Evaluation of Crop Management Packages in "Mukunuwenna" (*Alternanthera sessilis*)

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ABSTRACT

"Mukunuwenna" (*Alternanthera sessilis*) is the most demanded leafy vegetable in Sri Lanka. A survey was conducted in January and February months of year 2005 to study cultural practices and identify pest and disease problems of Mukunuwenna growers in Chilaw, Mugunuwatawana area of Puttlam district (IL1b). Survey data showed that they were using fertilizer and pesticides higher than the recommended quantities. Further, *Cercospora* leaf spot and white rust (*Albugo* spp) diseases are available in higher incidences which reduce the yield greatly.

An experiment was carried out in three locations where two locations were situated at Mugunuwatawana and other location was situated at Faculty of Agriculture and Plantation Management Wayamba University of Sri Lanka (IL1a). Out of these three locations, in two locations at Mugunuwatawana farmer fields, Department Of Agriculture(DOA) recommended crop management package 01 was compared with farmer crop management package 01 for the existing Mukunuwenna crop. In the other location at Wayamba University, the simulated farmer crop management package 02 was compared with DOA recommended crop management package 02 for the newly established crop at *yala* 2005. There was no significant difference of disease incidence of both diseases among farmer crop management packages and DOA recommended crop management packages. Disease severity, quantity and quality of the yield were not significantly different at farmer fields but in Wayamba University at the first and second weeks, disease severity of the *Cercospora* leaf spot and first harvest were significantly different among farmer crop management package 02 and DOA recommended crop management package 02. The second harvest of farmer crop management package 02 was in low quality. The benefit cost ratios were calculated for each package and the highest benefit cost ratio was recorded by DOA recommended crop management package 01.

KEY WORDS: *Cercospora* Leaf Spot, White Rust, Crop Management Package, Disease Management

INTRODUCTION

"Mukunuwenna" (*Alternanthera sessilis*) is the main green leafy vegetable cultivated commercially in Sri Lanka and it belongs to the family Amaranthaceae.

Mukunuwenna is rich in Calcium (510mg/100g), Iron (16.7mg/100g), carotene (5120mg/100g), vitamin B1(0.05mg/100g), vitamin B2(0.14mg/100g), niacin(1.2mg/100g) and vitamin C(17mg/100g)(Anon, 2000). In addition to that, high fiber content in the commodity is beneficial to the digestive system of human. *Mukunuwenna* is having an importance as a medicinal plant as well as an ornamental plant.

Mukunuwenna has good demand in the international green leafy vegetable trade. Sri Lanka is exporting this crop to European countries and Gulf countries (Silva, 2005). The most suitable region for large scale cultivation in Sri Lanka is the Low Country Wet Zone(Kudagamage *et al.*, 2000). The other very common and oldest form of *Mukunuwenna* cultivation is the home gardening. Almost every backyard of houses has several varieties of *Mukunuwenna*, where the production is mainly for domestic consumption.

Diseases of *Mukunuwenna* are important factors which cause economic losses. *Cercospora* leaf spot (CLS) and White rust diseases are very common in Sri Lanka. Those two diseases are caused by fungi. The causal organism of white rust disease is *Albugo spp* (Mehrotra, 1994). Hosts of white rust diseases are cruciferous crops such as cabbage, turnip, mustard and radish (Duggar, 1998). *Cercospora* leaf spot disease of

Mukunuwenna is caused by *Cercospora alternantherae* (Kudagamage *et al.*, 2000)

The pest and disease problems of *Mukunuwenna* are the major constraints to expand the export market. Farmers apply high amount of pesticides to control pests and diseases and as a result product contain pesticide residuals and cost of production is increased. To overcome these problems an experiment is designed to develop a crop management package that can reduce the pest problems in *Mukunuwenna*.

MATERIALS AND METHODS

Preliminary survey on the problem

A questionnaire was developed and a survey was conducted in January and February months of year 2005 to study cultural practices and identify pest and disease problems of *Mukunuwenna* cultivations in Chilaw, Mugunuwatawana area of Puttlam district (IL1b).Twenty commercial scale *Mukunuwenna* growers were interviewed in Weerapandiyana, Sippikalana, Hirigolla and Mahawilaththawa villages.

