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Effects of Planting Date and Tiller Removal on Growth and Yield of Sweet Corn Hybrids

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播種期와 蘗子除去가 단옥수수의 生育 및 收量에 미치는 影響

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Summary

Two sweet corn hybrids, 'Tanok 1' and 'Golden Cross Bantam 70 (GCB 70)' were grown on four planting dates (April 16 with or without transparent polyethylene mulch, April 30 and May 14), with or without tiller removal, to determine effects of tiller removal on growth and yield of sweet corn hybrids on various planting dates. the results obtained are summarized as follows :

1. The number of tillers per plant ranged 1.15 to 2.23 for Tanok 1 and 0.18 to 2.23 for GCB 70 depending on the planting dates.

2. There was no difference between Tanok 1 and GCB 70 for ear length, the number of ears per plant and per 10 ares. Tanok 1 had larger leaf area index (LAI) and stover yield than GCB 70, while GCB 70 had greater ear diameter and weight than Tanok 1.

3. The days from planting to silking decreased, delaying the plantings. The transparent polyethylene film mulch hastened silking by 9 days.

4. Compared with the earlier plantings, May 14 planting significantly reduced ear height, LAI, ear length and diameter, ear weight, and ear and stover yields.

5. Tiller removal reduced LAI and ear height but did not significantly reduce pollen shedding and silking dates, plant height, ear length and diameter, ear weight, the number of ears per plant and per 10 ares, or ear and stover yields.

6. Interaction between hybrid and tiller removal was significant for LAI, ear and filled ear length. Interaction between planting date and tiller removal was significant only for LAI.

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Introduction

The tillers of corn plants are basal branches of the main plant and retain a vascular connection with it, but develop an independent root system. [12]

Tiller prodution of corn is both genetically and environmentally controlled. Nearly all cultivars of sweet corn tiller more or less abundantly. [3, 5, 10]

However, modern dent corn cultivars tiller relatively infrequently and usually senesce before silking under intensive cultural condi-n. [13]

The optimal amount of available nutrient (especially nitrogen) markedly promotes tiller production. [4] Tiller production of corn is greatest when soil moisture is plentiful. [8] Tiller production is reduced by increased plant density. [3, 4, 10, 14]

In Korea, manual removal of tillers has been practiced in sweet corn production [11] Growers believe that plant performance is better if tillers are removed. However, removal of tillers has usually reduced yield of sweet corn. Also, there is some evidence that the presence of active, barren tillers may be an important characteristic for reducing maize yield losses, where environmental stress limits nutrient absorption and assimilation during late vegetative and early reproductive growth. [1, 13, 15]

Lee et al. [7] reported that grain yield of a field corn hybrid was similar among the three plantings (March 26, April 10 and April 25) but decreased as planting was delayed after the critical planting date in Suwon. Cho et al. [2] also observed that grain yield of two field corn hybrids was significantly decreased by delaying planting from May 5 to June 15 in Suwon. However, it seems that the effect of planting date on growth and yield of sweet corn hybrids has not been evaluated although sweet corn has been commercially grown in Korea since 1973. [11] Tiller removal effect on agronomic characteristics of sweet corn grown at various planting dates also has not been determined. The objective of this study was to determine the effect of tiller removal on growth and yield of sweet corn grown on the different planting dates and hybrid x tiller removal and planting date x tiller removal interactions.

Materials and Methods

A field trial was conducted on an upland field of the Crop Experiment Station at Suwon in 1984. The experiment consisted of all combinations of two hybrids ('Tanok 1' and 'Golden Cross Bantam 70'), four planting dates (April 16 with or without transparent polyethylene mulch, April 30 and May 14), and two tiller removal treatments (control and removal) in a split-split design. Each sub-subplot (tiller removal treatment) was replicated four times within each subplot per planting date of each hybrid. The smallest experimental unit was four rows of 5 m. Tillers were pulled when less than 15 cm tall.

