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Investigating the effects of two cowpea (Vignaunguiculata L Walp) leaf harvesting intervals on grain yield.

By

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ABSTRACT

Cowpea *(Vigna Unguiculata L)* has a variety of uses in Zimbabwe. The crop can be used as food, leaves as vegetable for human and stems as fodder for livestock. Maximising both leaf, grain and the above ground biomass yield of the dual purpose cowpea is one of the ways to improve food security in the country as well as nutritious hay in winter for livestock thus ensuring sustainability in agriculture which is being threatened by climate change. A research was carried out to find out the effects of three leaf harvesting intervals on the dual purpose use of cowpea.The trial was carried out at Drawcard Farm, Harare, Zimbabwe on plots of $6m^2$gross and $2.6m^2$ net. The plots were laid down in RCBD with three treatments (no harvesting, 7-days and 14-days leaf harvesting intervals) replicated three times. The cowpea variety used was CBC2. Data collection was carried out two weeks after crop emergence (three leaf stage) up to six weeks (early reproductive stage). Overall, the results showed that leaf yield was higher in 7-day than 14-day interval. However grain and above ground biomass yields were highest (400.1kg/ha and 907.4kg/ha respectively) in control treatments followed by 14-day (101.3kg/ha and 696.1kg/ha respectively) and lastly 7-day (79.1kg/ha and 598.5kg/ha respectively) harvesting intervals. The conclusion drawn from the trial is that 7-day leaf harvesting interval increases cowpea leaf yield and 14-day interval increases grain and above ground biomass yield.

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CHAPTER 1

1.1Introduction and justification

Cowpea (*Vigna Unguiculata L Walp)* is an important component of most traditional cropping systems in arid and semi-arid areas (Hort Science Vol. 45(3) March 2010. It is an annual warm season leguminous plant believed to have originated in Central Africa(Thomas, 2009). Its quick growth and rapid ground cover have made it an important component of sustainable subsistence agriculture in marginal lands. Cowpea is adapted for drier regions where rainfall is scanty and sandy soils with little organic matter (Singh, 2005). The cowpea crop is called ‘hungry-season crop’ because it is the first crop to be harvested before the cereal crops (Madamba, 2000). It has a great flexibility in use; farmers can choose to harvest them for grains, leaves for vegetable or forage for livestockdepending on economic and climatic constraints.

It is a major grain legume, fodder, green pod and leaf vegetable grown on 12.5million hectares in drought regions of Africa producing over 3million tonnes world- wide and is mainly grown by small scale farmers who practice intercropping in their small holdings so as to maximise land productivity (Mwanarusi et al., 2010). Under such cropping systems, cowpea not only offers diversity in available food stuffs but also serve as a security crop in case of failure of the main crops (Mwanarusi et al., 2010). It is among the most popular leaf vegetables mentioned throughout Eastern and Southern Africa (Kaler et al., 2005). Cowpea leaves are most commonly served boiled or consumed fresh in relish (Kaler et al., 2005). Cooking before drying of cowpea leaves is a widespread preservation method (Bittenbender

et al., 1984). In some African countries boiled cowpea leaves are sometimes ground into powder and stored for use in the dry season when fresh leaves are not availableand canning has been developed for cowpea leaves(Imugi and Porter, 1985). Cowpea leaves, dried or fresh are commonly sold in local or urban market (Bittenbender et al., 1984). In Zimbabwe they are sold in supermarkets and other retail outlets apart from the common markets like Mbare musika.

This dualpurpose production of cowpea is most common in subsistence farming systems in Zimbabwe (Madungwe and Matikiti, 2004). Dual purpose varieties have been developed to provide both grain and fodder while suiting the different cropping systems encountered in Africa (Tarawali et al., 1997). All parts of the cowpea crop are used as all are rich in nutrients and fibre. In Africa, humans consume young leaves, immature pods, and mature dried seeds. The stems, leaves and vines serve as animal feed and are often stored for use during the dry season. About 52% of Africa's production is used for food, 13% as animal feed, 10% for seeds, 9% other uses and 16% is wasted (Singh et al., 1997).

