BIBLIOGRAPHY

BALICDANG, JANET S. OCTOBER 2007. Growth and Yield of Chinese Kale (*Brassica oleracea* var. alboglabra) as Affected by Duration of Weed Control. Benguet State University, La Trinidad, Benguet.

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ABSTRACT

The study was conducted at the Balili Experimental Station, Benguet State University, La Trinidad, Benguet from June to July 2007 to determine the effects of weeding durations on the growth and yield, to establish the best time of weeding, and to assess the economics of the various weeding durations in Chinese kale production.

Results showed that plants weed-free from transplanting up to harvesting and weed-free for 30 days after transplanting (DAT) were comparable but considerably required longer duration of weeding than the other treatments.

Small flower galinsoga (*Galinsoga parviflora* Cav.) was identified as the predominantly weed species growing in association with the crop while the minor were goosegrass (*Eleusine indica* L.) and crabgrass (*Digitaria sanguinalis* L.). The population of *G. parviflora* at harvest was significantly higher in the unweeded plots than the rest of the treatments.

Plant growth increment measured in one, two and three weeks after transplanting were not significant. But on the fourth measurement, growth increment was significantly higher in plants weed-free for 30 DAT. On the fifth and sixth measurements, weed-free

plants for 30 DAT had markedly higher growth comparable to weed-free and those weed-free for 20 DAT but were considerably higher than those plants weed-free for 10 DAT and unweeded plots. Weed-free plants had the highest growth increment on the seventh measurement. For the final height at harvest, weed-free plants markedly had the tallest comparable with those plants at 30 DAT.

Plants kept weed-free and plants weeded for 30 DA T significantly produced higher average marketable weight per plant, marketable, total, computed yields, and benefit:cost ratio. Yield reduction ranges from 5.69 to 82.11%.

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INTRODUCTION

Vegetable production is a major industry in the highlands where majority of the people in the Cordillera are engaged because they gain profit from producing vegetable crops and the climatic conditions are favorable for their growth and development.

Chinese kale is an introduced crop in the Cordilleras. It offers benefits like a source of income and one of the leafy vegetables with the best eating quality. However, in growing vegetable crops, factors like weed occurrence should be considered. Weeds compete with crop plants for sunlight, water, nutrients and space and their growth must be limited to obtain a good yield of any food crop. Weed management strategies should be employed to limit the deleterious effects in growing vegetables crops. If weeds are able to utilize a sufficient amount of some growth factors to the detriment of the crop, the results can be, and most often is, an adverse effect on crop yield in terms of quality and volume. Therefore, it is important that weeds are controlled to prevent their competition with the vegetable crop grown.

The presence of weeds is a serious garden problem. They rob vegetable crops of sunlight, water and nutrients. They also provide hiding places for insects and serve as a source of crop diseases.

The existence of weeds in crop production is one major problem of vegetable growers. Villareal and Wallace (1969) stated that many adapted weed species are identified in the farmers' fields that caused losses due to competition for light, mineral nutrients, space and water. They also harbor insect pests and diseases that impair plant growth and development resulting to poor and low yield.

To attain satisfactory crop growth, development and good yield, weed control should be done at the earliest stage of crop growth during the cropping season. Thus, this study is conceptualized.

The study was conducted at the Balili Experimental Station, Benguet State University, La Trinidad, Benguet from June to July 2007 to determine the effects of weeding durations on the growth and yield, to establish the best time of weeding, and to assess the economics of the various weeding durations in Chinese kale production.

REVIEW OF LITERATURE

Description of the Crop

Chinese broccoli or Chinese kale, is a slightly bitter leaf vegetable featuring thick, flat, glossy blue-green leaves with thick stems and a small number of tiny, almost vestigial flower heads similar to those of broccoli. As a group of *Brassica oleracea*, kai-lan is one of the same species of plant as broccoli and kale. Its flavor is very similar to that of broccoli, though not identical, being a bit sweeter.

Chinese kale is a vegetable crop with slender, bright green stalks ending in slightly darker leafy greens, which are sometimes accompanied by clusters of tiny white flower buds. It has a flavor comparable to that of broccoli raab and is used in Chinese cuisine, typically chopped in stir-fry dishes. Chinese broccoli is also known as Chinese kale, flowering kale (English), kai-lan (Cantonese), gai-lan, jie-lan (Mandarin), cai -ro (Vietnamese), and kat-na (Khmer). This crop resembles the more familiar broccoli with a longer stem and very small head. Unlike many other Asian greens in the *Brassica* family, this crop has a thick stem like cole crops that originated in the Mediterranean, such as broccoli, cauliflower, and Brussels sprouts ("cole" means stem in old English). It is believed that early Portuguese explorers brought cabbage to Asia and through generations of selections, it has developed into Chinese broccoli (Anon, 2006).