Seeds were planted by corn jabber, two per hill, and plants were thinned to one per hill at 3 to 4 leaf stage. Hills were 25 cm apart within 60 cm rows, to give a population of 6670 plants per 10 ares. At planting, fertilizer was applied at the rate of 15, 13 and 13 kg per 10 ares for N, P_2O_5, and k_2O, respectively. Weeds were controlled by

preemergence application of alachlor and simazine at 74 and 35 g per 10 ares, and by hand-weeding as necessary.

The green leaf areas of four plants per plot were determined at silking. Leaf area was calculated as length x width x 0.75[9] At 25 days after silking, data were recorded for plant height, ear height and lodging, and two center rows were harvested for ear and stover yields. Ears were husked and graded by size as either marketable or cull. Marketable ears had at least 13 cm of grains. Ear characters were determined using marketable husked ears.

Results and Discussion

Tanok 1 produced about 2 tillers per plant up to at April 30 planting and 1.2 tillers at May 14 planting(Table 1). However, GCB 70 had less than 1 tillers per plant with the exception of the April 16 planting with the transparent polyethylene mulch where 2.2 tillers were produced in a plant. Park et al.[10] also reported that Tanok 1 tillered approximately twice as many as GCB 70 at the various plant densities.

Table 1. The number of tillers of two control sweet corn hybrids at silking as affected by planting date.

Planting date	No. of tillers per plant		
	Tanok 1	GCB 70	Mean
Apr. 16+M	1.93	2.23	2.08
Apr. 16	1.95	0.73	1.34
Apr. 30	2.23	0.70	1.46
May 14	1.15	0.18	0.66
LSD (0.05)	0.51	0.51	0.36

M indicates transparent polyethylene film mulch.

Since pollen shedding and silking dates were not signficantly affected by the tiller removal treatments, the average date of pollen shedding and silking as affected by the planting date is shown in Table 2. The transparent polyethylene film mulch hastened both pollen shedding and silking of two hybrids by 9 days. A 14-day delay in planting without the mulch resulted in delay in pollen shedding and silking of 4 to 8 days. The days from planting to silking decreased with the delay of the planting from April 16 to May 14(Table 4) due to increased air temperature.[2,7]

Mean squares from the analysis of variance for various agronomic characters are presented in Table 3. Since hybrid x planting date, hybrid x tiller removal, planting date x tiller removal, and hybrid x planting date x tiller removal interactions are not significant at 5% probability level for the days from planting to silking, ear height and ear diameter, only main effects of treatments for these characters are given in Table 4.

Table 2. Pollen shedding and silking dates of two sweet corn hybrids as affected by planting date.

Planting date	Pollen shedding date		Silking date	
	Tanok 1	GCB 70	Tanok 1	GCB 70
Apr. 16+M	June 23	June 15	June 24	June 16
Apr. 16	July 2	June 24	July 3	June 25
Apr. 30	July 7	June 28	July 10	July 1
May 14	July 15	July 6	July 18	July 9

M indicates transparent polyethylene film mulch.

Table 3. Mean squares from analysis of variance for various agronomic characters of two sweet corn hybrids.

Source of variation	df	Days to silking	Plant height	Ear height	Leaf area index	Ear length	Filled ear length
Block	3	17.04+	280.2+	51.5	0.62	1.75	1.61
Hybrid(H)	1	1260.25**	1463.1**	3751.6**	33.26**	3.11+	1.96
Error A	3	2.29	37.9	22.6	0.15	0.51	0.67
Planting date (PD)	3	520.13**	428.4+	122.9**	5.71**	6.48**	5.06+
H×PD	3	1.38	765.9**	42.6	2.59**	0.39	10.74**
Error B	18	2.24	142.3	22.6	0.38	1.17	1.66
Tiller removal (TR)	1	2.25	100.0	175.6**	13.91**	0.83	0.64
H×TR	1	1.00	1.0	0.3	2.12**	2.29*	2.98*
PD×TR	3	0.88	135.8	9.6	0.76**	0.88	0.79
H×PD×TR	3	0.63	46.9	12.8	0.25	2.36**	1.93*
Error C	24	0.89	40.6	8.8	0.12	0.49	0.53

