INFLUENCE OF REMOVAL OF SHOOT TIPS ON BIOMASS PRODUCTION OF GREENGRAM (*Vigna radiata* L.)

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ABSTRACT

Greengram is one of the important pulse crops grown and consumed mostly in developing countries. Human consumption of greengram is as dry seeds. Crop residue is also important feed resource for ruminants and has potential as a green manure. Specific cultural practices normally carry out to achieve maximum biological yield in legumes and other crops. Therefore, an attempt was made to study the effect of removal of shoot tips of greengram (*Vigna radiata* L.) on biomass production. This experiment was laid out in a Randomized Complete Block Design with five treatments and four replications. Treatments included removal of apical portions of main stems at 3rd, 4th, 5th and 6th weeks after planting of greengram cv. MI 5 and also unremoval of apical portion used as control. Plant height, number of leaves, number of branches and leaf area were recorded at regular intervals to evaluate the effect of decapitation on biological yield of greengram. Fresh and dry weights of plant were measured after harvesting of pods. The results showed that there was significant difference in number of branches among the treatments. Removal of apical portions at 3rd and 4th weeks significantly differed from other treatments in number of leaves, leaf area fresh and dry weights of plant. T_2 gave significantly high economic (162.85 kg per plot) and biological (405.75 kg per plot) yields among the treatment except T_3. The most effective stage of vegetative growth to remove the shoot tips to obtain high production of biomass in greengram grown in sandy regosol is the 3rd week of planting.

Key words: Biomass, Decapitation, Greengram,

INTRODUCTION

Greengram is one of the important pulse crops grown world wide. It is primarily for its protein rich edible seeds and also has potential as agreen manure and a forage crop. Its short duration, low water requirements, wide adaptability to fit into different crop rotations and varying cropping patterns can contribute to sustainability in increasing the farm productivity per unit area. In Sri Lanka, greengram can be successfully grown in dry and intermediate zones. Main growing areas are Anuradhapura, Hambantota, Moneragala, Puttalam, Rathnapura and Kurunegala. It is cultivated in *Maha* season in large extent under rainfed conditions.

Currently one of the major limitations in third world countries' agriculture is low crop productivity. It would be increased by expanding the cropping area but it is not possible because of the limited land area for crop cultivation. However, it is possible to raise the productivity per unit area when planting high yielding varieties, increasing the number of crops grown per year and applying some agronomic practices such as mulching, decapitation, hormone application, fertilizer application etc.

Decapitation means removal of apex which may result in production of a greater number of inflorecences because of more extensive branching (Carl and Paul, 1975) and has many advantages in legumes. In soyabean, removing apex during early flowering stage increased yield by 10-15% (Greer and Anderson, 1956). In various legumes, decapitation leads to increased levels of endogenous cytokinins in the stem (Li *et al.*, 1995) and increased delivery of cytokinins to axillary buds (Turnbull *et al.*, 2000). In cowpea, decapitation at the fifth leaf stage resulted in an increase in branching components, yields and harvest indices (Argall and Stewart, 1984). Therefore, an attempt was made to select the suitable stage of vegetable growth to remove the shoot tips to achieve maximum biomass production in greengram.

MATERIALS AND METHOD

This experiment was carried out at the Agronomy farm, Eastern University, Sri Lanka to study the effect of removal of shoot tips on biological yield of greengram. The design of the experiment was a Randomized Complete Block Design with five treatments and four replications. Treatments included the removal of apical portions of main stems at 3rd, 4th, 5th and 6th weeks after planting and also unremoval of apical portion used as control. Each plot was 70 cm x 90 cm. The plots were made according to the experimental design.

Seeds were soaked for one hour and were then treated with fungicide before planting. At each planting hole, three seeds were planted at a spacing of 30 cm between rows and 10 cm within plants. Plants were thinned out after two weeks of planting and vacant hills were planted with seedlings and maintained one plant per hill. Other agronomic practices were done as recommended by Department of Agriculture. The data on plant height, number of leaves, leaf area, number of branches and weights of plant parts were recorded and then analyzed using SAS software statistical package. The difference between means was compared using Duncan's Multiple Range Test (DMRT) at 5% level.

