METHODS FOR DELAYING FLOWERING OF GRAIN SORGHUM, SORGHUM BICOLOR (L.) MOENCH, LINES

by

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INTRODUCTION

Grain sorghum, *Sorghum bicolor* (L.) Moench, tradition-bound to the Texas High Plains has fanned out to new areas. While Texas, Kansas, and Nebraska remain unchallenged as the top-ranking states in sorghum acreage, the crop is gaining polularity in other areas. Reasons for these developments can be summarized in three points. First, a market demand was created for grain sorghum. Second, grain sorghum can be adapted to a wide range of cropping systems. Third, hybrids adapted to the new areas were developed as the market grew.

In 1956, when hybrids were first released, the grain sorghum crop was 205 million bushels. A year later, as 95% of all grain sorghum growers switched to hybrids, production reached 568 million bushels.

Increased acreage, number of acres planted has doubled in the last 30 years, has required production of a large volume of good quality seed.

One of the problems facing breeders and producers of hybrid grain sorghum seed is utilization of lines differing in time of flowering. It is often necessary to cross lines of different maturity to obtain maximum hybrid vigor. Both lines must reach the reproductive stage at the same time in order to obtain good cross pollination and to prevent contamination from other pollen sources.

Several methods have been used to delay flowering of one of the parent lines. Delayed planting of the earlier maturing line is the method most often used. Other methods used include clipping the earlier maturing line in its early stages of growth, flaming the earlier maturing line, and fertilizing the later maturing line with an abundant supply of plant nutrients.

The need has been widely recognized for a technique for regulating the rate of early growth in order that an entire seed field may be planted at one time.

This study was undertaken to compare flaming, clipping, and use of a contact herbicide as methods to delay flowering of grain sorghum lines.

REVIEW OF LITERATURE

Lindstrom (9) clipped F_1 hybrid corn plants as part of a study of heterosis. His treatments designated as double, mid, and late decapitation produced delays of 6.0, 2.7, and 3.2 days in date of silking, respectively. Whole plant dry-weight yields showed reductions accompanying the delays in silking.

Dungan and Gausman (5) reported clipping single cross and inbred lines of corn in early stages of growth was a practical means of delaying reproductive development. Clipping plants early and severely gave the greatest delay in flowering and least yield reduction. Plants clipped below or slightly above the growing point did not recover. Three to six days delay were obtained without a significant reduction in grain yield. Pollen production was also reduced when delays were obtained.

Reece, Hurst, and Russ (11) reported that corn which had been flamed when the plants were less than twelve-inches tall was retarded in maturity.

Green (7) reported small significant delays of white inbred lines of corn when flamed. The most effective treatment was when the plants were flamed at two inches in height and flamed again when the regrowth reached two inches. Maximum delay obtained was 2.6 days for anthesis and 2.8 days for silking. A slight reduction in grain yield indicated that it may be advisable to delay anthesis of the male parent rather than silking of the female parent. A significant line x treatment interaction indicated the advisability of testing the effects of flaming on different lines before attempting to flame on a field basis. He suggested that for greater delays, additional flamings at two inches could be used.

Register, Mahoney, and Minton (12) reported a delay in flowering and an extension of the pollination period for as long as one week when flame was used on several male-corn lines. The amount of delay could not be calculated because no check was left. Their results indicated very significant increases in yield by extending the pollination period.

Howard (8) reported no effects on yield or flowering period as a result of flaming at the pre-boot, boot, and flower stages of growth of a grain sorghum hybrid.

Price and Longnecker (10) reported "flaming off" grain sorghum resulted in a two-week delay in flowering over the original planting. Longnecker[1] later stated that sorghum could be flamed each time it grew back to a height of two inches for a total of three flamings without affecting stand or yield. Each flaming delayed maturity for three to five days.

Ball, Vanderlip, and Reece (2) reported that flaming RS 610 grain sorghum in the early growth stages significantly delayed flowering. They stated that the earlier and the more times the plants were flamed the greater the delay. Maximum delay, thirteen days, was obtained by flaming at all three growth stages tested; however, this treatment

[1]Letter of communication from Dr. T. C. Longnecker, Chief Soil Scientist, High Plains Research Foundation, Plainview, Texas.

decreased the stand. They stated that even though the stand was reduced, possibly enough plants would be left for hybrid-seed production if the restorer line was flamed.

