# EFFECT OF DATE OF PLANTING ON QUALITY AND YIELD OF FIVE VARIETIES OF GLADIOLUS

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# GLADIOLUS CULTURAL TRIALS

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## AN ABSTRACT OF THE THESIS OF

Mohammed Hussain Abdul Abbass for M.S. in Floriculture.

Title: Effect of date of planting on quality and yield of five varieties of gladiolus.

A one year of study was carried out at the Agricultural Research and Education Center of the American University of Beirut, to evaluate the effect of three dates of planting on quality and yield of spikes, percentage and duration of sprouting, and number of corms produced of five varieties of gladiolus namely: Spic and Span, Leewenhorst, H.v.d. Mark, Morning Kiss, and Lovely Melody.

The results revealed that the highest yield and the highest quality of spikes were obtained from the third planting, i.e. June 15th, and the lowest yield and the lowest quality were obtained from the second planting, i.e. May 15th, with the first planting, i.e. April 15th, intermediate between the two.

Varietal differences were apparent. H.v.d. Mark outstripped all other varieties in the percentage of sprouting, duration of sprouting (least number of days), and number of spikes produced. Spic and Span was second in the production of spikes. The varieties H.v.d. Mark and Lovely Melody exceeded other varieties in the number of florets per spike. Leewenhorst produced the heaviest spikes with the largest florets but was poorest in production. Morning Kiss was the earliest variety, spikes were harvested after 84.6 days, but produced inferior yields.

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# I. INTRODUCTION

In the Mediterranean, tropical and South African regions, there are about 250 species of gladiolus (3, 7). However, the cultivated gladiolus presents no one species; it has been derived by variation, selection, and hybridization from several species (7, 44, 46). The modern gladiolus made its appearance in 1841 when *Gladiolus gandavensis* was introduced, but according to Bailey (7) this species is a hybrid of *Gladiolus psittacinus* and *Gladiolus cardinalis*. Therefore it is impossible to give the cultivated gladiolus a clear botanical name.

Gladioli are grown extensively almost all over the world either for cut flowers or in gardens where they are massed in groups. They are grown either in the open where the climatic conditions are favorable or in the greenhouse (5, 20, 31, 39, 44, 68). The gladiolus has surpassed in production all other "bulbs" in the United States of America, while in Europe, it occupies only a modest place in "bulb" growing (61).

For Lebanon and the other Middle Eastern countries the author found no references concerning the importance of this ornamental crop. However, from personal observations, it appears that gladiolus production in Lebanon may be becoming an important industry. This is based on the following:

1. In a survey made by the author, it was found that all florists' shops in the Beirut area offer this ornamental crop for sale.
2. There are several gladiolus growers in the Beqa'a Valley who produce this crop in appreciable amounts. One grower produces gladiolus, not only to supply the local markets but also to export to neighbouring countries such as Iraq, Kuwait, Saudi Arabia and other Sheikhdom states.

Since the cultural requirements of the gladiolus have not been studied in Lebanon, an experiment was carried out at the Agricultural Research and Education Center (A.R.E.C.) to determine the effect of dates of planting on the quality and yield of gladiolus.

## II. REVIEW OF LITERATURE

### Types and Quality of Spikes

Since the gladiolus is grown mainly for cut flowers, the quality of the bloom (spike) is important. High quality of the spike cannot be produced all the year round. This is especially true for plants grown in the open or where there are extremely cold winters, or where summers are too hot and dry.

High spike quality plays an important role in successful commercial production as well as for exhibition purposes (49). In general, it can be stated that no single factor can exclusively determine the production of high quality spikes.

Cook (15) reported that the faster the corms develop a good root system, the higher the quality of the spike will be.

Lomis (41), however, reported that fast or slow forcing rates had no effect on the percentage of flowering corms or the size of the spike.

Menzies (48) has emphasized the high quality of the bloom and has given it the first consideration. He observed that a high quality of spike cannot be produced throughout the year where the winter is extremely cold.

Several workers have reported that spike quality is affected by soil salinity, soil acidity, soil alkalinity, sun, shade, time of topping in the previous season, quality of corms used and the use of herbicides (1, 16, 22, 28, 35, 81). It should be emphasized that a high quality of bloom cannot be obtained from diseased plants (9, 17, 18, 23, 29, 42, 43, 47, 64), nor can it be obtained from plants infested by insects or having other pest injuries (5, 21, 32, 33, 51, 52, 72). Furthermore, the quality of the spike can also be affected after the crop is harvested. This depends upon the storage temperature, the relative humidity, the conditions of the spikes, the time of cutting the spikes, daily change of water and the depth at which the spikes are submerged (49, 57, 70, 77).

## Succession of Bloom

From a commercial point of view, succession of bloom is important in order to respond to the demand, at least to a certain extent, and hence increase the value of the crop.

Rockwell (61) has suggested three ways to obtain succession production.

First, by planting difference in time required to reach maturity; for example early flowering varieties and late flowering varieties. That this can work is confirmed by the work of Krone (40) who reported that the number of days from planting time until the flower spike developed differed from one variety to another. In some varieties it required only 60 days while in others it required more than 100 days.

Secondly, Rockwell (61) suggested successive plantings. The validity of this idea was confirmed by the work of Kaicker and Nauriyal (31) who reported that flowering occurred within 90 to 100 days after planting, and that by regulating the date of planting the times of bloom could be regulated.

Thirdly, he suggested planting at different depths. The work of Kaicker and Nauriyal (31) and of Kolesnikov (36) showed that planting gladiolus corms 12 to 18 cm deep instead of the customary 7 cm would delay the flowering for an average of 10 to 11 days. However, not every variety of gladiolus gives the same response under all soil and climatic conditions (6, 16, 25, 37, 48, 67, 74, 75).

Watkins (74) also observed that varieties of gladiolus differed in the length of time required to form flower spikes. Some required a much longer time than others. However, high temperatures of air and soil would cause a reduction in the time required to bloom in all varieties. He added that there were several other factors which have certain effects on the determination of the time of flower spike formation. Such factors were the duration of the rest period previous to planting date, the fertility and moisture supply, and the amount of carbohydrate in the corm.

The Canadian Gladiolus Society has developed a classification according the season of bloom, as reported by Adamson (1), as follows: Early varieties bloom in 75 days or less, Early Midseason in 75 to 80 days, Midseason in 80 to 85 days, Late season in 85 to 90 days, and Late varieties in 90 days or more. However, this depends upon the location and climatic conditions. From data he (1) obtained at the University of Alberta, Canada, he suggested the following classification for Alberta: Early varieties bloom in about 85 days and less, Early Midseason in 86 to 93 days, Midseason in 94 to 101 days, Late season in 102 to 109 days, and Late varieties in 110 days and over.

Succession of bloom can also be obtained by different temperature treatments of the corms during the storage period as was suggested by several workers (19, 30, 50, 54, 55, 66, 67). However, no agreement exists as to whether high or low temperatures enhance the flowering. Nanny and Waters (50) reported that when corms were stored first at relatively high temperatures, then stored at a low temperature of 40$^{0}$F (4.44$^{0}$C), earliness and flower uniformity were obtained. Stuart (67) found that the best result concerning an early sprouting was obtained from cool storage at 40$^{0}$F (4.44$^{0}$C), followed by warm storage at 80$^{0}$F (26.66$^{0}$C). He concluded that this result indicates that some of the processes that are necessary for sprouting take place before planting. These processes are important to reduce the length of the growing season in the field. Others (19, 30, 54, 55, 66, 71), observed that flower production first started from the corms stored at 26.6 to 35$^{0}$C (80 to 95$^{0}$F) compared with those stored at 3.5, 8 and 12$^{0}$C (38.3, 46.4 and 53.6$^{0}$F).

After varying soil temperatures, Tavernetti and Emsweller (69) reported that electrically heating and maintaining the soil at a temperature of between 60 and 70$^{0}$F (15.5 and 21$^{0}$C) reduced by two to six weeks the time required for gladiolus to bloom. They also found that heating for 60 days was as good as heating for 100 days and even heating for 35 days was beneficial, but less than heating for 60 or 100 days.

## Time of Planting

Hartman and Kester (26) described the gladiolus as a semi-hardy to tender plant whose corms should be stored during the winter and planted in the spring in areas with severe winters. However, the planting time differs from one locality to another. In India the gladiolus can be planted at any time of the year, depending on the weather conditions (31), while in England the gladiolus can only be planted from March until the end of May (27), the exact time depending mainly upon the location, weather conditions and condition of the soil (5). Another report from England stated that the hybrids of *Gladiolus primulinus* can be forced in the open during July and August (4).

In Australia Menzies (48) said that a higher quality bloom could be produced on the east coast during the months of August to October and November.