Source of variation	df	Ear diameter	Ear weight	No. of ears/ plant	No. of ears/ 10a	Ear yield	Stover yield
Block	3	0.05	793	0.02	991239	64562	468878
Hybrid(H)	1	1.29*	458**	0.17	6965641	401639+	5688225*
Error A	3	0.04	58	0.06	2640316	69621	452911
Planting date (PD)	3	0.69**	7388**	0.02	529068	248963**	12731875**
H x PD	3	0.10	1831	0.12**	5219486**	258882**	245386
Error B	18	0.06	339	0.01	619846	17118	185201
Tiller removal (TR)	1	0.01	11	0.02	604506	18225	172225
H×TR	1	0.03	827+	0.00	10920	5929	68
PD×TR	3	0.01	169	0.01	654372	31822	520057
H×PD×TR	3	0.02	59	0.01	340225	11781	4158
Error C	24	0.04	236	0.02	838021	24816	104199

+, *, **Signficant at the 0.10, 0.05 and 0.01 probability levels, respectively.

Table 4. Some agronomic characters of sweet corn as affected by hybrid, planting date and tiller removal.

Treatment	Days to silking	Plant height	Ear height	Ear diameter [1]
		cm		
Hybrid				
Tanok 1	70.9	163.7	71.7	3.9
GCB 70	62.1	154.1	56.4	4.2
LSD (0.05)	1.2	4.9	3.8	0.2
Planting date				
Apr. 16+M	65.1	162.4	64.5	4.2
Apr. 16	74.3	162.8	67.3	4.1
Apr. 30	66.1	158.8	64.0	4.1
May 14	60.6	151.6	60.5	3.8
LSD(0.05)	1.1	NS	3.5	0.2
Tiller removal				
Control	66.7	160.2	65.7	4.0
Removal	66.3	157.7	62.4	4.1
LSD(0.05)	NS	NS	1.5	NS

1) Ear diameter was measured using marketable husked ears.
M indicates transparent polyethylene film mulch.
NS=Not significant at the 0.05 probability level.

Although hybrid x planting date interaction was significant for plant height, plant height was shown with ear heght in Table 4. Snice planting date x tiller removal interaction was significant for only leaf area index (LAI) and hybrid x planting date or hybrid x tiller removal interaction was significant except for the number of days from planting to silking, ear height and ear diameter, the effets of planting date and tiller removal on LAI and the other characters of two hybrid were presented in Table 5.

Plant height of two hybrids was not affected by either planting date or tiller removal treatment. Ear heights of Tanok 1 and GCB 70 were 71.7 and 56.4 cm, respectively. Ear height at May 14 planting was shorter than at the other plantings. Ear height was reduced by the tiller removal. Tanok 1 had sightly less ear diameter than GCB 70. Ear diameter at the May 14 planting was less than at the earlier plantings and was not influenced by the tiller removal.

Tanok 1 had much greater LAI at silking

than GCB 70. LAI of Tanok 1 was about 4, except at the May 14 planting, at which LAI was 2.2, while LAI of GCB 70 ranged from 1.9 to 2.5. Tiller removal reduced LAI in Tanok 1 more than in GCB 70, since Tanok 1 had more tillers per plant than GCB 70 (Table 1 and 5). This result is similar to that reported by Park et al.[10]

Table 5. Leaf area index at silking, and ear characters[1] and yield of two sweet corn hybrids at harvest as affected by planting date and tiller removal.

Treatment	Leaf area index		Ear length		Filled ear length		Ear wt.	
	Tanok 1	GCB 70	Tanok 1	GCB 70	Tanok 1	GCB 70	Tanok 1	GCB 70
			cm				g/ear	
Planing date								
Apr. 16+M	4.00	2.52	18.0	18.4	14.1	16.2	150	191
Apr. 16	4.06	2.25	17.7	18.0	16.4	15.5	153	155
Apr. 30	4.25	2.08	17.4	17.6	16.7	15.5	154	149
May 14	2.16	1.85	16.3	17.1	14.3	15.7	106	132
LSD[a] (0.05)	0.65		1.1		1.4		19	
Tiller removal								
Control	4.26	2.46	17.6	17.7	15.7	15.6	145	154
Removal	2.97	1.89	17.0	17.9	15.0	15.8	137	160
LSD[b] (0.05)	0.25		0.5		0.5		NS	