Yield Losses Due to Weeds

A study conducted by Anderson (1983) showed that weeds reduced yield by as much as 27% compared to weed-free potato plants. No yield reduction was noted on potatoes kept weed-free for the first four weeks after planting. In a similar study, King (1985) found that *Agropyron replus* reduces potato yield by 52% below weeded plants. In carrot, yield reduction reached 30% while up to 60% was observed in onions and beets (Stanbolts and Holm, 1956 cf. Crafts and Robbins, 1962). Subramanian (1981) reported that weeds decrease soybean yields by reducing pod, branch, leaf and flower number per plant, seed number per pod, and plant dry weight. Bongolan and Wells (1981) reported yield losses due to uncontrolled weed growth in soybeans planted after transplanted rice were negligible in most tropical countries contradicting the report of Anon. (1980) that mungbean yields were markedly reduced during the dry season under the same tropical conditions. Bleasedale (1960) mentioned that the presence of weed significantly reduced the weight of tops, total roots and marketability of carrots. He further stated that the time of weeding is important and that delaying the first weeding significantly reduced yield of marketable crops. Because weeds causes the heaviest yield losses, cultivation should be done when weeds are breaking through the soil surface since they are not yet well established (Guantes, 1980).

Crop-Weed Competition

Most injurious to crop caused by weeds occur during the first 25-30% of their life duration which is describe as the critical period of weed competition and the most appropriate time to apply weed control measures (Paller and Soriano, 1977). They added that emergence of weed after this period no longer reduces crop yield because the crop had already develop extensive root system and considerable foliage to compete favorably with the late emerging weeds. But Moody and Paller (1976) reported that in general, the critical period of weed competition of most crops is in the 25-55% of their life cycle.

They added that weeds growing in the place where they are not wanted inflict considerable damage like competing with crops for water, nutrients and space causing yield reduction. Chapman (1976) also stated that weeds grow taller and shade the crop to such extent that photosynthetic capacity of the crop is drastically reduced.

Thompson and Kelly (1957 cf. Serra, 1981) stated that weeding should be done when weeds are still small for it requires less labor and effectively checks competition between the crop and the weeds. Destroying weeds is important before they seriously compete with the crop for growth factors.

Crafts and Robbins (1962) claimed that plants differ in their competing ability. The characteristics that enable species to be successful in competition are high germination of seeds under adverse conditions and the rapid development of an extensive root system having both surface and deep roots.

Weed Control

Villareal and Wallace (1969) suggested that weed control should be started on land preparation and application of herbicide be applied to the surface and incorporated immediately through disking. Knott and Deanon (1969) also suggested that good control of weed is important for satisfactory crop production and that cultivation be started as the seedlings appear in order to check weed growth.

Effective weed control should include a combination of practices designed to suppress weeds during the entire year (Stall, n.d.). The same author stated some of the management practices include crop rotation, cover cropping, cultivation flooding and mulching.

Anon. (2007) stated that it is important to control weeds while they are small and before they get out of control. Most weeds can be controlled and kept from becoming serious problems in the garden. These methods of control include hand-pulling, cultivation, mulching and use of chemicals.

Anon. (1975) suggested that hand weeding is preferred during the growth period of the plant and that weeding should be done prior to fertilizer application.

For effective weed control as stated by Bawang (2006), control measures should be directed to plant organs responsible for reproduction. For annuals, direct control measure may be done by preventing the weeds from producing seeds. In other words, the time to control the weed is at the early vegetative stage. Also, try to deplete weed seed reserves in the soil by thorough land preparation. For perennials, effective control may be done by destroying the underground vegetative propagules. The same author also stated that control measure should be done until such time that the crop can take good care of itself and combination of two control measures is better than one.

MATERIALS AND METHODS

Materials

The materials used were Chinese Kale ('Kai-lan') seeds, sticks with identifying marks, insecticides, fungicides, fertilizers, weighing scale, 1 m x 1 m quadrant, and measuring stick.

Methods

Experimental design and treatments. The experiment was laid out in randomized complete block design (RCBD) with four replications. The treatments were as follows:

Code	Description
T_1	Weed-free from transplanting up to harvesting
T_2	Weed-free for 10 days after transplanting then unweeded up to harvesting
T_3	Weed-free for 20 days after transplanting then unweeded up to harvesting
T_4	Weed-free for 30 days after transplanting then unweeded up to harvesting
T_5	Unweeded from transplanting up to harvesting

Seedling production. A plot measuring 1 m x 10 m was be thoroughly prepared. Furrows across the plot were made for the seeds to be sown thinly, covered with soil followed by watering.

Land preparation and fertilizer application. An area of 120 m^2 was thoroughly prepared and divided into experimental plots with a dimension of 1 m x 5 m. The plots were leveled and holes were made 20 cm between hills and rows. The total amount of inorganic fertilizer (80-80-80 kg N-P_2O_5-K_2O/ha) and chicken manure (3.0t/ha) were applied in the prepared holes and immediately soil incorporated before transplanting.

