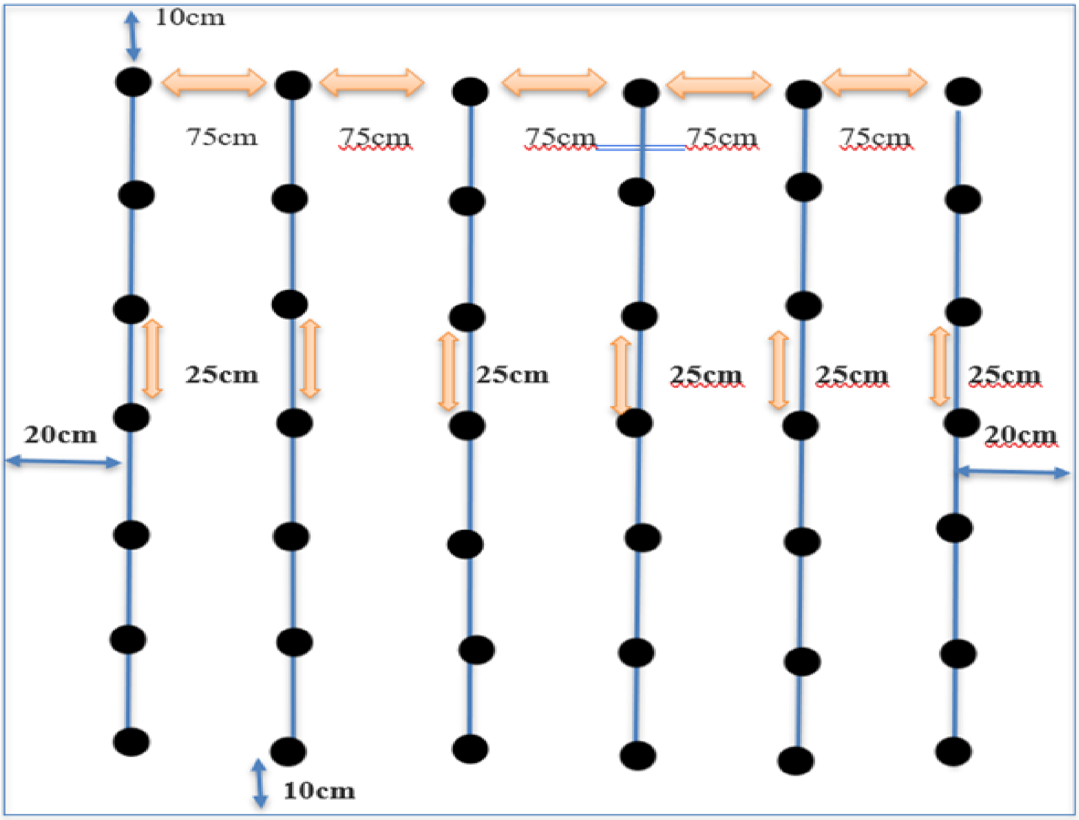
Plot lay out of 125 in-row spacing



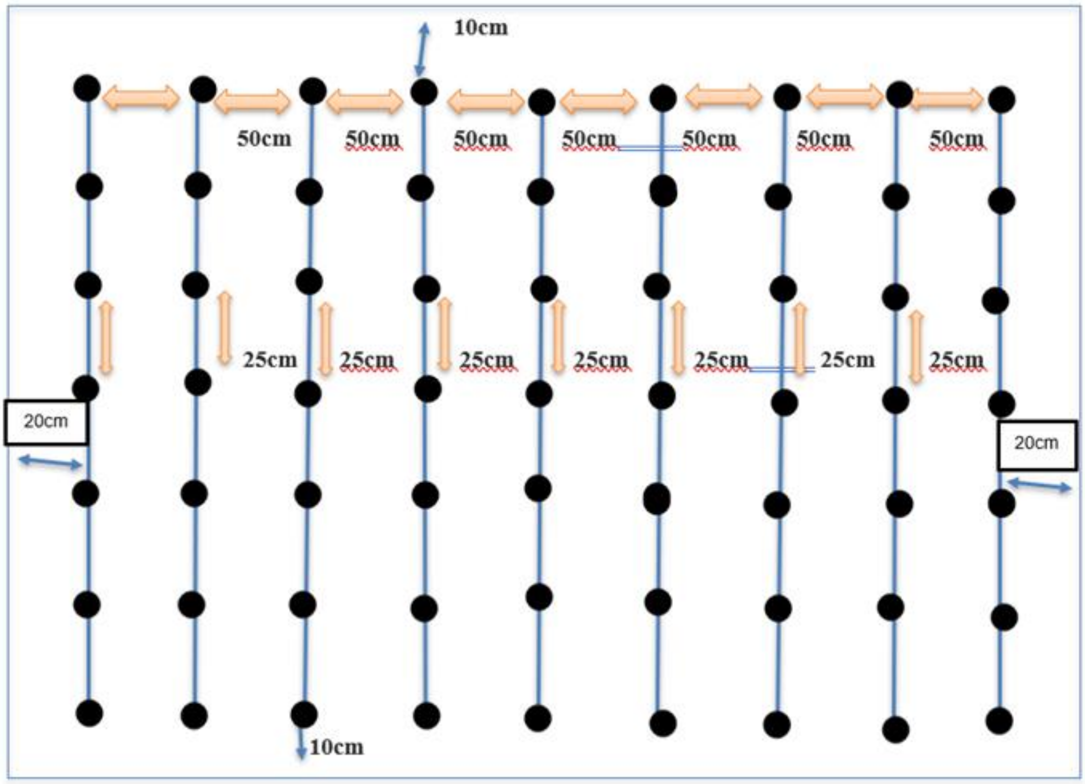
Plot lay out of 100 in-row spacing



Plot Lay out of 75 in-row spacing



Plot Lay out of 50 in-row spacing



Land Preparation

The experimental area has the primary plow material as bolo, grab, and the secondary harrowing will use a Hand Rotavator Machine to pulverize the soil. The land is plowed twice at an interval of two (2) weeks and harrowing is done afterward.

Intercropping Mung bean in Between Millet

Millet and mungbean will be planted simultaneously. Intercropping mungbean between millet will be based on the imposed treatments.

Cultural Management

Millet / Mung bean

The cultural management of millet is to practices and techniques used in the production, processing, and utilization of millet crop. The cultural management of mung beans refers the practices and techniques involved in the cultivation, processes and utilization of mung bean crops within specific cultural context:

Sowing/planting – Is a process of planting seeds into soil. During this agricultural process, proper precautions should be taken, including the appropriate depth, proper distance maintained, and soil should be clean.

Cultivation – Is the act of caring for our raising plants. Desiring our crop to grow in the field means you’ll be engaged in some heavy cultivation. The cultivation is most often used to talk about ways that farmers take care of crops.

Fertilization – Fertilizers are additional substances supplied to crops to increase their productivity. These are used by the farmers daily to increase the crop yield.

Weed management – 3 weeks after planting of the crop, removal of the weeds will be done. Hand weeding will be done using a bolo to control the weeds. This is to avoid the competition of the nutrients absorbed by the main crop against unwanted weeds.

Pest management – The pest and disease management of the 2 crops millet and mung bean will be done depending on the organisms that will attack and cause a disease on the plant.

Harvest Management - Harvesting will be done 3-4 months after planting, and will be using a plastic bag and scissor to cut the yield within the harvesting area. The roots will be cleaned and classified into marketable and non-marketable ones.

Data to be Collected

This data to be gathered should be based on two crops; Mung bean and Millet.

A. Growth parameters

