Title	琉球列島のサトウキビ畑における雑草の生理・生態 : 第13報 ハイキビ (Panicum repens L.) の除草時期がサトウキビの初期生育に及ぼす影響(附属農場)
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Physiological and Ecological Characteristics of Sugarcane Field Weeds in the Ryukyu Islands
13. Effect of Weeding time of Torpedo grass (*Panicum repens* L.) on Early Stage of Sugarcane Growth*

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Summary

A glass house pot experiment consisted of six treatments. For treatment A, only one cane sett was planted in each pot. For treatment B, one pot was planted one cane sett and two weed cuttings, one pot was planted one cane sett and four weed cuttings, and one pot was planted one cane sett and eight weed cuttings with five replications. Same procedure was done for the treatments C, D and E. For the treatment F, only one weed cutting was planted in each pot. The experiment was carried out from 18th May to 23rd December, 1992, at the experimental farm, College of Agriculture, University of the Ryukyus to study the effect of weeding time of Torpedo grass on early stage of sugarcane growth to determine the proper weeding time of this weed infested sugarcane field. Dark redish soil of pH 5.25-6.74, two-noded sprouted rhizome of Torpedo grass, one-eyed sugarcane sett (F-160), compound fertilizer (N : P : K = 2.6 : 2.0 : 2.8), wagner pot (1/2000a), organic phosphorus pesticide were used in the experiment. The results were summarized as follows:

1. Early stage of sugarcane was up to 150 days after planting (DAP) and its elongation rate was increased fastly from 60-90 DAP. On the other hand, Torpedo grass was increased up to 150 DAP, but increasing was occured very sharply up to 120 DAP, it's tiller increasing rate was highest from 30-60 DAP. So high competition was occured up to 150 DAP between sugarcane and Torpedo grass in absorption of plant nutrient.

2. Before weeding, cane growth was almost stunted and no tiller was come out for the loose mat forming rhizome of the said weed. Early weeding always gave higher plant length and early tillers as the period of weeding was prolonged that is reflected more survaival of tillers and cane formation, ultimately resulted in higher cane

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yield/unit area.

3.Stalk lenght, stalk diameter, stalk fresh (yield) weight, dry weight of stalk, dry weight of green leaf and dry weight of root were highest in the weed free cane and lowest in the unweeded cane. Weeding showed good effect on the yield parameters of cane. Early weeding increased yield cotributing parameters as the weeding was prolonged that ultimate resulted in higher cane yield/unit area. Torpedo grass decreased 65-80% sugarcane yield compared to pure cane. On the other hand, weeding increased 19-134% yield compared to non-weeded cane, early weeding (30-60 DAP) gave 45-97% higher yield compared to late weeded cane.

4.The visual observation showed no rhizome in the mixed pots which were weeded at 30 DAP, but at 60 DAP weeded pots showed 13% and 120 DAP weeded pots showed 100% of rhizome at final harvest.

Therefore, the results demonstrated that growth of sugarcane can be recovered to satisfactory level either by removing weeds from the sugarcane field or by suppressing the weed growth below economic injury level. For successful weed control and getting higher yield in Torpedo grass infested field, sugarcane field must kept free from this weed up to 150 DAP and first removal of weeds may be recomended within 30-60 days after planting in all density of weed infested field such as cane + two weeds, cane + four weeds and cane + eight weeds.

Introduction

Weeding in proper time is one of the important agronomic practices for obtaining higher yield of crops. Competition between weed and crop for soil nutrient, or the fertilizer absorptivity of the weed has been mentioned as one of the serious problems associated with crop yield reduction, and greater weed response to higher levels of fertilizer application have been reported by many investigators [1,2,3,12,17,19]. The long interval between planting and emergence, the slow seedling growth, the wider row spacing, liberal fertilizer application at the planting and frequent irrigations during the early crop season are the main factors which enhance weed population and their vigorous growth in the sugarcane fields. It is thus very important to keep the weed free environment during the early growth stages of cane crops[4,7,9]. Rangiah et al.[16] and Malavla et al.[9] reported that sugarcane crop requires a weed free condition up to 90 days from planting for realising it's maximum yield potential.