Bartos (8), in his study on the value of pre-cultivation of the gladiolus, reported that in Germany plants can be planted directly in the open in mid-March. Steffen (66) reported that delaying the time of planting in Germany from April to early June caused reduction in the time required from planting to flowering, but planting later than mid-June resulted in blindness of the plants.

A report from Japan (38) stated that cormels of four varieties were planted in May and August, while corms of two varieties were planted in August and March. It was found that growth and production were lower in the autumn-planted plots than those planted in the spring.

In the United States of America a wide variation in the time of planting exists. Post (56) referred to the Southern California region as the only region in the United States of America which produces the gladiolus the year around, and that in Florida the gladiolus is produced during the winter with the production moving progressively Northward as the weather gets warmer. Others have reported that in California and Florida the gladiolus is planted over a wide range of time (10, 11, 12, 19, 34, 45, 62, 63, 69, 73, 78, 79, 80).

In other regions of the United States of America, the gladiolus is planted at different times. In New York, planting occurs from April 15 to the first of June (58), in Michigan it occurs from April to July (40), in Washington D.C., planting is carried out in the first week of May (76), in Iowa, it is done around May 21 (24), in Ohio it starts from March 15 and continues until July first (60), in Washington State it is done in mid-May (2, 23), in Oregon it is done in April (13, 14), in Maryland it is done on May 1st (53), and in Wisconsin, planting is limited to the first week in June (28).

The variations in the date of planting are apparently mainly related to weather conditions, particularly soil and air temperature and humidity, and other factors such as the storage conditions of corms.

## Effect of Air, Soil, and Storage Temperatures on Gladiolus

It can be seen from the following results of various workers that no agreement has been reached regarding the effect of storage temperature in breaking the dormancy of the gladiolus, earliness of sprouting, earliness of flowering, and number of flower spikes produced.

Apte (6) reported that earlier sprouting and flowering were obtained as the temperature of the soil increased. The highest percentage of sprouting was obtained when the soil temperature was 26°C (78.8°F) and the lowest was obtained at a soil temperature of 6°C (42.8°F), while Lomis (41) reported that both storage and soil temperatures of 25 to 40°C (77 to 104°F) caused germination of all six varieties used. He further concluded that a week's storage treatment at 40°C (104°F), two weeks' treatment at 35°C (95°F), four weeks' treatment at 30°C (86°F), six weeks' treatment at 25°C (77°F) or eight to ten weeks' treatment at 20°C (68°F) had the same effect on germination of corms.

Emsweller (19) observed that following heat treatment of corms at 86°F (30°C) for two weeks, vegetative shoots become apparent 13 days earlier and flowering occurred 8 days before normal. Similar results were obtained by Volz and Keyes (71).

Stuart (67) found that earliest sprouting was obtained from cool storage at 40°F (4.44°C) followed by warm storage at 80°F (26.7°C). He concluded that this result indicated that some of the processes that are necessary for sprouting take place before planting. However, opposite results were obtained by Nanny and Waters (50) who reported that when corms were stored first at relatively high temperature of 70°F (21.1°C) and then stored at a low temperature of 40°F (4.44°C), earliness and flower uniformity were obtained. Comparing storage temperatures of 40, 55 and 70°F (4.44, 12.8, and 21.1°C), they reported that the lower the temperature, the larger were the number of spikes produced. However, the average weight of the spikes was lower and fewer corms were produced. Ryan (62) reported that the interruption of cold storage temperature with high temperature for 4 to 6 days had no effect on breaking the rest period.

Post (56) noted that corms stored at low temperature of 40°F (4.44°C) for 60 to 90 days grew rapidly after planting provided that the relative humidity in the storage chamber was maintained at 75 to 85 percent. Pridham and Ratsek (59), however, reported that the storage humidity seems to be associated only with the loss of weight of the corms during storage period and has no effect on the production of the flower spike or the production of corms. They also reported that the trend in flower spike production per corm varies, but in general, a high number of flower spikes are obtained from corms stored at 30°F (-1.1°C) than from those stored at 70°F (21°C).

## III. MATERIALS AND METHODS

This experiment was carried out at the Agricultural Research and Education Center (A.R.E.C.) of the American University of Beirut located in the northern Beqa'a Plain of Lebanon. The experiment was conducted during the spring and summer seasons of 1966. The aim of this experiment was to determine the effects of three dates of planting on five varieties of gladiolus. The quality, quantity (yield), and other response characteristics examined included percentage and duration of sprouting, length of growing period and size and number of mother corms produced.

The three dates of planting (treatments) were at intervals of one month. Plantings were made on April 15th, May 15th, and June 15th.

Five varieties were used, namely: Spic and Span, Leewenhorst, H.v.d. Mark, Morning Kiss, and Lovely Melody. These varieties were chosen on the basis of their popularity as cut flowers. The varieties were obtained from a local agent in Beirut, Lebanon.

### Field Technique

The experiment was laid out in a split plot design in which 3 beds of 1.2 m X 20 m each were prepared, one bed devoted to each date of planting. The beds are constructed in the open and are of the raised type, about 75 cm in height. The beds were leveled so that a uniform irrigation could be obtained.

Each date of planting was replicated three times. The distribution of the five varieties in each replicate was made at random. Randomization was also used in the distribution of the treatments to the beds.

Top soil from fallowed crop land was used in filling and preparing the beds. Since the soil is high in clay content, low in organic matter and phosphorus content, high in potassium content and is calcarious with a pH of about 8 (82, 83), only N and P were applied. N was applied at the rate of 400 #/acre (45.3 Kg per dunum) and P at the rate of 800 #/acre (90.6 Kg per dunum). The sources of the N and P were ammonium sulfate and superphosphate, respectively. The fertilizers were mixed thoroughly with the soil before planting. All blocks received uniform treatments of fertilizers and other cultural practices such as watering and weeding.

The corms were planted at a depth of seven cm and 20 cm apart in rows 1.2 m long. Each plot consisted of four rows planted with 24 corms i.e. six corms in each row.

## Laboratory Technique

Spike quality and quantity (yield), length of season between planting and bloom, and size and number of mother corms were determined from the middle two rows, excluding the two corms on the ends of each row. Percentage and duration of sprouting data were obtained from all corms in each plot during the 45 days subsequent to planting.

The spikes were harvested by cutting the stem at the soil level when one floret was fully opened. The weight of the spikes was taken after stripping off the leaves.

The average air and soil temperatures was taken from the meteorological data of the A.R.E.C. The average soil temperature was taken at sunset 10 cm deep in bare earth, while the average air temperature was measured 165 cm above ground.

## IV. RESULTS AND DISCUSSION

The results of the effects of three dates of planting and varieties on percent and duration of sprouting, quality, yield, length of growing season and number of corms produced are shown in Tables 1 through 9. Figures 1 through 10 illustrate the results accordingly.

### Percent of Sprouting

Data showing the effect of the three dates of planting on the percent of sprouting of the five varieties are presented in Table 1.

Table 1. Effect of dates of planting on percent of sprouting of five varieties of gladiolus in 1966.

| Treatments | Percent of sprouting | | | | | Total | Average |
|---|---|---|---|---|---|---|---|
| | Lovely Melody | Leewen-horst | H.v.d. Mark | Spic and Span | Morning Kiss | | |
| April 15 | 97.2 | 95.8 | 100 | 97.2 | 94.4 | 484.6 | 96.9 |
| May 15 | 95.8 | 98.6 | 100 | 93.1 | 91.7 | 479.2 | 95.8 |
| June 15 | 96.6 | 94.4 | 100 | 93.1 | 90.3 | 474.4 | 94.9 |
| Total | 289.6 | 288.8 | 300 | 283.4 | 276.4 | | |
| Average[x] | 96.5 | 96.3 | 100 | 94.5 | 92.1 | | |

[x] L.S.D. 5% 2.91, 1% 4.24.

Dates of planting had no significant effect on the percent of sprouting of the varieties. However, the highest percentage was obtained in the first treatment, and the lowest percentage was obtained in the third treatment, while the second treatment was intermediate between the two.

The average of the air and soil temperatures during sprouting (45 days elapsing after planting) for the first treatment were 14.28°C and 21.2°C, for the second treatment 17.3°C and 23.7°C, and for the third treatment 21.5°C and 25.4°C, respectively.

It is possible that the reduction in the percent of sprouting in each successive treatment could be due to the increase in soil temperature stimulating pathogenic organisms, present in the soil or on the corms themselves, into an attack on the corms. Evidence for this explanation was observed when corms were dug and some were found to have rotted.

Dodge and Ricket (17) found that bacteria, molds, mites and other organisms were likely to cause infections when temperature and relative humidity were high. They concluded that corm treatment before planting was essential to control several diseases.