The green portions of the plant, including leaves, form the photosynthetic machinery of the plant. Removal of leaves therefore constitutes the reduction in photosynthetic tissue, hence reduction in photo-assimilates used for growth. The reduction in photo-assimilation rate is even more pronounced if tender leaves are removed (Saidi et al., 2007). The timing of leaf removal affects cowpea's ability to recover from defoliation (Barrett, 1987). Defoliation during vegetative developmental phase does not significantly affect yield than defoliation during reproductive phase (Saidi et al., 2007).Where the crop is grown purely for vegetable production, the entire plant is uprooted at the 3-5 true leaf stage before the leaves become mature and fibrous. In the case of dual purpose production, sequential leaf harvests are made during vegetative growth stage followed by seed harvesting at the end of the season (Mwanarusi et al., 2010).Several studies have shown grain yield reduction mainly due to leaf harvesting, with variations owing to differences in time between leaf harvests and stage of development (Bittenbender, 1992;Madamba, 2000). The following are important cowpea growth stages according to Matikiti et al., (2009), where 2 weeks after crop emergence (WACE) corresponds to the three leaf stage, 2-5 WACE corresponds with the vegetative stage, 6WACE corresponds with the onset of pod formation or 50% flowering stage, 7WACE corresponds to the end of pod formation and the whole period between 6-8 WACE is called the early reproductive stage. It is therefore important for farmers to know the optimum period and stage when cowpea can tolerate leaf harvesting with minimum grain yield loss (Nielsen et al., 1997).

However very little research has been carried out on improving cowpea as a leaf vegetable and also information on the effects of leaf harvest intervals and timing on cowpea leaf and seed yield is hardly documented (Karikari and Molatakgosi, 1990; Saidi et al., 2008). With the introduction of new short season dwarf varieties of cowpeas in Zimbabwe such as IT18 a CBCI and CBC2, most communal farmers are growing cowpeas earlier in late October for early harvesting of the grains from green pods so as to cushion them against hunger before their main crop harvests. The targeted grain yield is however seen to be affected by random leaf harvesting intervals. This has necessitated this research to help farmers optimise leaf yield of cowpea without compromising grain yield too much.

1.2.0 OBJECTIVES

1.2.1 Main objective

- To investigate the effects of three cowpea leaf harvesting intervals on yield.

1.2.2 Specific objectives

- To determine leaf harvesting interval with higher leaf yield.

- To determine leaf harvesting interval with the higher grain yield.
- To establish the leaf harvesting interval with more above ground biomass.

1.2.3 Hypotheses

There is no significant difference between grain yields of cowpeas *(Vigna unguiculata L Walp*) with 7days leaf harvesting interval and that with 14 days leaf harvesting interval.

There is no significant difference in leaf yield between the cow pea crop with 7 days leaf harvesting interval and that with 14 days leaf harvesting interval.

There is no significant difference between the above ground biomass of a cowpea crop with 7 days leaf harvesting interval with that of 14 days leaf harvesting interval.

CHAPTER 2

2.0 Literature review

2.1 Origin of cowpeas

Cowpea (*Vigna Unguiculata LWalp*) is one of the most ancient human food sources and has probably been used as a crop plant since Neolithic times. A lack of archaeological evidence has resulted in contradicting views supporting Africa, Asia and South America as origin. Cowpea is believed to have originated from Central Africa by some workers because of both wild and cultivated species abound in the region (Fatokun et al., 2002).

In Africa, it is grown on 12,5million hectares producing about 3million tonnes annually and is consumed by over 200million people in Africa (African Agricultural Technology Foundation, 2013). Nigeria is the leading producer in Africa followed by Niger and in other continents, countries like Brazil and India are dominating (Shiringani, 2007).In Zimbabwe, it is produced in most of the marginal regions such as natural farming region 3-5.

2.2 Importance of cowpeas

In Zimbabwe cowpeas are mainly grown for its dual purposes and have great flexibility in use (Dube and Fanadzo, 2013). It is regarded as “poor man’s diet” but in a sense, it is a fulcrum for leveraging Africa’s basic nutrition and has been called “a newly perfect match for African soil, weather and people”(National Research Council, 2006). The dual purpose of cowpea makes it an attractive crop where land is becoming scarce (Singh et al., 2003). The crop is used throughout its entire growing period, beginning with highly nutritious tender leaves immediately after emergence through the growing season to the grains after harvesting and lastly livestock fodder from all the above ground biomass (Ohler et al., 1996). Some of its uses include:

2.2.1. Leaves as vegetables

Cowpea is among the most popular leafy vegetable mentioned throughout Eastern and Southern Africa (Kaler et al., 2005). Cowpea leaves are most commonly served boiled accompanying starchy porridge, but also consumed fried or in relish and cooking before drying of cowpea leaves is a widespread method of preservation (Bittenbender et al., 1984). In some African countries boiled and dried cowpea leaves are sometimes ground into powder and stored for use in the dry season when fresh leaves are not available, moreover canning techniques have been developed for cowpea leaves (Imungi and Porter, 1985).