Banks (3) reported that flaming significantly delayed the flowering of six grain sorghum lines. The earlier and more times the plants were flamed, the greater the delay. Duration of bloom was increased and yield was decreased by the more severe flamings. He also stated that it may be difficult or impossible to obtain the same amount of delay from a line year after year, even though the same flaming combination is used. Although statistically significant, the magnitude of the differences in delay between the two years was not large, only one to two days.

Gohlke (6) reported that residue from a one-quart treatment of Treflan to a previous cotton crop delayed the growth rate of a succeeding grain sorghum crop. Plants headed ten days later than untreated plots. Yield was not affected.

Ball, et al. (1) tested 33 herbicides under field conditions. Although apparent differences occurred in the degree of injury as measured by grain sorghum stand counts, there were no consistent differences in date of flowering. Differences observed in early seedling growth had disappeared by flowering time.

METHODS AND MATERIALS

Two pollinator lines, Combine 7078 and Plainsman, and two male-sterile or female lines, ms Redlan and ms Combine Kafir 60, were planted in a split-plot design at the Kansas State University Agronomy Farm, Manhattan, Kansas, and at the South Central Experiment Field, Hutchinson, Kansas, in 1969 and 1970.

Plantings were made in 76-cm rows at the rate of 98,840 to 111,195 plants per hectare. This row spacing and plant population was used both years at the two locations.

Plantings at Manhattan were made on June 5, 1969, and June 17, 1970, in an unnamed alluvial silt loam. Fertilizer was applied preplant at the rate of 112 kg of nitrogen per hectare in 1969 and 1970.

Soil moisture conditions at planting time were good at Manhattan both years. In 1969, 6.86 cm of rain was received during the two weeks following planting. Above normal precipitation occurred during July, 19.84 cm, which is over 8.89 cm above normal. August precipitation was only 1.98 cm. This was 8.89 cm below normal. Over half of the August rainfall occurred on August 2, and only .64 cm was received the rest of the month. Although very little rainfall was recieved in August, grain sorghum was never under drouth stress because of the abundant moisture received early in the growing season. The rainfall for the six-month period, April through September, was normal.

The 1970 rainfall for the six-month period, April through September, was 17.78 cm above normal. In June, before planting time, 19.66 cm of rainfall was received. However, the plants were subjected to drouth stress in July and August as only 5.36 cm was recieved the 65 days following planting.

Nine of the ten days between July 29 and August 7 had temperature readings above 37.8 C. These high temperatures accompanied by hot, dry winds put the sorghum under stress during the latter part of July and the first three weeks in August.

Plantings at Hutchinson were made on June 10, 1969, and June 9, 1970, in a Clark-Ost complex soil to which no fertilizer was applied. Environmental conditions were similar to those at Manhattan in that the 1970 growing season was hotter and dryer.

Good soil conditions existed at planting time both years. Precipitation the first two days following planting in 1969 was 1.4 cm. Precipitation the six days following planting in 1970 was 10.92 cm. Rainfall during July and August in 1969 was 14.22 cm which was about normal. In 1970, only 4.9 cm of rainfall was received in July and August. Heavy rains in September were too late to be beneficial. Eighteen days in July and the first two weeks of August in 1969 and 17 days in August of 1970 were above 37.8 C.

Atrazine applied at the rate of 2.7 kg/ha was used to control weeds at Manhattan in 1969. Herban 21A at the rate of 2.7 kg/ha was used in 1970. Mechanical cultivation and hand hoeing were necessary to remove weeds, primarily grass, not killed by the herbicide applications. Weed control at Hutchinson consisted of several sweep cultivations early in the growing season and hand hoeing when necessary.

The flame equipment consisted of two Afco burners placed perpendicular to the row and offset front to rear so that the flame did not meet in the row. The burners were placed at a 30-degree angle with the horizontal and 15.2 cm above the soil surface. The burners were 61 cm apart or 30.5 cm from the row. Liquid LP-gas at 1.4 kg/cm^2 pressure was used. The tractor speed was 3.0 mph.

Clipping was done by hand with a pair of hedge trimmers. The plants were clipped at the first true leaf. The purpose of hand clipping was to remove the same amount of leaf area by clipping as was removed by flaming.