It can be seen from Table 1 that highly significant varietal differences existed. H.v.d. Mark, in which maximum possible sprouting was obtained in all three treatments, outstripped all other varieties, while Morning Kiss had the lowest percentage of sprouting in all three treatments. The percent of sprouting of the varieties is illustrated in Figure 1. These results agree with the findings of Apte (6) who concluded that different varieties react differently to environmental

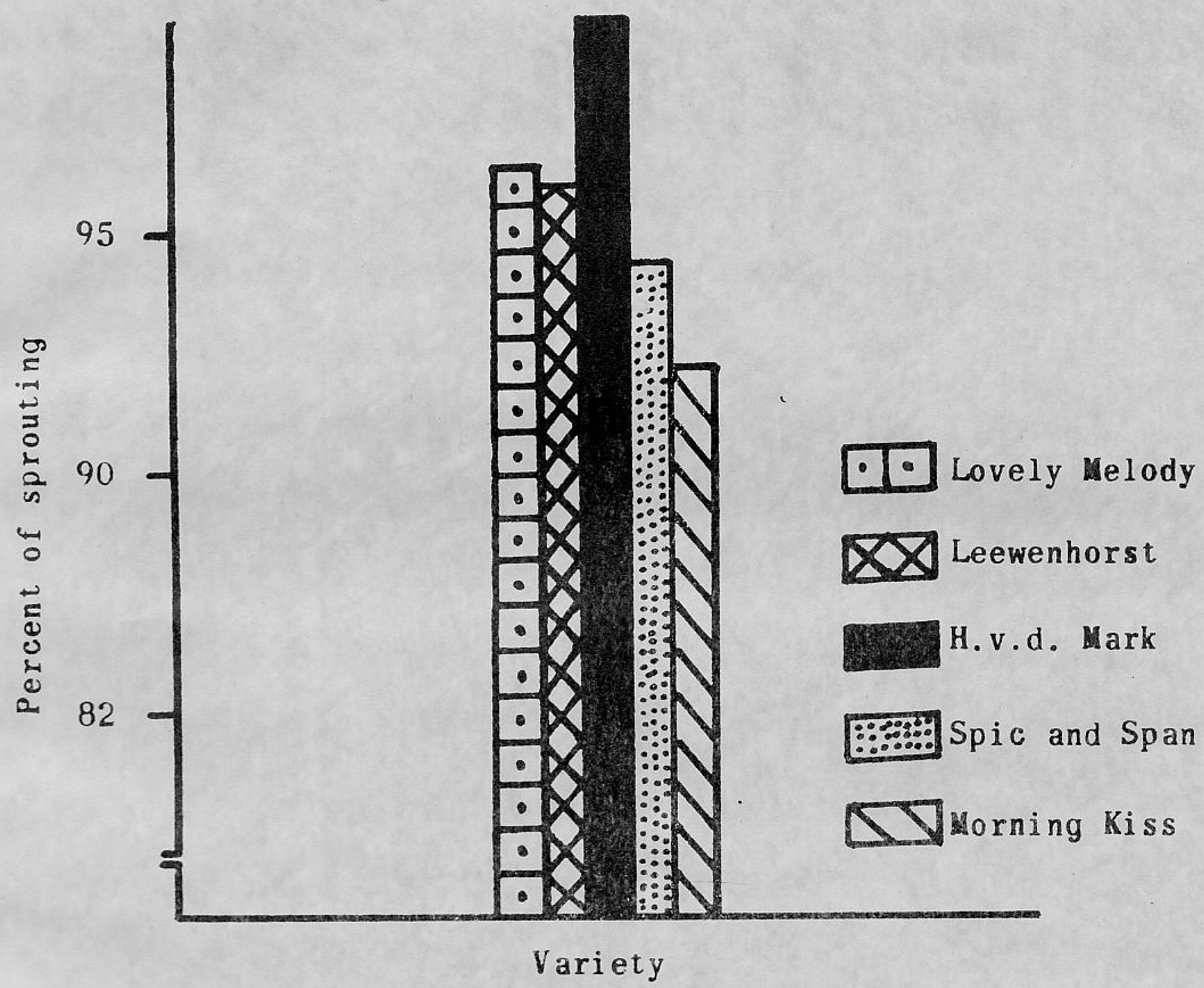


Figure 1. Average percent of sprouting of five varieties of gladioli during 1966.

factors such as temperature, daylength, and moisture as regards sprouting percentage.

Halevy (25) reported that gladiolus varieties differ in their reactions toward soil moisture, and that no single factor can be used to determine the need for irrigation. This difference in reaction to moisture by varieties may also be a possible explanation for the results obtained, since all varieties were irrigated equally. Menzies (48) also observed that varieties of gladiolus do not behave similarly under all soil and climatic conditions.

## Duration of Sprouting

The slowest sprouting was obtained from the earliest planting (April 15), while a significantly faster sprouting was obtained from the latest (June 15). The duration of sprouting of corms from the second planting (May 15) was intermediate between the first and third but was not significantly different from either (Table 2 and Figure 2).

Table 2. Effect of dates of planting on duration of sprouting of the five varieties used in 1966.

| Treatments | Rate of sprouting days | | | | | Total | Average[xx] |
|---|---|---|---|---|---|---|---|
| | Lovely Melody | Leewen-horst | H.v.d. Mark | Spic and Span | Morning Kiss | | |
| April 15 | 15.0 | 19.4 | 13.2 | 21.6 | 18.0 | 87.2 | 17.4 |
| May 15 | 15.1 | 14.5 | 12.8 | 21.9 | 17.1 | 81.4 | 16.3 |
| June 15 | 14.1 | 13.5 | 12.8 | 20.2 | 16.6 | 77.2 | 15.4 |
| Total | 44.2 | 47.4 | 38.8 | 63.7 | 51.7 | | |
| Average[x] | 14.7 | 15.8 | 12.9 | 21.2 | 17.2 | | |

[x] L.S.D. 5% 2.42, 1% 3.52.

[xx] L.S.D. 5% 1.87.

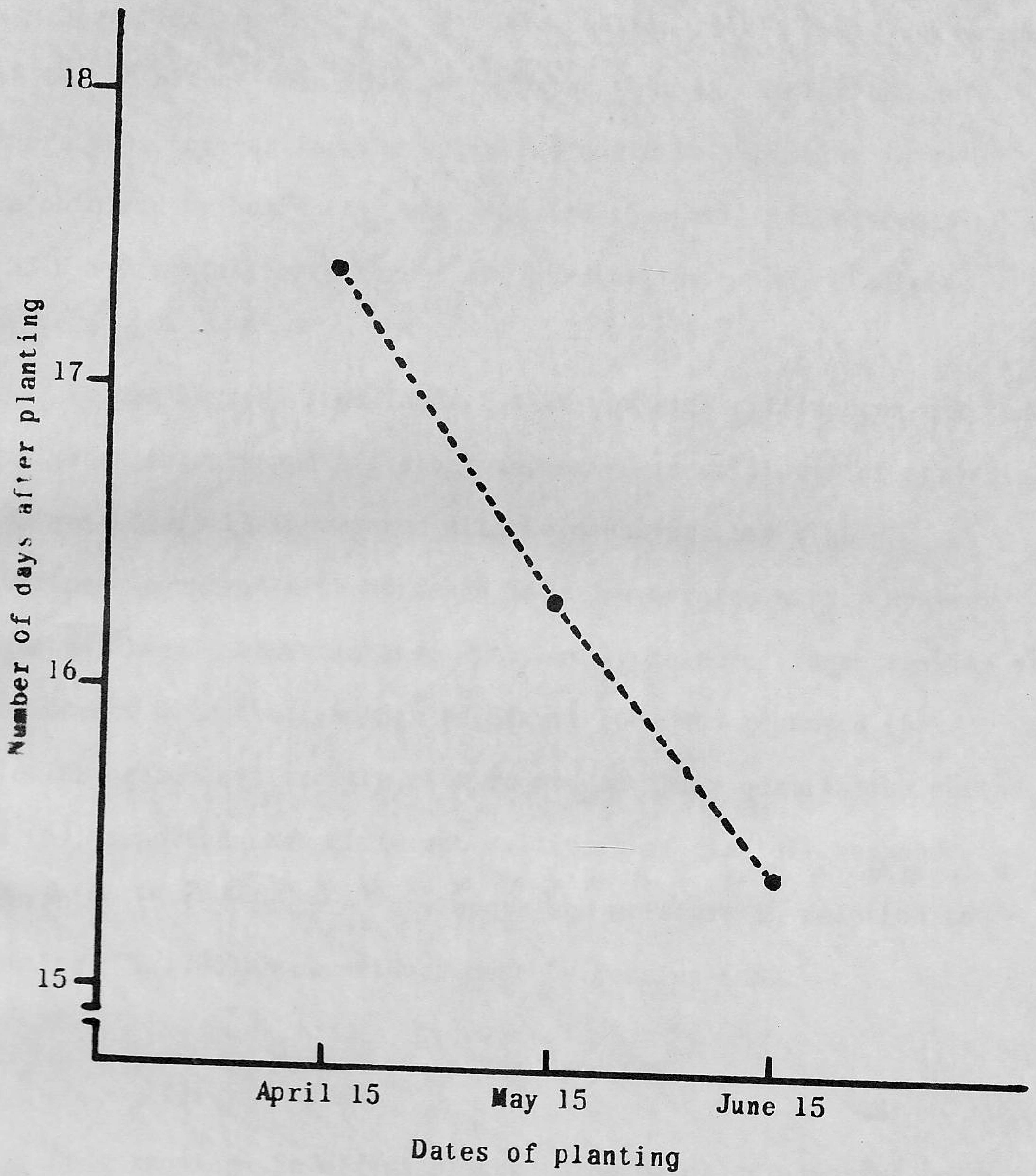


Figure 2. Effect of dates of planting on average number of days required for sprouting in 1966.