Experiment

This experiment was carried out in three locations from April to August in year 2005 where two locations were situated at Mugunuwatawana Puttlam district (IL1b) and the other location was situated at Faculty of Agriculture and Plantation Management, Wayamba University of Sri Lanka (IL1a). Out of these three locations, in two locations at farmer fields, recommended by Department of Agriculture (DOA)

crop management package 01(control 1) was compared with farmer crop management package 01 for the existing *Mukunuwenna* crop (table 01). In the other location at Wayamba University, the simulated farmer crop management package 02 was compared with DOA recommended crop management package 02(control 2) for the newly established crop (Table 02). At the beginning of the application of crop management packages, the selected cultivations were same aged in the same location. All other cultural practices like weeding and irrigation except cultural practices including above mentioned crop management packages, were done in same manner.

Data recording

In data recording 45cm X 45cm size quadrant was used and five bushes were selected in zigzag way in the quadrant. Single placement of the quadrant was regarded as one replicate. Disease incidence and disease severity were recorded separately for the diseases of *Cercospora* leaf spot and White rust. Green yield was also recorded. Disease incidence and disease severity were calculated using following equations.

Disease incidence % = $\frac{\text{(No of disease infected bushes)}}{\text{(Total no of bushes assessed)}}$ X 100

Disease severity % = $\frac{\sum N}{N_T \times N_M}$ X 100

Where,

N - Severity score

N_M - Maximum number in the scale

N_T - Total No of observations

Following disease score was used in assessing disease severities of both *Cercospora* leaf spot and white rust.

0-No any visual symptoms by pathogen
1-Visual symptoms between 1%-20% of whole canopy
2-Visual symptoms between 21%-40% of whole canopy
3-Visual symptoms between 41%- 60% of whole canopy
4-Visual symptoms between 61%-80% of whole canopy
5-Visual symptoms between 81%-100% of whole canopy

In data analyzing t-test and ANOVA procedure were applied using SAS system.

Benefit Cost Ratio (BCR) calculation

In BCR calculations for farmer crop management package 01 and DOA recommended crop management package 01, cost for the fertilizer and pesticides, irrigation, weeding and labour cost for all other cultural practices were considered. For the calculation of BCR for farmer crop management package 02 and DOA recommended crop management package 02, cost for the land preparation, fertilizer and pesticides, planting materials, field planting, irrigation, weeding and labour cost for the all other cultural practices were considered.

RESULTS

Survey

The survey results of planting materials, irrigation and fertilizer applications are shown in table 3.

Broad leaves variety was the most popular *Mukunuwenna* variety and all farmers used unrooted stem cuttings as planting materials (Table 3). The farmers' irrigation method was flooding and most of them applied 15mt of poultry manure for one hectare once in three months. *Mukunuwenna* growers in Chilaw area applied about 200kg of urea for one hectare per week as inorganic fertilizer.

Survey results in relation to pest and diseases and their controlling measures are shown in table 4.

Major pests associated with *Mukunuwenna* are *Omiyodis indicata, Sellipus spp, Cassida spp* and *Aphis gossypii.* Most important diseases are *Cercospora* leaf spot and white rust disease. Disease incidence of most of farmer fields was between 70% - 100% and disease severity was between 25% - 50%. Farmers applied high dosages of Indofil as a fungicide and Imidacloprid as an insecticide and some farmers applied mixtures of fungicides and insecticides. The average pesticide application interval was one week and pre harvesting period was lesser than one week.

Table 1. Crop management packages for the existing crop in the field

Time after harvest	Farmer Crop Management Package 01	DOA Recommended Crop Management Package 01 (Control 01)
1st week	22g/m² of urea application	5.5g/m² of urea application
2nd week	Application of Indofil (Recommended quantity) 22g/m² of urea application Application of Indofil (Recommended quantity)	1.5g/m² Muriate Of Potash application Application of Indofil(Recommended quantity)
3rd week	Application of Imidacloprid (Recommended quantity) 22g/m² of urea application Application of Indofil (Recommended quantity)	
4th week	Harvesting	Harvesting

DOA = Department of Agriculture

Table 2. Crop management packages for the newly established crop.

