

Effect of Different Planting Dates on Seed Production of Sudangrass. II. Germination Ability⁽¹⁾

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Received : Oct. 4, 2001; Accepted : Jun. 11, 2002

Abstract

Sudangrass (*Sorghum sudanense* Stapf) is a short-period forage crop adapted to growth in Taiwan. The objectives of this study were to determine the management method for forage and seed production of sudangrass and to determine the optimum planting date for seed production. Sudangrass, CV. Taishi No. 1, was planted in March, May, July and September for 2 years. The seeds were harvested from the sown plants and the ratoon plants after seed harvesting and cutting. Germination tests were conducted immediately after seed harvesting and 6 months after storage at 4°C and at ambient temperature, respectively. The seeds harvested from the sown plants planted in September had the highest germination ability among the four planting months. No significant difference was observed between germination percentages of sudangrass seeds harvested from the sown plants and those from the first ratoon plants. However, seed germination percentages and germination rate indices (GRI) decreased severely from the second ratoon plants as compared to those from the sown plants or the first ratoon plants. The seeds harvested from the ratoon plants were more deteriorated than those seeds of the sown plants stored at ambient temperature for 6 months. Germination percentages and GRIs of sudangrass seeds harvested from the sown plants were not significantly different from those harvested from the first ratoon plants after cutting in the first year. However, the germination ability of the seeds harvested from the first ratoon plants after cutting were higher than those from the sown plants in the second year. Both germination percentages and GRIs of the seeds germinated immediately after harvesting and storing at 4°C for 6 months were higher than those at ambient temperature for 6 months. It was suggested that sudangrass could be planted in July and the seeds harvested in October first. Then the ratoon plants could be cut for forage.

Key words : *Sorghum sudanense*, Planting date, Germination ability, Ratoon plant.

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Introduction

Sudangrass (*Sorghum sudanense* Stapf) is a tropical forage species with short growth period. It is productive, drought tolerant, nutritious, tillering and capable of regrowth after cutting. It has high content of crude protein and low amounts of crude fiber and hydrocyanic acid. It is adapted to growth in Taiwan and is used for forage.

Sudangrass CV. Taishi No. 1 was registered for release by the Taiwan Livestock Research Institute, Council of Agriculture (Shaug *et al.* 1997). It is seed-propagated and the seeds can be produced by the farmers themselves. Seed maturity of sudangrass was not uniform because the blooming period lasted over 58 days (Hsu *et al.*, 1999). Hsu and Hong (1999) reported that sudangrass could be planted before May to get more cuts in order to produce higher forage yield. Hsu *et al.* (2000) indicated that the emergence percentage of sudangrass was reduced by waterlogging immediately after sowing. In addition, the hypocotyl or the radicle cortex of sudangrass with a low germination or emergence percentage was damaged during waterlogging. Lin *et al.* (2001) showed that the agronomic traits and the chemical compositions of sudangrass were not affected when harvested at the milk stage and confirmed that sudangrass could recover rapidly from waterlogging stress.

Information about the optimum planting date and the methods of producing both the forage and seeds of sudangrass were little known. The objectives of this study were to determine the effects of different planting dates and production methods for both forage and seed production of sudangrass. Further, the germination ability of the seeds harvested from different planting dates and production methods were determined.

Materials and Methods

Seeds of sudangrass, CV. Taishi No. 1, were planted on July 15 and September 17, 1997 and March 15 and May 15, 1998 for the first year, and on July 16 and September 15, 1998 and March 15 and May 14, 1999 for the second year, respectively. The split plot design, with the planting date as the main plot and the method of seed production as the subplot was used. Each treatment had four replications. The plot areas of subplots were $4\text{ m} \times 4.2\text{ m} = 16.8\text{ m}^2$. Each plot had 6 rows with 70 cm wide between rows. One hundred and twenty seeds were planted in each row. Newly emerged seedlings were marked with a toothpick inserted into the soil near the emerged seedling. The work was conducted daily until no emergence occurred for 5 to 7 days. Emergence percentage was calculated and arcsin-transformed prior to statistical analysis (Snedecor and Cochran, 1980). Both emergence percentage and emergence rate index (ERI) were used to evaluate emergence ability. The ERI, as proposed by Hsu and Nelson (1986), was calculated as the summation of the emergence percentage at each counting date divided by the days after planting. The survival plants were determined by counting the live plants of the third row at the third leaf stage and the survival percents of the plants were calculated. Then the seedlings were thinned down to 40 plants in each row.