Figure 3 illustrates the effect of average air and soil temperatures (during germination) on sprouting in all three treatments. The lower the average of air and soil temperatures the longer the time required for sprouting. This result is in agreement with the result of Apte (6) who reported that the higher the soil temperature, the earlier the sprouting would be. Similar results were obtained by Lomis (41) who reported that soil temperatures of 25 to 35$^{0}$C had successfully forced the germination of all gladiolus varieties used.

It can be seen from Table 2 that varietal differences existed. H.v.d. Mark outstripped all other varieties in earliness of sprouting, which was significant compared with Leewenhorst, and highly significant compared with Spic and Span and Morning Kiss. However, it was not significant compared with Lovely Melody. These results are in agreement with the findings of Stuart (60) who reported that varieties behave differently with regard to their germination period. Apte (6), reported that different cultivars of gladioli respond differently to temperature, daylength and moisture in relation to sprouting. A similar report was made by Menzies (48).

## Number of Spikes Produced

Data showing the effect of the three dates of planting on the average number of spikes (yield) produced in plots planted with 24 corms are presented in Table 3.

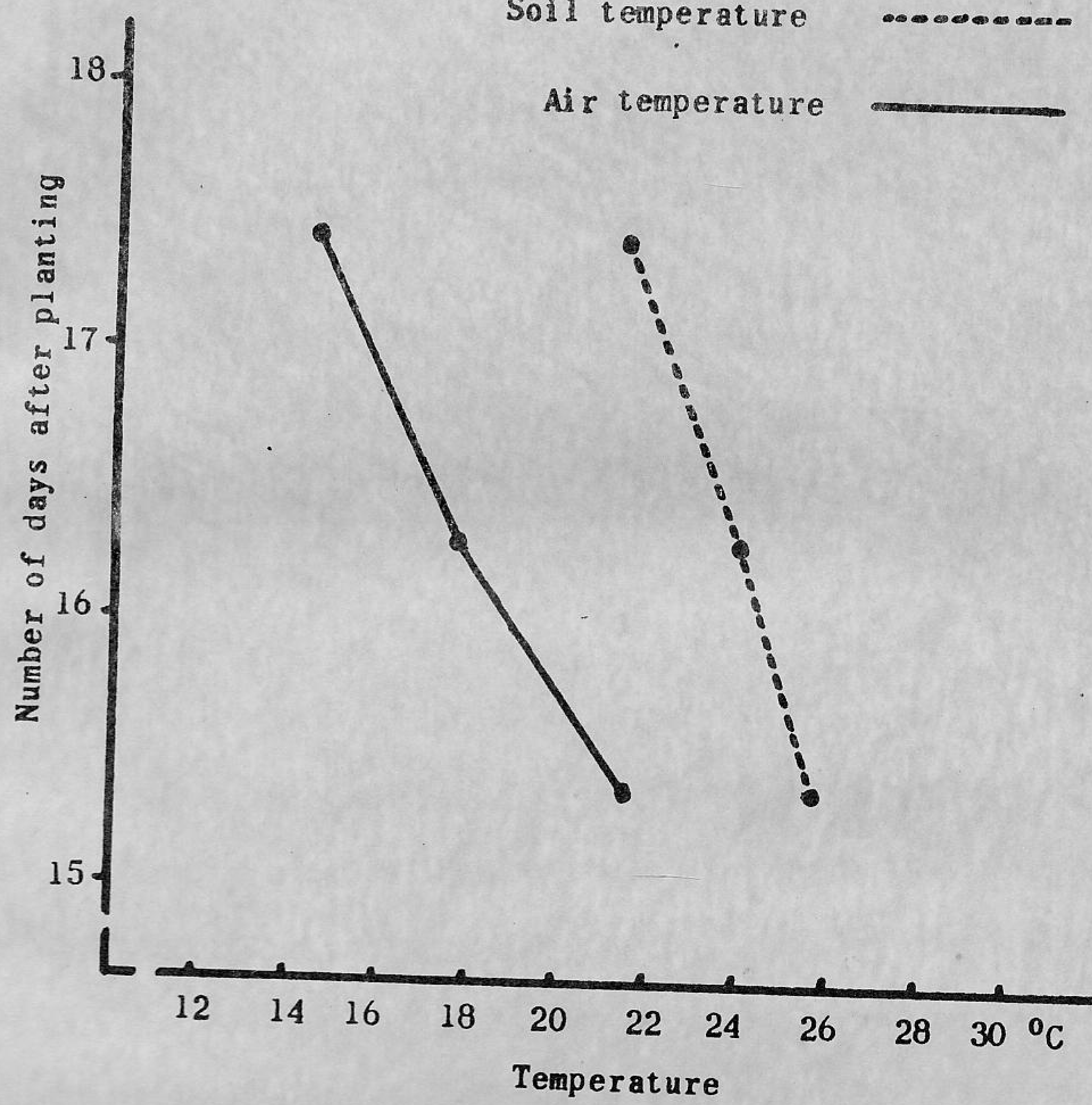


Figure 3. Effect of average air and soil temperatures during germination on average number of days required for sprouting in 1966.

Table 3. Effect of dates of planting on number of spikes produced in 1966.

| Treatments | Number of spikes produced: Lovely Melody | Leewen-horst | H.v.d. Mark | Spic and Span | Morning Kiss | Total | Average[xx] |
|---|---|---|---|---|---|---|---|
| April 15 | 10 | 1 | 21 | 15 | 4 | 51 | 10.2 |
| May 15 | 5 | 1 | 15 | 9 | 0 | 30 | 6.0 |
| June 15 | 11 | 3 | 22 | 21 | 6 | 63 | 12.6 |
| Total | 26 | 5 | 58 | 45 | 10 | | |
| Average[x] | 8.7 | 1.7 | 19.3 | 15.0 | 3.3 | | |

[x] L.S.D. 5% 3.71, 1% 5.4.

[xx] L.S.D. 5% 2.88, 1% 4.19.

The highest number of spikes was obtained from the June 15th planting, the lowest number was obtained from the May 15th planting, while the planting on April 15th produced an intermediate number of spikes. The numbers of spikes produced in the earliest and latest plantings did not significantly differ but that from the second planting was highly significantly lower with the other plantings.