The loss in cane productivity due to weed infestation was estimated up to 75%[16,18]. Noguchi et al.[11], observed that in order to establish an economic and effective control measure for any competing weed species, competition between crop and weed needs to be elucided particularly the suppression effect exerted by weed on the growth of crop and vice versa. Torpedo grass (*Panicum repens* L.) is a serious perennial weed of sugarcane fields in tropical and sub-tropical regions[15].In Taiwan Torpedo grass is found in almost all sugarcane field[15]. Recently, Torpedo grass has been indicated as a serious weed of various crops in Okinawa[5,6] and Bangladesh[8]. This weed also infests a vast number of crops viz. mustard, wheat, pulse, rice and jute[8], and is characterized by it's highly regenerative rhizomes for colonizing the fields and creating hazards to the cane growers causing a great economic losses every year[5,6,15]. Therefore, the present investigation was initiated to study the effect of weeding time of Torpedo grass on the early stage of sugarcane growth.

Materials and Methods

A glass-house pot experiment was conducted from May 18 to December 23, 1992 at the experimental farm , College of Agriculture, University of the Ryukyus, Okinawa, Japan. Dark redish soil (Shimajiri mahji) with value pH ranges from 5.25 to 6.74 were collected from the experimental field and weed seeds(rhizome) were collected from the fallow land of Nishihara, Okinawa. Sugarcane (*Saccharum officinarum* L.) variety F-160 was used as the test crop. Two-noded rhizome cuttings of Torpedo grass and one-eyed sugarcane setts were used in the experiment. Sprouted weed cuttings and sugarcane setts were planted in wagner (1/2000a) pots according to the treatments on the 27th May, 1992. The experiment consisted of six treatments where 15 pots were used for each treatment and followed by completely randomized design. The treatments were as follows:

A : Weed free cane.

B : Weeding was done at 30 days after planting (DAP)

C : Weeding was done at 60 DAP

D : Weeding was done at 120 DAP

E : Non-weeding cane.

F : Cane free weed (This treatment was taken for the study of weed growth's character).

For the treatment A, one sugarcane sett except weed was planted at the center of each pot. For treatment B, one cane sett and two weed cuttings were planted in each pot, one cane sett and four weed cuttings were planted in each pot, and one cane sett and eight weed cuttings were planted in each pot with five replications. Same procedure was done for the treatments C,D, and E. For the treatment F, one weed cutting except cane was planted in the center of each pot. Individual pots were fertilized with a compound fertilizers (N : P : K = 2.6 : 2.0 : 2.8) at 3.7kg/a during plantation following three top dressings in the same rate. Organic phosphorus pesticide was applied two times for controling insects at 3 kg/10a when required. Monthly data on sugarcane growth viz. plant length up to top visible dewlap (TVD) , tiller numbers, stalk length, diameter and matter production were taken for sugarcane. Plant lenght and tiller number were also recorded monthly for weed. For drying the working sample, an electric oven operated at 85°C for 48 hours and for leaf area measurement, leaf-areameter were used.

Results and Discussion

Seasonal elongation of stem up to TVD shown in Fig.1 represented that sugarcane length was increased sharply up to 150 days after planting and then it increased a bit slowly. The elongation rate was increased rapidly from 60 to 90 DAP and from 90 to 150 DAP, the elongation rate was almost similar in high level and after 150 DAP, a sharp decreased rate was observed (Fig.1). From Fig.2, it is evident that weed length was increased very fast up to 120 DAP, then remained almost constant. On the other hand, the peak elongation rate of the weed was observed at 120 DAP and after that, it showed a sharp decrease up to 150 DAP (Fig.2).

