CHAPTER V

RESULTS OF FIELD EXPERIMENT

5.1 Topography and soil characteristics of the study site

Some chemical and physical properties of study area are presented in Table 5.1. The results show that phosphorus, nitrogen, potassium and organic matter contents were very low. Specially, the amount of available phosphorus in 0-15 and 15-30 cm depth found to be 8.5 and 3.5 ppm respectively. The other soil properties viz. EC, ECEC, soil pH, were not also optimum (Table 5.1).

5.2 Climatic conditions

Rainfall and temperature data of Chom Tong Land Reform in the year 2000 presented in Figure 5.1. The data showed that 895.4 mm of annual rainfall continued from mid-April to mid-October with a double peak in mid-April to June and August to October because of the influence of the southwest monsoon. The annual average temperature was 26.2 °C (minimum 17.3 and maximum 35.2). In addition, the highest temperature (39° C) was found in March and April 2000. Temperatures occasionally reach at 39 °C especially in March-June and sometimes reached as lowest as 9 °C during the winter season.

Table 5.1 Some chemical and physical properties of rainfed upland in the Chom Tong Land Reform area

Descriptions	Soil depth (cm)	
	0-15	15-30
pH (1:1, soil: water)	5.64	5.54
Nitrogen (N)	0.0195 %	0.011 %
Phosphorus (P)	8.5 ppm	3.5 ppm
Potassium (K)	45 ppm	25 ppm
Organic matter (OM)	0.55 %	0.16 %
EC	152.80 micro moh/cm	74.10 micro moh/cm
ECEC	2.60 me/100 g	2.50 me/100 g
Soil texture	Sandy Loam	Sandy Loam
Particle size distribution		
-Sand	75.68 %	75.88 %
-Silt	12.56 %	13.36 %
-Clay	11.76 %	10.76 %

Source: survey, 2000

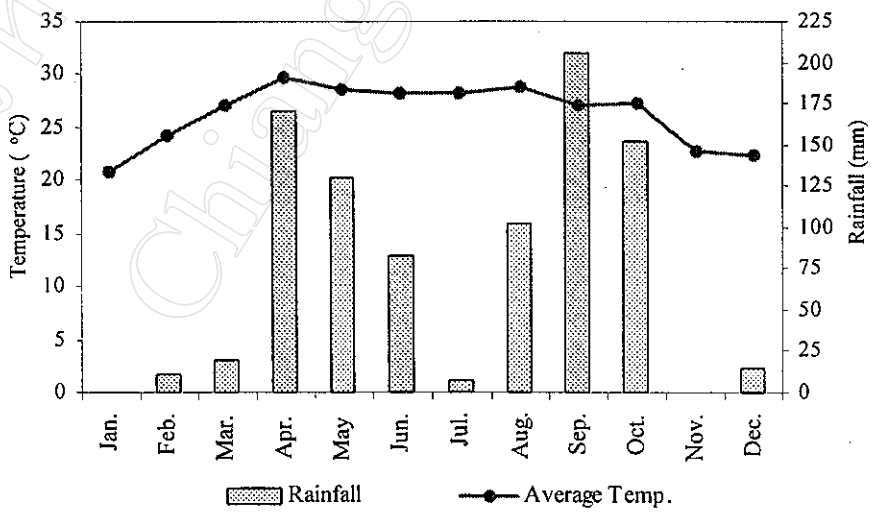

Figure 5.1 Monthly average rainfall and temperatures in the Chom Tong Land Reform area, Chiang Mai province (2000)

5.3 Effect of phosphorus fertilizer, cutting frequency and weed control on *Stylosanthes hamata*

Stylosanthes hamata is a herbaceous annual to short-lived perennial with a non-determinate, much-branched, semi-erect growth habit. Therefore, the population combines many of the virtues of both new plants and mature plants (Figure 5.2 and 5.3). In addition, it also has semi-erect growth habit (mixed both erect and prostrate). After plantation of third-year it was observed that the plant community of *S. hamata* growing between the mango alleys consisted of both newly germinated plants and mature plants. The new newly germinated plants mostly germinated in the early wet season (mid-May to the end of May) while mature plants in the second dry season (November-April) remained alive throughout the third year.

Figure 5.2 The seedling of *S. hamata* germinated in the early wet season of third year

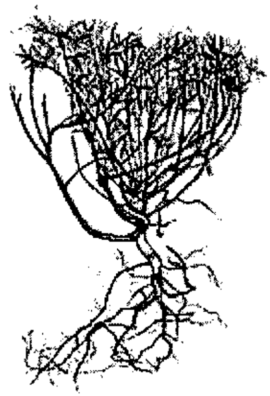

Figure 5.3 The mature plant of *S. hamata* regenerated leaves and branches in the early wet season of third year

5.3.1 Establishment of the newly germinated and mature plants of *S. hamata* in the third-year

The field experiment resulted that the mature plants of *S. hamata* continue to produce leaves and green growth actively between mango allays in rainfed upland area which prolonged till the late rainy season. Nevertheless, plant numbers varied widely in the second year. Consequently, in the early wet season (beginning of May) of third year, the plant population was 21 plants/m^2. However, in the last week of

October (25 week after emergence), the population of mature plants (from the second year) was decreased at 16 plants/ m^2 when the declining percentage was 24.

During wet season, the number of the mature plants were slightly declined after putting the treatments (phosphorus application, weeding practice and cutting practice) which were shown in Figure 5.4, 5.5 and 5.6. Moreover, the population of mature plants at the early wet season was 20 plants/m^2 (no fertilizer) and 21 plants/m^2 (P-fertilizer) thereafter found 13 plants/m^2 (no fertilizer) and 19 plants/m^2 (P-fertilizer) at the late wet season (Figure 5.4). In addition, the plant population of the mature plants in weeding and cutting treatment was in the same trend as 20 plants/m^2 throughout wet season (Figure 5.5 and 5.6).

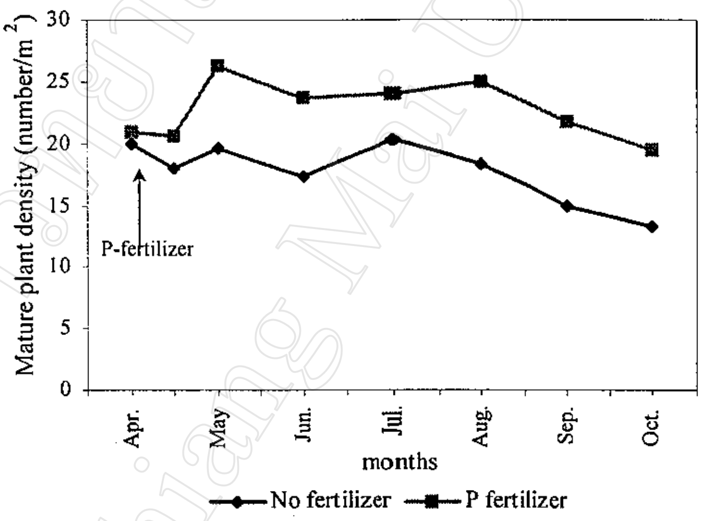

Figure 5.4 The effect of fertilizer on the population of mature plants of *S. hamata* from the previous year

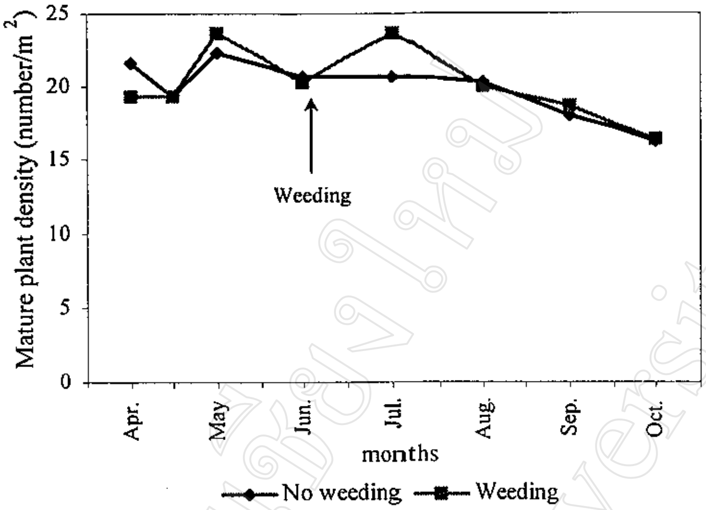

Figure 5.5 The effect of weeding on the population of mature plants of *S. hamata*

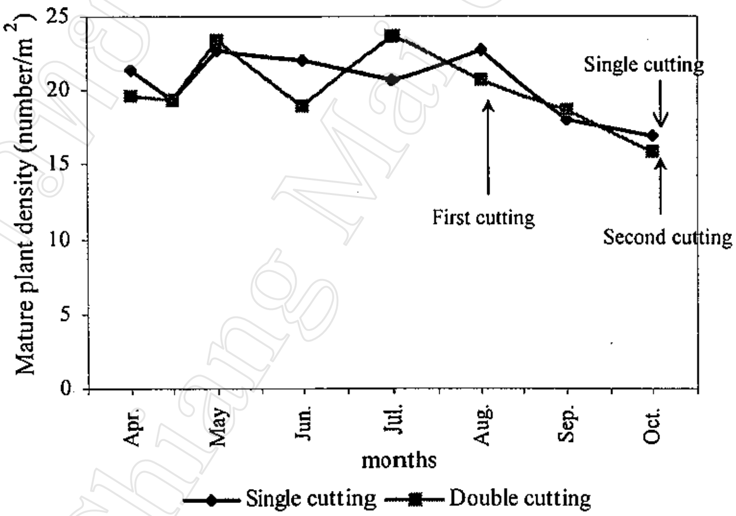

Figure 5.6 The effect of cutting on the population of mature plants of *S. hamata*

The variable analysis of population density of mature plants showed that phosphorus fertilizer application, weeding and cutting treatments did not affect significantly ($P<0.05$) on them throughout the growing season (Table 5.2).

