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Effect of Delayed Sowing on Growth, Flowering Date, and Yield in Sesame

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ABSTRACT : The purpose of this study was to investigate the decreased ratio of growth and yield by delayed seeding and flowering because drought of spring season often cause to delay seeding and sprout emergence. Equation of linear regression, y=-11.914x+818.61 (R^2=0.916) and y= -16.961x+913.98 (R^2=0.885) were derived from relationship between sowing date and yield of leading variety, Yangbaeckkae in 1999 and 2000, respectively. Yield was decreased by 7, 24, 40, 57, 74%, respectively, according as sowing date was delayed more 5, 15, 26, 36, 46 days than May 15, standard sowing date under the culture mulched with black P.E. film. Number of capsules per plant and length of stem bearing capsule were greatly decreased, while plant height, stem diameter, and day to flowering were affected little by delayed seeding date. Equation of linear regression, y=-0.7081x+41.04 (R^2=0.861) was derived from relationship between flowering date and yield of 33 accessions. Yield was decreased by 7.7, 8.3, 9.2, 10.1, 11.2%, respectively, according as flowering date was delayed more 1, 2, 3, 4, 5 days than July 3, normal flowering date of Yangbaeckkae when it was sown on May 15, and the more flowering date was delayed, the more yield was decreased. Number of capsules per plant and length of stem bearing capsules were greatly decreased, but plant height and harvest index were decreased little by delay of flowering date

Keywords **:** sesame, sowing date, flowering date, regression, yield

Sesame (*Sesamum indicum* L.) is a oil crop with indeterminate flowering habit and flowering duration is generally as long as 60~70 days. Therefore ripening was not uniform in a plant and capsules flowered late were not ripened fully by low air temperature during ripening season. Optimum growing duration of sesame is about 120 days from May 10 to September 10 under the atmosphere of Korea. Flowering was normally started from June 25 and ended August 30 under transparent polyethylene film mulching while it was started from July 5 and ended September 5, under black polyethylene film mulching, respectively. Plant height, number of capsules per plant and day to flowering were significantly decreased, while full grain weight and oil contents showed not significant difference by delay of seeding and yield was decreased differently by varieties at late sowing (Park & Lee, 1964). Lee *et al.* (1982) also reported that plant height, number of capsule per plant, stem diameter, number of seeds per capsule and percent of ripened grain were significantly decreased by delay of seeding and yield showed positive correlation with integrated sunshine hours and accumulative temperature. Sesame flowered at intervals of 0.8 to 1 day from lower part to upper and the intervals was different by varieties (Lee *et al.*, 1984), and yield was actually determined with the capsule attached in less than 18 joints of stem because of unripe seed by low air temperature during ripening season (Lee & Park, 1985). Seed weight in capsule was come to maximum at 35~50 days after flowering and the time reached at peak was different by varieties (Guh & Lee, 1980; Lee *et al.*, 1980; Kang *et al.*, 1985), and seed weight was not more increased since mean air temperature was fallen by 20°C and leaves were shed by 50% (Lee *et al.*, 1980). It is necessary to estimate the change of growth and yield by delay of seeding and flowering because seeding was often delayed by double cropping after barley and drought at the time of sowing. This experiment was conducted to estimate relationship among yield, growth characteristics, sowing date, and flowering date by sowing one leading variety from May 15 to June 30 at intervals of 5 days and by investigating flowering date of 33 accessions with flowering variation of 10 days.

MATERIALS AND METHODS

Sesame variety, Yangbaeckkae was sown at the field of National Crop Experiment Station(NCES) from May 15 to June 30 at intervals of 5 days to experiment relationship between sowing date and yield in 2000, while Yangbaeckkae was sown on May 15, May 30, June 10, June 20, and June 30 in 1999. Thirty three accessions were sown on May 20 in order to investigate effect of flowering date on growth characteristics and yield in 2000. Black polyethylene film of 0.015 mm with holes of 30× 10 cm interspace was mulched on soil surface with furrow width of 70 cm. Experimental

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Table 1. Changes of mean temperature and duration of sunshine during cultivation period at Suwon in 1999 and 2000.