Treatment	Ear no/plant		Ear no/10a		Ear yield		Stover yield	
	Tanok 1	GCB 70	Tanok 1	GCB 70	Tanok 1	GCB 70	Tanok 1	GCB 70
					kg/10a			
Planing date								
Apr. 16+M	0.54	0.89	3592	5917	541	1079	4353	3558
Apr. 16	0.72	0.70	4800	4642	709	711	4115	3185
Apr. 30	0.71	0.80	4733	5208	750	776	3410	2797
May 14	0.69	0.68	4528	4525	491	559	2208	1861
LSD (0.05)	0.13		827		137		236	
Tiller removal								
Control	0.67	0.79	4497	5183	649	788	3572	2978
Removal	0.65	0.74	4329	4963	596	774	3470	2872
LSD (0.05)	NS		NS		NS		NS	

1) Ear characters were measured using marketable husked ears.

M indicates transparent polyethylene film mulch.

LSD[a] for a comparison of the two planting date means at the same or different hybrid.

LSD[b] for a comparison of the two tiller removal treatment means within a hybrid.

NS=Not significant at the 0.05 probability level.

Tanok 1 and GCB 70 had similar ear and filled ear lengths (Table 3 and 5). Ear length of two hybrids tended to decrease as planting was delayed. Filled ear length was not consistently influenced by planting date in Tanok 1 and was not significantly affected in GCB 70. Tiller removal reduced ear and filled ear lengths of Tanok 1 but did not reduce those of GCB 70.

Ear weight of Tanok 1 was about 150 g per ear at April 16 and 30 plantings but 106 g at the May 14 planting. Ear weight of GCB 70 was increased by the mulch and tended to decrease with the delay in planting. Ear weight of two hybrids was not significantly affected by tiller removal.

The number of ears per plant and per 10 ares was not consistently influenced by planting date and was not significantly affected by either hybrid or the tiller removal.

Ear yield of GCB 70 was 25% higher than that of Tanok 1 ($p<0.10$. Table 2 and 5). Ear yield was reduced in Tanok 1 but was increased in GCB 70 by the mulch. Ear yield of two hybrids at May 14 was slightly lower than at April 16 and 30 plantings. Ear yield was not significantly affected by the tiller removal. Park et al.[10] reported that Tanok 1 and GCB 70 had similar ear yield and tiller removal reduced ear yield by 10% ($p<0.10$). Hong et al.[5] observed that removal of first tiller per plant did not affect sweet corn yield but removal of more than two tillers markedly reduced yield

Sweet corn stover is usually utilized for cattle. Stover yield of Tanok 1 was 20% higher than that of GCB 70. Stover yield of two hybrids tended to decrease with the delay in planting and was not significantly influenced by the tiller removal. Park et al., however, reported that Tanok 1 had greater stover yield than GCB 70 and tiller removal reduced stover yield by 16%.

Since the price of sweet corn decreases as marketing of sweet corn is delayed[11], income of earlier plantings is better tnan that of late plantings. Based on these results and those of Hong et al[5]., Jones et al[6]. and Park et al.[10], tiller removal has no advantage at any planting date for sweet corn production. However, tiller removal may facilitate spray, or dusting and harvest.

摘　　要

播種期를 달리할 때 蘖子除去가 단옥수수의 生育 및 收量에 미치는 影響을 究明하고자 단옥 1호와 Golden Cross Bantam 70 (GCB 70)을 4月 16日(투명 폴리에칠렌 멀칭 및 무멀칭), 4月 30日, 5月 14日에 각각 播種하여 蘖子의 草長이 15㎝일 때 蘖子를 除去하는 區와 除去하지 않은 區의 生育 및 收量을 조사한 結果를 요약하면 다음과 같다.

1. 播種期에 따른 개체당 蘖子數는 단옥 1호에서는 1.15-2.23개 였고 GCB 70에서는 0.18-2.23개였다.