Three models of seed production were used as follows : Model A – the seeds were harvested from the sown plants and from the 2 consecutive ratoon plants. A_0 , A_1 and A_2 indicated the seeds harvested from the sown plants and the first and the second ratoon plants after seed harvesting, respectively. Model B—the

seeds were harvested from the sown plants. Then the first and the second ratoon plants were cut for forage. B₀, B₁ and B₂ indicated the seeds harvested from the sown plants and the plants cut for forages from the first and the second ratoon plants, respectively. Model C—the plants were cut for forages from the sown plants at milk stage. Then the seeds were harvested from the first ratoon plants and the plants were cut for forage from the second ratoon plants after seed harvesting. C₀, C₁ and C₂ indicated the plants cut for forages from the sown plants and the seeds harvested from the first ratoon plants and the plants cut for forage from the second ratoon plants, respectively.

All the harvesting seeds were divided into three parts. The first part had their germination test immediately after harvesting (G). The other two parts were stored at 4°C (F) and at ambient temperature (R) for six months, respectively. Then the seeds were used for the germination test. Since the seeds of both A₀ and B₀ were harvested from the sown plants, those of A₀ were only used for the germination test.

For germination test, the Petri dishes with a diameter of 9 cm were used. A piece of sponge with the same diameter as the dish was used and absorbed with enough distilled water. One filter paper was put on the top of the sponge. Then, 50 seeds of sudangrass for each treatment were uniformly distributed on the filter paper. A completely randomized design (CRD) with 5 replications was used. The Petri dishes were then put in the incubator at 25°C with an 8 hour light period. The seeds were considered germinated when the radicle reached 2 mm. Germinated seeds were counted and removed twice daily during the first week after incubation and once daily after that, and thereafter until the end of germination test.

The germination ability was expressed by final germination percentage and germination rate index (GRI). Germination rate index, as proposed by Hsu *et al.* (1985), was calculated and statistical analysis was done similar to the ERI as mentioned above.

Results and Discussion

For both years, germination percentages of the seeds harvested from the plants planted in September were the highest and those planted in March the lowest (Table 1). Germination rate indices (GRI) were the highest for the seeds harvested from the plants planted in May and September. This showed that the seeds harvested from the plants sown in September had the highest germination ability among the four planting months. Hsu *et al.* (1986) indicated that perennial warm-season forage grasses planted between late April and mid-May could maximize emergence percentages and reduce the risks of high temperature and soil moisture stress in the Central States of U.S.A. Wilson and Trawatha (1991) reported that delaying planting of shrunken-2 sweet corn until mid-June lowered maximum attainable field emergence to 30% ~ 40%. These results showed that the planting date would affect seed vigor. The same results were shown in this study.

Table 1. Germination percentages and germination rate indices of sudangrass seeds harvested from the plants sown in different months

Planting month	Germination percentage			Germination rate index		
	1st year	2nd year	Mean	1st year	2nd year	Mean
	%			% day ⁻¹		
March	88.4 ^b	72.4 ^c	80.4 ^c	23.7 ^{ab}	12.3 ^b	18.0 ^c
May	94.4 ^{ab}	89.2 ^b	91.8 ^b	24.6 ^a	23.9 ^a	24.3 ^a
July	91.6 ^{ab}	86.8 ^b	89.2 ^b	21.8 ^b	22.5 ^a	22.1 ^b
September	96.4 ^a	95.2 ^a	95.8 ^a	23.1 ^{ab}	24.2 ^a	23.7 ^a

^{a,b,c} Means with the same letter in the same column are not significantly different at 5% level.

No significant difference was observed between germination percentages of sudangrass seeds harvested from the sown plants and those from the first ratoon plants after seed harvesting except for those planted in September (Table 2). Similar results were also observed in GRIs. Further, germination ability was compared among the sown plants, the first and the second ratoon plants after seed harvesting planted in July for both years (Table 3). Germination percentages and GRIs decreased for the seeds harvested from the second ratoon plants as compared to those from the sown and the first ratoon plants when the seeds were germinated immediately after harvesting and storing at 4°C and at ambient temperature for 6 months, respectively (Table 3). Both germination percentages and GRIs of the sudangrass seeds were significantly different among the three seed sources, i.e., A₀, A₁ and A₂, especially when stored at ambient temperature for 6 months. This showed that the seeds harvested from the ratoon plants after seed harvesting deteriorated more than those harvested from the sown plants stored at ambient temperature. Hsu *et al.* (1999) reported that the panicle weight, 1000-seed weight and germination ability of sudangrass seeds harvested from the ratoon plants were lower than those harvested from the sown plants.