Table 5.2 The variable analysis of population density of mature plants

Source of Variation	Significant level of *S. hamata* density							
	Apr.	mid-May	May	Jun.	Jul.	Aug.	Sep.	Oct.
Replication (A)	ns	ns	ns	ns	ns	ns	ns	ns
Fertilizer (B)	ns	ns	ns	ns	ns	ns	ns	ns
Weeding (C)	-	-	-	ns	ns	ns	ns	ns
Cutting (D)	-	-	-	-	-	ns	ns	ns
B x C	-	-	-	ns	ns	ns	ns	ns
B x D	-	-	-	-	-	ns	ns	ns
C x D	-	-	-	-	-	ns	ns	ns
B x C x D	-	-	-	-	-	ns	ns	ns
CV (%)	51.56	37.94	46.49	46.14	31.47	37.07	54.94	48.34

ns indicates not significant
- indicates no input factor

On the other hand, regarding newly germinated plants of *S. hamata*, there was a greater number of newly germinated plants were found. The new seedlings mostly germinated in mid-May, 2000. According to grand mean of newly germinated plants population in each treatment, there were 57 seedlings/m^2 which grew rapidly in the first week after emergence (WAE). The seedling density of *S. hamata* increased up to 116 plants/m^2 within 4 WAE (30 May). After 17 WAE (30 August), they produced 98 plants/m^2. Moreover, after 25 WAE (last week of October), the newly germinated plants declined by 26% while the population density was 84 plants/m^2.

The effects of phosphorus application, weeding practice and cutting frequency on the newly germinated plant numbers of *S. hamata* are illustrated in Figure 5.7, 5.8 and 5.9. The newly germinated plant numbers of *S. hamata* increased rapidly in early wet season (mid-May to the end of May) and thereafter the numbers of newly germinated plants slightly declined (Jun.-Oct.).

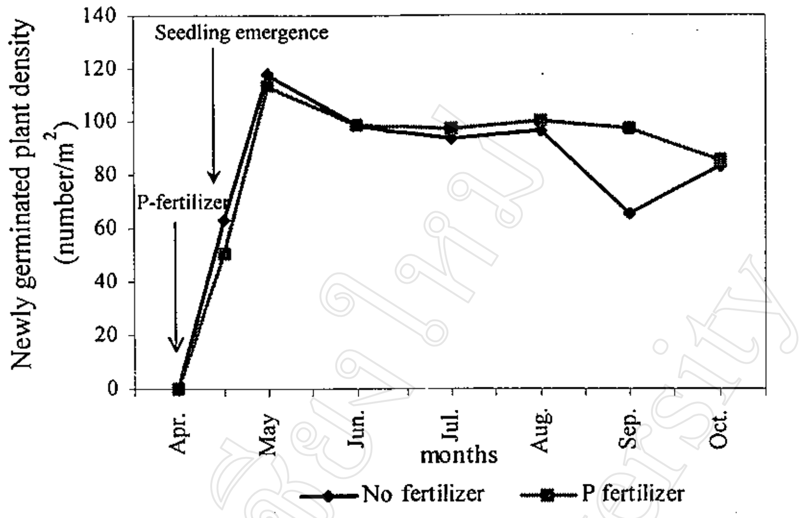

Figure 5.7 The effect of fertilizer on newly germinated plant number of *S. hamata*

Figure 5.8 The effect of weeding on newly germinated plant number of *S. hamata*

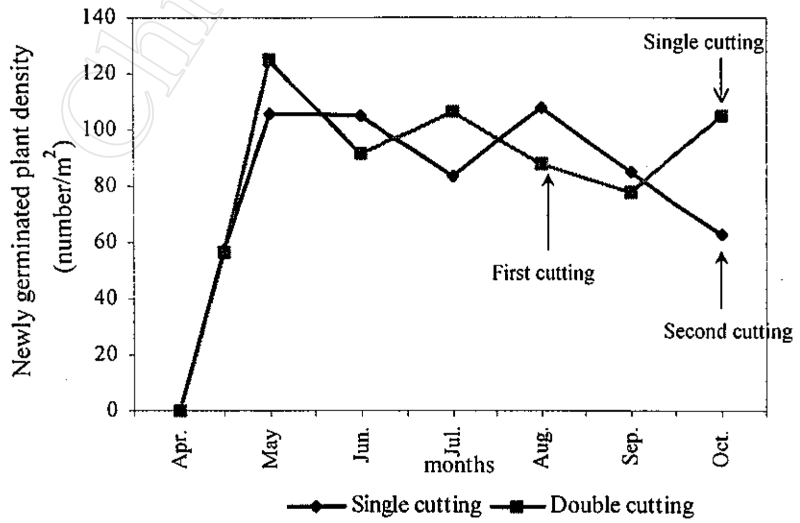

Figure 5.9 The effect of cutting on newly germinated plant number of *S. hamata*

According to grand mean (phosphorus fertilizer, weeding and cutting treatments), the total population (newly germinated and mature plants) of *S. hamata* was greater in early wet season compared to late wet season. There was 76 plants/m^2 at the first weeks after emergence (WAE) and increased up to 139 plants/m^2 within 4 WAE. However, in the last week in 25 WAE (October), the population declined by 27% when the population density was 101 plants/m^2 (Figure 5.10). The ratio of the mature plants and newly germinated plants was 1:3 in early wet season (mid-May) and slightly declined up to 1:5.25 (Figure 5.1 1) at the end of rainy season.

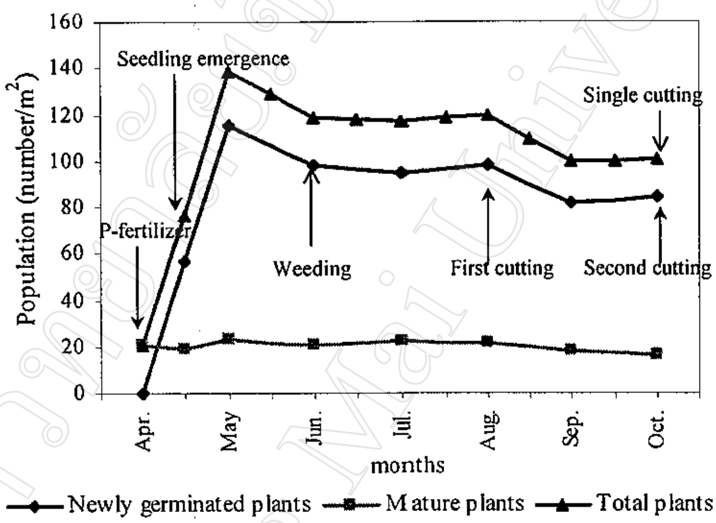

Figure 5.10 The population of newly germinated and mature plants of *S. hamata* in a third wet season

However, from the result it was found that phosphorus application had effect on plant population of *S. hamata* in September or at 21 WAE (Table 5.3). The plant population was revealed by 119 plants/m^2 and 80 plants/m^2 with and without application of phosphorus respectively. The ratio of newly germinated plants and mature plants was 4.56:1. Regarding weeding practice did not show any effect on population density. However, cutting practice affected on their population during August to October (17 to 25 WAE) (Table 5.3).

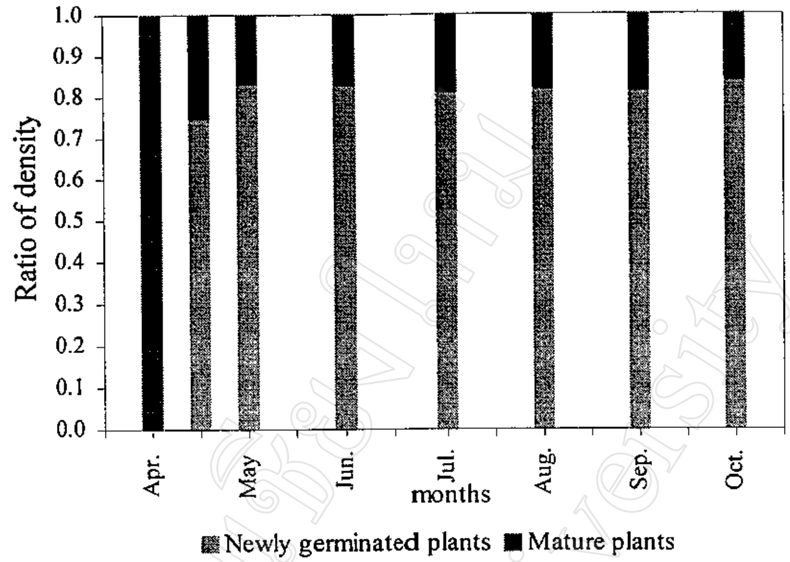

Figure 5.11 The ratio of newly germinated and mature plants of *S. hamata* in a third wet season

Table 5.3 The variable analysis of population density (newly germinated and mature plants) of *S. hamata*

Source of Variation	Significant level of *S. hamata* density						
	mid-May	May	Jun.	Jul.	Aug.	Sep.	Oct.
Replication (A)	*	ns	ns	ns	ns	ns	ns
Fertilizer (B)	ns	ns	ns	ns	ns	*	ns
Weeding (C)	-	-	ns	ns	ns	ns	ns
Cutting (D)	-	-	-	-	*	**	*
B x C	-	-	ns	ns	ns	ns	ns
B x D	-	-	-	-	ns	*	ns
C x D	-	-	-	-	ns	ns	ns
B x C x D	-	-	-	-	*	*	ns
CV (%)	51.85	25.02	22.47	23.51	24.92	38.82	39.99

* indicates significant at 0.05% level
** indicates significant at 0.01% level
ns indicates not significant
- indicates no input factor

5.3.2 Height of *S. hamata* in a third-year growing

From the result, it was found that the average height of mature plants and the seedlings were 13.6 and 3.8 cm respectively in third year in the early wet season (middle of May) at first week after emergence (WAE). In addition, their heights increased rapidly in two periods at 1-6 WAE and 18-21 WAE (Figure 5.12, 5.13 and 5.14). The height of newly germinated plants became 29 cm, which was almost in the same height of 12 WAE (31 July) mature plant. Nevertheless, their heights were nearly constant at 30 cm during 8-15 WAE and again dropped to 25 cm at 19 WAE, which was due to cutting effect. After that their height rapidly increased up to 45 cm at 25 WAE. However, their highest growth became 55 cm within 21 WAE.