Figure 4 shows that all varieties except Leewenhorst, which produced very few spikes for any planting, produced fewer spikes in the first planting than in the third, and considerably fewer in the second than in either the first or third planting. The lowest yield was obtained from the variety Leewenhorst and the next lowest was

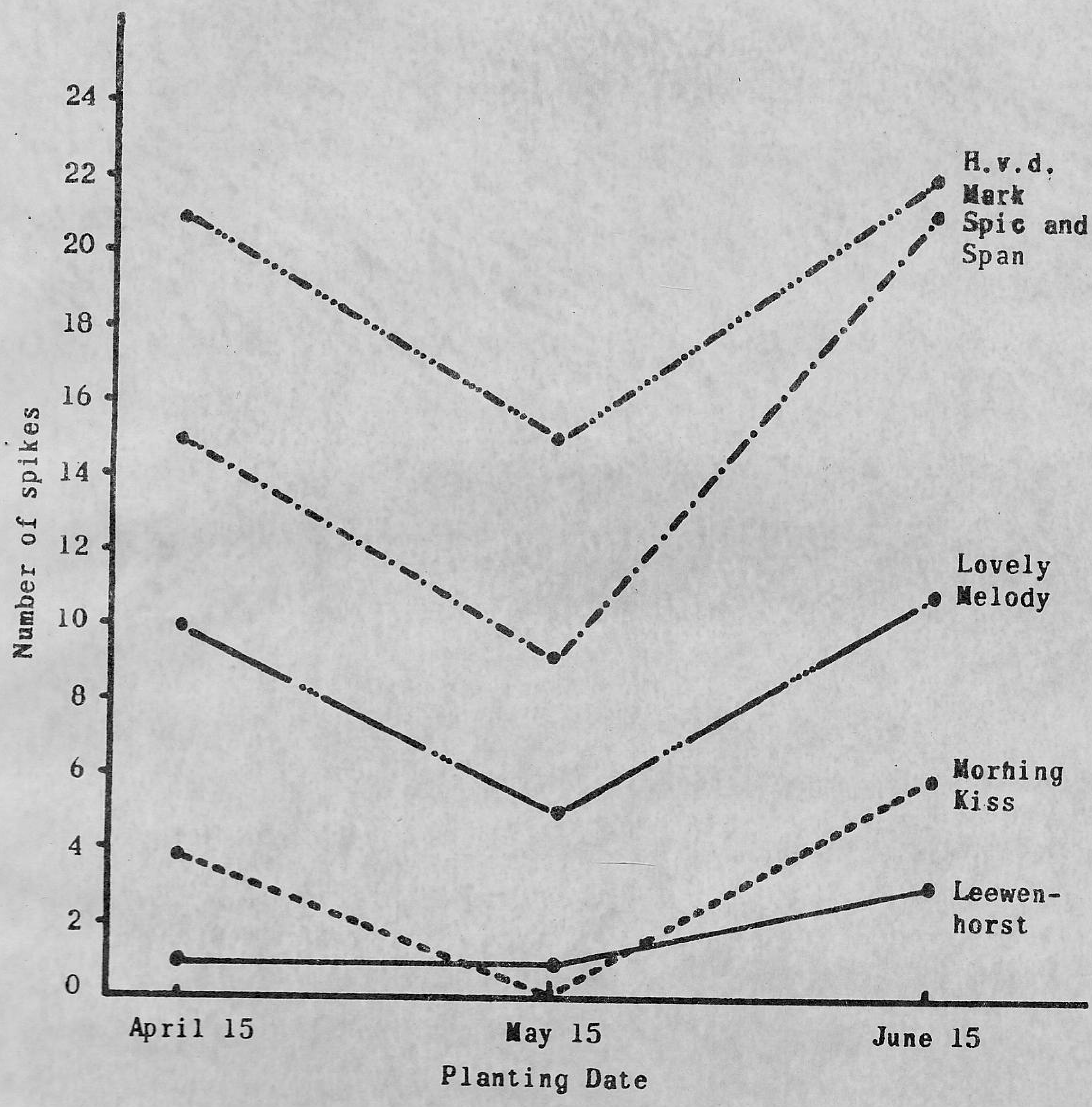


Figure 4. Effect of three dates of planting on average number of spikes produced of five varieties of gladioli in 1966.

obtained from the variety Morning Kiss. Similar results were obtained by Stefan (65), with the Leewenhorst variety. He reported that its' yield was generally lower than most of the varieties. Morning Kiss was reported by Woltz (80) to be one of the varieties that respond more to fertilizers than others. It is possible that the low yield of spikes obtained might be due to the soil fertility level being too low for this variety.

It was found that a relationship existed between the average air temperature during flower spike development and the number of spikes produced with every variety (Figure 5). The period of flower spike development is referred to as the time between the initial appearance of the flowering spikes and their harvest.

The average of the air temperature during flower spike development for the first treatment was 23.6$^{o}$C, for the second treatment 24.4$^{o}$C, and for the third treatment 18.0$^{o}$C.

It can be seen that as the average air temperature increased the number of spikes produced decreased. These findings agree with the 1933 results of Pridham as referred to by Post (56) who found that although all corms may differentiate flower spikes, the spikes usually abort a few inches from the corm in high temperatures. He concluded that normal flowering occurred when the corms were grown at night temperatures of 50$^{o}$F (10$^{o}$C) during cloudy weather, and 55 to 60$^{o}$F (12.8 to 15.5$^{o}$C) during higher light intensity.

## Length of Spikes

Data showing the effects of dates of planting on length of the spikes of all the varieties are presented in Table 4.

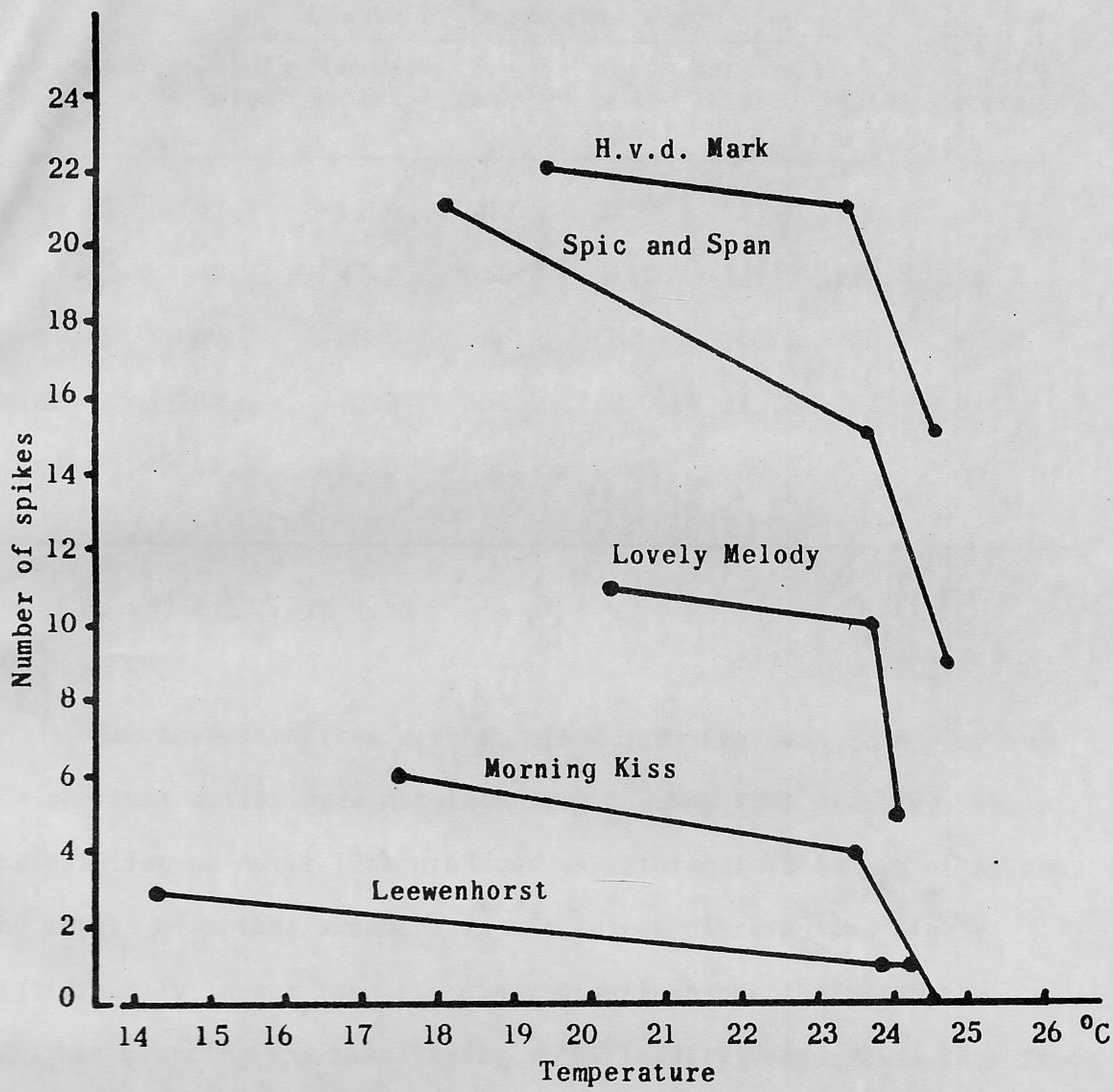


Figure 5. Relation between average air temperature during flower development on yield as measured by number of spikes produced in 1966.