Dow-Premerge (2-sec-butyl-4,6-dinitrophenol, as the alkanolamine salts of the ethanol and isopropanol series), a dinitro weed killer, was the contact herbicide used. It was applied with a one-row sprayer using an 8003-E nozzle tip at the rate of 9.34 liters of Dow-Premerge in 187 liters of solution per hectare at 1.4 kg/cm^2 pressure. The recommended rate of Dow-Premerge used to control seedling grasses in corn and sorghum is "one to 1.5 gallons of Premerge in 30 gallons of water."[2] According to the herbicide label the activity of Dow-Premerge is affected by temperature. Less Dow-Premerge is required at higher temperatures. No recommended rates were given for use with a given temperature on grain sorghum, but recommended rates were given for use on soybeans. These rates were "four quarts per acre if temperatures were below 70 F; three quarts per acre for temperatures between 70 and 80 F; and two quarts per acre for temperatures between 80 and 95 F. If temperatures are above 95 F, do not apply Dow-Premerge for weed control in soybeans."[3]

Plants were treated at the three-leaf stage, five-leaf stage, or both. These stages are determined when the collar of the designated leaf is fully visible. When the plots were to be treated twice, the treatments were made when the check plots reached the five-leaf stage. The time when the plants reached the various leaf stages is recorded in Table 1.

The split-plot design consisted of lines as main plots and treatments as subplots. Each main plot contained the nine combinations of stages of

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[2]Dow Chemical Company's specimen label, 86-1110, for Premerge dinitro weed killer, July 1970.

[3]Ibid.

development and methods of leaf removal plus a no treatment plot. Each plot consisted of a single row 10.7 meters long, bordered by a single untreated row on each side. About 4.6 meters of the plot row was used as an alley for starting and stopping the tractor. Main plots or lines were separated by two untreated rows. All treatments were replicated four times at both locations.

Table 1. Dates of planting and dates plots were treated at the three- and five-leaf stages at Manhattan and Hutchinson.

		1969	1970
Manhattan			
	Plant	June 5	June 17
	3-leaf	June 25	June 30
	5-leaf	July 3	July 4
Hutchinson			
	Plant	June 10	June 9
	3-leaf	June 27	June 22
	5-leaf	July 2	June 28

Maturity was measured by days from planting to first, half, and full bloom. First bloom was defined as the time when any plant in the plot was in some stage of bloom. Half bloom occurred when 50 percent of the plants were in bloom. Full bloom occurred when 95 percent of the plants in a plot were in some stage of bloom. Days delay was obtained by subtracting the untreated plot values from those of the treated plots.

A 4.6-m section of each plot was harvested for yield. The number of heads in the 4.6-m section and the amount of threshed grain was recorded. Grain yield per acre was calculated and adjusted to 12.5 percent moisture.

Statistical analyses were made according to the methods outlined by Cochran and Cox (4). Least significant differences were calculated by the method outlined for the split-plot design.

RESULTS AND DISCUSSION

The treatments have been coded to show the leaf stages at which the plants were treated. Codes in Table 2 are used in presenting and discussing the results.

Days delay to half bloom is discussed in detail. Since half bloom is less affected by flowering of very early or very late plants, it is considered to be the best measure of maturity. There will be no discussion of first and full bloom; only the results will be presented. Hartley's homogeneity of variance test was used to determine data that could be combined over years. Individual years data are presented first and if statistically acceptable, later combined over years.

Table 2. Combinations of stages of growth at which the plants were treated. Plus indicates the plants were treated at that stage.

Combination Number	Stage 3-leaf	Stage 5-leaf
100	+	-
010	-	+
110	+	+

Days Delay to First Bloom

Hutchinson 1969. Table 3 shows lines, methods, stages, a line x stage interaction, and a method x stage interaction were highly significant.[4] A line x method interaction was significant.

The line x method interaction in Table 4 points out that flaming

[4]Significance at the 5% level will be termed significant and significance at the 1% level will be termed highly significant.

and clipping produced the same amount of delay within a line, while applying Dow-Premerge produced significantly less delay. The pollinator lines, Combine 7078 and Plainsman, were delayed more than ms Redlan and ms Combine Kafir 60 for all methods.

Table 3. Analysis of variance for days delay to first bloom at Hutchinson in 1969.

Source	d.f.	Ms	F
Replication	3	2.76	0.48
Line	3	75.87	13.08**[5]
Error (a)	9	5.80	
Method	2	111.58	91.56**
Stage	2	139.75	114.67**
Line x Method	6	3.34	2.74*
Line x Stage	6	4.56	3.75**
Method x Stage	4	26.27	21.56**
Line x Method X Stage	12	1.06	0.87
Error (b)	96	1.22	

Table 4. Days delay to first bloom as affected by lines and methods at Hutchinson in 1969.