Transplanting. Three week-old seedlings were transplanted in the holes followed immediately by watering. There were three rows per raised beds.

Other cultural management practices. Except for the imposition of the various treatments, all the cultural management practices such as insect pests and diseases control and irrigation were strictly followed.

Harvesting. All plants were hand harvested using a sharp knife at the marketable stage and was based when the plants show opening of the first vestigial flower.

Data gathering. The data gathered and subjected for variance analysis and mean separation test by Duncan's multiple range test (DMRT) were the following:

1. Weeding time (hours). The time duration of weeding in each treatment was recorded.

2. Weed identification and count. The weeds growing in association with the crop were identified and counted in a 1 m x 1 m quadrant after harvest.

3. Plant growth increment (cm/week). The initial height of four randomly selected seedlings was taken before transplanting and at 7-day intervals and at harvest.

4. Percentage survival. The number of plants harvested was counted and the percentage of survival was computed using the formula:

$$\text{Survival (\%)} = \frac{\text{Number of harvested plants/plot}}{\text{Total number of plants/plot}} \times 100$$

5. Average marketable plant weight (g). This was taken by using the formula:

Average (g) = Total marketable plant weight (kg/plot) ¸ Number of marketable plants

6. Marketable yield (kg/plot). The weight of marketable plants without any defects was taken at harvest.

7. Non-marketable yield (kg/plot). The weight of non-marketable plants such as excessively small and rotten plants was taken at harvest.

8. Total yield (kg/plot). This was obtained by taking all the weight of harvested plants per plot.

9. Computed marketable yield (t/ha). This was computed using the formula:

Computed yield (t/ha) = Marketable yield (kg/plot) x 2

where: 2 is a factor to convert the marketable yield (kg/plot) to t/ha based on the experimental plot size used.

10. Others. The following data will also be taken but will not be subjected to variance analysis.

a. Benefit cost ratio (BCR). This will be obtained by recording the man-days/ha of weeding and BCR will be computed by using the formula:

$$BCR = \frac{\text{Benefit-Cost}}{\text{Cost}} + 1$$

b. Documentation of the study through pictures.

RESULTS AND DISCUSSION

Weeding Time

Table 1 shows the time of weeding recorded from the various weed control treatments after transplanting. Results showed that plants weed-free from transplanting up to harvesting and weed-free for 30 days after transplanting (DAT) were comparable but considerably required longer duration of weeding than the other treatments.

Identified Weed Species and Population

Small flower galinsoga (*Galinsoga parviflora* Cav.) was identified as the predominantly weed species growing in association with the crop while the minor were goosegrass (*Eleusine indica* L.) and crabgrass (*Digitaria sanguinalis* L.) as presented in Table 2. The population of *G. parviflora* at harvest was significantly higher in the unweeded plots than the rest of the treatments. Plots weeded 10, 20 and 30 DAT have comparable population.

Table 1. Weeding time

WEEDING DURATION (days)	MEAN (hr)
Weed-free	0.91a
Weed-free for 10 DAT	0.08c
Weed-free for 20 DAT	0.34b
Weed-free for 30 DAT	0.77a

Unweeded	0.00d

Means with a common letter are not significantly different at 5% by DMRT

Table 2. Identified weed species and population

WEEDING DURATION (days)	WEED SPECIES		
	G. parviflora	*E. indica*	*D. sanguinalis*
Weed-free	0.0c	0.0b	0.0c
Weed-free for 10 DAT	213.25b	206.25a	148.75ab
Wed-free for 20 DAT	214.50b	192.25a	107.50ab
Weed-free for 30 DAT	213.00b	187.25a	88.50b
Unweeded	270.75a	208.25a	170.25a

In a column, means a with common letter are not significantly different at 5% level by DMRT

Growth Increment and Final Height

Table 3 shows that plant growth increment measured in one, two and three weeks after transplanting were not significant. But on the fourth measurement, growth increment was significantly higher in plants weed-free for 30 DAT compared to the rest of the weeding durations. On the fifth and sixth measurements, weed-free plants for 30 DAT had markedly higher growth but comparable to weed-free and those weed-free for 20 DAT but were considerably higher than those plants weed-free for 10 DAT and unweeded plots. On the other hand, the weed-free plants had the highest increment but was comparable to weed-free plants for 20 and 30 DAT on the seventh measurement.

For the final height at harvest, weed-free plants markedly had the tallest however, comparable with those plants at 30 DAT (Table 3). But the former was significantly taller compared to the rest of the treatments.