RESULTS AND DISCUSSION

Height of plant canopy

The result showed that there were no significant differences in the height of plant canopy except at 5th week after planting. The height of plant canopy in T_2 was low among the treatments during 4th – 7th weeks after planting (Figure 1). This may be due to the decapitation which practiced at 3rd week after planting. It is the active vegetative growth stage and this practice ceased the growth of apical portion and also caused to reduce the increasing height of greengram plant. However, branches were developed more upright after removal of the apical bud of the main stem. Similar result was also reported by Carl and Paul (1975).

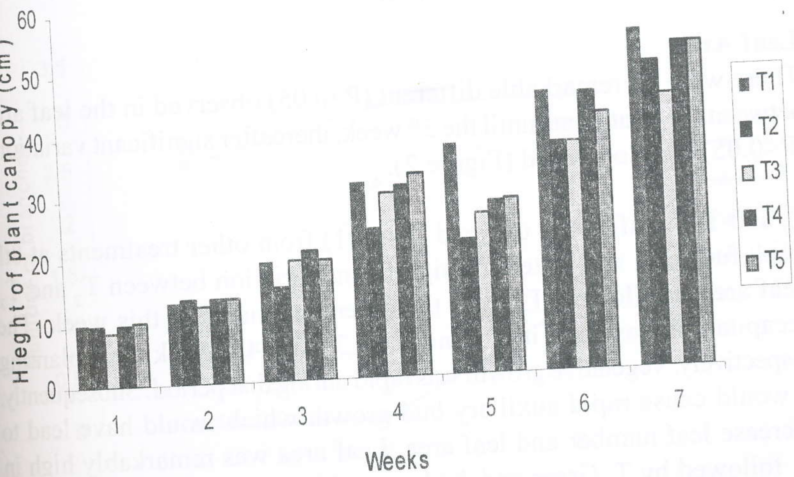

Figure 1: The average height of plant canopy in each treatment at weekly intervals.

Number of leaves

In this experiment, there were no significant differences observed in the number of leaves per plant until the 4[th] week of planting (Table 1) thereafter, significant differences were observed between treatments. The average number of leaves was significantly high (18) in T_2 than other treatments at 8[th] week. It would be due to the decapitation practiced at early stage of vegetative growth. This leads to increase in the number of leaves. This would be the reason for increasing the number of leaves in T_2 and T_3. Gautam *et al.* (1983) reported that apex removal from legume plants prior to transition to flowering resulted in increased vegetative growth, delayed leaf and nodule senescence.

Table 1: The average number of leaves per plant in each treatment at two weeks interval.

Treatment	At 2nd week	At 4th week	At 6th week	At 8th week
T_1	2.0	7.50 ± 0.28	10.25 ± 0.75 ab	09.25 ± 1.10 c
T_2	2.0	8.25 ± 0.94	13.00 ± 1.08 a	18.00 ± 1.47 a
T_3	2.0	8.25 ± 0.62	09.50 ± 0.50 b	14.00 ± 1.35 b
T_4	2.0	8.00 ± 0.00	09.75 ± 0.47 ab	07.75 ± 1.35 c
T_5	2.0	7.75 ± 0.25	11.00 ± 0.70 ab	09.25 ± 1.25 c
F value	ns	ns	*	**

Value represents mean ± standard error.
F test: * : P< 0.05; ** : P< 0.01; ns: not significant
Means followed by the same letter in each column are not significantly different according to Duncan's Multiple Range Test at 5% level.

Leaf Area

There were no remarkable different (P>0.05) observed in the leaf area between the treatments until the 5[th] week, thereafter significant variations (P<0.05) were observed (Figure 2).

