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Effects of Seeding Date and Planting Spaces on Growth and Yield of Swordbean (*Canavalia gladiata* DC.)

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ABSTRACT

Swordbean was recently introduced to Korea, and cultural technique for stable production, e.g. optimum seeding date and planting space, has not been established. This experiment was conducted to elucidate the changes of growth characteristics, yield components, and yield as affected by different seeding dates and planting spaces. Days to flowering was shortened by 4~28 days as seeding was delayed. Stem diameter, number of pods per plant, number of seeds per plant, 100-seed weight, and seed yield tended to increase with delaying seeding up to 5 April and then to decrease with further delaying seeding. These results indicate that optimum seeding date of swordbean in unheated polyvinyl house would be early April.

Although, the swordbean exhibited large increases in plant height, number of branches per plant, and stem diameter at the wider spacings, planting space could be decreased to the 60 cm plant-spacing and 30 cm row-spacing with no deleterious effect on yield.

Keywords : swordbean, seeding date, planting space.

Swordbean is propagated by seeds, sown at a depth of 5~7.5 cm. Swordbean plants are usually spaced 45~60 cm apart in rows 75~90 cm apart. In Hong Kong, seeds sown singly in pots in February, and seedlings transplanted or sown in March to May. In India, seeds sown from mid-April to late June, 5~7.5 cm deep, in rows 60 cm apart along a strong high fence. In the case of soybean, many researches have been reported about seeding date and planting density. Optimum intrarow space combined with interrow space is a potentially important limiting factor of yield (Donavan et al. 1963). Late seedings of determinate soybean are lower in yield because of reductions in branch number, pod number and seed number (Board, 1985; Boquet, 1990). Kim et al. (1993) investigated responses of growth and yield characters on planting density in determinate and indeterminate soybean. In their study, number of branches and number of nodes on branches per unit area (m^2) were greater in determinate varieties than in indeterminate ones and number of nodes on main stem were greater in indeterminate varieties than in determinate ones. The higher planting density increased those characters. As swordbean was recently introduced, there is little information on cultural practice. This study was initiated to examine the effects of seeding date and planting space on plant height, yield components and seed yield of swordbean in unheated polyvinyl house.

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MATERIALS AND METHODS

A series of trials were conducted from 1997 to 1998 in unheated polyvinyl house of Chungbuk Agricultural Research and Extension Services in Korea using swordbean cultivar that had red seed coat. Mean soil test values for surface soil (0 to 10 cm) were shown in Table 1. Fertilizer was applied prior to seeding at a rate of 40-70-60 kg/ha (N-P_2O_5-K_2O). Cucumber netting was used to stake the plants.

Response of growth and yield of swordbean as a function of different seeding dates

To determine optimum seeding date swordbeans were seeded five times from 25 March to 5 May with 10 days interval. The row space and plant space were 60 and 40 cm, respectively.

Response of growth and yield of swordbean as a function of different planting spaces

To determine optimum planting space swordbean were seeded on 15 April. Row and plant spacing treatments were; 60×30, 60×40, 60×50, 90×30, 90×40 and 90 cm×50 cm, respectively. Both Experiments consisted of two replications in randomized block design. Days to flowering was recorded at R_1 stage (Fehr et al., 1971).

At maturity ten random plants in the center rows

Table 1. Physico-chemical properties of the soil before experiment.

pH (1:5)	OM (g/kg)	P_2O_5 (mg/kg)	Ex-Cation (cmol(+)/kg)			C. E. C (cmol(+) /kg)
			Ca	Mg	K	
7.1	17	52	6.2	1.3	0.05	10.0

of each plot were sampled to investigate agronomic traits such as plant height, stem diameter, number of branches per plant and yield components. Plant heights were measured from the ground surface to the top node. Stem diameters 25 mm above the soil surface were measured. Seed yield was determined by hand harvest of two center rows with 2 m long. Harvested seeds were air-dried to the seed moisture content of about 12%. Random 100-seed samples were drawn from the harvested seed of each plot and were weighed to measure seed size (g/100 seed). Differences among mean values were tested by Duncan's multiple range test.