Table 3. Weekly growth increment

WEEDING DURATION (days)	WEEKLY MEASUREMENT (cm/plant)							FINAL HEIGHT (cm)
	1	2	3	4	5	6	7	
Weed-free	0.54a	1.08a	1.40a	3.75b	8.55a	8.90a	8.75a	40.25a
Weed-free for 10 DAT	0.48a	0.70a	1.39a	3.85b	4.08bc	6.23b	5.78bc	29.63c
Weed-free for 20 DAT	0.49a	0.65a	1.60a	4.13b	5.38abc	10.68a	7.90a	34.90b
Weed-free for 30 DAT	0.67a	0.85a	1.33a	6.10a	7.43ab	10.10a	7.45ab	37.75ab
Unweeded	0.41a	0.60a	0.55a	3.23b	3.45c	4.57c	4.55c	23.30d

In a column, means a with common letter are not significantly different at 5% level by DMRT

Crop Survival

Plants kept weed-free from transplanting up harvesting had significantly higher percentage survival than the other of the treatments but comparable to 20 and 30 DAT (Table 4). Plants kept unweeded had the lowest percentage survival however, comparable to 10 DAT.

Average Weight of Marketable, Non-marketable and Marketable Yields

Table 5 shows the average weight of marketable and non-marketable and marketable yields. The average marketable weight per plant was significantly higher in plots kept weed-free but was comparable to those kept weed-free for 20 and 30 DAT. However, the former was significantly higher than those kept weed-free for 10 DAT and unweeded plants. In terms of the non-marketable yield per plot, there were significant differences among the treatments. Plants kept weed-free and those weed-free for 20 and 30 DAT were comparable with each other but these treatments produce higher non-marketable yield than those at 20 Table 4. Crop survival

WEEDING DURATION (days)	MEAN (%)
Weed-free	68.00a
Weed-free for 10 DAT	37.75bc
Weed-free for 20 DAT	57.50ab
Weed-free for 30 DAT	67.75a
Unweeded	31.00c

Means with a common letter are not significantly different at 5% by DMRT

Table 5. Average marketable weight, non-marketable, and marketable yields

WEEDING DURATION	AVERAGE WEIGHT	YIELDS (kg/plot)	
(days)	(g/plant)	Non-marketable	Marketable
Weed-free	121.45a	2.35a	3.80a
Weed-free for 10 DAT	53.94b	0.75b	1.35c
Weed-free for 20 DAT	100.65ab	2.15a	

2.40b			
Weed-free for 30 DAT	117.092a	2.25a	3.95a
Unweeded	54.69b	0.55b	0.70c

In a column, means a with common letter are not significantly different at 5% level by DMRT

DAT and unweeded plots. The marketable yields per plot were significantly higher in the weed-free plants and those weed-free for 30 DAT than those weeded for 10 and 20 DAT and the unweeded plants.

Total and Computed Yields, Yield Reduction, and Benefit:Cost Ratio

The total and computed yields of plants kept weed-free up to harvesting was markedly the highest compared to the rest of the treatments except for those plants kept weed-free for 30 DAT as presented in Table 6. Yield reduction ranges from 5.69 to 82.11% for plants kept weed-free for 30 DAT and those unweeded. In terms of benefit:cost ratio, the highest was realized from plants kept weed-free for 30 DAT followed by those kept weed-free up to harvesting.

Pictorial Documentation

Figs. 1 and 2 show the overview of the experiment before harvest and the harvested plants, respectively.

The weeding time (Table 1) required to remove *G. parviflora, E. indica, D. sanguinalis* identified and counted weeds (Table 2) growing in association with the crop increases with longer durations of weed control. This is attributed to more weeds with well-

Table 6. Total and computed marketable yields, yield reduction and benefit:cost ratio

WEEDING DURATION (days)	TOTAL YIELD (kg/plot)	YIELD REDUCTION (%)	COMPUTED YIELD (t/ha)	BENEFIT: COST RATIO
Weed-free	6.15a	-	7.45a	31.73
Weed-free for 10 DAT	2.10c	65.85	2.70bc	16.63
Weed-free for 20 DAT	4.05b	34.14	4.30b	23.03
Weed-free for 30 DAT	5.80a	5.69	7.90a	34.86
Unweeded	1.10c	82.11	1.40c	-

In a column, means a with common letter are not significantly different at 5% level by DMRT established root system when allowed to grow for a longer duration making them harder to uproot than at earlier period supporting the statement of Anderson (1983) that weeding tool 20-30% of farmers' time and the it accounted for only 2.0 to 6.0% of that production cost.

Allowing crop-weed mixtures after 10 to 30 days from transplanting (DAT) did not result to a significant increase in plant growth increments (Table 3) but significantly affected four to seven weeks after transplanting. Results suggest that transplanted Chinese kale crop can effectively compete with the weeds because they were given a head-start.