T_2 and T_3 significantly differed (P<0.01) from other treatments at 8th week further it was noted the significant variation between T_2 and T_3. Leaf area was low in T_4 from the other treatments at this week. The decapitation was done in T_2 and T_3 at 3[rd] and 4th week after planting respectively. Vegetative growth was rapid during that period. Subsequently, it would cause rapid auxillary bud growth which would have lead to increase leaf number and leaf area. Leaf area was remarkably high in T_2 followed by T_3.Greer and Anderson (1956) reported that removing apex during early flowering stage facilitated branching and increased leaf numbers in soyabean.

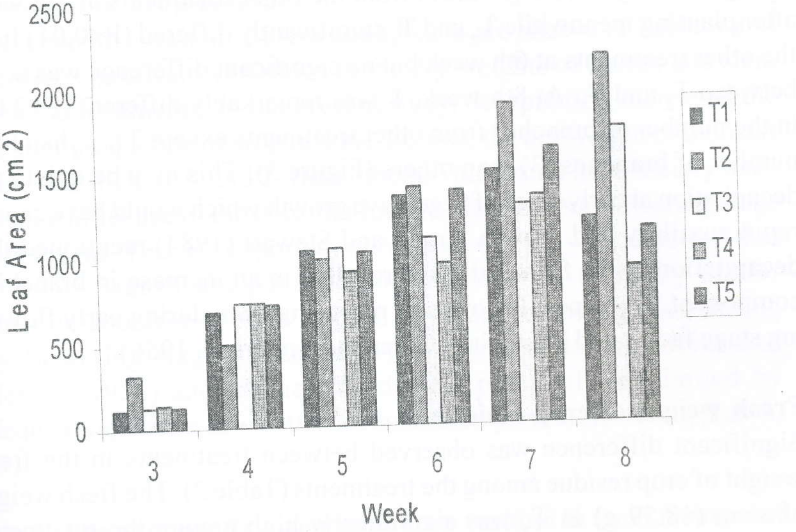

Figure 2: The average Leaf area in each treatment at weekly interval.

Number of branches

It was found that there were no significant differences between treatments in the number of branches until the 3rd week after planting thereafter significant variations were noted at different time intervals.

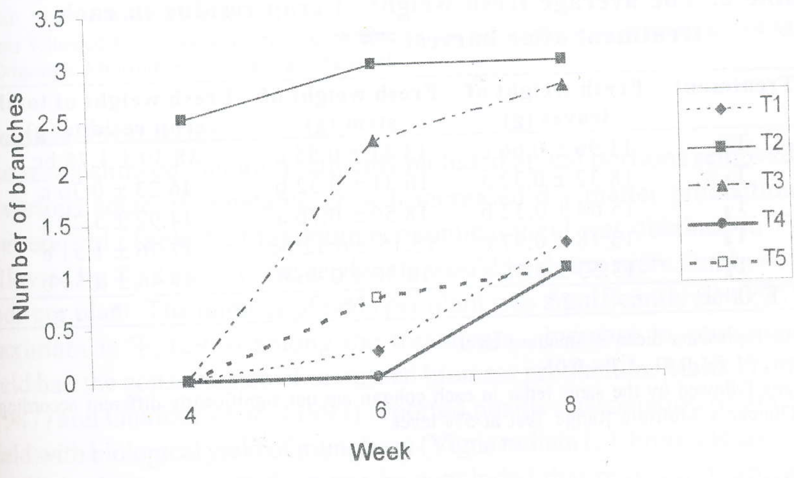

Figure 3: The average number of branches per plant in each treatment at different time intervals.