Use of cowpeas not only means that farmers maximise nutritional benefits they obtain from growing cowpeas, but also ensures that food is available earlier in the season to poor households in the form of leaves of young plants.Cowpea leaves are therefore consumed as a nutritional supplement and extension of that supplied by the grain (Singh et al., 2003). Smith and Eyzaguirre (2007) listed cowpea leaves among the top indigenous leafy vegetables that are consumed across the entire African continent and they argued that the amount of cowpea consumed is likely to increase greatly due to increasing human population.

A high demand of cowpea leaves is found across the African continent from Zimbabwe (Matikiti et al.,2012) through Tanzania Hallensleben et al., 2009) up to Nigeria (Ibrahim et al., 2010). In addition, cowpea leaf consumption is being actively promoted as an important source of nutrition for those with low income who may not be able to afford animal protein (Madode et al., 2011; Matikiti et al., 2012). Mamiro et al (2011) reported daily percapita cowpea consumption in rural Tanzania as ranging from 41-200g. Unlike leaves of other grain legumes, cowpea leaves may be more valuable than the seed because their protein content and protein productivity exceeds that of the seed in a dry weight basis and protein concentrations of 29-43% have been reported for cowpea leaves against 21-33% in seed (Nielsen et al., 1997: Ahenkora et al., 1998).

Because cowpea leaves are produced earlier and in much greater weight per plant than seeds, their protein productivity has been reported to be as higher as 15 times that of seeds (Bittenbender et al., 1984). Leaves also possess considerable amounts of other beneficial dietary components, for example on weight for weight basis as compared to raw cowpea seed, 20% more thiamine, twice the amount of riboflavin and equal amounts of niacin (Bubenheim et al.,1990). Additionally, leaves contain considerable large amounts of the essential amino acids, methionine and cysteine (Nielsen et al., 1997). Nawiri et al (2013) recommended the promotion of sun dried cowpea leaves in Kenya in the diets of pre-school children as they do not only prevent anaemia by increasing haemoglobin levels but also prevent vitamin A deficiency.

2.2.2. Cowpea grain as food

Cowpeas are grown mainly for their edible beans, although the leaves and fresh peas and fresh pea pods can be consumed. Cowpea provides a rich source of protein and calories, as well as minerals and vitamins. A cowpea seed consists of 25% protein, 50-67% starch, fat is 1.3%, fibre is 1.8% and 8-9% water (Thomas, 2009).It is low in anti-nutritional factors and the diet complement the mainly cereal diet in countries that grow cowpeas as a major food crop (Gomez, 2004).

Cowpea grain yield varies with varieties, management and the cropping system. In Zimbabwe yield can be as low as 50kg/ha especially in intercrops. On average sole crop grain yield is 1.5t/ha and the intercrop is 400kg/ha (Technology Research Development, 2012). In Zimbabwe, the seeds can be boiled together with dried maize (mutakura) and consumed or can be ground into a powder and cooked into a porridge (rupiza) used as relish (Matikiti et al., 2012).

2.2.3. Fresh immature pods as food

The fresh immature pods of cowpeas can be harvested, boiled and consumed. They can be chopped into smaller pieces and mixed with some relish just as green snap beans. Cowpea pods can be boiled when the seed is mature but not dry and in that case only the seed is consumed from the pod. Yield of the green immature pods can be up to 18t/ha in 3-4 pickings from 45 days after planting (Technology Research Development, 2012).

2.2.4. Above ground biomass as fodder

Although cowpeas are generally too valuable as food, they are occasionally used as feed for livestock (Fatokun et al., 2002). Cowpea forage (vines and leaves) fresh or as hay or silage is often used as fodder and there have been attempts at using cowpea leaf meal in pig feeding (Imugi and Porter (1985). The haulms contain about 45-65% stems and 45-65% leaves and the cowpea pod husks obtained after threshing are used to feed livestock (Oluokun, 2005).

The sole crop can produce a yield of 1-2.5t/ha fresh fodder and an intercrop cowpea can give 0.35-1t/ha of fresh fodder. Superior fodder varieties produce dry matter of more than 10t/ha (Technology Research Development, 2012).

2.2.5. Soil Nitrogen fixation

Cowpea guarantees sustainability of some farming systems in arid and semi-arid regions of Africa and being a legume it serves as an important crop in the crop rotation programmes (Giller et al., 1994). Legume intercrops are potential sources of plant nutrients, especially nitrogen (N) that complements or supplements inorganic fertilizers and are important due to their ability to reduce soil erosion (Giller and Cadisch, 1995), suppress weeds and fix nitrogen (Giller et al., 1994).