- **Plant height –** Measure the plant height in centimeters(cm) from the base of the stem to the top of the canopy, or the highest part of the crop.

B. Morphological Parameters

- **Leaf area index (LAI)** this was obtained by measuring the length and width of all functional leaves. Nitrogen-to-protein conversion of millet and mung bean.
- **Harvest Index (HI).** HI will be determined by taking the ratio of the economic yield (weight of roots) to the biological yield (weight of

roots +herbage yield) on a fresh weight basis. All the sample plants per treatment per replication within the harvestable area were harvested to measure HI value and was calculated using the formula below:

$$HI = \frac{\text{Economic Yield (total root yield)}}{\text{Biological Yield (root yield + herbage yield)}}$$

C. **Weed Parameters**

- **Rate of Weed Incidence.** Please use the hedonic scale (0-9) to rate the number of weeds presence in the area.

D. **Yield and Yield Components**

- **Fresh grain weight-** The weight recorded immediately when our product is harvested.
- **Dry grain weight –** the weight can record after drying plant tissue at temperatures higher than ambient temperature.
- **Mung bean Number of seed per pod-** They contain 7to20 small, ellipsoid or cube shaped seeds.
- **Millet number of seed per pod-** There are approximately 155,000 seed per lb
- **Weight of Marketable and Non-Marketable (Kg ha^{-1})**
- **Total yield (Kg ha^{-1})**

E. **Economic Analysis**

- **Return on Investment -**A calculate the monetary value of an investment versus its cost of millet and mung bean.
- **Cost -** The amount or equivalent paid for the seeds
- **Profits –** is the money a business pulls in after accounting for all expenses.

- **Formula -** $P = \frac{F}{(1+i)}$

F. Meteorological Data

Total monthly rainfall and average temperature will be collected from the PAG-ASA station at CARAGA.

Statistical Analysis

The results from various in-row spacing replications were subjective to analysis of variance (ANOVA) to evaluate whether there were any significant differences between the types. These statistical analysis findings contributed to a better understanding of the genetic diversity, agronomic performance, overall effect in row spacing in kabog millet intercrop with mungbean paving the way for informed decision-making in conservation efforts, breeding programs, and sustainable agricultural practices.