Stage	Farmer Crop Management Package 02	DOA Recommended Crop Management Package 02(Control 02)
Before planting	Land preparation	Land preparation
		$10g/m^2$ of urea application
		$13.5g/m^2$ of Triple Super Phosphate application
		$10g/m^2$ of Muriate of potash application
		$1kg/m^2$ of poultry manure application
At planting	Broadcast cuttings	10-12cm long cuttings pretreated with Chlorothalonil 20*10cm spacing kept
1st week after planting	$22g/m^2$ urea application	$9g/m^2$ of urea application
2nd week after planting	$22g/m^2$ urea application Application of Indofil(Recommended quantity)	Application of Indofil(Recommended quantity)
3rd week after planting	$22g/m^2$ urea application Application of Indofil(Recommended quantity	
4th week after planting	Harvesting	Harvesting

DOA =Department of agriculture

Table 3. Percentage of the application of agronomic practices of *Mukunuwenna* growers in Chilaw area

Activity	Out put	Average no of farmers
Cultivated variety	Narrow leaves variety	40%
	Medium leaves variety	10%
	Broad leaves variety	50%
Type of planting materials	Unrooted stem cuttings	100%
Irrigation method	Flooding	100%
Organic fertilizer application	Poultry manure (15000kg/1 ha/3 months)	70%
	Poultry manure (16250/1 ha/3 months)	10%
	Poultry manure (10500kg/1 ha/3 months)	20%
Inorganic fertilizer application	Urea (225kg/ 1ha/1 week)	65%
	Urea (250kg/ 1ha/1 week)	15%
	Urea (175kg/ 1ha/1 week)	20%

Table 4. Pest and disease management practices of *Mukunuwenna* growers in Chilaw area

Activity	Output	Average no of farmers
Pests	*Omiyodis indicata, Sellipus spp, Cassida spp, Aphis gossypii*	High population ***
Disease incidence % *	51% - 75%	20%
	76% - 100%	80%
Disease severity% **	0% - 25%	30%
	26% - 50%	45%
	51% - 75%	15%
	76% - 100%	10%
Fungicides applied	Indofil	40%
	Propineb	30%
	Ridomil	20%
Insecticides applied	Imidacloprid	40%
	Carbosulfan	30%
	Permethrin	10%
	Quinalphos	5%
Pesticides application method	Mixed form recommended quantity	45%
	Mixed form higher than recommended quantity	55%
Pesticide application interval	0 - 7 days	80%
	8 - 14 days	20%
Pre harvesting period	0 days	5%
	1 - 3 days	25%
	4 - 7 days	65%
	8 - 14 days	5%

* for both diseases   ** for both diseases 0 - 5 scale used   *** visually

Table 5. The survey results of yield and income of interviewed *Mukunuwenna* farmers.

Activity	Out put	Average no of farmers
Yield (1 ha/ 1month)	< 37500 bunches(< 3300kg)	30%
	37500 - 75000 bunches(3300kg – 6600kg)	35%
	>75000 bunches(> 6600kg)	35%
Income(1 ha/1 month)	Rs 125000 - Rs 75000	80%
	>Rs 187500	20%

The survey results of yield and income of interviewed *Mukunuwenna* farmers are shown in table 5. Most of the farmers' received Rs 187,500 as income from one hectare per month.

Field experiment

There was no significant difference of disease incidence of *Cercospora* leaf spot and White rust among farmer crop management packages and DOA recommended crop management packages. Disease severity, quantity and quality of the yield were not significantly different at farmer fields but in Wayamba university at the first and second weeks disease severity of the *Cercospora* leaf spot and first harvest was significantly different among farmer crop management package 02 and DOA recommended crop management package 02. With the application of fungicides the disease severities of all plots decreased. Application of urea without fungicide application or without MOP application increased the disease severities. The incidence of both diseases had not changed with time. Disease incidence and severity of white rust was lower than the incidence and severity of *Cercospora* leaf spot (figure 1 and figure 2).