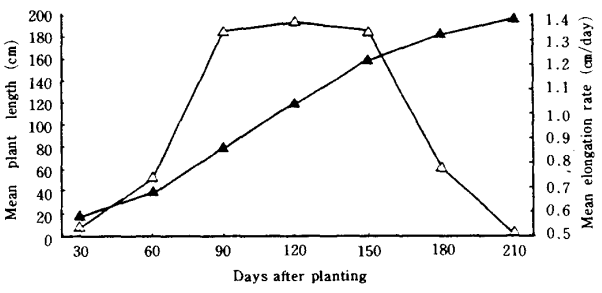

Fig. 1 Graphical representation of sugarcane growth and development

▲ Elongation of stem. △ Elongation rate

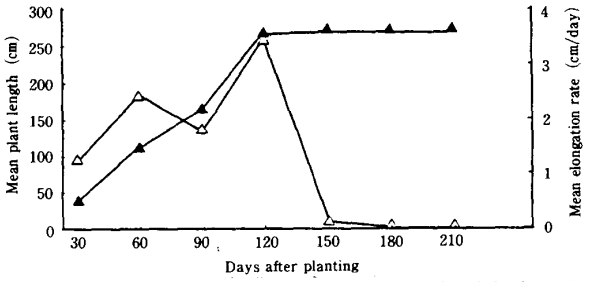

Fig. 2 Graphical representation of Torpedo grass growth and development

▲ Elongation of stem, △ Elongation rate

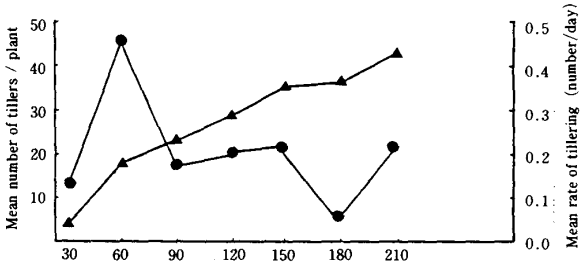

Fig. 3 Graphical representation of Torpedo grass Tillering and Tillering rate

▲ Numbers of tiller, ● Rate of Tillering

Fig.3 showed that number of weed tillers were increased althrough the experimental period. But, tiller increasing rate was maximum within 30 to 60 DAP (Fig.3).

Seasonal stem elongation up to top visible dewlap (TVD) of sugarcane was adversely affected by weed infestation (Table 1). The weed free cane grew rapidly throughout the growth period. But in the

Table 1. Effect of weeding time on stem elongation of sugarcane.

Treatments		Stem elongation (cm) with time (DAP)						
Weeding schedule	Weed density	30	60	90	120	150	180	210
Weed free	Pure cane	16	38	78	119	159	182	197
	Cane+2weeds	14	33*	56**	88**	117**	138**	163*
30 DAP	Cane+4weeds	15	36	66	97*	131*	153*	174
	Cane+8weeds	11*	37	61**	92**	123**	149*	170*
	Cane+2weeds	16	32**	54**	82**	113**	126**	147**
60 DAP	Cane+4weeds	10**	26**	55**	89**	125**	149**	169**
	Cane+8weeds	11*	28**	48**	77**	114**	137**	155**
	Cane+2weeds	14	35	57**	81**	113**	128**	146**
120 DAP	Cane+4weeds	15	34	50**	64**	93**	115**	137**
	Cane+8weeds	12	30**	42**	56**	87**	107**	127**
	Cane+2weeds	15	32**	50**	73**	104**	119**	134**
Non-weeded	Cane+4weeds	15	34	54**	73**	100**	115**	129**
	Cane+8weeds	13	31**	44**	59**	82**	94**	108**

Note: *, ** Indicates significance of differences between control and other treatments at 5% and 1% level respectively (done by T-test). DAP indicates days after planting.

pots containing weed, cane growth was stunted before weeding. After weeding, cane growth was increased sharply (Table 1). Final data for seasonal plant length showed that the weed free cane length was increased significantly compared to non-weeded and partially weeded cane. Early weeding showed some beneficial effect on sugarcane plant length compared to non-weeded and late weeded cane. The lowest cane length of 108 cm was recorded in non-weeded cane and the highest length of 197 cm was recorded in weed free cane which was significantly different. In weeded cane, 163-174 cm at 30 DAP, 147-169 cm at 60 DAP and 127-146 cm at 120 DAP were recorded in the mixed pots respectively. Plant length decreased due to the late weeding might be the caused for competition of plant nutrient. This supports the results of Ishimine et al[4].

Table 2 showed that the sugarcane stem elongation rate was increased up to 150 DAP in all treatments. But before weeding, elongation rate was almost stunted and after weeding, it increased

Table 2. Effect of weeding time on stem elongation rate of sugarcane.