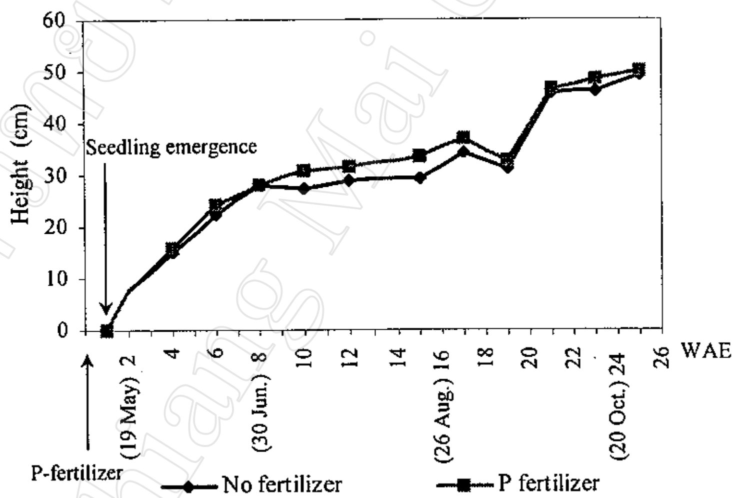

Figure 5.12 The effect of fertilizer on the height of *S. hamata*

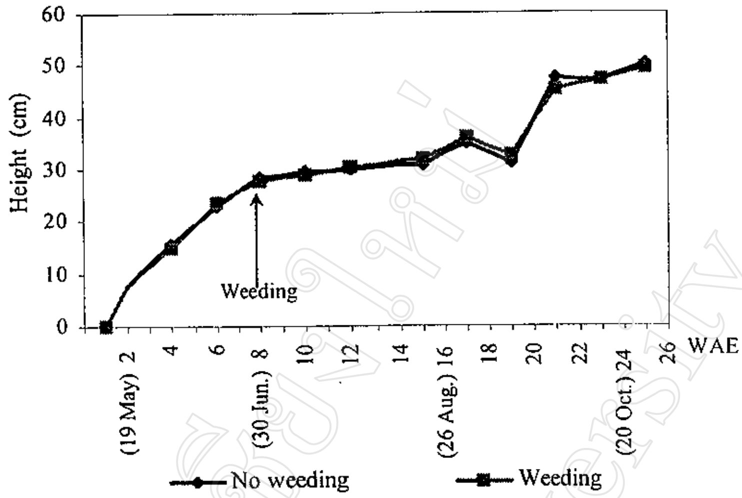

Figure 5.13 The effect of weeding on the height of *S. hamata*

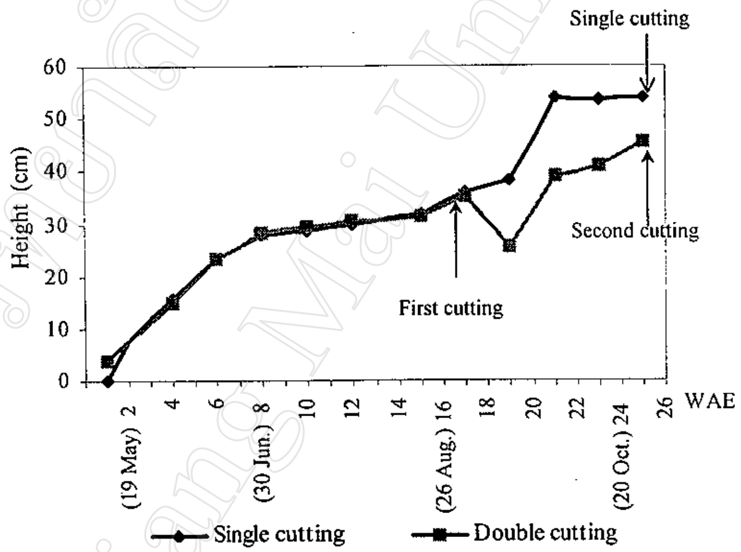

Figure 5.14 The effect of cutting on the height of *S. hamata*

The effect of different treatments on the height *S. hamata* in newly germinated plants was given in Table 5.4. The height of plants generally responded to phosphorus fertilizer during 10-17 WAE. However, no significant effect was observed on the height due to weeding practice. Moreover, cutting treatment became effective during 19, 21, 23 and 25 WAE by increasing height of 38.1, 53.8, 53.6 and 54.0 cm respectively in single cutting practice as well as 25.8, 38.9, 40.8 and 53.0 cm respectively in double cutting practice.

Table 5.4 The variable analysis of *S. hamata* height (newly germinated plants)

Source of Variation	Significant level of height											
	1	4	6	8	10	12	15	17	19	21	23	25
	WAE											
Replication (A)	ns	*	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
Fertilizer (B)	ns	ns	ns	ns	**	*	**	*	ns	ns	ns	ns
Weeding (C)	-	-	-	ns	ns	ns	ns	ns	ns	ns	ns	ns
Cutting (D)	-	-	-	-	-	-	-	ns	**	**	**	**
B x C	-	-	-	ns	ns	ns	ns	ns	ns	ns	ns	ns
B x D	-	-	-	-	-	-	-	ns	ns	ns	ns	ns
C x D	-	-	-	-	-	-	-	ns	ns	ns	ns	ns
B x C x D	-	-	-	-	-	-	-	ns	ns	ns	ns	ns
CV (%)	12.3	8.66	11.16	8.20	9.59	9.11	11.31	8.11	22.16	20.20	18.71	13.57

* indicates significant at 0.05% level ** indicates significant at 0.01% level
ns indicates not significant - indicates no input factor

Mature plants responded to phosphorus fertilizer application in 17 WAE. In 17 WAE, the height was 37.9 cm after applying phosphorus when the height was 34.5 cm in case of without phosphorus application (Table 5.5). There was no any significant effect found as a result of weeding practice throughout the wet season. However, the cutting practice at 19, 21, 23 and 25 WAE were responded in height by 38.5, 49.3, 53.1 and 54.2 cm respectively in single cutting practice and by 26.3, 35.7, 41.0 and 44.7 cm respectively in double cutting practice.

Table 5.5 The analysis of variation for the height of mature plants of *S. hamata*

Source of Variation	Significant level of the height											
	1	4	6	8	10	12	15	17	19	21	23	25
	WAE											
Replication (A)	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
Fertilizer (B)	ns	ns	ns	ns	ns	ns	ns	**	ns	ns	ns	ns
Weeding (C)	-	-	-	ns	ns	ns	ns	ns	ns	ns	ns	ns
Cutting (D)	-	-	-	-	-	-	-	ns	**	**	**	**
B x C	-	-	-	ns	ns	ns	ns	ns	ns	ns	ns	ns
B x D	-	-	-	-	-	-	-	ns	ns	ns	ns	ns
C x D	-	-	-	-	-	-	-	ns	ns	ns	ns	ns
B x C x D	-	-	-	-	-	-	-	ns	ns	ns	ns	ns
CV (%)	5.72	8.06	22.87	8.55	6.50	8.05	10.10	8.49	21.56	20.97	17.81	13.22

* indicates significant at 0.05% level
** indicates significant at 0.01% level
ns indicates not significant
\- indicates no input factor

5.3.3 Ground coverage of *S. hamata*

In the third year, the ground coverage of *S. hamata* was combined with newly germinated plants and mature plants. The mature plants of *S. hamata* continued actively to produce leaves and branches in the early wet season, which they established between mango alleys. The grand mean of initial coverage was 15.8% at 1 WAE by mature plants only. Within 6 WAE, the seedlings of newly germinated plant already established which combined with mature plants (old plants) and rapidly covered about 50% and almost complete coverage was done by 21 WAE (Figure 5.15, 5.16 and 5.17). The highest ground coverage was 96% at 23 WAE and it reduced at 92.3% in the end of wet season (25 WAE).

Phosphorus fertilizer had significant effect on the ground coverage of *S. hamata* during 10 to 23 WAE (Table 5.6). The higher coverage was noticed due to phosphorus application (Figure 5.15). In addition to phosphorus application, the cutting factor also affected on *S. hamata* coverage at 19 to 21 WAE (Table 5.7). The ground coverage of *S. hamata* was not influenced by weeding practice (Figure 5.16). Nevertheless, The ground coverage in single cutting treatment was higher than in double cutting treatment during 19 to 21 WAE (Figure 5.17).

However, dry matter of *S. hamata* tended to increase as well as their ground coverage (Figure 5.18). In addition, their coverage rapidly increased, while plant density of *S. hamata* standing and weed coverage slightly declined during mid to late wet season in a third-year (Figure 5.19).

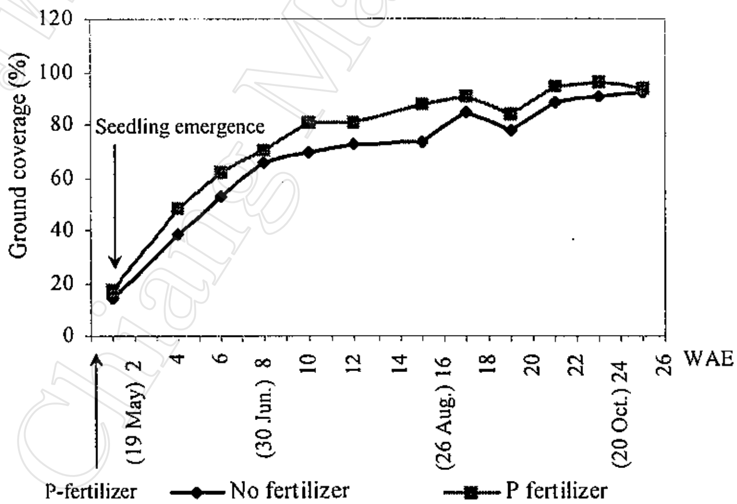

Figure 5.15 The effect of phosphorus fertilizer on ground coverage of *S. hamata*