RESULTS AND DISCUSSION

Response of growth and yield of swordbean as a function of different seeding dates

Days to flowering was shortened from 4 to 28 days as planting was delayed from 25 March to 5 May (Fig. 1). Warmer nights hastened R_1 and R_2 stages considerably, while they had little additional effect on the subsequent reproductive stages. Thomas & Raper (1978) reported that warm night temperature shortend the time to anthesis and also shortened the time period between anthesis and pod formation after soybeans were photo-induced, regardless of the day temperature. These results showed that flowering of swordbean was more sensitive to temperature than day length. Plant height was significantly affected by seeding date (Table 2). As seeding was delayed from 25 March to 5 May the plant height was reduced from 337 to 248 cm. There were no significant differences in node number on main stem and branches per plant

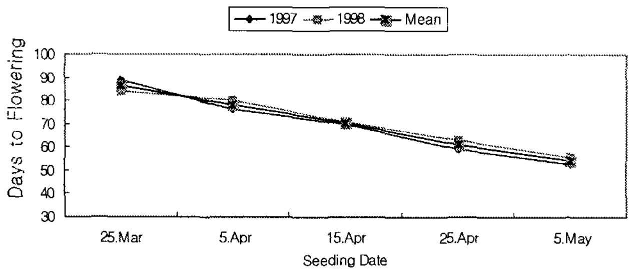

Fig. 1. Days to flowering according to seeding date.

(Table 2). But number of branches per plant tended to increase with delaying seeding up to 15 April and then to decrease with further delaying seeding. Also, the stem diameter was almost same with delaying seeding up to 25 April and then decreased with further delaying seeding (Table 2).

There were significant differences in number of pods per plant and number of seeds per plant (Table 3). The number of pods per plant was the lowest on 5 May and the number of seeds per plant was increased with delaying seeding up to 5 April and then decreased with further delaying seeding. Seddigh & Jolliff (1984) reported that pod abortion appeared to be more severe in the low night temperatures than warmer night. In this study, pod abortion was also closely associated with late flowering. The number of seeds per plant at 5 May seeding was fewer than those at any other seeding dates. Fewer seeds per plant at the late seeding date were probably associated with aborted pods during the seed filling period. Increase in number of seeds per plant was due to increasing in number of pods per plant and number of seeds per pods (Data not shown). One hundred-seed weight tended to decline from 247 to 228 g as seeding was delayed from 5 April to 5 May, but there was no significant difference statistically (Table 3). This result that growth duration has high correlation with 100-seed weight were in agreement with some investigators (Beatty et al., 1982; Elmore, 1990). Mean seed yield at the seedings of 25 March, 5 April, 15 April, 25 April, and 5 May seedings were 2.99, 3.07, 2.83, 2.63 and

Table 2. Effects of seeding date on stem traits of swordbean in unheated polyvinyl house.

Seeding date	Plant height (cm)	Node no. on main stem	No. of branches per plant	Stem diameter (mm)
25 March	337 a[z]	24 a	3.2 a	9.1 ab
5 April	294 b	24 a	3.7 a	9.2 a
15 April	291 b	24 a	3.7 a	8.8 ab
25 April	286 b	27 a	2.9 a	8.0 ab
5 May	248 c	25 a	2.4 a	7.5 b

[z] Means in a column not followed by the same letter are significantly different at $p \leq 0.05$ based on Duncan's multiple range test.

2.44 ton/ha (Table 3). The differences in seed yield of swordbean treated different seeding dates were primarily due to differences in the number of seeds per plant. Hanway & Weber (1971) reported that yield was correlated with maturation period. While higher temperature hastend reproductive development, excessively high night temperatures could be deleterious to maximum seed yield since it would initiate flowering before adequate vegetative growth has occurred. Our results indicate that optimum seeding date of swordbean in unheated greenhouse would be early April..