Jeranyama et al (2000) reported that cowpea has a low nitrogen harvesting index, implying that it has a low nitrogen removal percentage from the field through grain. Cowpeas together with pigeon pea *(Cajanus cajan L*) are the two promising legumes for semi arid areas (Mapfumo and Giller, 2001) and both nodulate freely in Zimbabwean soils without inoculation (Mpepereki and Makonese, 1995). The plant is known to be promiscuous in nitrogen fixation and most soils contain some indigenous rhizobia capable of nodulating it. Cowpea can fix up to 240kg of nitrogen per hectare from atmospheric nitrogen and makes available about 60-70kg of nitrogen for the succeeding crop in rotation with it (Aikins and Afuakwa, 2008).Cowpea crop can be grown and used for green manuring (Crop Research Institute, 2006). The cowpea plant contributes as a direct agricultural product by maintaining and restoring soil fertility through fixing a large proportion of its own nitrogen (Matikiti et al., 2012).

2.2.6. Soil erosion control, weeds and pests suppression

Cowpea is a deep rooted crop and does well in marginalised sandy soils and is more tolerant to drought than soya beans. This means that even with minimum rainfall and poor soil nutrition, there is atleast a cover and stabilization of the soil against erosion (Dadson et al., 2003). Cowpea cover crop had shown to suppress nematodes in tomato production systems (Roberts et al., 2005). The crop have also shown to suppress the build up of with weed (Striga Asiatica L) in a maize in a maize intercrop(Rimawu, 2012).Singh et al. (1997) reported that cowpea has the ability to cause suicidal germination of some weed species such as Striga species and such effects are greater with higher plant densities.

2.3.0 Leaf Harvesting

Defoliating cowpea plants through leaf harvesting is a form of disturbance similar to insect herbivory (Nyakanda et al., 2004). Some early research reported higher seed yield in leaf harvested cowpeas (Mehta, 1971) since it was hypothesised that defoliation permitted greater light penetration into the canopy and altered the hormonal balance of the plant. However,in subsistence farming in Africa the traditional practice of harvesting young leaves is frequently identified as one of the factors responsible for the reduction in yield and quality of the grain (Madamba 2000; Matkiti et al., 2012). It is also suspected that the negative effects of this practice may extend to the reduction of other cowpea benefits such as nodulation, nitrogen fixation and soil fertility improvements. The green portions of the plant including leaves form the photosynthetic machinery of the plant and leaf removal constitute the reduction in photosynthetic tissue resulting in reduction of photo assimilates used for growth (Saidi et al., 2007). Plants have evolved many secondary metabolites involved in plant defence, which are collectively known as anti-herbivore compounds such as alkaloids, cyanogenic, glycosides, glucosinolates, benzoxazinoids, terpenoids and phenolics (Mamiro et al., (2011). There is a tendency for plants to increase these compounds in their leaves in response to herbivory. Lignin and silica may also increase and reduce the palatability of the leaves harvested from the cowpea plant which will continuously decrease with every subsequent harvest.

2.3.1. Timing of leaf harvesting

The timing of leaf removal affects the cowpea's ability to recover from defoliation (Barrett, 1987).Timing of leaf harvesting also enables leaves to be harvested when they are highly nutritious and tender. Farmers preferably harvest the youngest leaves or tender shoots as they contain little fibre and less tannin, tastes better and have a good texture compared to older leaves. Ohler et al. (1996) showed that total dietary fibre increased from 19-26% as time to harvest decreased from 50-20 days. Harvesting 2-4 recently formed trifoliate leaves from each branch on a plant 25 and 40 days after germination suppressed plant biomass, seed yield, seed number and number of pods per plants on plants grown on soilless media in a green house (Bubenheim et al., 1990). Ibrahim et al., (2010) reported that as much as 50%

defoliation of certain cowpea cultivars prior to flowering by removal of every other leaf or part of the expanded leaves reduced seed yield by only 15% relative to controls. Matikiti et al.(2009) came up with some important cowpea developmental stages that can help in the timing of leaf harvesting. They reported that 2 weeks after crop emergence (WACE) corresponds to the 3-leaf stage, 2-5WACE corresponds to the vegetative stage, 6WACE corresponds to the on- set of pod formation,7WACE corresponds to the end of pod formation and 6-8WACE corresponds to the early reproductive stage. It is therefore important for farmers to know the optimum period and stage when cowpea can tolerate leaf harvesting with minimum grain loss (Nielsen et al., 1997).