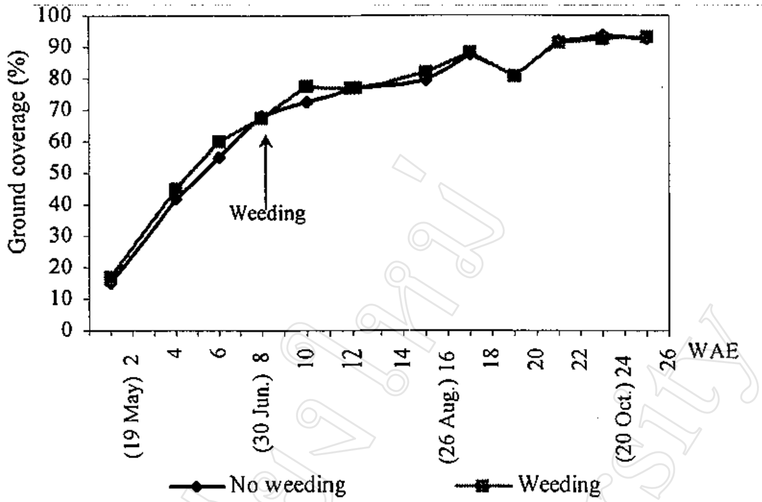

Figure 5.16 The effect of weeding on growth of *S. hamata*

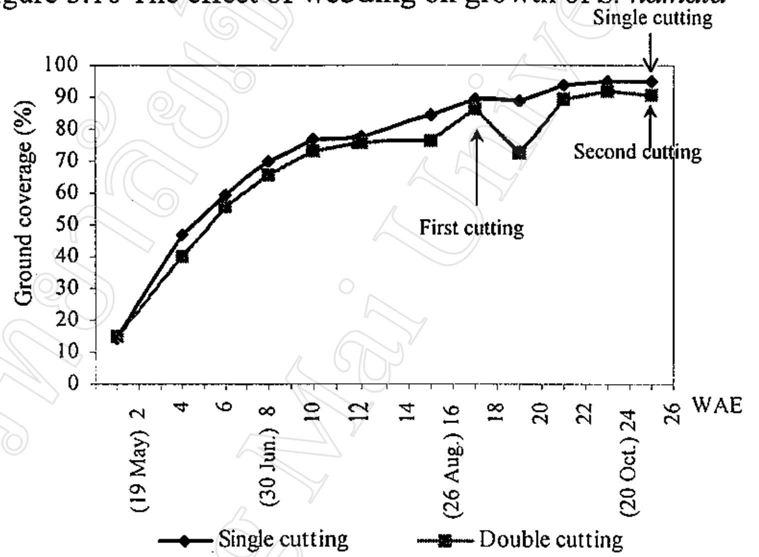

Figure 5.17 The effect of cutting practice on ground coverage of *S. hamata*

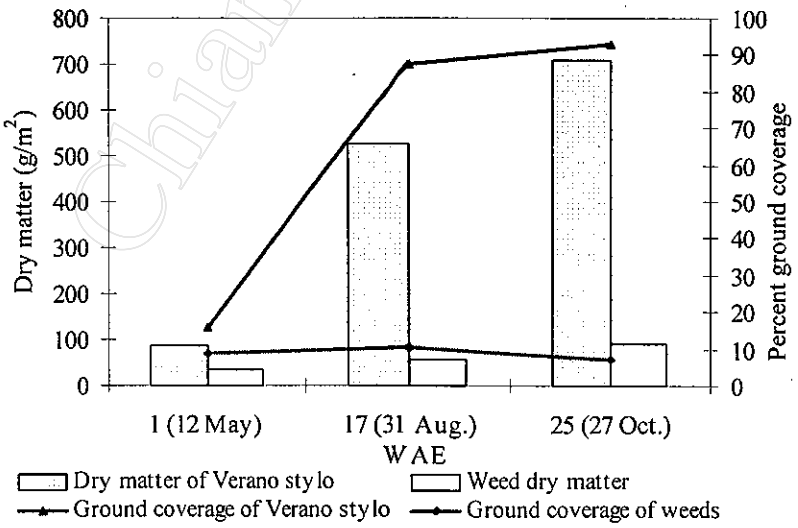

Figure 5.18 Comparison between dry matter and ground coverage of Verano stylo (*S. hamata*) and weeds

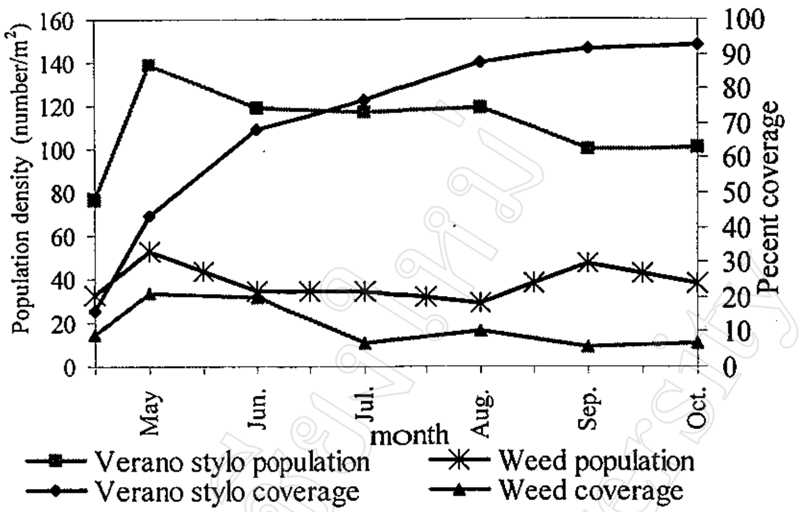

Figure 5.19 Comparison between population density and ground coverage of Verano stylo (mature plants+newly germinated plants) and weeds

Table 5.6 The statistical analysis of the ground coverage of *S. hamata*

Source of Variation	Significant level of ground coverage											
	1	4	6	8	10	12	15	17	19	21	23	25
	WAE											
Replication (A)	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
Fertilizer (B)	ns	ns	ns	ns	*	*	*	*	*	**	*	ns
Weeding (C)	-	-	-	ns	ns	ns	ns	ns	ns	ns	ns	ns
Cutting (D)	-	-	-	-	-	-	-	ns	**	*	ns	ns
B x C	-	-	-	ns	ns	ns	ns	ns	*	ns	ns	ns
B x D	-	-	-	-	-	-	-	ns	ns	ns	ns	ns
C x D	-	-	-	-	-	-	-	ns	ns	ns	ns	ns
B x C x D	-	-	-	-	-	-	-	ns	ns	ns	ns	ns
CV (%)	30.41	32.40	23.22	14.39	16.68	10.65	14.99	7.70	13.67	6.33	6.03	4.85

* indicates significant at 0.05% level ** indicates significant at 0.01% level
ns indicates not significant - indicates no input factor

5.3.4 Dry matter and forage yield of *S. hamata*

Changes in the dry matter (whole plants above ground level) of *S. hamata* during the course of the experiment and treatment are illustrated in Figure 5.20, 5.21 and 5.22. Considering the grand mean of dry matter of *S. hamata,* the dry matter became increase rapidly during the early wet season (1-17 WAE). The initial dry matter of *S. hamata* at 1 WAE (only mature plants) was 86.2 g/m^2 and it (dry matter combination of newly germinated plants and mature plants) increased up to 526.6 and 708.3 g/m^2 at 17 and 25 WAE respectively.

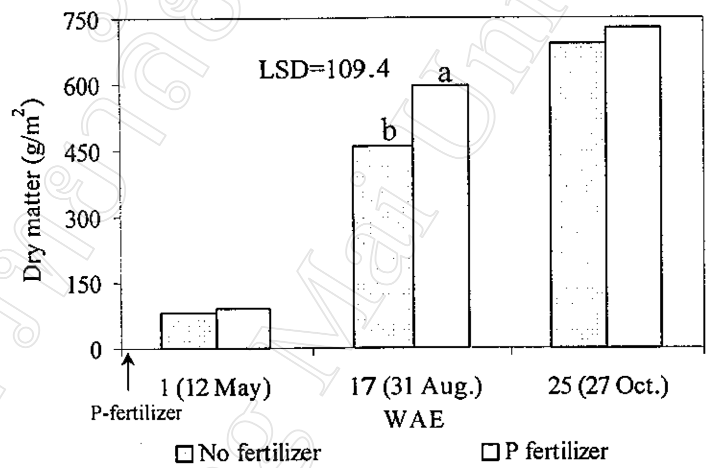

Figure 5.20 The effect of phosphorus fertilizer on dry matter of *S. hamata*

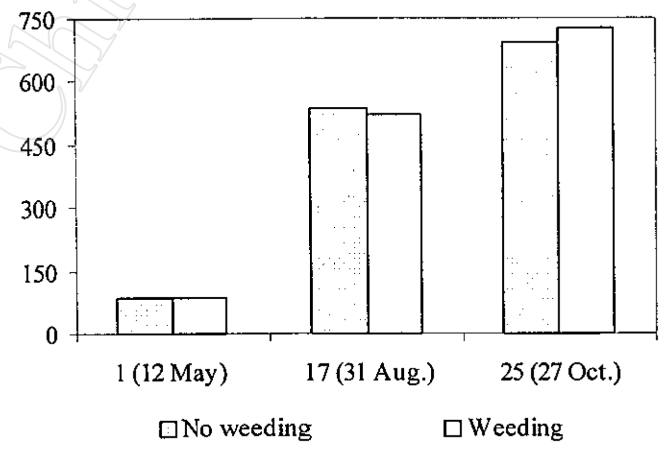

Figure 5.21 The effect of weeding on dry matter of *S. hamata*

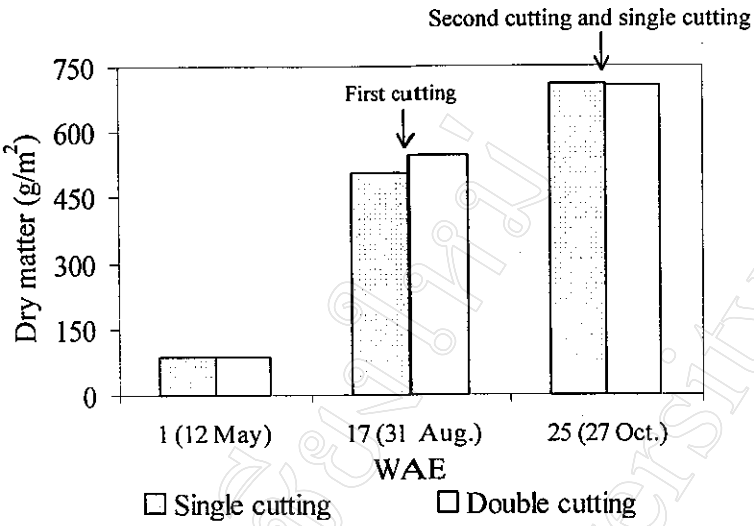

Figure 5.22 The effect of cutting on dry matter of *S. hamata*

The statistical analysis of dry matter change of *S. hamata* due to management practice viz. phosphorus fertilizer, weeding and cutting treatments is presented in Table 5.7. Among the various management practices, only phosphorus application showed significant effect ($P<0.05$) on dry matter change at 17 WAE. After P-fertilizer application, the dry weight became 594.3 g/m^2 while without P-application the dry weight was 458.9 g/m^2. However, the weeding practices (measured at 17 and 25 WAE) had no effect ($P<0.05$) on *S. hamata* yield. Similarly, cutting practice which was done at 25 WAE did not give any significant change on yield of *S. hamata* i.e. due to single and double cutting the dry matter produced by 711.3 and 705.4 g/m^2 respectively, which were not significantly different.