Manifestation of crop-weed competition were noticeable as the association was prolonged causing a remarkable reduction in crop survival, average plant weight, marketable and total yields resulting to a tremendous yield reductions (Tables 4-6). These repercussions indicated that the crop lost its competitiveness with the weeds for growth factors essential for growth and development (Villareal and Wallace, 1969; Anderson, 1983). Moody (1993) also stated that any weed growing in association with the crop will reduce the vegetative dry matter potential of the crop. In this study, allowing crop-weed mixtures from transplanting to harvesting resulted to 82.11% yield reduction (Table 6) supporting several reports that crop-weed mixture reduced yields by as much as 30% in carrot, 60% in onions and beets (Stanbold and Holms, 1956 cf. Crafts and Robbins, 1962), and 52% in potato (King, 1985). Subramanian (1981) also reported that weeds decrease soybean yields by reducing pod, branch, leaf, and flower numbers per plant, seed number per pod, and plant dry weight. Bleasedale (1960) mentioned that the presence of weed significantly reduced the weight of tops, total roots and marketability of carrots. In lettuce, a maximum yield was obtained with a single weeding 25 days after transplanting (Cardona, 1977). Also, increasing the time that weeds remained in plots before removal, the greater the reduction in garlic yield and quality (Qasem, 1996). Yield reductions ranging from 6.12 to 88.57% was also reported by Diaz (1998) in lettuce crop while 22.48-70.33% in cabbage crop (Atiwon, 1999).

SUMMARY, CONCLUSION AND RECOMMENDATION

Summary

The study was conducted at the Balili Experimental Station, Benguet State University, La Trinidad, Benguet from June to July 2007 to determine the effects of weeding durations on the growth and yield, to establish the best time of weeding, and to assess the economics of the various weeding durations in Chinese kale production.

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Plant growth increment measured in one, two and three weeks after transplanting were not significant. But on the fourth measurement, growth increment was significantly higher in plants weed-free for 30 DAT compared to the rest of the weeding durations. On the fifth and sixth measurements, weed-free plants for 30 DAT had markedly higher growth but comparable to weed-free and those weed-free for 20 DAT but were considerably higher than those plants weed-free for 10 DAT and unweeded plots. On the other hand, the weed-free plants had the highest increment but was comparable to weed-

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The average marketable weight per plant was significantly higher in plots kept weed-free but was comparable to those kept weed-free for 20 and 30 DAT. However, the former was significantly higher than those kept weed-free for 10 DAT and unweeded plants. In terms of the non-marketable yield per plot, there were significant differences among the treatments. Plants kept weed-free and those weed-free for 20 and 30 DAT were comparable with each other but these treatments produce higher non-marketable yield than those weed-free for 20 DAT and unweeded plots. The marketable yields per plot were significantly higher in the weed-free plants and those weed-free for 30 DAT than those weeded for 10 and 20 DAT and the unweeded plants. The total and computed yields of plants kept weed-free up to harvesting was markedly the highest compared to the rest of the treatments except for those plants kept weed-free for 30 DAT. Yield reduction ranges from 5.69 to 82.11% for plants kept weed-free for 30 DAT and those unweeded. In terms of benefit:cost ratio, the highest was realized from plants kept weed-free for 30 DAT followed by those kept weed-free up to harvesting.

Conclusion

Based from the results of the study, plants kept weed-free and those weed-free for 30 days after transplanting had the highest yield and profitability. In conclusion, keeping the plants weed-free for 30 days after transplanting could be done to reduce labor cost in controlling in weeds for Chinese kale production.

<u>Recommendation</u>

From the preceding results and discussions, it is recommended to keep the plants weed-free for at least 30 days after transplanting. It is further recommended that a similar study will be conducted on Chinese kale production during the dry cropping season.

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APPENDICES

Appendix Table 1. Weeding time (hrs)

TREATMENT	REPLICATION I	II	III	IV	TOTAL	MEAN
T_1	1.13	0.97	0.73	0.78	3.61	0.91
T_2	0.10	0.08	0.07	0.07	0.32	0.08
T_3	0.53	0.33	0.32	0.18	1.36	0.34
T_4	1.00	0.08	0.68	0.58	3.06	0.77
T_5	0.00	0.00	0.00	0.00	0.00	0.00

Analysis of Variance

Source of variation	Degrees of freedom	Sum of squares	Mean square	Computed F	TABULAR F 0.05	0.01
Replication	3	0.154	0.051			
Treatment	4	2.601	0.650	72.59**	3.26	5.41
Error	12	0.107	0.009			
Total	19	2.063				

** = Highly significant   Coefficient of variation = 22.67%

Appendix Table 2. Growth increment one week after transplanting (cm)

TREATMENT	REPLICATION				TOTAL	MEAN
	I	II	III	IV		
T_1	0.66	0.50	0.70	0.30	2.16	0.54
T_2	0.60	0.30	0.40	0.60	1.90	0.48
T_3	0.80	0.40	0.46	0.30	1.96	0.49
T_4	1.10	0.78	0.30	0.50	2.68	0.67
T_5	0.34	0.60	0.20	0.50	1.64	0.41