In addition, Dube and Fanadzo (2013), came up with general morphological indicators of various growth stages of cowpea as follows 2WACE corresponds to 3-leaf stage, 3WACE corresponds to the start of branching, 4WACE corresponds to the 3-branch stage and 5WACE corresponds to the start of flowering. They therefore suggested that leaf harvesting should be done before flowering but not to be initiated too early as this may not allow recovery. At the 2-leaf stage insufficient foliage is left after harvesting to support subsequent biomass production. However, after the plant have formed lateral shoots and three fully expanded true leaves harvesting of a single leaf may leave the plant with adequate foliage to support sufficient photosynthesis for recovery. They also reported that judicious defoliation of cowpea plants during vegetative development is likely to have a lesser effect on reduction of grain yield than defoliation during reproductive stage.

Bubenheim et al., (1990), in green house experiments reported that twice as much dry weight of leaves was obtained from cowpea plants harvested at the vegetative stage only than in cow peas harvested in a traditional way where no timing is done.

2.3.2. Leaf harvesting intensity

Leaf harvesting intensity refers to the number of leaves compared with total that can be harvested at any given time and farmers sometimes harvest as many leaves as possible, dry them and use in the off season (Matikiti et al., 2012).

An increase in leaf harvesting intensity from 0-3 leaves per growing point increases leaf fibre and decreases protein content of cowpea grain (Nyakanda et al., 2004).

Agbogidi and Ego (1987), reported that harvesting a single leaf from each growing point occasionally may not supply adequate vegetable matter for household consumption.

Nitrogen fixation by cowpea under high leaf harvesting intensity is limited due to reduced supply of photosynthates and an increase in leaf harvesting from 1-3 leaves per branch reduced nodule numbers per plant (Matikiti et al., 2012). Intense harvesting of cowpea leaves is suspected to result in little or no nitrogen contribution by the crop to the soil and up to 65% of the total plant nitrogenin mature plant is present in seed, 30% is in foliage (Ingram and Swift 1990).Ezedinma, (1973) showed that severe defoliation at any stage prior to maturity drastically reduced grain yield.

Nowak and Caldwell 1984; Strauss and Agrawal 1999 proposed the harvesting of leaflets instead of the whole leaf since cowpea leaves are trifoliate and this is said to reduce the negative effects of leaf harvesting. This proposition arises from the ability of partially damaged plant leaves to restore carbon-grain capacity fully since photosynthetic rate is not much affected and there is delayed senescence of the remaining leaf portions.

2.3.3 .Leaf harvesting frequency

Refers to how often the farmers harvest leaves. Mwanarusi et al (2010) found that cowpea vegetable yields were significantly influenced by leaf harvesting frequency in both sole and intercrop cowpea and in contrary, cowpea grain tended to increase with decrease in leaf harvesting frequency. In a research they carried in Kenya, they found that harvesting cowpea at 7 day interval gave higher leaf vegetable yield compared to a 14 day interval. Grain yield was also found to be higher for 14 days compared to 7 day interval.

2.4.0. CBC2 cowpea variety characteristics (Progene Seed Production Manual. 2013)

It is an erect type with reddish-brown grains with light brown hilum. The cowpea seed is very small in size with a smooth seed coat. Most of the pods occur above the canopy .The variety matures in 70-80 days and under optimum conditions the variety can yield up to 3t/ha. It can be grown successfully in all cowpea growing areas in Zimbabwe and flowers in 30-40 days after emergence.

CHAPTER 3

3.0 MATERIALS AND METHODS

3.1 SITE

The field experiment was conducted during 2013-2014 summer season under the rainfed conditions at Drawcard farm situated between latitude S17^0 48$^'$ and longitude 30^{0}50E$^'$. The farm is located 21km from Harare along Harare-Bulawayo road. The area falls in natural farming region IIa with annual rainfall ranging from 750-1000mm and a temperature range between 14 – 28^{0}C.

The site was characterised by well drained loamy soils of the Harare 5G4 series with a pH of 5.8 on a calcium chloride scale and an altitude of about 1200m above sea level and a 2% slope.

3.2 Experimental Design

Three blocks of 10mx2m separated by a pathway of 0.5m wide ere used. They were block 1, 2 and 3. Each block was subdivided into three equal plots (P0, P1 and P2) of 3m x 2m sizes with0.5m pathway between them. P0 means plot with no leaf harvesting, P1 means plot with one week leaf harvesting interval and P2 means plot with two weeks leaf harvesting interval, P0 wasthe control plot. The treatments were randomly assigned to the plots using the hat method. All other agronomic conditions were uniform for all plots throughout the growing period.

The experiment was set up as a randomised complete block design with two harvesting intervals as the treatments with three replications. Cow pea seeds (CBC2 variety) were planted with an interow spacing of 0.5m and an in row spacing of 0.2m.There were 4 rows per plot with each row having 15 plants giving a plant population of 60 plants per plot.