In case of 20 cm above from the ground level, regarding double cutting treatment, the forage yield was found by 310.4 g/m^2 (at 17 WAE) and 389.1 g/m^2 (at 25 WAE) after first time and second time cutting respectively while the single cutting treatment resulted 455.9 g/m^2 at 25 WAE. Therefore, the total forage yield (combination of 17 WAE and 25 WAE) of *S. hamata* in double cutting treatment was higher (699.5 g/m^2) than the single cutting practice (455.9 g/m^2). However, regarding whole plant, in case of double cutting the forage yield found to be 546.2 g/m^2 (at 17 WAE) and 705.4 g/m^2 (at 25 WAE) after first and second time cutting, respectively while the single cutting treatment gave 711.3 g/m^2 at 25 WAE.

Table 5.7 The analysis of variance *S. hamata* dry matter

Source of Variation	Significant level of dry matter		
	1	17	25
	WAE		
Replication (A)	ns	ns	ns
Fertilizer (B)	ns	*	ns
Weeding (C)	-	ns	ns
Cutting (D)	-	ns	ns
B x C	-	ns	ns
B x D	-	ns	ns
C x D	-	ns	ns
B x C x D	-	ns	ns
CV (%)	26.39	25.94	28.47

* indicates significant at 0.05% level ns indicates not significant
\- indicates no input factor

5.3.5 Forage quality

The forage quality of *S. hamata* (17 WAE) measured by neutral detergent fiber (NDF), acid-detergent fiber (ADF), crude protein (CP) and dry matter (DM). The result revealed the weeding and fertilizer factors did not show any significant (P <0.05) effect on forage quality in first cutting of double cutting treatment at 17 WAE (Table 5.8). However, at 25 WAE (Table 5.9) the forage quality differed significantly (P<0.01) between the treatment means according to NDF, ADF, CP and DM. Nevertheless, both fertilizer and weeding factors did not reveal any significant effect on the forage qualities.

In addition, the percentage of NDF, ADF and DM on forage yield in single cutting was higher compared to double cutting (Table 5.10). Nevertheless, percentage of CP in double cutting was higher than in single cutting practice.

Table 5.8 The statistical analysis of the forage qualities (dried at 65 °C) of *S. hamata* at 17 WAE

Source of Variation	Significant level of quality at 17 WAE			
	NDF (%)	ADF (%)	CP (%)	DM (%)
Replication (A)	ns	ns	ns	ns
Fertilizer (B)	ns	ns	ns	ns
Weeding (C)	ns	ns	ns	ns
B x C	ns	ns	ns	ns
A x B x C	ns	ns	ns	ns
CV (%)	6.46	4.98	13.64	26.32

ns indicates not significant

Table 5.9 The statistical analysis of the forage qualities (dried at 65 °C) of *S. hamata* at 25 WAE

Source of Variation	Significant level of quality at 25 WAE			
	NDF (%)	ADF (%)	CP (%)	DM (%)
Replication (A)	ns	ns	ns	ns
Fertilizer (B)	ns	ns	ns	ns
Weeding (C)	ns	ns	ns	ns
Cutting (D)	**	**	**	**
B x C	ns	ns	ns	ns
B x D	ns	ns	ns	ns
C x D	ns	ns	ns	ns
B x C x D	ns	ns	ns	ns
CV (%)	6.09	6.09	7.37	7.96

** indicates significant at 0.01% level ns indicates not significant

Table 5.10 The neutral detergent fiber (NDF), acid-detergent fiber (ADF), crude protein (CP) and dry matter (DM) of *S. hamata* measured in different cutting practices at 25 WAE

Cutting practice	Significant level of quality at 25 WAE			
	NDF (%)	ADF (%)	CP (%)	DM (%)
Single cutting	47.43a	37.05a	13.64b	31.29a
Double cutting	43.58b	34.45b	14.93a	28.69b
LSD 0.05	1.90	1.62	0.80	1.86
CV (%)	6.09	6.09	7.37	7.96

Numbers in the same column followed by the same letter are significant at the 5% level

5.4 Predominant weed species in the integrated farming system found in third year of *Stylosanthes hamata* establishment

Richardia brasiliensis was the most predominant weed species in *S. hamata* field (Table 5.11 and 5.12). The Summed Dominance Ratio (SDR) was found to be 42.4 and 27.4%, which were observed on May 2000 and August 2000 respectively. In addition, the other weed species were noticed in early wet season included *Rhynchelytrum repens, Digitaria setigera, Dactyloctenium aegyptium*, *Boerhavia diffusa* and *Urochloa distachya* (Table 5.11).

Table 5.11 Relative density, relative frequency, relative dry weight and Summed Dominance Ratio (SDR) of predominant weed species found in *Stylosanthes hamata* field in May 2000 at the Chom Tong Land Reform area, Chiang Mai

Scientific name of weeds	Relative density (%)	Relative frequency (%)	Relative dry weight (%)	SDR (%)	Palatability
Richardia brasiliensis Gomez	40.0	39.2	47.9	42.4	L
Rhynchelytrum repens (Willd.) C.E. Hubb.	28.5	25.0	24.6	26.0	P*
Digitaria setigera Roth ex Roem. & Schult. var. *setigera*	22.8	25.0	19.3	22.4	P*
Dactyloctenium aegyptium (L.) P. Beauv.	2.9	3.6	3.3	3.2	P*
Boerhavia diffusa L.	2.9	3.6	3.1	3.2	L
Urochloa distachya (L.) T. Q. Nguyen	2.9	3.6	1.8	2.8	P
Total	100	100	100	100	

Source: survey, 2000 and * cited in Radanachaless (1990)
P = Palatable, L = less palatable and U = unpalatable

Richardia brasiliensis was appeared as a predominant weed species with SDR 27.4% in the end of August followed by *Urochloa distachya* with SDR 19.6% in August and 29.6% (Table 5.12) in October (Table 5.13) at the middle and late rainy season respectively. Moreover, the other observed predominant weed species were

Borreria laevis, *Dactyloetenium aegyptium* and *Rhynchelytrum repens* etc. (Table 5.12).

Table 5.12 Relative density, relative frequency, relative dry weight and Summed Dominance Ratio (SDR) of predominant weed species found in *Stylosanthes hamata* field in August 2000 at the Chom Tong Land Reform area, Chiang Mai

Scientific name of weeds	Relative density (%)	Relative frequency (%)	Relative dry weight (%)	SDR (%)	Palatability
Richardia brasiliensis Gomez	21.8	19	41.3	27.4	L
Urochloa distachya (L.) T. Q. Nguyen	17.3	18	23.6	19.6	P
Borreria laevis (Lmk.) Griseb.	27.0	16	7.5	16.8	U
Dactyloctenium aegyptium (L.) P. Beauv	11.5	15	10.0	12.2	P*
Rhynchelytrum repens (Willd.) C.E. Hubb.	7.5	12	10.9	10.1	P*
Eleusine indica (L.) Gaertn.	2.3	4	3.9	3.4	P*
Tridax procumbens L.	2.3	3	1.2	2.2	P*
Hedyotis corymbosa (L.) Lmk.	1.7	3	0.03	1.6	L
Commelina benghalensis L.	1.7	2	0.33	1.4	P
Eragrostis amabilis (L.) Ness	1.7	2	0.33	1.3	P
Lindernia ciliata (Colsm.) Penn.	1.7	2	0.02	1.2	L
Digitaria setigera *Roth ex Roem. & Schult. var.* setigera	1.2	2	0.57	1.2	P*
Gomphrena celosioides Mart.	1.7	1	0.24	1.0	U
Ammannia baccifera L.	0.6	1	0.08	0.6	L*
Total	100	100	100	100	

Source: survey, 2000 and * cited in Radanachaless (1990)
P = Palatable, L = less palatable and U = unpalatable

Table 5.13 showed, in the *S. hamata* field, *Borreria laevis, Brachiaria distachya* and *Richardia brasiliensis* were found to predominant weed with SDR 36.5, 29.6 and 19.8% respectively in the end of rainy season (October 2000). Weed species were found during mid and late wet season, which decreased from 14 to 9 species respectively. In addition to these two weeds, the other weed species viz. *Rhynchelytrum repens, Commelina benghalensis, Eragrostis amabolis, Hedyotis corymbosa, Sida acuta* and *Tridax procumbens* were found during late wet season (August-October). However, these weeds showed less SDR compared to *B. laevis, U. distachya* and *R. brasiliensis.*

Table 5.13 Relative density, relative frequency, relative dry weight and Summed Dominance Ratio (SDR) of predominant weed species found in *Stylosanthes hamata* field in October 2000 at the Chom Tong Land Reform area, Chiang Mai

Scientific name of weeds	Relative density (%)	Relative frequency (%)	Relative dry weight (%)	SDR (%)	Palatability
Borreria laevis (Lmk.) Griseb.	56.0	29.1	24.4	36.5	U
Urochloa distachya (L.) T. Q. Nguyen	16.7	26.4	45.8	29.6	P
Richardia brasiliensis Gomez.	19.8	23.6	15.9	19.8	L
Rhynchelytrum repens (Willd.) C.E. Hubb.	3.1	9.7	12.8	8.5	P*
Commelina benghalensis L.	1.8	2.8	0.6	1.7	L
Eragrostis amabilis (L.) Nees	0.9	2.8	0.05	1.2	P
Hedyotis corymbosa (L.) Lmk.	0.9	2.8	0.02	1.2	L
Sida acuta Burm. f.	0.4	1.4	0.38	0.8	U*
Tridax procumbens L.	0.4	1.4	0.05	0.7	P*
Total	100	100	100	100	

Source: survey, 2000 and * cited in Radanachaless (1990)
P = Palatable, L = less palatable and U = unpalatable

5.5 Effect of phosphorus fertilizer, cutting frequency and weeding on height, coverage, dry matter and density of weeds

5.5.1 Effect on density of broadleaved and grass weeds

At the early rainy season, the newly germinated seedlings and mature plants of predominant weed species (*Richardia brasiliensis)* adversely covered the ground of *S. hamata* field in the third year of growing stage. In addition, there were many newly germinated seedlings of other predominant weed species simultaneously emerged with *R. brasiliensis* such as *R. repen, D. setigera, D. aegyptium*, *B. diffusa* and *B. distachya*.

The average density of broadleaved and grass weeds rapidly increased during early May and late October (1-4 and 17-21 WAE), while their numbers declined during 4-17 and 21-25 WAE (Figure 5.23, 5.24 and 5.25). In phosphorus fertilizer applied treatment, higher average density was observed than without phosphorus fertilizer treatment throughout the wet season (Figure 5.23).