Table 2. Germination percentages and germination rate indices of sudangrass seeds harvested from the sown plants and the ratoon plants after seed harvesting planted in different months

Planting month	Plant status	Germination percentage			Germination rate index		
		1st year	2nd year	Mean	1st year	2nd year	Mean
		%			% day ⁻¹		
March	A ₀ [#]	88.4 ^a	72.4 ^a	80.4 ^a	23.7 ^b	12.3 ^b	18.0 ^a
	A ₁	91.6 ^a	70.8 ^a	81.2 ^a	27.8 ^a	18.2 ^a	23.0 ^a
May	A ₀	94.4 ^a	89.2 ^a	91.8 ^a	24.6 ^a	23.9 ^a	24.3 ^a
	A ₁	92.4 ^a	79.6 ^b	86.0 ^a	27.2 ^a	18.5 ^b	22.8 ^a
July	A ₀	91.6 ^a	86.8 ^a	89.2 ^a	21.8 ^b	22.5 ^b	22.1 ^b
	A ₁	90.8 ^a	88.4 ^a	89.6 ^a	28.5 ^a	25.3 ^a	26.9 ^a
September	A ₀	96.4 ^a	95.2 ^a	95.8 ^a	23.1 ^a	24.2 ^a	23.7 ^a
	A ₁	80.4 ^b	63.6 ^b	72.0 ^b	20.1 ^b	11.6 ^b	15.9 ^b

[#] A₀ and A₁ indicate the sown plants and the ratoon plants after seed harvesting, respectively.

^{a,b} Means with the same letter within the same planting month in the same column are not significantly different at 5 % level.

Table 3. Germination percentages and germination rate indices of sudangrass seeds harvested from the sown and the ratoon plants stored under different conditions

Stored condition	Plant status	Germination percentage			Germination rate index		
		1st year	2nd year	Mean	1st year	2nd year	Mean
		%			% day ⁻¹		
G [#]	A ₀ [§]	91.6 ^b	86.8 ^a	89.2 ^a	21.8 ^b	22.5 ^b	22.1 ^{ab}
	A ₁	90.8 ^b	88.4 ^a	89.6 ^a	28.5 ^a	25.3 ^a	26.9 ^a
	A ₂	98.0 ^a	46.4 ^b	72.2 ^a	28.2 ^a	7.2 ^c	17.7 ^b
F	A ₀	80.8 ^c	84.8 ^a	82.8 ^a	17.7 ^c	21.9 ^a	19.8 ^a
	A ₁	88.0 ^b	91.2 ^a	89.6 ^a	21.9 ^b	24.2 ^a	23.1 ^a
	A ₂	96.8 ^a	56.4 ^b	76.6 ^a	27.7 ^a	10.1 ^b	18.9 ^a
R	A ₀	96.4 ^a	90.0 ^a	93.2 ^a	32.2 ^a	21.1 ^a	26.6 ^a
	A ₁	73.2 ^b	76.8 ^b	75.0 ^b	13.4 ^c	18.8 ^b	16.1 ^b
	A ₂	83.6 ^b	32.8 ^c	58.2 ^b	17.4 ^b	4.5 ^c	11.0 ^b

G, F and R indicate germination test immediately after seed harvesting and 6 months after storing at 4 °C and at ambient temperature, respectively.

§ A₀, A₁ and A₂ indicate the sown plants, the 1st and the 2nd ratoon plants after seed harvesting, respectively.

^{a,b,c} Means with the same letter within the same stored condition in the same column are not significantly different at 5 % level.

Germination percentages and the GRIs of sudangrass seeds harvested from the sown plants were not significantly different from those harvested from the ratoon plants after cutting in the first year except for those planted in September. However, germination percentages of the seeds harvested from the ratoon plants were significantly higher than those from the sown plants in the second year except for those planted in September (Table 4). No significant difference was observed for GRIs between the seeds harvested from sown and ratoon plants after cutting except for those planted in March. The results indicated that the germination abilities of the seeds harvested from the ratoon plants after cutting were similar to or higher than those harvested from the sown plants. The results were different from those observed from the ratoon plants after seed harvesting (Table 3). It seemed likely that the ratoon plants after cutting had more energy available to supply the plants to produce seeds than they did after seed harvesting.