Table 4. Effect of dates of planting on length of spikes of the five varieties used in 1966.

| Treatments | Length of the spikes (cm) | | | | | | |
|---|---|---|---|---|---|---|---|
| | Lovely Melody | Leewen-horst | H.v.d. Mark | Spic and Span | Morning Kiss | Total | Average[x] |
| April 15 | 62.7 | 61.0 | 48.5 | 52.9 | 57.3 | 282.4 | 56.5 |
| May 15 | 53.2 | 47.0 | 52.4 | 41.2 | 49.9 | 243.7 | 48.7 |
| June 15 | 69.7 | 68.5 | 60.2 | 68.9 | 68.6 | 335.9 | 67.2 |
| Total | 185.6 | 176.5 | 161.1 | 163.0 | 175.8 | | |
| Average | 61.7 | 58.8 | 53.7 | 54.4 | 58.6 | | |

[x] L.S.D. 5% 6.27, 1% 9.12

The longest spikes were obtained from the June 15th planting, the shortest spikes were obtained from the May 15th planting, while the planting on April 15th produced an intermediate length of spikes. The length of spikes produced in the latest planting was highly significantly longer than the other plantings but that from the earliest planting was also highly significantly longer than that from second planting.

Figure 6 shows that all varieties except H.v.d. Mark, which produced a higher average length of spikes in the second planting than in the first, produced shorter spikes in the first planting than in the third, and considerably shorter in the second than in either the first or third planting.

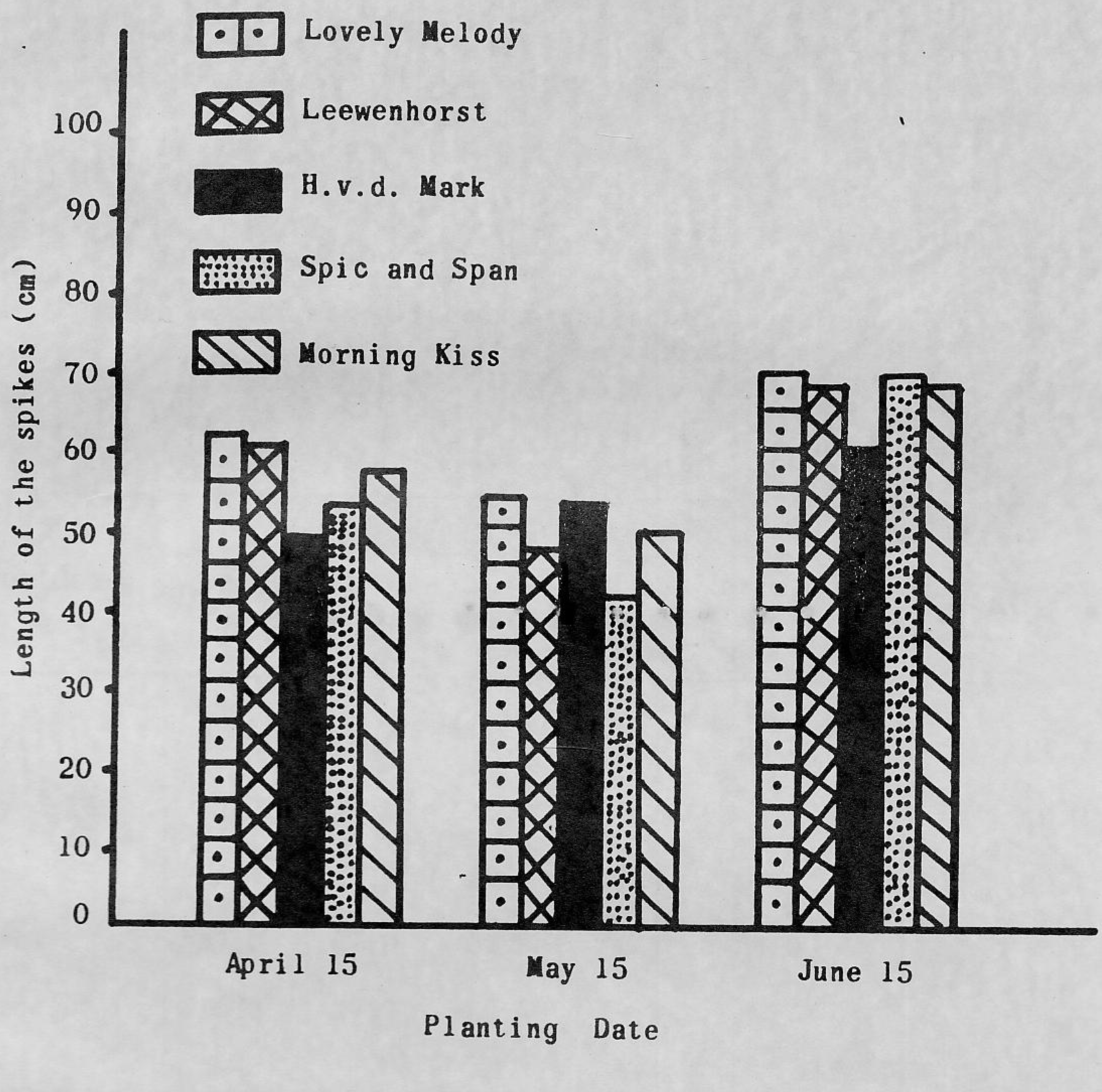


Figure 6. Effect of dates of planting on length of spikes of five varieties of gladioli in 1966.

Figure 7 illustrates the effect of average air and soil temperatures during flower development on the length of the spikes. The lower the average of air and soil temperature the longer the spikes are. Such a relation will be discussed later.

## Weight of Spikes

Data showing the effect of the three dates of planting on the weight of the spikes are presented in Table 5.

Table 5. Effect of dates of planting on weight of spikes of the five varieties used in 1966.

| Treatments | Weight of the spikes (gr) | | | | | | |
|---|---|---|---|---|---|---|---|
| | Lovely Melody | Leewen-horst | H.v.d. Mark | Spic and Span | Morning Kiss | Total | Average[xx] |
| April 15 | 18.4 | 35.0 | 21.8 | 25.0 | 23.3 | 123.5 | 24.7 |
| May 15 | 7.7 | 10.0 | 16.2 | 9.6 | 8.1 | 51.6 | 10.3 |
| June 15 | 22.9 | 42.0 | 29.9 | 31.1 | 27.6 | 153.5 | 30.7 |
| Total | 49.0 | 87.0 | 67.9 | 65.7 | 59.0 | | |
| Average[x] | 16.3 | 29.0 | 22.6 | 21.9 | 19.7 | | |

[x] L.S.D. 5% 7.9, 1% 11.5.