(a) *Cercospora* leaf spot

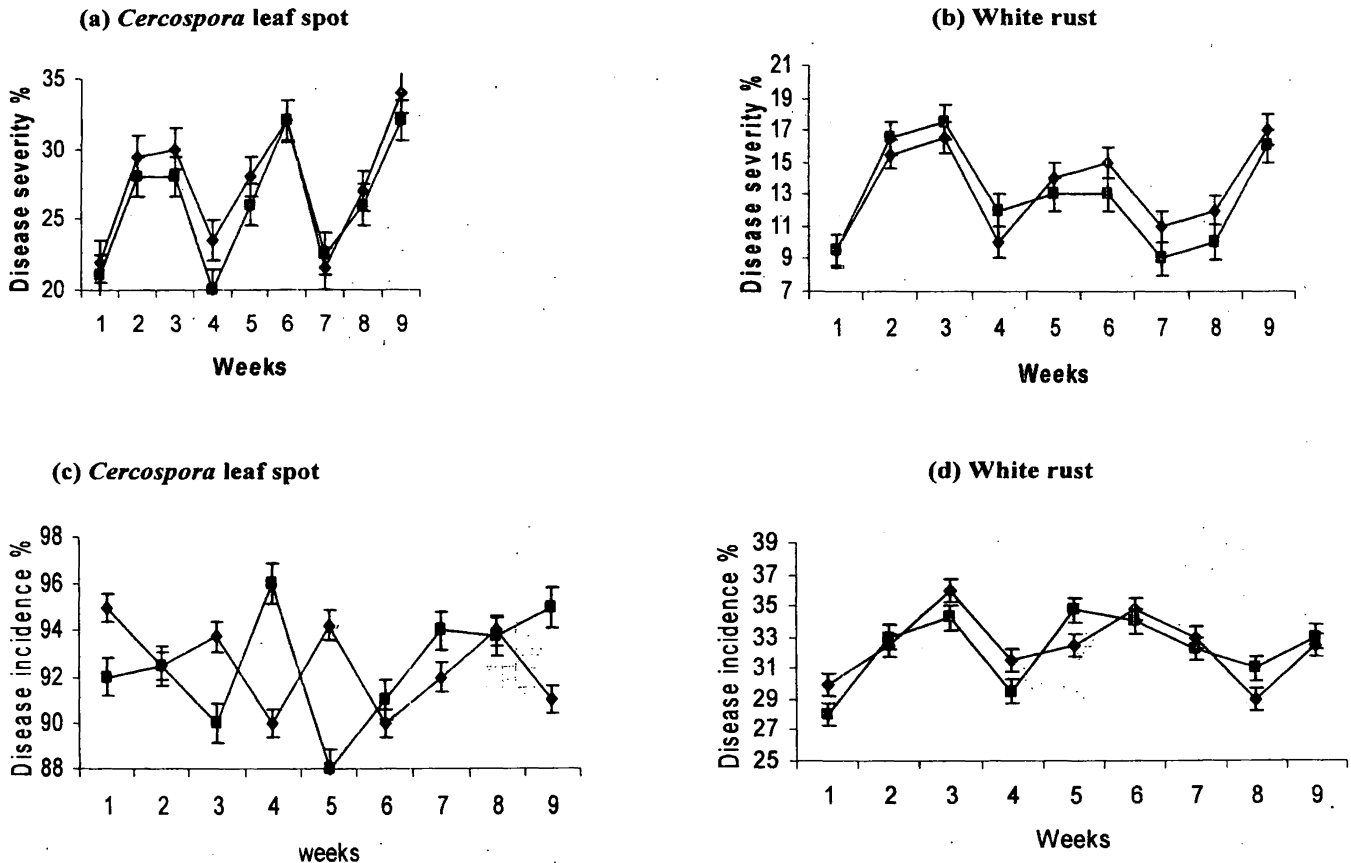(b) White rust

(c) *Cercospora* leaf spot

(d) White rust

Figure 1. Changes of disease severity % (a and b) and disease incidence % (c and d) of *Cercospora* leaf spot and white rust of farmer crop management package 1(◆——◆) vs. DOA crop management package 1 (■——■) with time in existing *Mukunuwenna* crop in farmer fields.
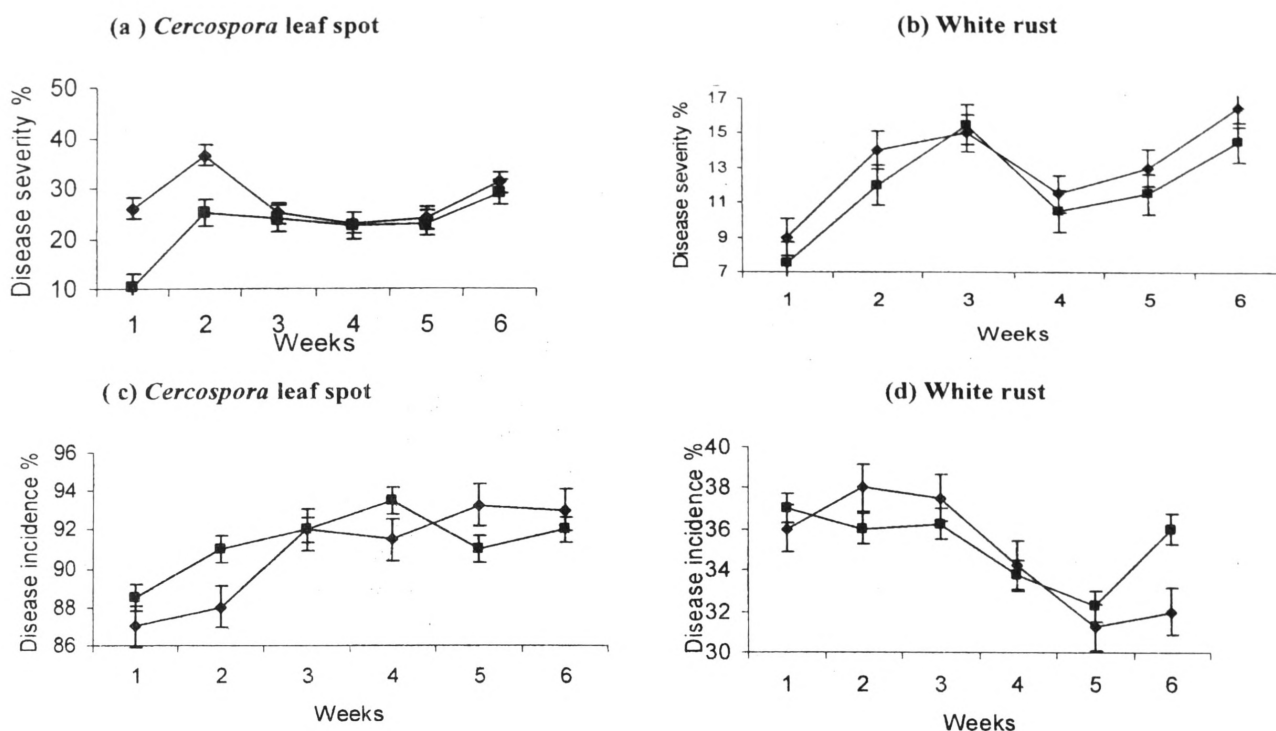
Figure 2. Changes of disease severity % (a and b) and disease incidence % (c and d) of *Cercospora* leaf spot and white rust in simulated farmer crop management package2 (◆—◆) vs. DOA crop management package 2 (■—■) with time in newly established *Mukunuwenna* crop at Wayamba University.