Treatments		Elongation rate (cm/day) with time (DAP)						
Weeding schedule	Weed density	30	60	90	120	150	180	210
Weed free	Pure cane	0.53	0.73	1.33	1.37	1.33	0.77	0.50
	Cane+2weeds	0.47	0.63	0.77	1.07	0.96	0.70	0.83
30 DAP	Cane+4weeds	0.50	0.70	1.00	1.03	1.13	0.73	0.70
	Cane+8weeds	0.37	0.86	0.80	1.03	1.03	0.86	0.70
	Cane+2weeds	0.53	0.53	0.73	0.93	1.03	0.43	0.70
60 DAP	Cane+4weeds	0.33	0.53	0.97	1.13	1.20	0.80	0.67
	Cane+8weeds	0.37	0.53	0.67	0.97	1.23	0.77	0.60
	Cane+2weeds	0.47	0.70	0.73	0.80	1.06	0.50	0.60
120 DAP	Cane+4weeds	0.50	0.63	0.53	0.47	0.97	0.73	0.73
	Cane+8weeds	0.40	0.60	0.40	0.47	1.03	0.67	0.67
	Cane+2weeds	0.50	0.57	0.60	0.77	1.03	0.50	0.50
Non-weeded	Cane+4weeds	0.50	0.63	0.66	0.63	0.90	0.50	0.57
	Cane+8weeds	0.43	0.60	0.43	0.50	0.77	0.40	0.47

Note: DAP indicates days after planting.

sharply. Stem elongation rate was not suffered seriously by Torpedo grass at 120 DAP because of minimum growth as well as less competition of Torpedo grass. The table also showed the recovery for elongation tendency of weed infested cane when they got proper weeding, but elongation rate at 150 DAP in weed free cane was decreased naturally.

Effect of weeding time on tillering of sugarcane was shown in the Table 3. At 60 DAP, the monthly observed data showed the tillers in weed free cane and in 30 DAP weeded cane. In weed free cane, number of tillers were increased with a high rate from 60 to 90 DAP. In weed mixed cane, almost no tiller

Table 3. Effect of weeding time on tillering of sugarcane

Treatments		Number of tillers/pot with time (DAP)						
Weeding schedule	Weed density	30	60	90	120	150	180	210
Weed free	Pure cane	-	0.4	1.6	1.8	2.2	2.6	3.2
	Cane+2weeds	-	0.4	0.6	1.0	1.8	1.8	2.2
30 DAP	Cane+4weeds	-	-	0.2	0.2	0.6	0.6	1.0
	Cane+8weeds	-	0.2	0.4	0.4	1.0	1.0	1.8
	Cane+2weeds	-	-	0.2	0.2	2.0	2.0	2.6
60 DAP	Cane+4weeds	-	-	0.2	0.2	0.6	0.6	1.0
	Cane+8weeds	-	0.2	0.4	0.4	1.0	1.0	1.8
	Cane+2weeds	-	-	-	-	0.2	0.2	1.2
120 DAP	Cane+4weeds	-	-	-	-	0.2	0.2	2.0
	Cane+8weeds	-	-	-	-	0.6	0.6	3.4
	Cane+2weeds	-	-	-	-	-	-	1.4
Non-weeded	Cane+4weeds	-	-	-	-	-	-	0.4
	Cane+8weeds	-	-	-	-	-	-	0.2

Note: DAP indicates days after planting.

was recorded before weeding up to 180 DAP. Perhaps, it was due to the loose mat formation characteristics of the weed which may prevent the tiller outcome. At 180 DAP, Torpedo grass could not check tillering of sugarcane because of stunting growth of Torpedo grass. These results are in support with Malavla et al.[9] and Ishimane et al[4].

Sugarcane stalk length, stalk diameter, dry weight of stalk, dry weight of shoot, dry weight of root, dry weight of top and dry weight of green leaf were highest in the weed free cane and decreased in mixed cane as weeding were delayed (Table 4). In weed free cane, maximum stalk length of 148 cm, diameter of 2.22 cm, stalk dry weight of 183 g, shoot dry weight of 317 g, root dry weight of 104 g, top dry weight of 35 g and green leaf dry weight of 51 g were recorded. Accordingly minimum stalk length of 58 cm, diameter of 1.50 cm, stalk dry weight of 34 g, shoot dry weight of 84 g, root dry weight of 49 g, top dry weight of 13 g and green leaf dry weight of 24 g were noted in non-weeded cane. Weed infestation decreased stalk length by about 45-61%, diameter by about 25-32%, stalk dry weight by about 62-81%, shoot dry weight by about 56-73%, root dry weight by about 48-53%, top dry weight by about 40-63% and green leaf dry weight by about 45-53% compared to pure cane. However, the reduction of cane yield parameters due to weed infestation may be recovered satisfactorily to some extent by removing weed or suppressing weed growth. Weeding increased yield parameters compared to non-weeded cane. Early weeding increased yield parameters compared to prolong weed infested cane. The table also showed the only decreased top dry weight significantly in non-weeded cane. But some weeded cane showed higher top dry weight than weed free cane which may be due to the loss recovery

tendency by receiving proper weeding at final harvest.