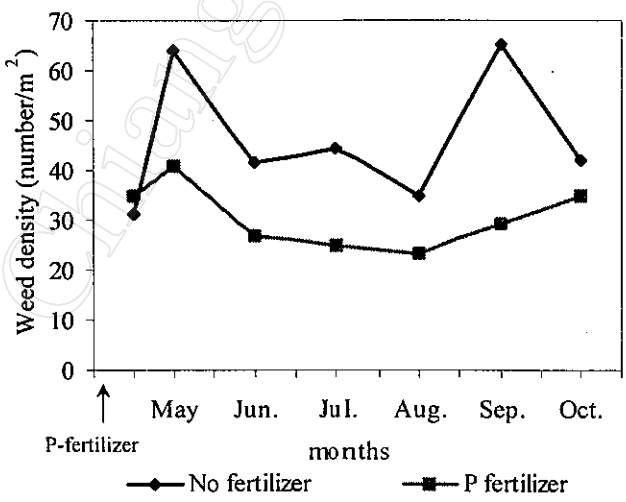

Figure 5.23 Effect of phosphorus fertilizer on broadleaved and grass weed population

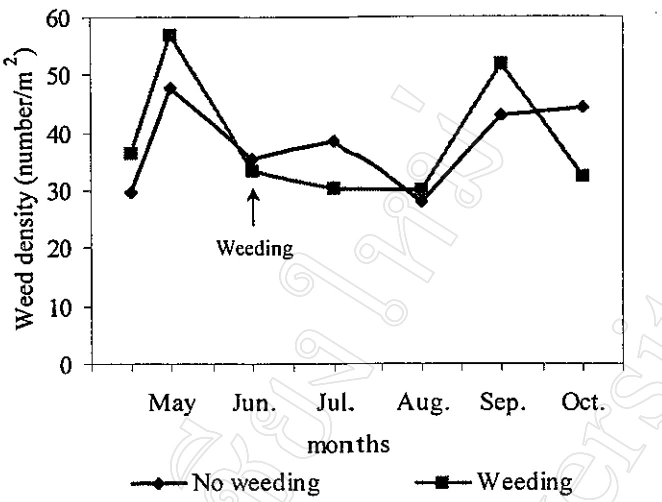

Figure 5.24 Effect of weeding practice on broadleaved and grass weed population

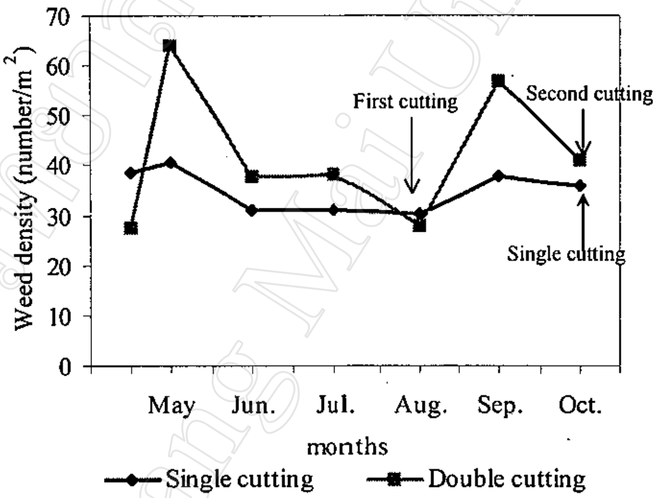

Figure 5.25 Effect of cutting practice on broadleaved and grass weed population

Furthermore, the statistical analysis of the data indicated that during 8-12 and 21 WAE, the population density of broadleaved and grass weeds was affected significantly by applying phosphorus fertilizer (Table 5.14). At 8, 12 and 21 WAE, the weed numbers were 27, 24.7 and 29.3 plants/m^2 respectively in phosphorus fertilizer treatment and 41.7, 44.3 and 65.3 plants/m^2 respectively in without phosphorus fertilizer treatment. Nevertheless, in cutting practice and weeding practice did not affect on the numbers of broadleaved and grass weeds in the third year of *S. hamata* establishment.

Table 5.14 The analysis of variation for broadleaved and grass weed density

Source of Variation	Significant level of broadleaved and grass weed density						
	mid-May	May	Jun.	Jul.	Aug.	Sep.	Oct.
Replication (A)	ns	ns	ns	ns	ns	*	**
Fertilizer (B)	ns	ns	*	*	ns	**	ns
Weeding (C)	-	-	ns	ns	ns	ns	ns
Cutting (D)	-	-	-	-	ns	ns	ns
B x C	-	-	ns	ns	ns	ns	*
B x D	-	-	-	-	ns	ns	ns
C x D	-	-	-	-	ns	ns	ns
B x C x D	-	-	-	-	ns	ns	*
CV (%)	52.44	68.88	42.76	62.37	55.06	81.84	65.99

* indicates significant at 0.05% level ** indicates significant at 0.01% level
ns indicates not significant - indicates no input factor

5.5.2 Effect on height of predominant weeds

Regarding to average height of predominant weed (*R. brasiliensis*) was found to be 23.2 cm in mid-May, when the seeds of *S. hamata* started to germinate. The young seedlings of this weed species rapidly grew at the early of the rainy season and the maximum height reached up to 38.5 cm during 1 to 8 WAE. Thereafter, its height dropped to 32.0 cm at 8 WAE due to weeding practice (Figure 5.26, 5.27 and 5.28) and slightly increased up to 35.5 cm during 10-17 WAE. Then the height of this predominant weed species dropped to 23.9 cm at 17 WAE due to first cutting practice in double cutting treatment of *S. hamata.* However, the single cutting practice increased the height (Figure 5.28). It was eventually noticed that the single cutting practice were able to keep higher height compared to double cutting practice from 19 to 25 WAE.

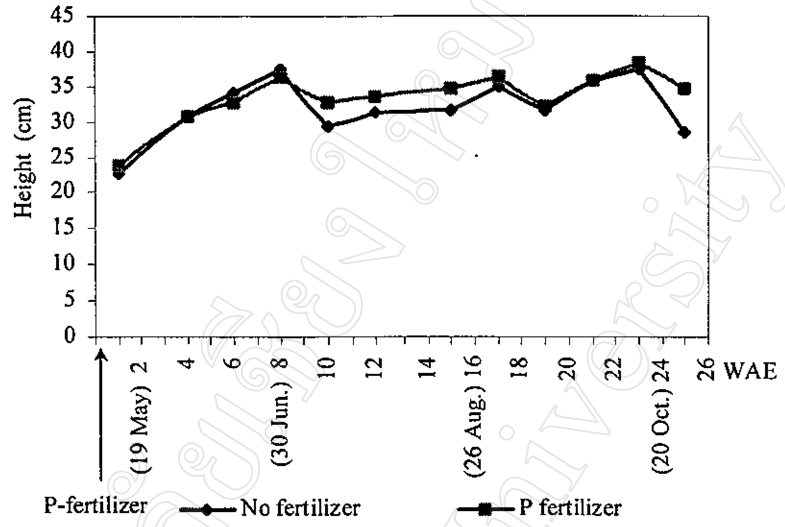

Figure 5.26 Effect of phosphorus fertilizer on height of predominant weed species *Richardia brasiliensis*

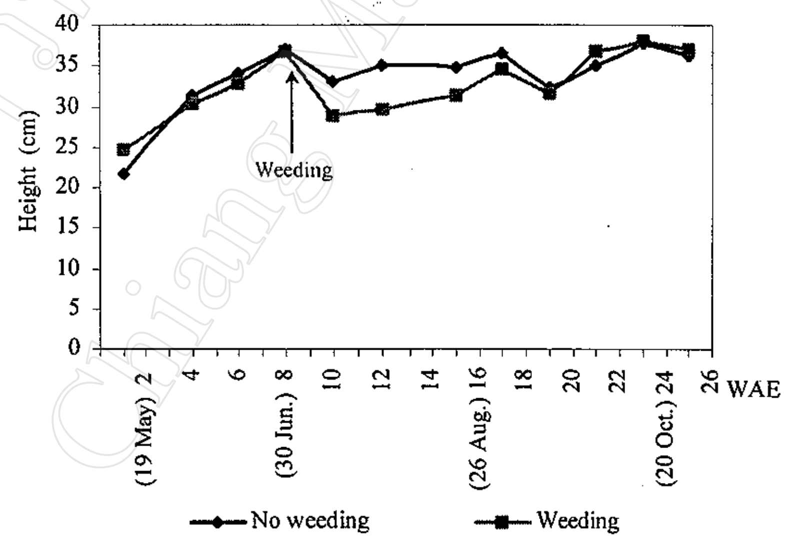

Figure 5.27 Effect of weeding practice on height of predominant weed species *Richardia brasiliensis*

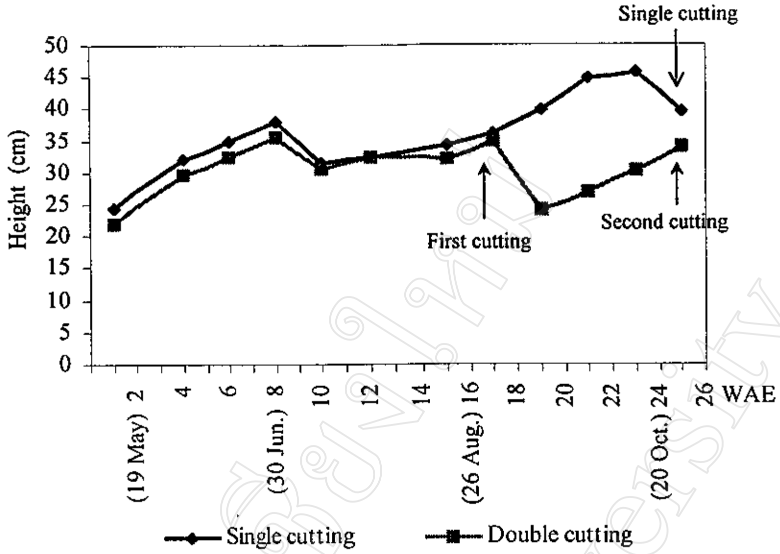

Figure 5.28 Effect of cutting practice on height of predominant weed species *Richardia brasiliensis*

The statistical analysis of height of the predominant weed species showed in Table 5.15. It was found that the phosphorus fertilizer did not affect on the height of predominant weed throughout the wet season. However, weeding practice affected on their heights. The height was decreased by 29-31 cm because of weeding while the decreasing was observed by 33-35 cm in case of without weeding at 10-15 weeks after emergence (WAE). In addition, the first cutting practice of *S. hamata* affected on the height of predominant weed species. During 19-25 WAE, the height was 24-34 cm in the first cutting practice of double cutting treatment while in single cutting treatment the height became 40-46 cm.