Table 4. Germination percentages and germination rate indices of sudangrass seeds harvested from the sown plants and the ratoon plants after cutting planted in different months

Planting month	Plant status	Germination percentage			Germination rate index		
		1st year	2nd year	Mean	1st year	2nd year	Mean
		%			% day ⁻¹		
March	A [#]	88.4 ^a	72.4 ^b	80.4 ^b	23.7 ^a	12.3 ^b	18.0 ^b
	C	88.8 ^a	95.2 ^a	92.0 ^a	23.1 ^a	27.9 ^a	25.5 ^a
May	A	94.4 ^a	89.2 ^a	91.8 ^a	24.6 ^a	23.9 ^a	24.3 ^a
	C	90.8 ^a	91.6 ^a	91.2 ^a	25.4 ^a	22.2 ^a	23.8 ^a
July	A	91.6 ^a	86.8 ^b	89.2 ^a	21.8 ^a	22.5 ^a	22.1 ^a
	C	82.0 ^b	98.8 ^a	90.4 ^a	18.4 ^a	22.8 ^a	20.6 ^a
September	A	96.4 ^a	95.2 ^a	95.8 ^a	23.1 ^a	24.2 ^a	23.7 ^a
	C	91.6 ^b	91.6 ^a	91.6 ^b	19.8 ^b	26.5 ^a	23.1 ^a

A and C indicate the sown plants and the ratoon plants after cutting, respectively.

^{a,b} Means with the same letter within the same planting month in the same column are not significantly different at 5 % level.

Comparing the germination ability of the sudangrass seeds harvested from the sown plants and the ratoon plants after cutting under different stored conditions, the results showed that the germination abilities of G and F were higher than those of R for the seeds harvested from both the sown and ratoon plants for the two years (Table 5). In addition, germination percentages and GRIs of the seeds harvested from the ratoon plants after cutting were higher than those harvested from the sown plants at any stored conditions in the second year.

Table 5. Germination percentages and germination rate indices of sudangrass seeds harvested from the sown plants and the ratoon plants after cutting stored under different conditions

Plant status	Stored condition	Germination percentage			Germination rate index		
		1st year	2nd year	Mean	1st year	2nd year	Mean
		%			% day ⁻¹		
A [§]	G [#]	92.7 ^{aM}	85.9 ^{aN}	89.3 ^{aM}	23.3 ^{aM}	20.7 ^{aN}	22.0 ^{aM}
	F	89.6 ^{aM}	87.1 ^{aN}	88.4 ^{aM}	21.7 ^{aM}	21.5 ^{aN}	21.6 ^{aN}
	R	92.4 ^{aM}	79.9 ^{bN}	86.2 ^{aM}	23.5 ^{aM}	16.9 ^{bN}	20.2 ^{aM}
C	G	88.3 ^{aN}	94.3 ^{aM}	91.3 ^{aM}	21.7 ^{aM}	24.8 ^{abM}	23.2 ^{aM}
	F	88.5 ^{aM}	91.7 ^{abM}	90.1 ^{aM}	22.0 ^{aM}	26.9 ^{aM}	24.5 ^{aM}
	R	75.9 ^{aN}	89.5 ^{bM}	82.7 ^{bM}	16.1 ^{bN}	22.0 ^{bM}	19.0 ^{bM}

§ As shown in Table 4.

As shown in Table 3.

^{a,b} Means with the same small letter within the same plant status in the same column are not significantly different at 5 % level.

^{M,N} Means with the same capital letter within the same stored condition in the same column are not significantly different at 5 % level.

Based on the results obtained, it was suggested that sudangrass could be planted in July to harvest seeds in October first. Then the ratoon plants be cut for forage. This management method might be more profitable than the other methods.

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不同播種期對蘇丹草採種模式之研究

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收件日期：90 年 10 月 4 日；接受日期：91 年 6 月 11 日

摘 要

蘇丹草 (*Sorghum sudanense* Stapf) 是一種適於台灣種植的短期芻料作物。本試驗研究的目的，乃在於探討蘇丹草適當的播種期及採種模式，及不同採種模式下的種子發芽力，以供栽培管理之參考。蘇丹草台畜草一號種子分別於三、五、七及九月各播種一次，進行 2 年，將不同採種模式所收穫的種子分為三種處理作發芽試驗。一種處理為種子採收後立即作發芽試驗，另外二種處理分別將種子貯存於 4℃ 及室溫下 6 個月後才作發芽試驗。在四種播種期中，以九月播種所採收的種子發芽力最高，種植植株與第一次採種後再生植株所採收的種子發芽率沒有顯著差異，但第二次採種後再生植株所採收的種子發芽率及校正發芽速率指數(GRI) 則比前兩者所採的種子為低。再生植株所採收的種子於室溫貯存 6 個月後比當期種植植株所採收者較易劣變，第一年割後再生植株所採收的種子發芽力與當期種植植株所採收者沒有差異，但第二年則前者的發芽力比後者為高。採收後的種子發芽力及在 4℃ 下貯存 6 個月後之發芽力均比在室溫下貯存 6 個月者為高。根據試驗結果建議蘇丹草採種時，宜於七月播種，採種後的植株可令其再生收割供芻料用。

關鍵詞：蘇丹草、播種期、發芽力、宿根植株。

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