	Year	May	June	July	Aug.	Sept.	Total
Mean temperature (°C)	1999	16.9	22.4	25.4	26.0	22.9	113.6
	2000	17.4	23.3	26.7	25.9	20.1	113.4
Duration of sunshine (hrs)	1999	222.4	226.9	155.9	198.1	156.1	959.4
	2000	184.3	166.7	153.0	151.9	150.9	806.8

plot was arrayed by randomized block design with 3 replications and each plot size was 3 m^2. Fertilizer (N-P_2O_5-K_2O=80-40-90 kg/ha) was applied as basal fertilizer before planting. Other cultural practices were conducted according to standard cultural methods developed by NCES. Flowering date was measured at the time of 50% flowering stage, and total dry matter weight and seed weight per plant were measured to induce harvest index at harvesting time. Other measurements were plant height, length of stem bearing capsule, number of capsules per plant, and stem diameter. Mean temperature and sunshine duration in 1999 and 2000 were shown as Table 1.

RESULTS AND DISCUSSION

Decrease ratio of yield by delay of seeding in 1999 and 2000

Equations of linear regression, $y = -11.914x + 818.61$ (R^2= 0.916) and $y = -16.961x + 913.98$ (R^2=0.885) was derived from relationship between seeding date and yield of Yangbaeckkae in 1999 and 2000, respectively (Fig. 1). Delay of 5 days in seeding decreased yield by 6 to 8%, while those of 10, 20 and 41 days decreased yield by 13 to 17%, 28 to 36% and 58 to 74%, respectively by using both of linear regression equation, when yield was compared to that of May 15, standard seeding date under culture mulched with black P.E. film as shown in Table 2. Yield was more decreased in 2000 than that of 1999 because of the severe typhoons and the shortage of sunshining during ripening season of August and September in 2000 as shown in Table 1. Though decrease ratio of yield was different by year of climatic conditions, yield shall

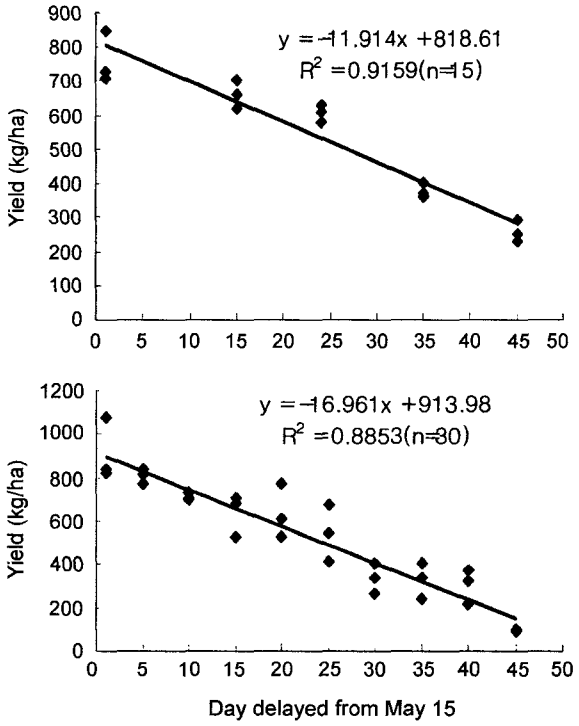

Fig. 1. Relationships between sowing date and yield of sesame variety, Yangbaeckkae in 1999 (upside) and 2000 (base).

be decreased by 35 to 45% when seeds was sown at June 10 for double cropping after barley in Suwon, central part of Korean Peninsula.

Relationship between sowing date and growth characters

Sowing date and growth characteristics showed negative correlation in sesame variety, Yangbaeckkae, and plant height, length of stem bearing capsule, number of capsules

Table 2. Decreased ratio of yield derived from equation of linear regression in 1999 and 2000 by delayed sowing date of sesame variety, Yangbaeckkae.

Sowing date	May 15	May 20	May 25	May 30	June 5	June 10	June 15	June 20	June 25	June 30
Days delayed from May 15	0	5	10	15	21	26	31	36	41	46
Decreased ratio in 1999	0	6	13	21	28	35	43	50	58	65
Decreased ratio in 2000	0	8	17	26	36	45	55	64	74	83
Average	-	7	15	24	32	40	49	57	66	74
Yield (kg/ha)	910.3†	800.7	710.3	640.0	630.7	540.0	330.3	320.7	300.0	90.7

†Yield that was actually producted in 2000.

Table 3. Relationship between sowing date and growth characteristics of sesame variety, Yangbaeckkae in 2000.

Growth characteristics	Equation of linear regression(n=30)	Coefficient determination (R^2)
1. Plant height	Y=-1.782x+130.27	0.231**
2. Length of stem bearing capsule	Y=-3.093x+98.84	0.522**
3. No. of capsules per plant	Y=-6.622x+106.69	0.736**
4. Stem diameter	Y=-0.302x+10.45	0.652**
5. Day to flowering	Y=-1.101x+44.76	0.914**

Table 4. Relationship between flowering date and growth characteristics of 33 sesame accessions in 2000.