Table 5.15 Analysis of variation for height of predominant weed species

Richardia brasiliensis

Source of Variation	Significant level of predominant weed height											
	1	4	6	8	10	12	15	17	19	21	23	25
	WAE											
Replication (A)	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
Fertilizer (B)	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
Weeding (C)	-	-	-	ns	*	**	*	ns	ns	ns	ns	ns
Cutting (D)	-	-	-	-	-	-	-	ns	**	**	**	*
B x C	-	-	-	ns	ns	ns	ns	ns	ns	ns	ns	ns
B x D	-	-	-	-	-	-	-	ns	ns	ns	ns	ns
C x D	-	-	-	-	-	-	-	ns	ns	ns	ns	ns
B x C x D	-	-	-	-	-	-	-	ns	ns	ns	ns	ns
CV (%)	23.51	10.38	9.80	6.84	15.38	13.15	13.12	13.94	26.83	28.2	25.92	14.92

* indicates significant at 0.05% level
ns indicates not significant
** indicates significant at 0.01% level
\- indicates no input factor

5.5.3 Effect on ground coverage of broadleaved and grass weeds

According to grand mean, 9% ground coverage of broadleaved and grass weeds was found in the early wet season (1 WAE). Their coverage rapidly increased up to 9 to 21% during 1 to 4 WAE (Figure 5.29, 5.30 and 5.31). Thereafter, their ground coverage dropped by 6.9% at 8 WAE due to weeding practice and again increased up to 14.2% during 12-15 WAE. Again the ground coverage reduced up to 9.2% at 19 WAE, which was caused by first cutting practice in double cutting treatment and then almost stable coverage (about 7%) was existed till 25 WAE.

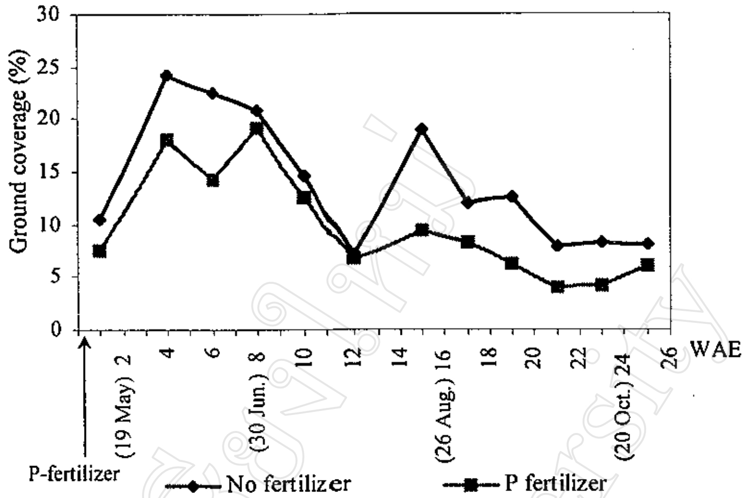

Figure 5.29 Effect of fertilizer on ground coverage of broadleaved and grass weeds

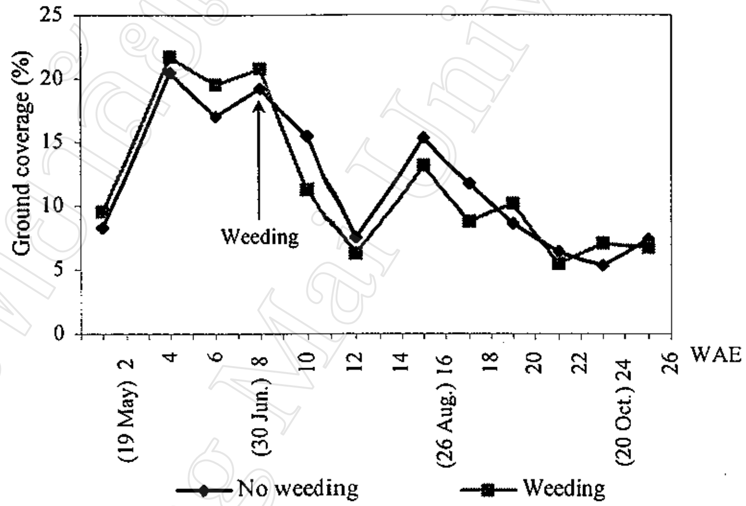

Figure 5.30 Effect of weeding on ground coverage of broadleaved and grass weeds

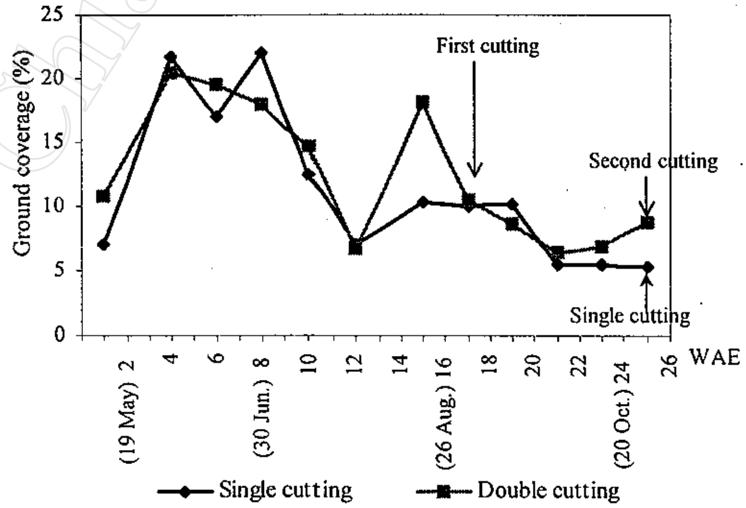

Figure 5.31 Effect of cutting on ground coverage of broadleaved and grass weeds

Statistical analysis of data indicated the significant effect (P<0.01) of phosphorus on the ground coverage of broadleaved and grass weeds during wet season (Table 5.16). Due to phosphorus fertilizer application the ground coverage decreased by 18% at 4 WAE and 14.2% at 6 WAE. However, the ground coverage became increased up to 24.2% at 4 WAE and 22.5% at 6 WAE as a result of without phosphorous application. In addition, it was also noticed that due to phosphorous application, ground coverage significantly reduced during 15, 19, 21 and 23 WAE. Moreover, the ground coverage was affected by weeding practice during 10 WAE while weeding and without weeding resulted 11.3% and 15.4% ground coverage respectively. Furthermore, the cutting practice also influenced on ground coverage at 25 WAE as single and double cutting showed 5.3% and 8.8% respectively.

Table 5.16 The analysis of variation for ground coverage of broadleaved and grass weeds

Source of Variation	Significant level of ground coverage											
	1	4	6	8	10	12	15	17	19	21	23	25
	WAE											
Replication (A)	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
Fertilizer (B)	ns	*	**	ns	ns	ns	*	ns	*	*	*	ns
Weeding (C)	-	-	-	ns	*	ns	ns	ns	ns	ns	ns	ns
Cutting (D)	-	-	-	-	-	-	-	ns	ns	ns	ns	**
B x C	-	-	-	ns	ns	ns	ns	ns	*	ns	ns	ns
B x D	-	-	-	-	-	-	-	ns	ns	ns	ns	ns
C x D	-	-	-	-	-	-	-	ns	ns	ns	ns	ns
B x C x D	-	-	-	-	-	-	-	ns	ns	ns	ns	ns
CV (%)	67.82	33.59	39.94	35.36	34.38	35.97	47.13	53.03	71.78	62.15	71.20	42.39

* indicates significant at 0.05% level
ns indicates not significant
** indicates significant at 0.01% level
\- indicates no input factor

5.5.4 Effect on dry matter of broadleaved and grass weeds

Dry matter of broadleaved and grass weeds continually increased throughout the wet season (Figure 5.32, 5.33 and 5.34). The average dry matter of weed was 34.6, 58.7 and 89.5 g/m^2 during 1, 17 and 25 WAE respectively. Although weeding practice was done at 8 WAE but their dry matter got still increased.

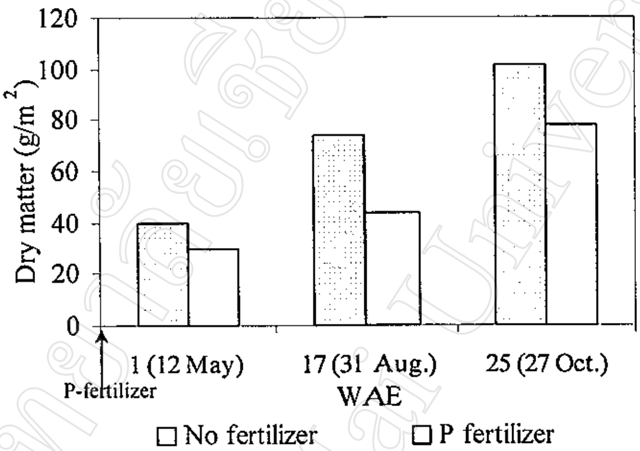

Figure 5.32 Effect of phosphorus fertilizer on dry matter of broadleaved and grass weeds

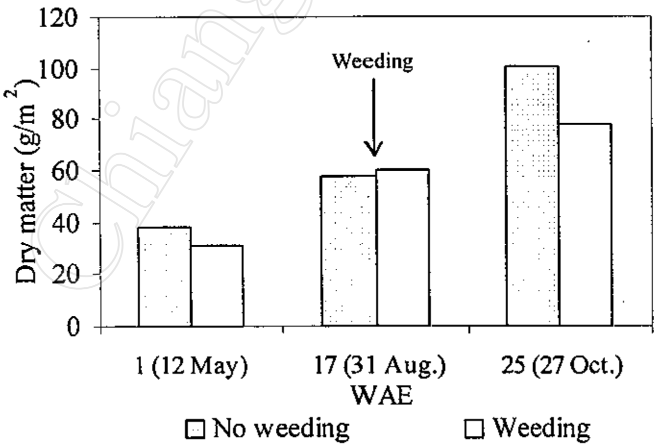

Figure 5.33 Effect of weeding practice on dry matter of broadleaved and grass weeds

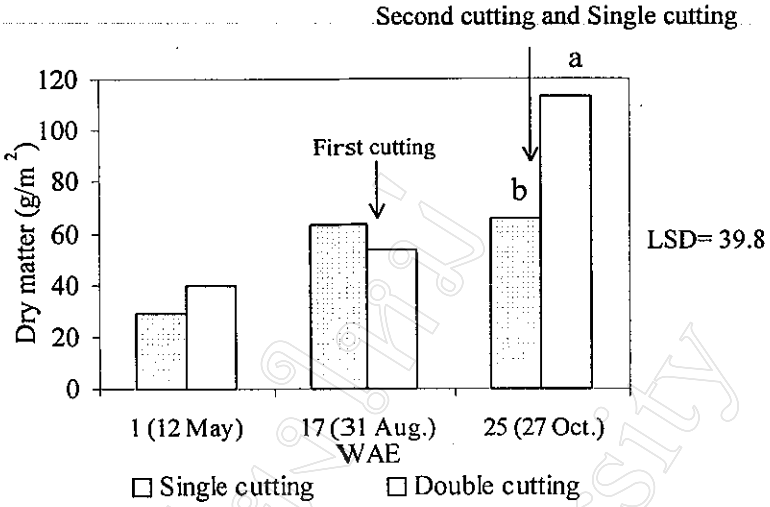

Figure 5.34 Effect of cutting practice on dry matter of broadleaved and grass weeds

Statistical analysis of data revealed that phosphorus fertilizer and weeding practice did not affect ($P<0.05$) on dry matter content of weed throughout the wet season (Table 5.17). However, cutting practice influenced ($P<0.05$) on dry matter content during 25 WAE. In fact, double cutting practice produced higher weed dry matter (113.5 g/m^2) compared to single cutting practice (65.5 g/m^2) (Figure 5.34).