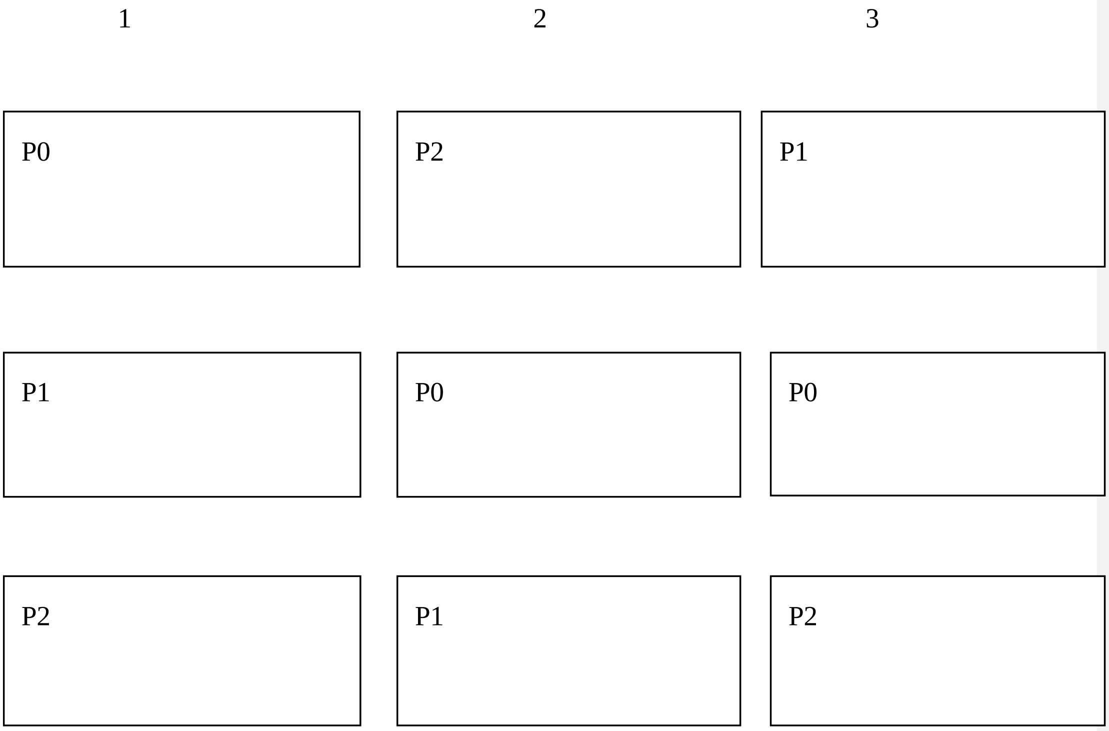

Figure 1. The layout of the experiment

Key

A................block A

P0...........plot with no leaf harvesting (control)

P1..........plot with 7 days leaf harvesting interval

P2.........plot with 14 days leaf harvesting interval

3.3 Data collection

Data for each plot was collected from the net plot with about 26 plants per plot and all of them were used for data collection. Leaf harvesting was done according to the proposal of Dube and Fanadzo (2013). A single leaf was harvested per growing point in the first harvesting week and all the expanded true, soft and tender leaves thereafter up to sixth weeks after crop emergence.

Treatment application entails manual picking of fully expanded soft and tender leaves per branch from three weeks after crop emergence up to 50% flowering stage (six weeks or pod formation). Leaves at this stage are what most growers harvest for vegetable. No leaf harvesting was done in the control plots.

Leaf harvesting was done on 7 day and 14 day intervals upon initiation of harvesting. The harvested leaves were weighed while fresh on a digital scale, expressed in kg/ha and recorded in their respective treatments and dates. At the end of the harvesting period average leaf yields per treatment were computed and recorded.

At the end of the growing period, cowpea grain was harvested from plants with weekly and fortnightly leaf harvesting intervals as well as in the control plots. These were oven dried at 70^0C for 24hours to approximately 12%moisture content and then weighed on a digital scale and were expressed in kg/haand then recorded on the respective treatments.

After harvesting of the cowpea grain, all the pods and remaining leaves and the cowpea plants were uprooted and roots removed. All these above ground materials were oven dried at 70^0C for 24hours and weighed to find the above ground biomass for each treatment including that of the control crop and expressed in kg/ha.