Response of growth and yield of swordbean as a function of different planting spaces

As planting distance became wider the plant height was increased not significantly (Table 4). Previous research has shown that decreasing either inter or intra row space of soybean plants increased both plant heights and lodging, resulting in yield reductions if lodging occurred early in the growing season (Cooper, 1971; Weber et al., 1966) The different response between Cooper (1971) & Weber et al. (1966) and this study may have resulted from different growth type. There were no significantly difference in node number on main stem and number of branches per plant (Table 4). Number of branches per plant was increased from 0.1 to 0.5 as planting space increased. This result was in good agreement with previous reports (Ju et al., 1996; Lee, 1974). The stem diameter was increased from 0.3 to 0.6 mm as planting space increased (Table 4). Previous work by Kim et al. (1992) suggested that the stem diameter of indeterminate varieties was thin at the higher plan-

Table 3. Effects of seeding date on yield components and yield of swordbean in unheated polyvinyl house.

Seeding date	No. of pods per plant	No. of seeds per plant	100-seed weight (g)	Seed yield (ton/ha)
25 March	7.2 a[J]	44.6 bc	247 a	2.99 a
5 April	6.9 ab	49.7 a	243 a	3.07 a
15 April	6.6 ab	46.6 ab	238 a	2.83 ab
25 April	5.9 ab	42.9 bc	234 a	2.63 ab
5 May	5.4 b	41.3 c	228 a	2.44 b

[J]Means in a column not followed by the same letter are significantly different at $p \leq 0.05$ based on Duncan's multiple range test.

Table 4. Effects of planting space on stem traits of swordbean in unheated polyvinyl house.

Planting space	Plant height (cm)	Node no. on main stem	No. of branches per plant	Stem diameter (mm)
60×30	292 a[J]	23 a	3.4 a	8.6 b
60×40	297 a	24 a	3.5 a	8.9 ab
60×50	301 a	26 a	3.7 a	8.9 ab
90×30	305 a	25 a	3.6 a	8.9 ab
90×40	307 a	26 a	3.7 a	9.1 a
90×50	310 a	27 a	3.9 a	9.2 a

[J] Means in a column not followed by the same letter are significantly different at $p \leq 0.05$ based on Duncan's multiple range test.

Table 5. Effects of planting space on yield components and yield of swordbean in unheated polyvinyl house.

Planting space	No. of pods per m^2	No. of seeds per m^2	100-seed weight (g)	Seed yield (ton/ha)
60×30	34.5 a J	227 a	234 a	2.83 a
60×40	27.9 ab	196 b	238 a	2.76 a
60×50	22.3 b	180 bc	239 a	2.52 ab
90×30	27.4 ab	183 bc	234 a	2.60 ab
90×40	25.3 b	174 cd	240 a	2.44 ab
90×50	21.5 b	154 d	244 a	2.29 b

[J] Means in a column not followed by the same letter are significantly different at $p \leq 0.05$ based on Duncan's multiple range test.

ting density. Number of pods per unit area (m^2) and number of seeds per unit area were significantly affected by planting space (Table 5). Number of pods per unit area was declined from 6.6 to 13.0 pods as planting space increased. This was consistent with the result of Kang et al. (1998). Number of seeds per unit area was declined from 31 to 73 seeds as planting space increased. 100-seed weight tended to increased as planting space increased not significantly (Table 5). Other researchers (Lee, 1974; Park et al., 1990) reported that seed weight was not significantly affected by the planting density. Seed yield was significantly affected by planting space (Table 5). Seed yield was highest in the treatment of 60 cm plant-spacing and 30 cm row-spacing exhibiting large increase in number of pods per unit area and number of seeds per unit area. The data show that planting space could be decreased to the 60 cm plant-spacing and 30 cm row-spacing with no deleterious effect on yield.

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