2. 穗長 및 株當 또는 10a당 이삭수는 交雜種間 유의한 차이가 없었지만 出穗까지 日數, 稈長, 着穗高, 葉面積指數, 稈葉重은 단옥 1호가 GCB 70보다 큰 반면 穗經 및 穗重은 GCB 70이 단옥 1호보다 컸었다.

3. 出絲까지 日數는 播種期가 遲延됨에따라 감소되었고, 폴리에칠렌멀칭에 의해서 약 9일 短縮되었다.

4. 5月 14日 播種區에서는 着穗高, 葉面積指數, 穗長, 穗經, 穗重, 이삭 및 稈葉收量이 早播에 비하여 크게 감소되었다.

5. 蘖子除去에 의하여 着穗高 및 葉面積指數가 감소되었으나 出絲期, 稈長, 穗經, 穗重, 주당

또는 10당 이삭수, 10a당 이삭 및 稈葉収量은 크게 영향을 받지 않았다.

6. 交雜種과 雄子除去間 交互作用은 葉面積指數, 穗長 및 着粒 穗長에서 有意하였고 播種期와 雄子除去間 交互作用은 葉面積指數에서만 有意하였다.

Literature Cited

1. Alofe, C. O. and L. E. Schrader. 1975. Photosynthate translocation in tillered *Zea mays* following $^{14}CO_2$ assimilation. Can. J. Plant Sci. 55 : 407-414.
2. Cho, J. Y., H. J. Kwon, Y. K. Kang and S. K. Jong. 1983. Effect of plant density and planting date on growth and grain yield of maize hybrids. Korean J. Crop Sci. 28(2) : 227-232.
3. Crockett, R. F. and R. K. Crookston. 1980. Tillering of sweet corn reduced by clipping of early leaves. J. Amer. Soc. Hort. Sci. 105 : 565-567.
4. Dungan, G. H., A. L. Lang and J. W. Pendleton. 1958. Corn plant population in relation to soil productivity. Adv. Agron. 10 : 435-473.
5. Hong, C. K., H. K. Min, S. K. Han and B. Y. Huh. 1983. Effects of tiller removing on growth and yield of sweet corn, *Zea mays* L. Res. Rept. ORD 25(C) : 195-199.
6. Jones. D. F., W. R. Singleton and L. C. Curtis. 1935. The correlation between tillering and productiveness in sweet corn crosses. J. Amer. Soc. Agron. 27 : 138-141.
7. Lee, S. S., K. Y. Park and S. K. Jung. 1981. Growth duration and grain and silage yields of maize at different planting dates. Korean J. Crop Sci. 26(4) : 337-343.
8. McCrory, S. A. 1942. Heat and drought tolerance of sweet corn as influenced by tillers. Proc. Amer. Soc. Hort Sci. 40 : 424-428.
9. Montgomery, E. C. 1911. Correlation studies of Corn. Nebraska Agric. Exp. Sta. 24th Ann. Rep. Univ. of Nebraska, Licoln, Nebraska, USA.
10. Park, K. Y., Y. K. Kang, S. E. Park and H. G. Moon. 1989. Effects of planting density and tiller removal on growth and yield of sweet corn hybrids. Korean J. Crop Sci. 34(2) : 192-197.
11. Park, K. Y., S. E. Park, B. H. Choi, H. G. Moon and R. K. Park. 1987. Present situation and problems in growing sweet corn. Korean J. Crop Sci. 32 (Suppl. 2) : 46-47.
12. Rosenquist, C. E. 1941. The effect of tillers in corn upon the development of the main stalk. J. Amer. Soc. Agron. 33 : 915-917.
13. Russelle, M. P., J. A. Schild and R. A. Olson. 1984. Phosphorus translocation between small, non-productive tillers and the main plant of maize. Agron. J. 76 : 1-4.
14 Tetio-Kagho, F. and F. P. Gardner, 1988. Responses of maize to plant population density. I. Canopy development, light relationship, and vegetative growth. Agron J. 80 : 930-935.
15. Yoshida, K. and M. Yoshida. 1977. Relation between main shoot and tillers in corn (*Zea mays* L.), with special reference to translocation of ^{14}C-assimilates. Japan J. Crop Sci. 46(2) : 171-177.