In farmer fields there were no significant differences of yields among farmer crop management package 01 and DOA recommended crop management package 01. However, at Wayamba University premises, first yield showed a significant difference among farmer crop management package 02 and DOA recommended crop management package 02.

In farmer fields the yield was almost constant with the time, while at Wayamba university premises the yields changed with time (Figure 3). The quality of the yields of all plots were in same level except the second harvest of farmer crop management package 02, which showed poor quality due to necrotic chlorosis.
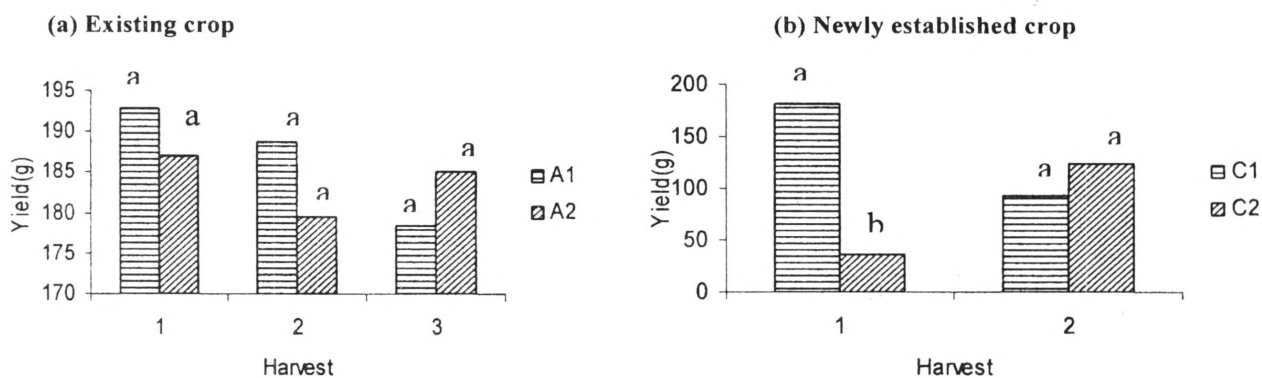

Figure 3. Changes of the yields with time in farmer crop management package 1(A1) vs. DOA crop management package 1(A2) in farmer fields (a) and simulated farmer crop management package 2(C1) vs. DOA crop management package 2 (C2) in newly established crop at Wayamba University(b).