CHAPTER 4

4.0 RESULTS AND DISCUSSION

4.1 Effects of harvesting interval on leaf yield

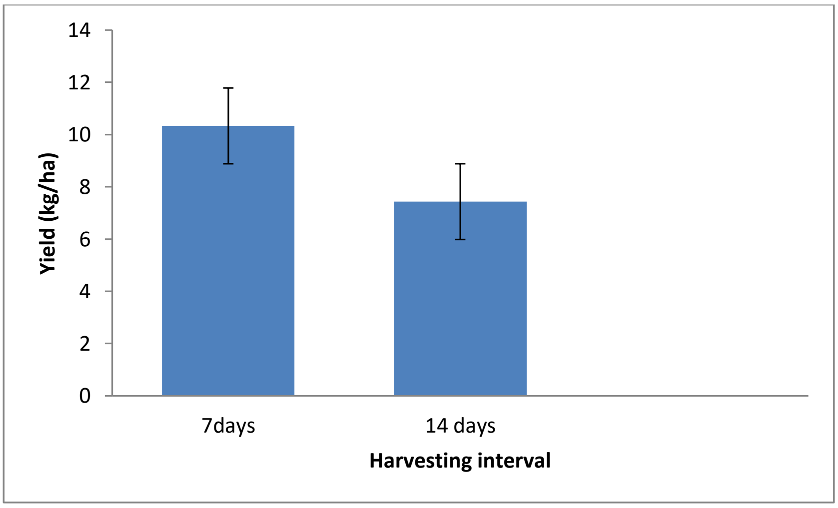

Figure 2. Effects of leaf harvesting interval on leaf yield

Cowpea leaf vegetable yields were significantly influenced by leaf harvesting interval (P = 0.03). Harvesting cowpea leaves more frequently at 7 days resulted in significantly higher leaf vegetable yields compared to harvesting leaves at 14 day interval. Defoliation has been shown to stimulate leaf production in cowpea as compensatory growth occurs when leaves are harvested (Bubenheim et al., 1990). Higher leaf yields obtained under more frequent harvesting could have been the result of stimulation of leaf production. Ibrahim et al. (2010) hypothesised that defoliation permitted greater light penetration into the canopy and altered the hormonal balance promoting more leaf production prolonging the duration of leaf harvesting period making food available to the resource poor farmers. Low yield from the 14 day harvesting interval is also attributed by the fact that some of the leaves produced between harvesting intervals would surpass the consumable stage before the next harvest. Only young and tender leaves are consumed as vegetables.

4.2 Effects of leaf harvesting interval on grain yield

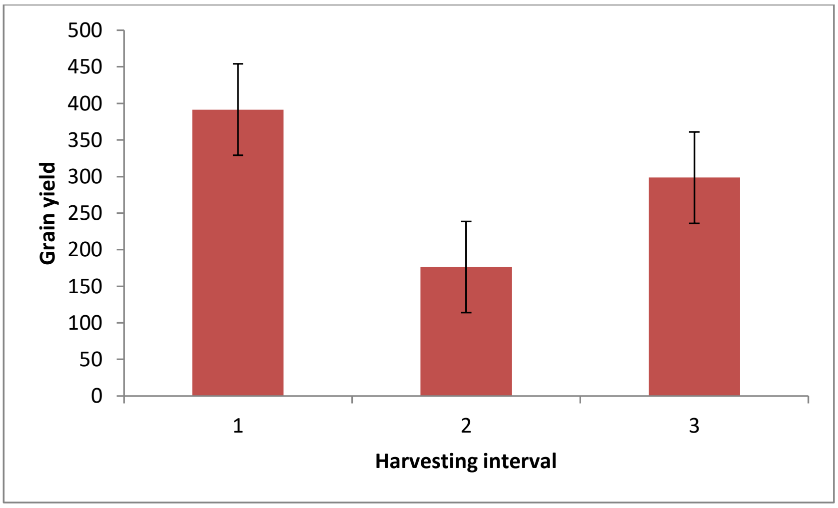

Figure 3 Effects of leaf harvesting interval on grain yield

Key

1...........no leaf harvesting

2..........7 days leaf harvesting interval

3.........14 days leaf harvesting interval

There was a significant effect of harvesting interval on grain yield (P=0.01) of cowpeas between the two leaf harvesting intervals. Contrary to leaf vegetables being higher under more frequent leaf harvesting, cowpea grain yields were lower in these treatments. Cowpea grain yield tended to increase with increase in leaf harvesting frequency. The highest grain yield was obtained in control plots followed by 14 days harvesting interval and the least being the 7 days leaf harvesting interval. Since during sequential harvests only tender leaves are harvested for consumption as leaf vegetables, harvesting cowpea leaves less often or not harvesting leaves at all left the plant with more foliage offering a greater photosynthetic surface which favours grain formation. In an earlier study under greenhouse conditions, Saidi et al. (2007) similarly recorded an increase in grain yields of two varieties as leaf harvesting frequency was decreased from one week to no leaf harvesting.