Analysis of Variance

Source of variation	Degrees of freedom	Sum of squares	Mean square	Computed F	TABULAR F 0.05	TABULAR F 0.01
Replication	3	0.252	0.084			
Treatment	4	0.152	0.038	0.89ns	3.26	5.41
Error	12	0.512	0.043			
Total	19	0.915				

ns = Not significant

Coefficient of variation = 39.94%

Appendix Table 3. Growth increment two week after transplanting (cm)

TREATMENT	REPLICATION I	II	III	IV	TOTAL	MEAN
T_1	1.1	1.4	1.3	0.5	4.30	1.08
T_2	1.0	0.8	0.5	0.5	2.80	0.70
T_3	0.8	0.7	0.6	0.5	2.60	0.65
T_4	0.8	1.0	0.5	1.1	3.40	0.85
T_5	0.8	0.6	0.5	0.5	2.40	0.60

Analysis of Variance

Source of variation	Degrees of freedom	Sum of squares	Mean square	Computed F	TABULAR F 0.05	0.01
Replication	3	0.322	0.107			
Treatment	4	0.590	0.147	2.66ns	3.26	5.41
Error	12	0.666	0.055			
Total	19	1.577				

ns = Not significant

Coefficient of variation = 30.40%

Appendix Table 4. Growth increment three weeks after transplanting (cm)

TREATMENT	REPLICATION				TOTAL	MEAN
	I	II	III	IV		
T_1	1.50	1.40	0.80	1.90	5.60	1.40
T_2	2.50	0.90	1.10	1.05	5.55	1.39
T_3	1.90	1.70	1.00	1.80	6.40	1.60
T_4	1.40	1.20	1.10	1.60	5.30	1.33
T_5	0.70	0.40	0.60	0.50	2.20	0.55

Analysis of Variance

Source of variation	Degrees of freedom	Sum of squares	Mean square	Computed F	TABULAR F 0.05	TABULAR F 0.01
Replication	3	1.313	0.438			
Treatment	4	2.638	0.659	4.72*	3.26	5.41
Error	12	1.676	0.140			
Total	19	5.627				

* = Significant

Coefficient of variation = 29.84%

Appendix Table 5. Growth increment four weeks after transplanting (cm)

TREATMENT	REPLICATION I	II	III	IV	TOTAL	MEAN
T_1	3.8	3.5	4.6	3.1	15.00	3.75
T_2	3.0	4.5	4.6	3.3	15.40	3.85
T_3	2.7	3.3	5.4	5.1	16.50	4.13
T_4	3.7	7.3	5.7	7.7	24.40	6.10
T_5	2.1	2.0	4.2	4.6	12.90	3.23

Analysis of Variance

Source of variation	Degrees of freedom	Sum of squares	Mean square	Computed F	TABULAR F 0.05	0.01
Replication	3	10.546	3.515			
Treatment	4	19.563	4.891	4.35*	3.26	5.41
Error	12	13.489	1.124			
Total	19	43.598				

* = Significant

Coefficient of variation = 25.18%

Appendix Table 6. Growth increment five weeks after transplanting (cm)

TREATMENT	REPLICATION I	II	III	IV	TOTAL	MEAN
T_1	6.4	10.1	13.7	4.0	34.20	8.55
T_2	2.5	4.7	5.7	3.4	16.30	4.08
T_3	4.4	4.0	5.5	7.6	21.50	5.38
T_4	8.5	5.0	7.7	8.5	29.70	7.43
T_5	2.7	2.0	5.4	3.7	13.80	3.45

Analysis of Variance

Source of variation	Degrees of freedom	Sum of squares	Mean square	Computed F	TABULAR F 0.05	0.01
Replication	3	22.933	7.644			
Treatment	4	75.515	18.879	3.78*	3.26	5.41
Error	12	59.889	4.991			
Total	19	158.337				

* = Significant

Coefficient of variation = 38.68%

Appendix Table 7. Growth increment six weeks after transplanting (cm)

TREATMENT	REPLICATION I	II	III	IV	TOTAL	MEAN
T_1	9.1	8.0	12.5	6.0	35.60	8.90
T_2	4.6	9.8	4.6	5.9	24.90	6.23
T_3	10.1	12.7	12.0	7.9	42.70	10.68
T_4	10.0	10.6	10.8	9.0	40.40	10.10
T_5	4.6	4.2	5.6	3.9	18.30	4.57

Analysis of Variance

Source of variation	Degrees of freedom	Sum of squares	Mean square	Computed F	TABULAR F 0.05	TABULAR F 0.01
Replication	3	22.657	7.552			
Treatment	4	108.847	27.212	9.27**	3.26	5.41
Error	12	35.225	2.935			
Total	19	166.730				