Lines	Method		
	Flame	Clip	Herbicide
Combine 7078	6.00	6.25	4.33
Plainsman	6.00	6.33	2.83
ms Redlan	3.83	4.92	1.17
ms Combine Kafir 60	3.83	3.00	1.00

LSD Methods within a line = 0.90 day.[6]
LSD Lines within a Method = 1.13 days.

[5]Significance at the 5% level will be designated by one asterisk (*) and significance at the 1% level by two asterisks (**).

[6]All least significant differences are calculated at the 5% level.

The line x stage interaction in Table 5 also points out that the two pollinator lines were delayed more than the two male-sterile lines for all stages. There was no significant difference between stages 100 and 010 within a line. Treating the plants twice (110) produced significantly more delay than treating at either stage 100 or 010.

Table 5. Days delay to first bloom as affected by lines and stages at Hutchinson in 1969.

Lines	Stages		
	100	010	110
Combine 7078	4.58	5.33	6.67
Plainsman	3.83	3.67	7.67
ms Redlan	1.67	2.50	5.67
ms Combine Kafir 60	1.50	1.67	4.17

LSD Stages within a line = 0.90 day.
LSD Lines within a stage = 1.13 days.

Table 6. Days delay to first bloom as affected by methods and stages at Hutchinson in 1969.

Methods	Stages		
	100	010	110
Flame	3.75	2.88	7.75
Clip	2.88	5.06	7.38
Herbicide	2.06	1.94	3.00

LSD = 0.78 day.

The method x stage interaction (Table 6) also points out that treating the plants at both the three- and five-leaf stages resulted in the greatest delay for all three methods. Flaming and applying a contact herbicide produced more delay when the plants were treated at the three-leaf stage rather than the five-leaf stage, while clipping the plants at the three-leaf stage resulted in less delay than clipping at the five-leaf stage.

<u>Hutchinson 1970</u>. Table 7 presents the analysis of first bloom data at Hutchinson in 1970. Methods, stages, and a method x stage interaction were highly significant.

There was no significant difference in the amount of delay obtained between stages 100 and 010 for flaming and clipping as shown in Table 8. Treating the plants twice (110) gave significantly more delay than treating at either stage 100 or 010. Applying Dow-Premerge produced no significant delay in flowering for all three stages.

Hutchinson first bloom data can not be combined over years because Hartley's homogeneity of variance test was highly significant.

Table 7. Analysis of variance for days delay to first bloom at Hutchinson in 1970.

Source	d.f.	Ms	F
Replication	3	35.71	0.64
Line	3	39.62	0.71
Error (a)	9	55.68	
Method	2	369.25	36.23**
Stage	2	176.52	17.32**
Line x Method	6	15.78	1.55
Line x Stage	6	6.85	0.67
Method x Stage	4	47.58	4.67**
Line x Method x Stage	12	15.64	1.53
Error (b)	96	10.19	

<u>Manhattan 1969</u>. Methods, stages and a method x stage interaction were highly significant at Manhattan in 1969 as shown in Table 9.

The method x stage interaction is shown in Table 10. There was no significant difference in the amount of delay obtained for stages 100 and 010 when the plants were clipped or Dow-Premerge was applied. Flaming at stage 100 delayed flowering significantly more than flaming at stage 010.

Treating the plants twice (110) gave the greatest delay for all methods. Flaming and clipping caused more delay to first bloom than applying Dow-Premerge.

Table 8. Days delay to first bloom as affected by methods and stages at Hutchinson in 1970.

Methods	Stages 100	010	110
Flame	2.31	0.31	6.56
Clip	4.38	3.12	8.06
Herbicide	-0.81	0.06	-0.19

LSD = 2.26 days.

Table 9. Analysis of variance for days delay to first bloom at Manhattan in 1969.

Source	d.f.	Ms	F
Replication	3	0.76	0.03
Line	3	88.58	3.56
Error (a)	9	24.90	
Method	2	97.03	23.32**
Stage	2	409.59	98.45**
Line x Method	6	6.21	1.49
Line x Stage	6	8.69	2.09
Method x Stage	4	23.02	5.53**
Line x Method x Stage	12	5.90	1.42
Error (b)	96	4.16	

<u>Manhattan 1970</u>. Methods, stages, a line x method interaction, a line x stage interaction, and a method x stage interaction were highly significant at Manhattan in 1970. A line x method x stage interaction was significant at the 5% level (Table 11).