Table 5.17 Analysis of variation for dry matter of broadleaved and grass weeds

Source of Variation	Significant level of dry matter		
	1	17	25
		WAE	
Replication (A)	ns	ns	ns
Fertilizer (B)	ns	ns	ns
Weeding (C)	-	ns	ns
Cutting (D)	-	ns	*
B x C	-	ns	ns
B x D	-	ns	ns
C x D	-	ns	ns
B x C x D	-	ns	ns
CV (%)	58.06	80.15	61.90

* indicates significant at 0.05% level　　** indicates significant at 0.01% level
ns indicates not significant　　- indicates no input factor

5.5.5 Comparison effects of phosphorus fertilizer, weeding and cutting on *S. hamata* and weeds

The comparison of effect of P-fertilizer, weeding and cutting between the height of *S. hamata* and predominant weed species in third-year was illustrated in Figure 5.35. The height of both *S. hamata* and predominant weed increased rapidly almost in equal trend till 8 WAE and then reached together (at 10 WAE) which continued up to 17 WAE. Thereafter, the height of *S. hamata* increased rapidly although predominant weed's height remained almost same during 19-25 WAE.

The population of *S. hamata* was about 80-140 plants/m^2, and broadleaved and grass weed was about 30-50 plants/m^2 (Figure 5.36). However, the trend of population increasing and decreasing was noticed similar.

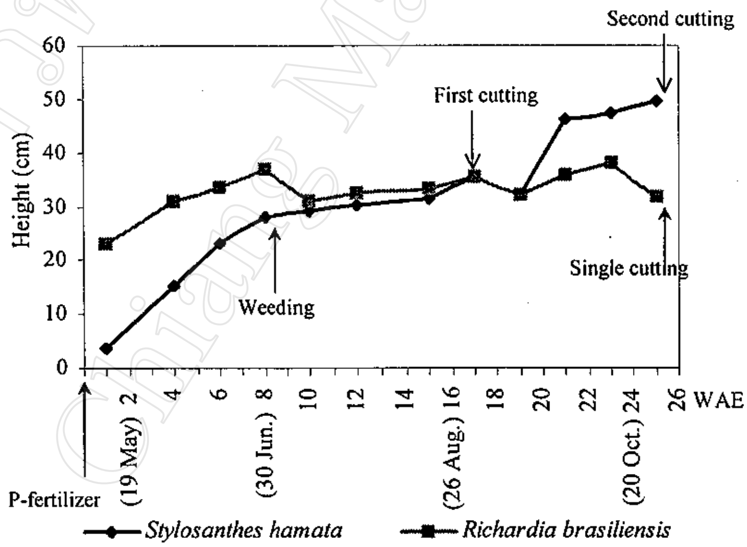

Figure 5.35 Comparison between height of *Stylosanthes hamata* and predominant weed from 1 to 25 WAE

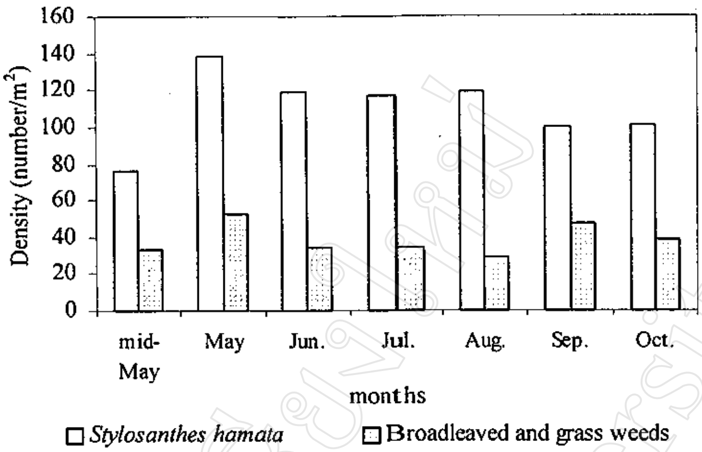

Figure 5.36 Comparison between population of *Stylosanthes hamata* and broadleaved and grass weeds from 1 to 25 WAE

The ground coverage of *S. hamata* sharply increased in early rainy season (1-10 WAE) up to about 80 percent and then the increasing rate became declined and reached at about 90 percent (at 17 WAE). However, after 17 WAE, again the ground coverage declined at 70% during 19 WAE. Thereafter, again increased up to 90% during 21 WAE, which was remained same till 25 WAE.

On the other hand, regarding broadleaved and grass weeds, the ground coverage increased 10 to 20% (during 1-4 WAE) which continued up to 8 WAE and then decreased at about 5% (during 12 WAE). Again, the ground coverage sharply increased up to 15% within next 3 WAE. Moreover, it again started declining steadily up to 5% within 21 WAE, which remained almost stable the end of wet season (25 WAE). However, the highest of weed coverage was 21.1% in early wet season (4 WAE) while *S. hamata* was 93.3 % at 23 WAE.

The dry matter of *S. hamata* sharply increased from about 80 to 500 g/m^2 (from 1 to 17 WAE). Then it reached up to nearly 730 g/m^2 at 25 WAE. Regarding dry matter of weed, dry matter increased slowly from 35 to 90 g/m^2 within 1 to 25 WAE (Figure 5.38).

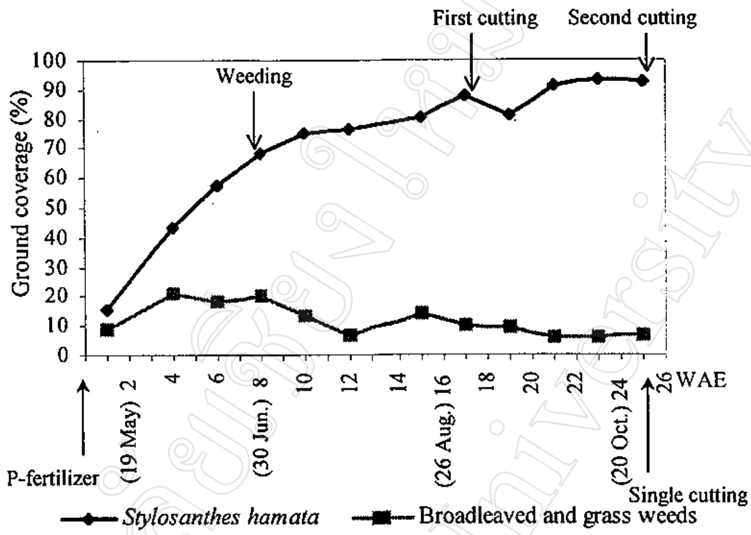

Figure 5.37 Comparison between ground coverage of *Stylosanthes hamata* and broadleaved and grass weeds from 1 to 25 WAE

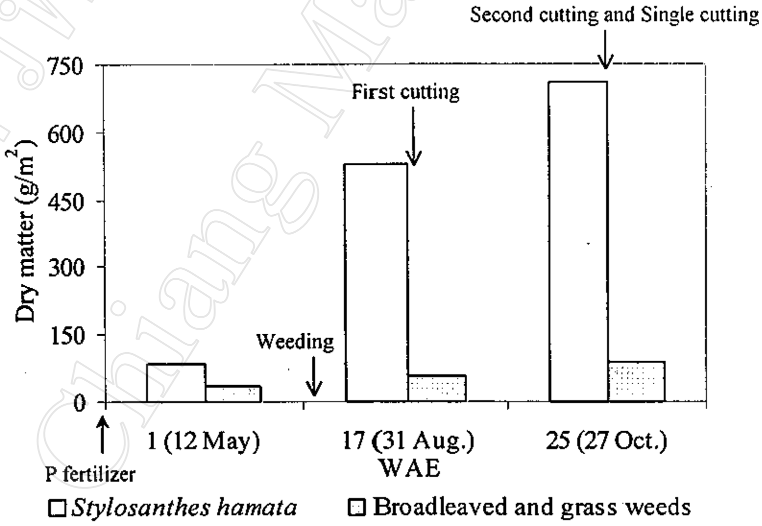

Figure 5.38 Comparison between dry matter of *Stylosanthes hamata* and broadleaved and grass weeds from 1 to 25 WAE

The relative density, relative frequency, relative dry weight and Summed Dominance Ratio (SDR) of *S. hamata* and weeds were presented in the Table 5.18. SDR of *S. hamata* and weeds was 70.3% and 29.7% respectively in the early rainy season (May, 2000). The SDR of *S. hamata* increased up to 83.7% while regarding weeds, it declined at 16.3% in the middle of wet season. However, in the end of growing season (October, 2000), SDR of *S. hamata* and weeds was found to be 77.9% and 22.1% respectively.

Table 5.18 Relative density, relative frequency, relative dry weight and Summed Dominance Ratio (SDR) of *Stylosanthes hamata* and broadleaved and grass weeds found in *S. hamata* field at the Chom Tong Land Reform area, Chiang Mai during May, August and October, 2000

Description	May, 2000		August, 2000		October, 2000	
	S. hamata	Weeds	*S. hamata*	Weeds	*S. hamata*	Weeds
Relative density (%)	69.8	30.2	80.5	19.5	72.4	27.6
Relative frequency (%)	69.8	30.2	80.5	19.5	72.4	27.6
Relative dry weight (%)	71.4	28.6	90.0	10.0	88.8	11.2
SDR (%)	70.3	29.7	83.7	16.3	77.9	22.1