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APPENDICES

TREATMENT 1 IN-ROW SPACING 75cm x 25cm

Number of Row = (length of plot -2 border length)/Row Spacing

Number of hill = (width of plot – 2 border width)/hills spacing

- Length of plot- = 4m
- Width of plot = 5m
- Row spacing = 75cm (0.75m)
- Border length =10cm (or 0.1m) on each side
- Border width = 20cm

Solution

NR = (4m-2'0.1m)/0.75m

= (4m-0.2m)/0.75m

= 3.8 / 0.75m

= $\boxed{\text{5.0 rows}}$

NC = (5m – 2 0.2m) / 0.25m

= (5m-0.4m) / 0.25 m

= 4.6m / 0.25m

= $\boxed{\text{18.4 Hills}}$

Millet = 18.4 x 5 = 92 seeds

Mung bean = 18.4 x 4 =73.6 seeds

Total = 92 + 73.6 = **165 seeds treatment 1**

TREATMENT 2 IN-ROW SPACING 125cm x 25cm

Number of Row = (length of plot -2 border length)/Row Spacing

Number of Column = (width of plot – 2 border width)/Column spacing

- Length of plot- = 4m
- Width of plot = 5m
- Row spacing = 125cm (1.25m)
- Border length = 10cm
- Border width = 20 cm

Solution

NR = (4m-2'0.1m)/1.25m

= (4m-0.2m)/1.25m

= 3.8/ 1.25m

= $\boxed{\text{3.04 row}}$

NC = (5m – 2 0.2) / 0.25m

= (5m-0.4m) / 0.25 m

= 4.6 / 0.25

= $\boxed{\text{18.4 Hills}}$

Millet = 18.4 x 3.04 = 57.72

Mung bean = 18.4 x 2 = 36.8

Total = 75.72 +36.8 = **113.52 seeds treatment 2**

TREATMENT 3 IN-ROW SPACING 100cm x 25cm

Number of Row = (length of plot -2 border length)/Row Spacing

Number of Column = (width of plot – 2 border width)/Column spacing

- Length of plot- = 4m
- Width of plot = 5m
- Row spacing = 100cm (1m)
- Border length = 10cm (or 0.2m) on each side
- Border width = 20 cm

Solution

NR = (4m-2'0.1m)/1m

= (4m-0.2m)/1m

= 3.8/ 1m

= $\boxed{\text{4.0 row}}$

NC = (5m – 2 0.2) / 0.25m

= (5m-0.4m) / 0.25 m

= 4.6 / 0.25

$\boxed{\text{18.4 Hills}}$

Millet = 18.4 x 4 = 73.6 seeds

Mung bean = 18.4 x 3 = 55.2

Total = 73.6 + 55.2 = **73.8 Seeds treatment 3**

TREATMENT 4 IN-ROW SPACING 75cm x 25cm

Number of Row = (length of plot -2 border length)/Row Spacing

Number of Column = (width of plot – 2 border width)/Column spacing

- Length of plot- = 4m
- Width of plot = 5m
- Row spacing = 75cm (0.75m)
- Border length = 10cm

- Border width = 20 cm

Solution

NR = (4m-2’0.1m)/0.75m

= (4m-0.2m)/0.75m

= 3.8/ 0.75m

= 5.0 row

NC = (5m – 2 0.2) / 0.25m

= (5m-0.4m) / 0.25 m

= 4.6 / 0.25

18.4 Hills

Millet = 18.4 x 5 = 92 seeds

Mung bean = 18.4 x 4

Total = 92+ 73.6 = **165 seeds treatment 4**

TREATMENT 5 IN-ROW SPACING 50cm x 25cm

Number of Row = (length of plot -2 border length)/Row Spacing

Number of Column = (width of plot – 2 border width)/Column spacing

- Length of plot- = 4m
- Width of plot = 5m
- Row spacing = 50cm (0.5m)
- Border length = 10
- Border width = 20 cm

Solution

NR = (4m-2’0.1m)/0.5m

= (4m-0.2m)/0.5m

= 3.8/ 0.5m

7.6 row

NC = (5m – 2 0.2) / 0.25m

= (5m-0.4m) / 0.25 m

= 4.6 / 0.25

18.4 Hills

Millet = 18.4 x 7.6 = 140 seeds

Mung bean = 18.4 x 3.8 = 70 seeds

Total = 139 +70 = **210 seeds treatment 5**

Fertilizer Computation

120 -90- 60 kg/ha

$$\text{Amount of Urea} = \left[\frac{\text{recommended rate}}{\text{fertilizer grade}} \times 100 \right]$$

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$$\text{Urea} = \left[\frac{120\ \text{kg/ha}}{46} \times 100 \right]$$

$$= 260.87\ \text{kg/ha}$$

$$\text{T1} = \left[\frac{260\ \text{kg/ha}}{10{,}000\text{m}^2} \times (4\text{x}5\text{m}) \right]$$

= $\boxed{\textbf{5.2kg or 5200kg plot}^{1}}$

T1 = 5200 / 165 seeds T1

= $\boxed{\textbf{31.51 grams per hill}}$

T2 = 5200 / 113.52 seeds T2

= $\boxed{\textbf{45.80 grams per hill}}$

T3 = 5200 / 73.8 seed T3

= $\boxed{\textbf{70.46 grams per hill}}$

T4 = 5200 / 165 seed T4

= $\boxed{\textbf{31.5 grams per hill}}$

T5 = 5200 / 210 seed T5

= $\boxed{\textbf{24 grams per hill}}$