Table 4. Effect of weeding time on the following parameters of sugarcane

Treatments		Stalk length (cm)	Stalk diameter (cm)	Stalk dry weight (g/pot)	Shoot dry weight (g/pot)	Root dry weight (g/pot)	Top dry weight (g/pot)	Green leaf dry weight (g/pot)
Weeding schedule	Weed density							
Weed free	Pure cane	148 (100)	2.22 (100)	183 (100)	317 (100)	104 (100)	35 (100)	51 (100)
30 DAP	Cane+2weeds	110** (74)	2.20 (99)	159** (87)	263** (83)	91 (88)	36 (103)	50 (98)
	Cane+4weeds	123** (83)	2.20 (99)	143** (78)	268** (85)	89 (86)	39 (111)	46 (90)
	Cane+8weeds	120** (81)	2.02 (91)	139** (76)	251** (79)	93 (89)	28 (80)	47 (92)
60 DAP	Cane+2weeds	105** (71)	2.10 (95)	116** (63)	223** (70)	87 (84)	34 (97)	47 (92)
	Cane+4weeds	120** (81)	1.86** (84)	108** (59)	206** (65)	77* (74)	33 (94)	46 (90)
	Cane+8weeds	104** (70)	1.84** (83)	98** (54)	190** (60)	91 (88)	28 (80)	42 (82)
120 DAP	Cane+2weeds	91** (62)	1.76** (79)	92** (50)	182** (57)	66** (88)	31 (89)	41 (80)
	Cane+4weeds	90** (61)	1.70** (77)	87** (48)	173** (55)	60** (58)	30 (86)	44 (86)
	Cane+8weeds	74** (50)	1.62** (73)	46** (25)	115** (36)	66** (64)	23** (66)	37 (73)
Non-weeded	Cane+2weeds	82** (55)	1.66** (75)	69** (38)	140** (44)	54** (52)	21** (60)	28** (55)
	Cane+4weeds	83** (56)	1.62** (73)	68** (37)	139** (44)	54** (51)	24** (69)	31** (61)
	Cane+8weeds	58** (39)	1.50** (68)	34** (19)	84** (27)	49** (47)	13** (37)	24** (47)

Note: *, ** Indicates significance of differences between control and other treatments at 5% and 1% level respectively (done by T-test). DAP indicates days after planting.

From Fig.4, it is revealed that maximum yield of sugarcane/pot (594g) was recorded in the weed free cane and minimum yield of sugarcane/pot (117g) in unweeded cane. Partially and prolonged weed infested cane gave significantly lower yield of cane compared to the weed free cane. Weed infestation decreased about 65-80% sugarcane yield, and is supported by the experimental results of Ishimine et al. [6], Peng and Twu[14] and Singh and Moolani[18]. Weeding increased 19-134% yield com-

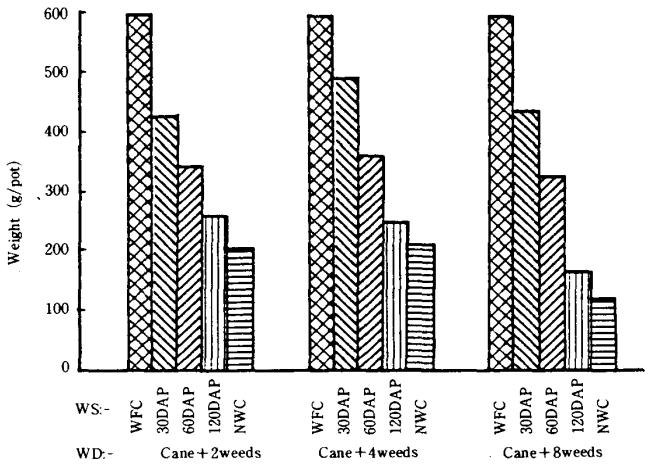

Fig. 4 Effect of weeding time on sugarcane yield
NOTE : WS=weeding schedule, WD=weed density, NWC=Non-weeded Cane, WFC=weed free Cane, DAP=Days after planting

pared to non-weeded cane and early weeding gave 45-97% higher yield compared to late weeded cane.