T_2 significantly varied ($P<0.01$) from the other treatments at 4th week after planting meanwhile T_2 and T_3 significantly differed ($P<0.01$) from the other treatments at 6th week but no significant difference was noted between T_2 and T_3. At 8th week, T_2 was remarkably different ($P<0.05$) in the number of branches from other treatments except T_3. T_2 had high number of branches (3) than others (Figure 3). This may be due to the decapitation at early stage of vegetative growth which would have caused rapid auxillary bud growth. Argall and Stewart (1984) mentioned that decapitation at the fifth leaf stage resulted in an increase in branching component in cowpea. In soybean, removing apex during early flowering stage facilitated branching (Greer and Anderson, 1956).

Fresh weight of crop residue

Significant difference was observed between treatments in the fresh weight of crop residue among the treatments (Table 2). The fresh weight of stem (18.59 g) in T_3 was significantly high among the treatments whereas fresh weight of leaves (18.32 g) was remarkably more in T_2. Further, it was noted that fresh weight of crop residue in T_2 and T_3 significantly differed ($P<0.05$) from the other treatments and no significant difference was observed between T_2 and T_3. The biological yield depends on the number of leaves per plant, number of branches per plant etc. The decapitated plants especially in T_2 and T_3 produced more number of leaves and branches in greengram. This would be the reason for increase in fresh weight of crop residue per plant.

Table 2: The average fresh weight of crop residue in each treatment after harvest.

Treatment	Fresh weight of leaves (g)	Fresh weight of stem (g)	Fresh weight of total crop residue (g)
T_1	11.96 ± 0.66 c	13.41 ± 0.85 c	38.39 ± 1.75 bc
T_2	18.32 ± 0.32 a	16.31 ± 0.32 b	46.23 ± 0.36 a
T_3	15.64 ± 0.32 b	18.59 ± 0.76 a	44.92 ± 3.20 a
T_4	13.18 ± 0.97 c	15.15 ± 0.52 bc	37.76 ± 1.51 c
T_5	13.53 ± 0.36 c	15.56 ± 0.46 b	41.46 ± 0.54 b
F value	**	**	*

Value represents mean ± standard error.

F test: ** $P< 0.01$; * $P< 0.05$

Means followed by the same letter in each column are not significantly different according to Duncan's Multiple Range Test at 5% level.

Dry weight of crop residue

The average dry weights of leaves and stem are shown in Table 3 and there were significant variations in the dry weights of leaves and stem among the treatments. In the present study, decapitation increased the dry matter production of crop residue. Further, the dry weight of biomass residue was high in T_2 and T_3 than others. This would have mainly been due to the influence of the decapitation practiced before flowering stage in greengram. This is supported by Mandal (1993) who reported that LAI shows significant positive correlation with total dry matter production and crop growth rate. In soybean, removing apex during early flowering stage increased dry matter production (Greer and Anderson, 1956) and ultimate seed yield potential was limited by inadequate vegetative dry matter accumulation prior to flowering (Lawn, 1979).

Table 3. The average dry weight of crop residue in each treatment after harvest.

Treatment	Dry weight of leaves (g)	Dry weight of stem (g)	Dry weight of total crop residue (g)
T_1	3.72 ± 0.37 c	4.63 ± 0.32 b	13.40 ± 0.80 b
T_2	5.22 ± 0.16 a	5.45 ± 0.37 ab	16.20 ± 0.46 a
T_3	4.73 ± 0.19 ab	6.28 ± 0.45 a	15.98 ± 0.52 a
T_4	4.05 ± 0.10 c	4.79 ± 0.39 b	13.72 ± 0.63 b
T_5	4.14 ± 0.10 bc	5.14 ± 0.29 ab	14.23 ± 0.65 ab
F value	**	*	**

Value represents mean ± standard error.

F test: ** $P < 0.01$; * $P < 0.05$

Means followed by the same letter in each column are not significantly different according to Duncan's Multiple Range Test at 5% level.