4.3 Effects of harvesting interval on above ground biomass yield

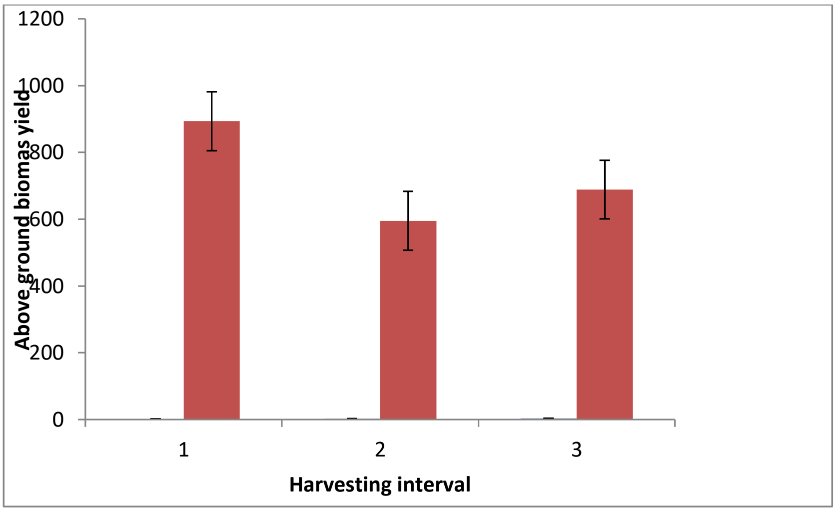

Figure 4. Effects of harvesting interval on the yield of above ground biomass

Key

1..........no leaf harvesting

2.........7days leaf harvesting interval

3........14 days leaf harvesting interval

Above ground biomass was significantly affected by leaf harvesting interval (P=0.01). There was an increase in biomass with increased leaf harvesting interval with the highest biomass obtained in the control plots followed by 14 days interval and lastly weekly harvesting interval. This is because leaf harvesting interval deprives the plant with photosynthetic tissue to form some reproductive structures such as pods and the general accumulation of biomass. However biomass accumulation was less affected by leaf harvesting interval than grain yield as over 50% of the potential biomass yield was obtained from both treatments. This maintenance of a stable weight might mean that the plant compensated leaf loss by re-growth of new shoots though separation of the above ground biomass into component parts such as leaves, shoots and grain could have made it easier to make such conclusions. It can be deduced that the plant has to attain a threshold above ground biomass level before channelling extra photoasimilates to grain formation.

CHAPTER 5

5.0. CONCLUSSION AND RECOMMENDATIONS

5.1 Conclusion

Basing on the results from the study, it can be strongly concluded that 7 day harvesting interval gives a higher leaf yield than 14 day harvesting interval due to compensation growth on leaves and also that most leaves will be within the consumable stage. 14 day harvesting interval gives a higher grain and above ground biomass yield than 7 day harvesting interval. Leaf harvesting has shown to affect grain yield more than the above ground biomass yield since the plant can compensate by forming more branches after defoliation.

5.2 Recommendations

From this study, farmers are recommended to employ strategies such as judicious defoliation of older leaves before flowering, harvesting leaflets, increasing plant density to compensate for defoliation, early planting and ratooning in order to optimise yield benefits from the dual purpose cowpea. Moreover soil fertility and other growing conditions must be considered as they determine the ability of a cowpea to tolerate the effects of leaf harvesting.

However there is need to further research on the effects of the two leaf harvesting intervals on cowpea grain yield in different agro-ecological regions of Zimbabwe and different cultivars.

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APPENDICES

Appendix 1: ANOVA for the effects of harvesting interval on leaf yield.

Analysis of variance

Variate: yield_kgs_ha

Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.
block stratum	2	0.4433	0.2217	0.49	
block.*Units* stratum					
treat	1	12.6150	12.6150	27.73	0.034
Residual	2	0.9100	0.4550		
Total	5	13.9683			

Appendix 2: Effects of leaf harvesting interval on grain yield.

Analysis of variance

Variate: yield_kg_ha

Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.
block stratum	2	38.30	19.15	0.56	
block.*Units* stratum					
treat	2	184018.27	92009.13	2682.92	<.001
Residual	4	137.18	34.29		
Total	8	184193.75			

Appendix 3 Effects of leaf harvesting interval on above ground biomass yield

Analysis of variance

Variate: yield_kg_ha

Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.
Block stratum	2	272.2	136.1	1.14	
Block.*Units* stratum					
Treat	2	402135.5	201067.8	1682.72	<.001
Residual	4	478.0	119.5		
Total	8	402885.7			