[xx] L.S.D. 5% 6.14, 1% 8.9

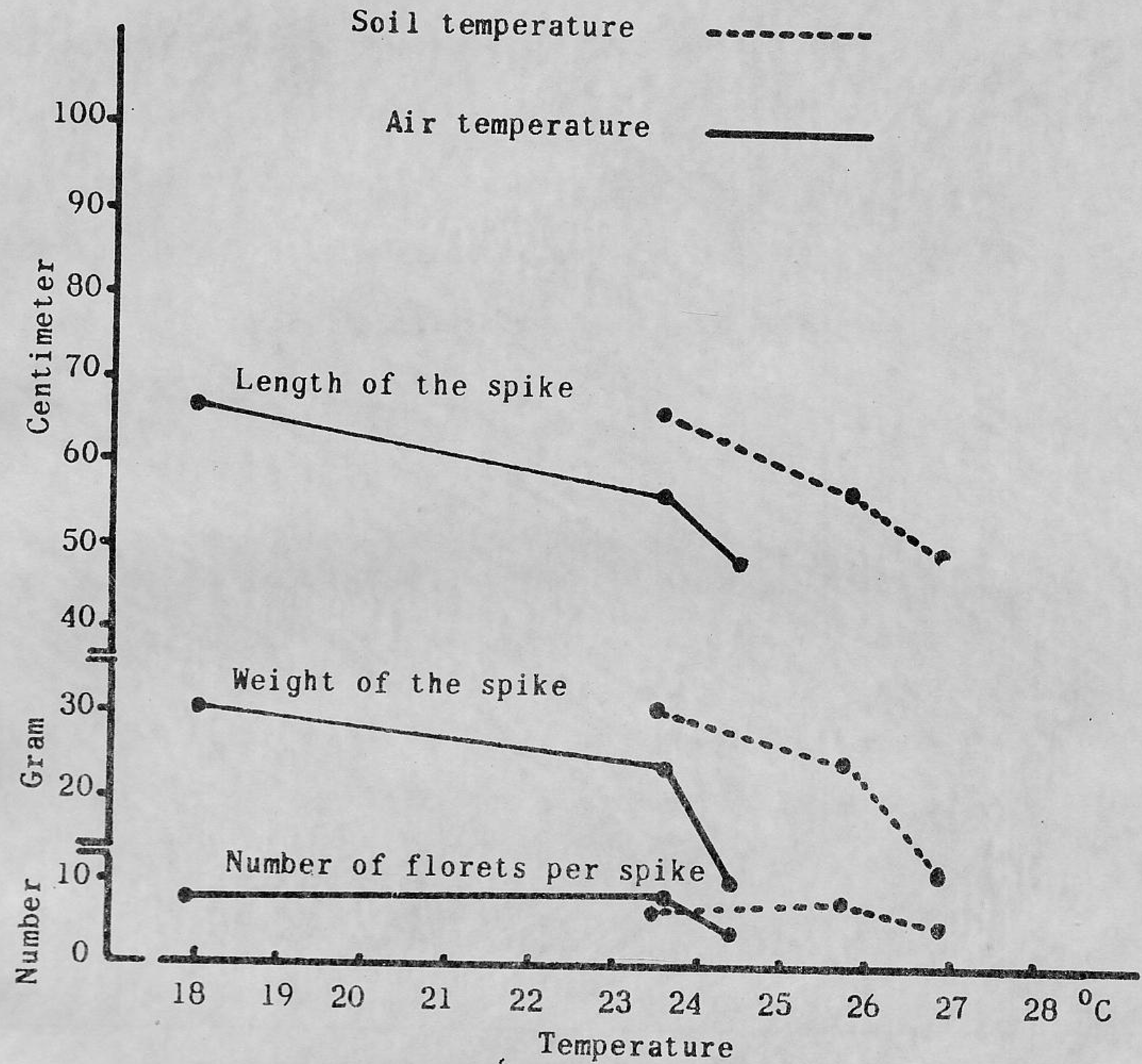


Figure 7. Effect of average air and soil temperatures during flower spike development on number of florets per spike, weight of spikes and length of spikes in 1966. Flower development period was between initial spike appearance and harvest.

The earliest and the latest plantings yielded superior spikes as far as their weights are concerned compared with those of the intermediate. This superiority was highly significant. Although the heaviest spikes were obtained in the latest planting it was not significant when compared with the earliest. A similar trend was observed without exception in each variety (Figure 8). Leewenhorst outweighed all other varieties but was only highly significantly heavier than Lovely Melody and significantly heavier than Morning Kiss. The effect of average air and soil temperature during flower spike development is shown in Figure 7. This effect will be discussed later.

## Number of Florets per Spike

Data showing the effect of the three dates of planting on the number of florets per spike are presented in Table 6.

Table 6. Effect of dates of planting on number of florets per spike of the five varieties used in 1966.

| Treatments | Number of florets per spike | | | | | | |
|---|---|---|---|---|---|---|---|
| | Lovely Melody | Leewen-horst | H.v.d. Mark | Spic and Span | Morning Kiss | Total | Average[xx] |
| April 15 | 10.1 | 9.0 | 8.1 | 8.5 | 7.5 | 43.2 | 8.6 |
| May 15 | 6.7 | 5.0 | 7.5 | 4.7 | 4.2 | 28.1 | 5.6 |
| June 15 | 8.1 | 7.7 | 9.3 | 9.6 | 6.8 | 41.5 | 8.3 |
| Total | 24.9 | 21.7 | 24.9 | 22.8 | 18.5 | | |
| Average[x] | 8.3 | 7.2 | 8.3 | 7.6 | 6.2 | | |

[x] L.S.D. 5% 1.85

[xx] L.S.D. 5% 1.43, 1% 2.08.

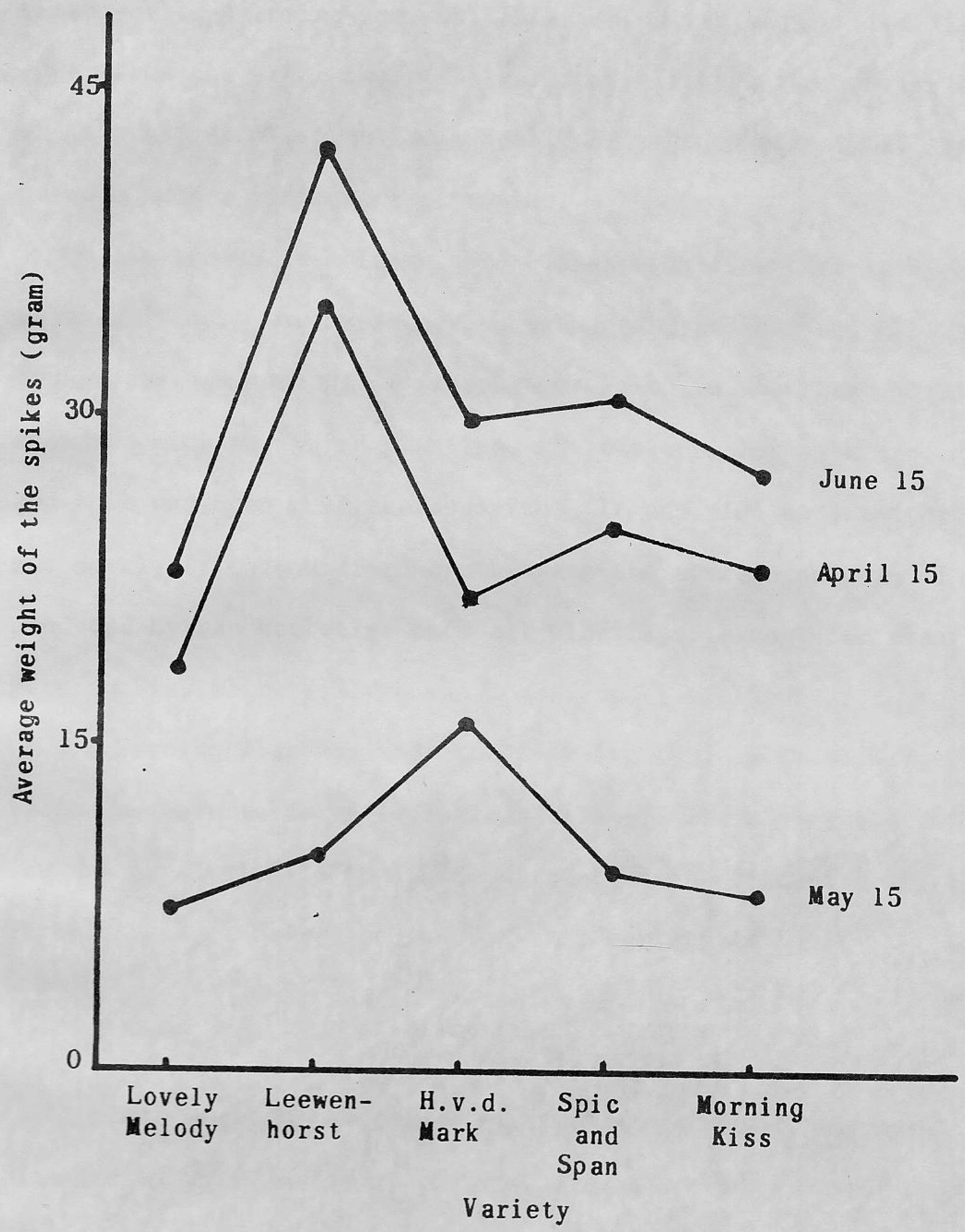


Figure 8. Effect of dates of planting on average weight of the spike in 1966.

The least number of florets per spike was obtained in the intermediate planting i.e. May 15th, which was highly significantly lower than the other two. The earliest planting i.e. April 15th, and the latest planting i.e. June 15th, yielded almost the same average number of florets per spike.

It can be seen from Table 6 that significant varietal differences existed. Lovely Melody, Leewenhorst, and Morning Kiss yielded higher average numbers of florets per spike in the first planting as compared with the third planting, while the yields of H.v.d. Mark and Spic and Span were the opposite. It can also be seen that there was no significant differences between the average numbers of florets produced by the varieties over all plantings, except for the variety Morning Kiss which yielded the least number of florets.

Morning Kiss was reported by Woltz (80) to be a variety that responded more to fertilizers than others. It is possible that the low number of florets per spike obtained might be due to the soil fertility level being too low for this variety.

## Diameter of Florets

Data showing the effect of the three dates of planting on the diameter of the florets of the five varieties are presented in Table 7.

Table 7. Effects of dates of planting on size of florets as measured by diameter for the five varieties used in 1966.

| Treatments | Diameter of florets (cm) | | | | | | |
|---|---|---|---|---|---|---|---|
| | Lovely Melody | Leewen-horst | H.v.d. Mark | Spic and Span | Morning Kiss | Total | Average[xx] |
| April 15 | 7.7 | 9.0 | 7.6 | 7.2 | 7.7 | 39.2 | 7.8 |
| May 15 | 7.0 | 8.8 | 6.5 | 7.4 | 7.5 | 37.2 | 7.4 |
| June 15 | 10.0 | 10.5 | 8.4 | 8.7 | 9.7 | 47.3 | 9.5 |
| Total | 24.7 | 28.3 | 22.5 | 23.3 | 24.9 | 123.7 | |
| Average[x] | 8.2 | 9.4 | 7.5 | 7.8 | 8.3 | | |

x L.S.D. 5% 0.78, 1% 1.14.

xx L.S.D. 5% 0.6 , 1% 0.87.