** = Highly significant Coefficient of variation = 21.16%

Appendix Table 8. Growth increment seven weeks after transplanting (cm)

TREATMENT	REPLICATION I	II	III	IV	TOTAL	MEAN
T_1	8.4	8.6	8.7	9.3	35.00	8.75
T_2	5.0	5.8	7.5	4.8	23.10	5.78
T_3	8.6	9.9	6.1	7.0	31.60	7.90
T_4	6.4	9.7	5.4	8.3	29.80	7.45
T_5	4.0	4.7	4.8	4.7	18.20	4.55

Analysis of Variance

Source of variation	Degrees of freedom	Sum of squares	Mean square	Computed F	TABULAR F 0.05	TABULAR F 0.01
Replication	3	5.237	1.746			
Treatment	4	46.048	11.512	6.98**	3.26	5.41
Error	12	19.780	1.648			
Total	19	71.065				

** = Highly significant

Coefficient of variation = 18.65%

Appendix Table 9. Final plant height (cm)

TREATMENT	REPLICATION I	II	III	IV	TOTAL	MEAN
T_1	33.4	45.6	42.2	39.8	161.00	40.25
T_2	24.5	31.6	37.8	24.6	118.50	29.63
T_3	33.6	36.4	34.6	35.0	139.60	34.90
T_4	36.2	38.8	36.2	39.8	151.00	37.75
T_5	17.2	28.6	25.6	21.8	93.20	23.30

Analysis of Variance

Source of variation	Degrees of freedom	Sum of squares	Mean square	Computed F	TABULAR F 0.05	0.01
Replication	3	160.649	53.550			
Treatment	4	736.318	184.079	17.24**	3.26	5.41
Error	12	128.138	10.678			
Total	19	1025.105				

** = Highly significant

Coefficient of variation = 9.85%

Appendix Table 10. Crop survival (%)

TREATMENT	REPLICATION I	II	III	IV	TOTAL	MEAN
T_1	56.0	51.0	80.0	85.0	272.0	68.00
T_2	41.0	40.0	53.0	17.0	151.0	37.75
T_3	41.0	68.0	80.0	41.0	230.0	57.50
T_4	52.0	53.0	79.0	87.0	271.0	67.75
T_5	36.0	31.0	45.0	12.0	124.0	31.00

Analysis of Variance

Source of variation	Degrees of freedom	Sum of squares	Mean square	Computed F	TABULAR F 0.05	0.01
Replication	3	1536.40	512.133			
Treatment	4	4710.30	1177.575	5.21*	3.26	5.41
Error	12	2714.10	226.175			
Total	19	8960.80				

* = Significant

Coefficient of variation = 28.70%

Appendix Table 11. Average marketable yield (g/plant)

TREATMENT	REPLICATION I	II	III	IV	TOTAL	MEAN
T_1	95.24	152.63	106.67	131.25	485.788	121.447
T_2	64.52	9.33	65.00	76.92	215.766	53.941
T_3	96.77	94.12	63.33	148.39	402.611	100.653
T_4	102.56	165.00	108.74	95.38	471.680	117.920
T_5	66.67	78.26	29.41	44.44	218.778	54.694

Analysis of Variance

Source of variation	Degrees of freedom	Sum of squares	Mean square	Computed F	TABULAR F 0.05	0.01
Replication	3	2214.321	738.107			
Treatment	4	17713.015	4428.254	4.95*	3.26	5.41
Error	12	10729.194	894.100			
Total	19	30656.530				

* = Significant

Coefficient of variation = 33.32%

Appendix Table 12. Non-marketable yield (kg/plot)

TREATMENT	REPLICATION I	II	III	IV	TOTAL	MEAN
T_1	0.8	2.2	3.0	3.4	9.40	2.35
T_2	0.8	1.0	1.0	0.2	3.00	0.75
T_3	1.0	3.8	1.8	2.0	8.60	2.15
T_4	0.6	2.6	3.4	2.4	9.00	2.25
T_5	0.8	0.8	0.4	0.2	2.20	0.55

Analysis of Variance

Source of variation	Degrees of freedom	Sum of squares	Mean square	Computed F	TABULAR F 0.05	0.01
Replication	3	4.870	1.623			
Treatment	4	12.448	3.112	4.58*	3.26	5.41
Error	12	8.160	0.680			
Total	19	25.478				

* = Significant

Coefficient of variation = 51.22%

Appendix Table 13. Marketable yield (kg/plot)

TREATMENT	REPLICATION I	II	III	IV	TOTAL	MEAN
T_1	3.2	3.6	3.4	5.0	15.20	3.80
T_2	1.2	1.8	1.6	0.8	5.40	1.35
T_3	2.0	3.0	2.0	2.6	9.60	2.40
T_4	3.4	4.0	3.8	4.6	15.80	3.95
T_5	1.0	1.0	0.6	0.2	2.80	0.70