Growth characteristics	Linear regression equation (n=33)	Coefficient of determination (R^2)
1. Plant height	Y=-0.120x+115.69	0.001
2. Length of stem bearing capsule	Y=-3.747x+246.70	0.522**
3. No. of capsule per plant	Y=-3.832x+245.11	0.662**
4. Stem diameter	Y=0.113x+4.10	0.174*
5. Total dry weight per plant	Y=-2.078x+135.47	0.411**
6. Harvest index	Y=-1.392x+86.46	0.829**

per plant, stem diameter, and day to flowering were significantly decreased by delay of sowing date (Table 3). Number of capsules per plant and length of stem bearing capsule were greatly decreased by delay of seeding. Number of capsules per plant and day to flowering showed high correlation coefficient in equation of linear regression but plant height was no correlation. Park & Lee (1964) and Lee *et al.* (1982) reported that plant height, number of capsule per plant, number of seeds per capsules, percent of ripened grain, and day to flowering were significantly decreased but seed weight and oil content of ripened grain were not significantly decreased by delay of seeding.

Relationship between flowering date and growth characters in 33 accessions

Flowering date and growth characteristics were showed negative correlation except stem diameter in 33 accessions (Table 4). Length of stem bearing capsules, number of capsules per plant, total dry weight, and harvest index were significantly decreased by delay of flowering except both of stem diameter and plant height. Number of capsules per plant and length of stem bearing capsule were greatly decreased by delay of flowering. The number of capsules per plant and length of stem bearing capsules were greatly affected by delay of flowering, while plant height and stem diameter were hardly affected as in case of delayed seeding (Table 3). Yield was mostly related with number of capsules per plant and length of stem bearing capsules (Lee *et al.*, 2000; Lee, 1988).

Changes of yield by delay of flowering in 33 accessions

Equation of linear regression, y=-0.7081x+41.04 (R^2=0.861) was derived from relationship between flowering date and yield per plant of 33 accessions showing flowering variation of 10 days in 2000 (Fig. 2).

If yield in each flowering date was compared to that of July 3, normal flowering date of Yangbaeckkae sown on May 15, standard sowing date under culture mulched with black P.E. film, delay of a day decreased yield by 8%, while delay of 5 and 10 days decreased yield by 39% and 77%, respectively by using above equation of linear regression (Table 5). The more flowering date was delayed, the more yield was decreased because not only number of capsules

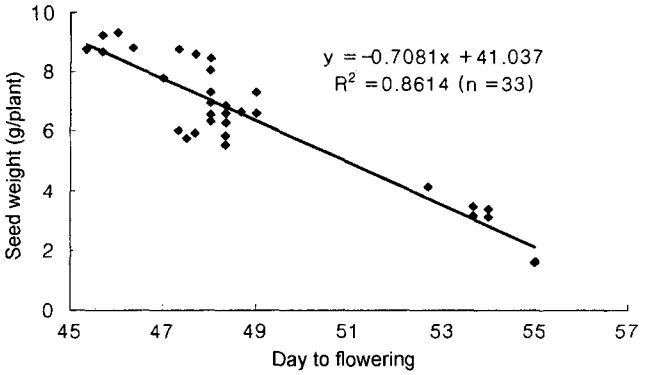

Fig. 2. Equation of linear regression derived from relationship between flowering date and seed weight per plant by using 33 accessions in 2000.

Table 5. Decreased ratio of yield by delayed flowering of 33 accessions in 2000.

Flowering date	July 3	July 4	July 5	July 6	July 7	July 8	July 9	July 10	July 11	July 12	July 13
Day to flowering	45	46	47	48	49	50	51	52	53	54	55
Seed weight per plant (g)	9.17†	8.46	7.76	7.05	6.34	5.63	4.92	4.22	3.51	2.80	2.09
Decreased ratio per day (%)	0	7.7	8.3	9.2	10.1	11.2	12.6	14.2	16.8	20.2	25.4
Accumulated ratio (%)	0	7.7	15.4	23.1	30.9	38.6	46.3	54.0	61.8	69.5	77.2

†Yield was derived from equation of linear regression.

per plant were greatly decreased but also seed was not ripened enough during ripening stage by low air temperature. Though sesame seed weight in capsule was increased until 40 to 45 days after flowering, capsule that flowered late showed insufficient ripening by falling down to below 20 since September 10 in Korea (Guh & Lee, 1980)

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