Table 10. Days delay to first bloom as affected by methods and stages at Manhattan in 1969.

Methods	Stages 100	010	110
Flame	7.25	4.25	12.06
Clip	6.62	6.31	11.12
Herbicide	3.69	4.56	8.19

LSD = 1.43 days.

Table 11. Analysis of variance for days delay to first bloom at Manhattan in 1970.

Source	d.f.	Ms	F
Replication	3	19.58	2.36
Line	3	16.14	1.95
Error (a)	9	8.28	
Method	2	451.90	128.54**
Stage	2	256.33	72.91**
Line x Method	6	13.16	3.74**
Line x Stage	6	11.24	3.20**
Method x Stage	4	58.95	16.77**
Line x Method x Stage	12	8.96	2.55*
Error (b)	96	3.52	

The line x method interaction is shown in Table 12. Flaming gave significantly more delay when used on Combine 7078. Flaming and clipping did not differ significantly for the other three lines. In all cases, applying Dow-Premerge produced significantly less delay than flaming or clipping. There was no significant difference between lines when Dow-Premerge was applied.

Days delay did not differ significantly when plants were treated at either stage 100 or 010 for all lines (Table 13). Treating the plants twice delayed all lines significantly more than treating at either the three- or five-leaf stage. Treatment 110 gave significantly more delay when used on Combine 7078 and ms Combine Kafir 60. Differences were not significant among lines at stages 100 and 010.

Flaming delayed flowering more at stage 100 than at stage 010; however, clipping the plants at stage 100 produced less delay than clipping at stage 010 (Table 14). Flaming or clipping the plants twice (110) gave significantly more delay than treating at either stage 100 or 010. There was no difference in delay obtained among all three stages when Dow-Premerge was applied. Applying Dow-Premerge at either stage 100 or 010 produced no significant delay in flowering.

Table 12. Days delay to first bloom as affected by lines and methods at Manhattan in 1970.

Lines	Methods		
	Flame	Clip	Herbicide
Combine 7078	9.17	5.33	2.00
Plainsman	6.50	6.42	0.67
ms Redlan	5.92	4.83	1.67
ms Combine Kafir 60	7.58	7.25	1.42

LSD Methods within a line = 1.52 days.
LSD Lines within a method = 1.69 days.

Table 13. Days delay to first floom as affected by lines and stages at Manhattan in 1970.

Lines	Stages		
	100	010	110
Combine 7078	3.17	4.25	9.08
Plainsman	3.92	2.58	7.08
ms Redlan	3.42	3.42	5.58
ms Combine Kafir 60	3.42	4.33	8.50

LSD Stages within a line = 1.52 days.
LSD Lines within a stage = 1.69 days.

Table 14. Days delay to first bloom as affected by methods and stages at Manhattan in 1970.

Methods	Stages 100	010	110
Flame	5.94	4.12	11.81
Clip	3.44	5.81	8.62
Herbicide	1.06	1.00	2.25

LSD = 1.32 days.

Manhattan 1969-1970. Effects which were significant and highly significant when the data were combined over years at Manhattan are shown in Table 15.

Table 15. Analysis of variance for days delay to first bloom combined over years at Manhattan.

Source	d.f.	Ms	F
Year	1	355.56	21.44**
Replicate/Year	6	10.17	0.61
Line	3	33.94	2.05
Year x Line	3	70.78	4.27*
Error (a)	18	16.59	
Method	2	475.84	123.98**
Stage	2	652.00	169.88**
Method x Stage	4	67.76	17.66**
Year x Method	2	73.08	19.04**
Year x Stage	2	13.92	3.63*
Line x Method	6	13.44	3.50**
Line x Stage	6	1.73	0.45
Year x Method x Stage	4	14.20	3.70**
Line x Method x Stage	12	6.95	1.81*
Year x Line x Method	6	5.93	1.55
Year x Line x Stage	6	18.20	4.74**
Year x Line x Method x Stage	12	7.92	2.06*
Error (b)	192	3.84	

The line x method interaction is shown in Table 16. Flaming and clipping did not differ significantly within lines when used on Plainsman, ms Redlan, and ms Combine Kafir 60. Combine 7078 was delayed significantly more by flaming. Applying Dow-Premerge resulted in significantly less delay. Differences were not significant among Plainsman, ms Redlan, and ms Combine Kafir 60 when flaming was used; however, Plainsman was delayed significantly more than Combine 7078, ms Redlan, and ms Combine Kafir 60 when the plants were clipped. When Dow-Premerge was applied, there was a significant difference in delay obtained between Combine 7078 and ms Combine Kafir 60.