Biomass Production

The result showed that all treatments included apical portions removed at various stage of vegetable growth increased dry matter production over control (Table 4). Maximum economical yield was obtained in T_2 followed by T_3. The increase seed yield would be due to more number of pods per plant. The number of pods per plant was significantly ($P<0.05$) maximum in T_2 (29.6) among the treatments. Increase in economic yield had the consequence of increased biomass production. Malik *et al*., (1987) and Ghafoor *et al*., (1993) reported positive association of grain yield with biological yield of mungbean (Vigna radiata L.). From the above results in the present study, it can be concluded that removal of apical portion before flowering stage increased the seed yield in greengram. Greer and Anderson (1956) revealed that removing apex during early flowing stage increased yield by 10-15% in soyabean. Similar results were reported by Argall and Stewart (1984) in cowpea.

Table 4. Biomass production in greengram in each treatment.

Treatment	Economic yield (g) per plot	Biological yield (g) per plot
T1	106.31 ± 08.27 b	307.20 ± 19.32 c
T2	162.85 ±14.89 a	405.95 ± 21.46 a
T3	136.98 ±12.27 ab	376.65 ± 20.75 ab
T4	115.90 ±12.62 b	321.60 ± 20.89 bc
T5	112.92 ±12.31 b	326.25 ± 18.99 bc
F value	*	*

Value represents mean ± standard error.
F test: * : $P < 0.05$
Means followed by the same letter in each column are not significantly different according to Duncan's Multiple Range Test at 5% level.

CONCLUSIONS

Plants decapitated at 3rd week after planting significantly increased the growth in terms of number of leaves and number of branches and also had high biological yield among the treatments. Decapitation at 3rd week after planting would be more effective to obtain high amount of biomass in greengram. Removal of apical portion at early stage of vegetative growth effectively increased the branching components and increased the biomass production. This ultimately increased the seed yield. However, decapitation at late vegetative or flowering stage did not result in effective branching and the vegetative growth of greengram plant was stopped after initiation of flowers.

REFERENCES

Argall, J. F. and Stewart. (1984). Effects of decapitation and benzyladenine on growth and yield of cowpea (*Vigna unguiculata* (L.) walp.). *Annals of Botany* 54:439-444.

Carl Leopold A and Paul E. Kriedemann (1975). Plant growth and development, Mcgraw-Hill, New York pp 266-276.

Gautam, S.k Lisa, M. B and Barbara, D. W. (1983). Effects of prevention of flowering on the growth of bean plants inoculated with an ineffective strain of Rhizobium phaseoli. *Botanical Gazette* 144: 225-230.

Ghafoor, A., M. Zubair and B. A. Malik (1993). Selection indices in *Vigna mungo* L. *Pakistan Journal of Agriculture, Agricultural Engineering and Veterinary Science* 9: 67-70.

Greer, H. A. L and Anderson, I. C. (1956). Response of soyabean to triodobenzoic acid under field condition. *Crop Science* 5:229-232.

Lawn, R. J. (1979). Agronomic studies on *Vigna* spp: II. In South – Estern Queenland vegetative and reproductive response of cultivars to sowing rate. *Australian Journal of Agricultural Research* 30:871-882.

Li, C. J., Herrera, G. J and Bangerth, F. (1995). Effect of apex excision and replacement by 1-naphthylacetic acid on cytokinin concentration and apical dominance in pea plants. *Plant Physiology 94*: 465–469.

Mandal, R. C. (1993). Tropical root and tuber crops. pp. 86-143. Agro-botanical publishers, India.

Malik, B. A., M. Tahir, I. A.Khan, M. Zubair and A. H. Chaudhry (1987). Genetic variability, character correlation and path analysis of yield components in mungbean (Vigna radiate L. Wilczek). *Pakistan Journal of Botany* 19: 89-97.

Robert, J. Weaver. (1972). Plant growth substences in Agriculture, W.H Freeman and company, California. pp. 594.

Turnbull, C. G. N., Beveridge, C. A and Symons, G. M. (2000). Auxin inhibition of decapitation-induced branching is dependent on graft-transmissible signals regulated by genes *Rms1* and *Rms2*. *Plant Physiol*ogy 123:689–697.