Analysis of Variance

Source of variation	Degrees of freedom	Sum of squares	Mean square	Computed F	TABULAR F 0.05	0.01
Replication	3	1.008	0.336			
Treatment	4	33.388	8.347	28.68**	3.26	5.41
Error	12	3.492	0.291			
Total	19	37.888				

** = Highly significant

Coefficient of variation = 22.11%

Appendix Table 14. Total yield (kg/plot)

TREATMENT	REPLICATION I	II	III	IV	TOTAL	MEAN
T_1	4.0	5.8	6.4	8.4	24.60	6.15
T_2	2.0	2.8	2.6	1.0	8.40	2.10
T_3	3.0	4.8	3.8	4.6	16.20	4.05
T_4	4.0	6.6	6.4	6.2	23.20	5.80
T_5	1.8	1.2	1.0	0.4	4.40	1.10

Analysis of Variance

Source of variation	Degrees of freedom	Sum of squares	Mean square	Computed F	TABULAR F 0.05	0.01
Replication	3	5.264	1.755			
Treatment	4	79.028	19.757	16.94**	3.26	5.41
Error	12	13.996	1.166			
Total	19	98.288				

** = Highly significant

Coefficient of variation = 28.12%

Appendix Table 15. Computed yield (t/ha)

TREATMENT	REPLICATION I	II	III	IV	TOTAL	MEAN
T_1	6.4	7.2	6.2	10.0	29.80	7.45
T_2	2.4	3.6	3.2	1.6	10.80	2.70
T_3	4.0	6.0	4.0	3.2	17.20	4.30
T_4	6.8	8.0	7.6	9.2	31.60	7.90
T_5	2.0	2.0	1.2	0.4	5.60	1.40

Analysis of Variance

Source of variation	Degrees of freedom	Sum of squares	Mean square	Computed F	TABULAR F 0.05	TABULAR F 0.01
Replication	3	3.35	1.117			
Treatment	4	131.36	32.840	22.81**	3.26	5.41
Error	12	17.28	1.440			
Total	19	151.99				

** = Highly significant

Coefficient of variation = 25.26%

Appendix Table 16. Population of *Galisoga parviflora* (1 m x 1 m quadrant)

TREATMENT	REPLICATION I	II	III	IV	TOTAL	MEAN
T_1	0.0	0.0	0.0	0.0	0.0	0.00
T_2	223.0	211.0	218.0	201.0	853.0	213.25
T_3	231.0	216.0	221.0	190.0	858.0	214.50
T_4	211.0	236.0	209.0	196.0	852.0	213.00
T_5	286.0	255.0	269.0	273.0	1083.0	270.75

Analysis of Variance

Source of variation	Degrees of freedom	Sum of squares	Mean square	Computed F	TABULAR F 0.05	0.01
Replication	3	857.00	285.667			
Treatment	4	175975.70	43993.925	318.12**	3.26	5.41
Error	12	1659.50	138.292			
Total	19	178492.20				

** = Highly significant

Coefficient of variation = 6.45%

Appendix Table 17. Population of *Eleucine indica* (1 m x 1 m quadrant)

TREATMENT	REPLICATION I	II	III	IV	TOTAL	MEAN
T_1	0.0	0.0	0.0	0.0	0.0	0.00
T_2	205.0	196.0	213.0	211.0	825.0	206.25
T_3	180.0	207.0	159.0	223.0	769.0	192.25
T_4	154.0	194.0	186.0	215.0	749.0	187.25
T_5	239.0	208.0	197.0	189.0	833.0	208.25

Analysis of Variance

Source of variation	Degrees of freedom	Sum of squares	Mean square	Computed F	TABULAR F 0.05	0.01
Replication	3	766.80	255.600			
Treatment	4	127370.20	31842.550	73.59**	3.26	5.41
Error	12	5192.20	432.683			
Total	19	133329.20				

** = Highly significant

Coefficient of variation = 13.10%

Appendix Table 18. Population of *Digitaria sanguinalis* (1 m x 1 m quadrant)

TREATMENT	REPLICATION I	II	III	IV	TOTAL	MEAN
T_1	0.0	0.0	0.0	0.0	0.0	0.00
T_2	206.0	86.0	211.0	92.0	595.0	148.75
T_3	91.0	115.0	127.0	97.0	430.0	107.50
T_4	87.0	91.0	103.0	73.0	354.0	88.50
T_5	255.0	211.0	98.0	117.0	681.0	170.25

Analysis of Variance

Source of variation	Degrees of freedom	Sum of squares	Mean square	Computed F	TABULAR F 0.05	0.01
Replication	3	6918.40	2306.133			
Treatment	4	69820.50	17455.125	8.19**	3.26	5.41
Error	12	25569.10	2130.758			
Total	19	102308.00				

** = Highly significant

Coefficient of variation = 44.82%