Days delay was significantly larger in 1969 when averaged over methods and stages (Table 17). Delays did not differ significantly between years when plants were flamed at the three-leaf stage and when plants were clipped at the five-leaf stage. Delays were significantly larger in 1969 for the other methods and stages. In 1969, there was no significant difference in flaming at stage 100 and clipping at stages 100 and 010. Applying Dow-Premerge at either stage 100 or 010 produced no significant difference in delay. Treating the plants twice (110) gave the greatest delay for all methods. In 1970, flaming at the three-leaf stage and clipping at the five-leaf stage produced the same delay; however, flaming at the five-leaf stage and clipping at the three-leaf stage produced the same delay. No significant difference occurred between stages when Dow-Premerge was applied.

The year x line x stage interaction is shown in Table 18. No significant differences occurred between stages 100 and 010 within lines for both years. Treating at both stages (110) produced significantly more delay. There was no significant difference between years for Combine 7078 treated at the three-leaf stage and both stages, ms Redlan at the five-leaf stage, and ms Combine Kafir 60 at all stages. In all other cases, delays were significantly higher in 1969.

Table 16. Days delay to first bloom as affected by lines and methods combined over years at Manhattan.

Lines	Methods		
	Flame	Clip	Herbicide
Combine 7078	9.04	6.75	4.04
Plainsman	7.58	8.45	3.45
ms Redlan	7.20	6.42	3.70
ms Combine Kafir 60	6.46	6.33	2.62

LSD Methods within a line = 1.11 days.
LSD Lines within a method = 1.36 days.

Table 17. Combined data of days delay to first bloom as affected by years, methods, and stages at Manhattan.

Methods	Stages					
	100		010		110	
	1969	1970	1969	1970	1969	1970
Flame	7.25	5.94	4.25	4.12	12.06	11.81
Clip	6.62	3.44	6.31	5.81	11.12	8.62
Herbicide	3.69	1.06	4.56	1.00	8.19	2.25

LSD Methods and stages within a year = 1.36 days.
LSD Years within a method and stage = 1.67 days.

Table 18. Combined data of days delay to first bloom as affected by years, lines, and stages at Manhattan.

Lines	Stages					
	100		010		110	
	1969	1970	1969	1970	1969	1970
Combine 7078	6.58	3.17	6.00	4.25	10.58	9.08
Plainsman	6.92	3.92	6.75	2.58	11.75	7.08
ms Redlan	5.67	3.42	4.50	3.42	12.08	5.58
ms CK-60	4.25	3.42	2.92	4.33	7.42	8.50

LSD Stages within a line and year = 1.58 days.
LSD Lines and years within a stage = 1.93 days.

Days Delay to Half Bloom

Hutchinson 1969. Methods, stages, a line x method interaction, a line x stage interaction, and a method x stage interaction were highly significant (Table 19).

Table 19. Analysis of variance for days delay to half bloom at Hutchinson in 1969.

Source	d.f.	Ms	F
Replication	3	3.19	0.36
Line	3	13.27	1.51
Error (a)	9	8.78	
Method	2	157.30	93.73**
Stage	2	197.59	117.74**
Line x Method	6	6.75	4.02**
Line x Stage	6	10.04	5.98**
Method x Stage	4	31.68	18.88**
Line x Method x Stage	12	3.54	2.11
Error (b)	96	1.68	

Differences in the amount of delay obtained between flaming and clipping within a line were not significant (Fig. 1). Days delay ranged from 3.67 to 5.83 days. Applying Dow-Premerge produced less delay. Delays obtained for lines within a method were variable. There was a significant difference between ms Combine Kafir 60 and Plainsman when the plants were flamed and between ms Combine Kafir 60 and ms Redlan when clipped. Combine 7078 was the only line significantly delayed by applying Dow-Premerge.