The table and all the figures showed that early weeding gave higher yield parameters. Early weeding (at 30 DAP) enhanced the early tillering and were received enough time to turn in to millable cane, ultimately resulted in higher cane yield.

The pots which were weeded at 30 DAP, showed no torpedo grass and no rhizome at final harvest due to possible of the complete uprooted of weed, at 60 DAP weeded cane, few Torpedo grass rhizome were seen in 13% pots at final harvest, and at 120 DAP weeded pots showed Torpedo grass rhizome in 100% pots at final harvest where complete uprooted was not possible due to the intermixing of roots of sugarcane and weeds.

The weed free cane elongation rate was high up to 150 DAP and the weed elongation rate was increased up to 150 DAP. Therefore, sugarcane field must kept free from Torpedo grass up to 150 DAP. For controling Torpedo grass and as well as for obtaining higher yields, it is suggested from the experimental results that the first removal of weeds are to be done within 30-60 DAP in all density of weed infesteted cane such cane + two weeds, cane + four weeds and cane + eight weeds.

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琉球列島のサトウキビ畑における雑草の生理・生態

第13報　ハイキビ（*Panicum repens* L.）の除草時期がサトウキビの初期生育に及ぼす影響

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摘　要

熱帯・亜熱帯地域の畑地にみられるイネ科多年生雑草ハイキビは、地下茎によって旺盛に繁殖し、畑地に群落を形成することから、農作物へ与える影響が大きい。本報では、ハイキビの除草時期がサトウキビの初期生育に及ぼす影響について調べ、サトウキビ畑におけるハイキビの合理的な除草時期を検討した。

実験は、1／2000aワグネルポットの中央にいずれも一節苗に揃えたサトウキビ（品種：F－160）を植え、その回りに二節苗に調整したハイキビの地下茎をそれぞれ2本植え、4本植え、8本植えし、さらに、それぞれを植付日から30日目除草区（30DAP）、60日目除草区（60DAP）、120日目除草区（120DAP）及び無除草区に分け実施した。対照区としてはサトウキビ、ハイキビそれぞれの単植区を設けた。

調査は、植付日から30日毎に210日目までサトウキビの草丈、茎長、茎径、分げつ数、ハイキビの草丈、分げつ数を計7回測定した。また、最終調査日の210日目には堀り取り調査を行い、サトウキビの茎重、

根重、葉面積、ハイキビの地上部重、根重を測定し、さらに除草区の中で、混植していた間に形成されたハイキビの地下茎残存の有無を調べた。

その結果、草丈の生長速度の急速な増加はサトウキビでは植付後60～90日の間に見られ（Fig.1）、ハイキビでは120日までの間に高い値を示した（Fig.2）。また両者とも150日まで草丈の伸長が高く、その後はゆるやかな伸長を示した。これらのことから、両者間の養分競合が植付後150日までの期間に起こることが考えられる。また、サトウキビの分げつは、いずれの区においても除草前には見られなかったが、除草後に見られた（Fig.3）。したがってハイキビがサトウキビの分げつを抑制していることが推察された。さらに、最終調査の結果、除草時期が遅延するにしたがって、サトウキビの茎長、茎径、茎重、根重は著しく減少した（Table 4）。また、無除草区の収量（茎重）はサトウキビ単植区に比べ70%減少という大きな数値を示した（Fig.4）。

一方、除草後にハイキビの地下茎が残存しているポットの割合は、30DAPでは0％、60DAPでは13%、120DAPでは100%であったことから、ハイキビの地下茎は植付日から30日以降に形成されると考えられる。

これらの実験の結果により、サトウキビの生育への影響および除草効果を考慮してハイキビの除草時期を検討すると、サトウキビの収量形質の減少が30日から次第に増え60日以降大きくなることから、ハイキビ2本植え、4本植え、8本植えのいずれの区においても、植付後30から60日以内の除草が適切と思われる。