Table 6. Benefit cost ratios of all packages applied

Package	Benefit- cost ratio
Farmer Crop Management Package 1	2.96
DOA Recommended Crop Management Package 1	3.42
Farmer Crop Management Package 2	1.82
DOA Recommended Crop Management Package 2	2.56

DISCUSSION

Farmer crop management packages include urea applications with higher doses than the recommended quantity. They applied only urea as an inorganic fertilizer. Therefore, plants became succulent and susceptible to pests and diseases. This may be a reason for increase of the disease severity of both diseases up to second week. Fungicide applications in farmer crop management packages could be the reason for the lower level of disease infections of *Cercospora* leaf spot and White rust .The leaf area of the bushes increased with the time after harvesting. New leaves were not showing any disease symptoms. Therefore, disease severity of both diseases remained in same level after second week of harvesting.

Mukunuwenna growers in Chilaw area apply fungicides in higher doses and higher number of applications in a mixture with insecticides. The same fungicide is being used for a long time period. This practice may develop resistance in fungi species to the fungicides.

By applying DOA recommended crop management package 01 disease severities of both diseases could be controlled as in the farmer crop management package 01. In DOA recommended crop management packages, two fungicides were applied alternatively. Significant difference of disease severity of *Cercospora* leaf spot among farmer crop management package 02 and DOA recommended crop management package 02 at first and second weeks at Wayamba University could be a result of the pre treatment of planting materials which in DOA recommended crop management package 02 with cholorothalonil.

The both diseases could not be eradicated from any plots by applying fungicides. Therefore, disease incidence remained at a constant level throughout the experiment. *Albugo spp,* the causal organism of white rust disease is an inhabitant of intracellular space of the lower surface of the leaves. Hence, it can not be controlled by applying contact fungicides with a hand sprayer.

There was no difference in the yield under farmer crop management package 01 and DOA recommended crop management package 01 in farmer fields. However, under DOA recommended crop management package 01, farmer fields were ready for the new harvest after 35 days of previous harvest. The reason behind this may be the application of only one top dressing with urea between two harvests under DOA recommended crop management package 01. In DOA recommended crop management package 02, 10-12cm long stem cuttings were used as planting materials and 10-20cm spacing was kept. Hence, the plant density was lower than farmer crop management package 02 at the stage of the first yield. The planting material requirement for farmer crop management package 02 was 10 times higher than that of DOA recommended crop management package 02. Therefore, the first yield under farmer crop management package 02 was higher than the yield under DOA recommended crop management package 02. However, there was no application of nutrients other than Nitrogen in farmer crop management package 02. As a result, plants showed necrotic chlorosis and slow growth rate. Subsequently, the yield had reduced in the second harvest of farmer crop management package 02. The quality of the second yield under farmer crop management package 02 was very low due to necrotic chlorosis.

The highest benefit cost ratio was obtained by DOA recommended crop management package 01.It may be due to application of necessary amounts of fertilizer and pesticides.

Weed management is the most serious problem of *Mukunuwenna* cultivation. There is no any other possible weed control method except manual weeding. Manual weeding is time consuming and requires high labour. Some weeds like wild mustard(*Brassica kaber*) can act as a host for *Cercospora spp.*

The irrigation method of *Mukunuwenna* cultivations in Chilaw area is flooding. This may cause the increase of disease incidence and severity.

Some dates of cultural practices were altered when crop management packages were applied due to the unfavourable conditions at the end of April, end of May and first week of June.

In farmer fields, initially the yields were measured as bunches and later it was converted to the weight.

In order to achieve the objectives of the experiment, farmer crop management package 02 and DOA recommended crop management package 02 should be tested in Chilaw area.

CONCLUSIONS

Mukunuwenna growers in Chilaw area are using fertilizer and pesticides in higher amounts than the required quantities. It leads to high cost of production and reduced quality of the yield.

DOA recommended crop management package 01 is superior to other crop management packages evaluated in this study for existing *Mukunuwenna* cultivations. As DOA recommended crop management package 01 takes 35 days for harvesting it is necessary to carry out further experiments in order to reduce the harvesting period. DOA recommended · . crop management package 02 has to be modified to get the optimum benefits.

Further, experiments should be carried out to develop a crop management package for *Mukunuwenna* which contains cultural practices that can manage pest problems with minimum pesticide applications.

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