Treating the plants at either stage 100 or 010 produced the same amount of delay to half bloom within lines (Fig. 2). Treating the plants twice (110) caused significantly more delay than treating at either stage 100 or 010. Combine 7078 was delayed significantly more than ms Redlan

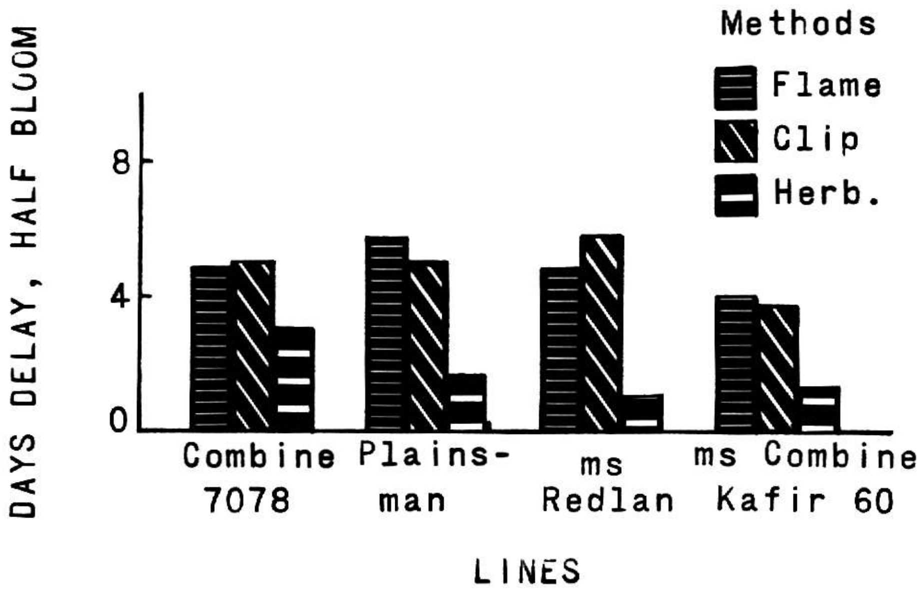

Fig. 1. Days delay to half bloom as affected by lines and methods at Hutchinson in 1969. LSD Methods within a line = 1.06 days. LSD Lines within a method = 1.35 days.

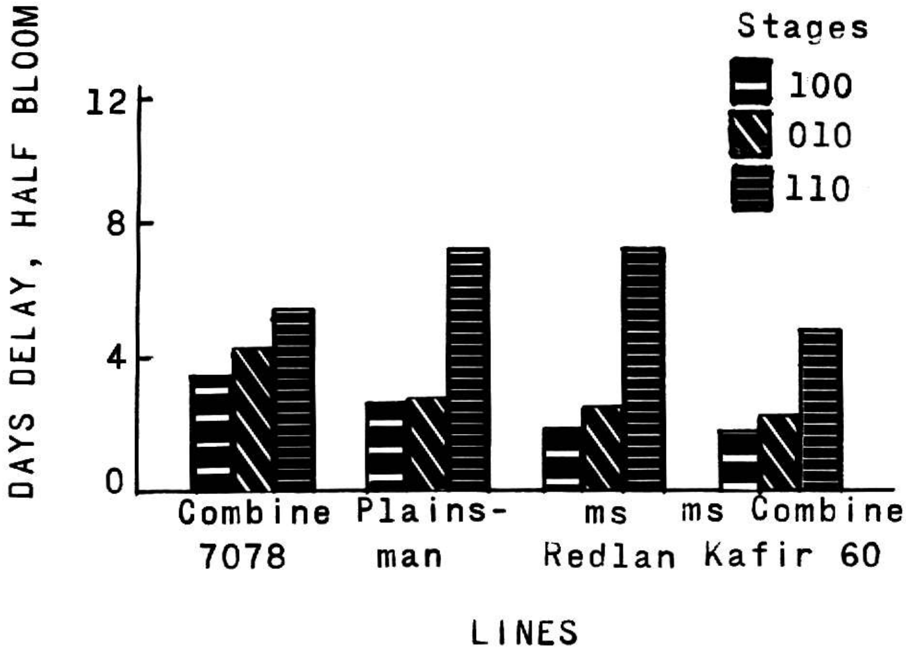

Fig. 2. Days delay to half bloom as affected by lines and stages at Hutchinson in 1969. LSD Stages within a line = 1.06 days. LSD Lines within a stage = 1.35 days.