The latest planting i.e. June 15th, yielded the largest florets compared with the other two; this difference was highly significant. The intermediate planting i.e. May 15th, produced the smallest florets but was not significantly different from the earliest i.e. April 15th. Such a trend was true in each variety except with Spic and Span which produced larger florets in the second planting than the first one.

It is apparent from Table 7 that varietal differences existed. Leewenhorst produced spikes with the largest florets which were significant when compared with Morning Kiss and highly significant when compared with the rest. H.v.d. Mark produced spikes with the smallest florets but not significantly smaller than Spic and Span and Lovely Melody.

## Relationship Between Average Air and Soil Temperatures During Flower Spike Development and Quality of Spike

Figures 7 and 9 illustrate the relationship between the average air and soil temperatures during flower spike development and the length, weight of the spike, number of florets per spike and size of the florets as expressed by the diameter.

The average of the air and soil temperatures during flower spike development for the first planting were 23.6 and 25.8$^{o}$C, for the second planting 24.4 and 26.9$^{o}$C, and for the third planting 18 and 23.5$^{o}$C, respectively.

It can be seen from the figures that as the average air and soil temperatures increased the quality of the spikes produced decreased. These findings agree with the 1933 results of Pridham as referred to by Post (56) who found that although all corms may differentiate flower spikes, the spikes usually abort a few inches from the corm in high temperatures. He concluded that normal flowering occurred when the corms were grown at night temperatures of 50$^{o}$F (10$^{o}$C) during cloudy weather, and 55 to 60$^{o}$F (12.8 to 15.5$^{o}$C) during higher light intensity. These findings also show partial agreement with the work of Tavernetti and Emsweller (69), who reported that quality of spikes was not affected by heating the soil to a temperature of between 60 and 70$^{o}$F (15.5 to 21.1$^{o}$C) for 60 to 100 days. By comparing the range of soil temperature given by Tavernetti and Emsweller (69) with the average soil temperature obtained in the three plantings in

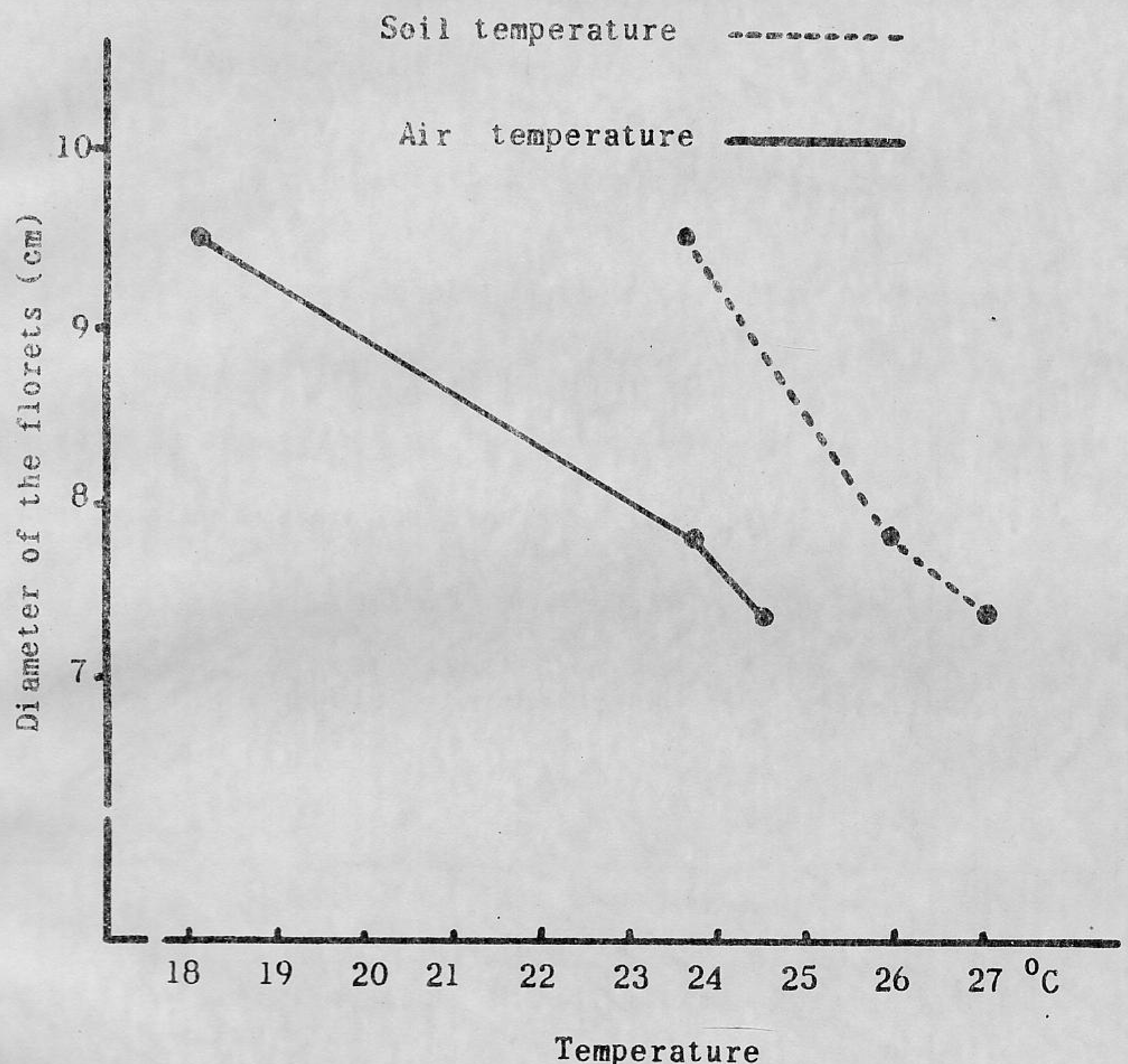


Figure 9. Effect of average air and soil temperatures during flower spike development on size of the florets as measured by diameter in 1966. Flower development period was between initial spike appearance and harvest.

the present study it can be seen that the lowest average temperature, which was obtained in the third planting, was closest to the range given and hence lower quality of spikes was obtained with any increase in the average soil temperature.

## Length of Growing Season

Length of growing season is referred to as the number of days required from planting the corms until the spikes are harvested. Data showing the effect of the three dates of planting on the length of the growing season are presented in Table 8.

Table 8. Effect of dates of planting on length of growing season for the five varieties used in 1966.

| | Number of days from planting until cutting the spikes | | | | | | |
|---|---|---|---|---|---|---|---|
| Treatments | Lovely Melody | Leewen-horst | H.v.d. Mark | Spic and Span | Morning Kiss | Total | Average |
| April 15 | 98.4 | 91.0 | 97.5 | 96.8 | 98.5 | 482.2 | 96.4 |
| May 15 | 113.7 | 108.0 | 109.1 | 107.1 | 91.6 | 529.5 | 105.9 |
| June 15 | 92.9 | 109.0 | 99.5 | 106.8 | 63.7 | 471.9 | 94.4 |
| Total | 305.0 | 308.0 | 306.1 | 310.7 | 253.8 | | |
| Average | 101.7 | 102.7 | 102.0 | 103.6 | 84.6 | | |

Date of planting had no significant effect on the length of the growing season of the varieties. These results agree with the work of Kaicker and Nauriyal (31) who reported that flowering of gladiolus occurs within 90 to 100 days after the planting date, and by regulating the date of planting a succession of bloom can be obtained.

It can be seen from Figure 10 that varietal differences existed but they were not significant. Morning Kiss was the only variety which flowered early. It is well known that not every variety of gladiolus will behave similarly under all soil and climatic conditions (5, 6, 31, 56, 67). Krone (40) and Watkins (74) observed that the number of days required from the date of planting until blooming time would vary from one variety to another. Some varieties required only about 60 days while others required over 100 days. Another report (5) mentioned that a succession of bloom can be obtained by careful plan and choice of the varieties, since flowering time of each variety varies.

These varieties can be classified on the basis of length of their growing season as follows: Lovely Melody, Leewenhorst, H.v.d. Mark, and Spic and Span are late varieties, and Morning Kiss is a midseason variety. This classification is according to the Canadian Gladiolus Society (1). According to the classification suggested by Adamson (1), Lovely Melody, Leewenhorst, H.v.d. Mark and Spic and Span, are late season varieties, and Morning Kiss is an early variety.

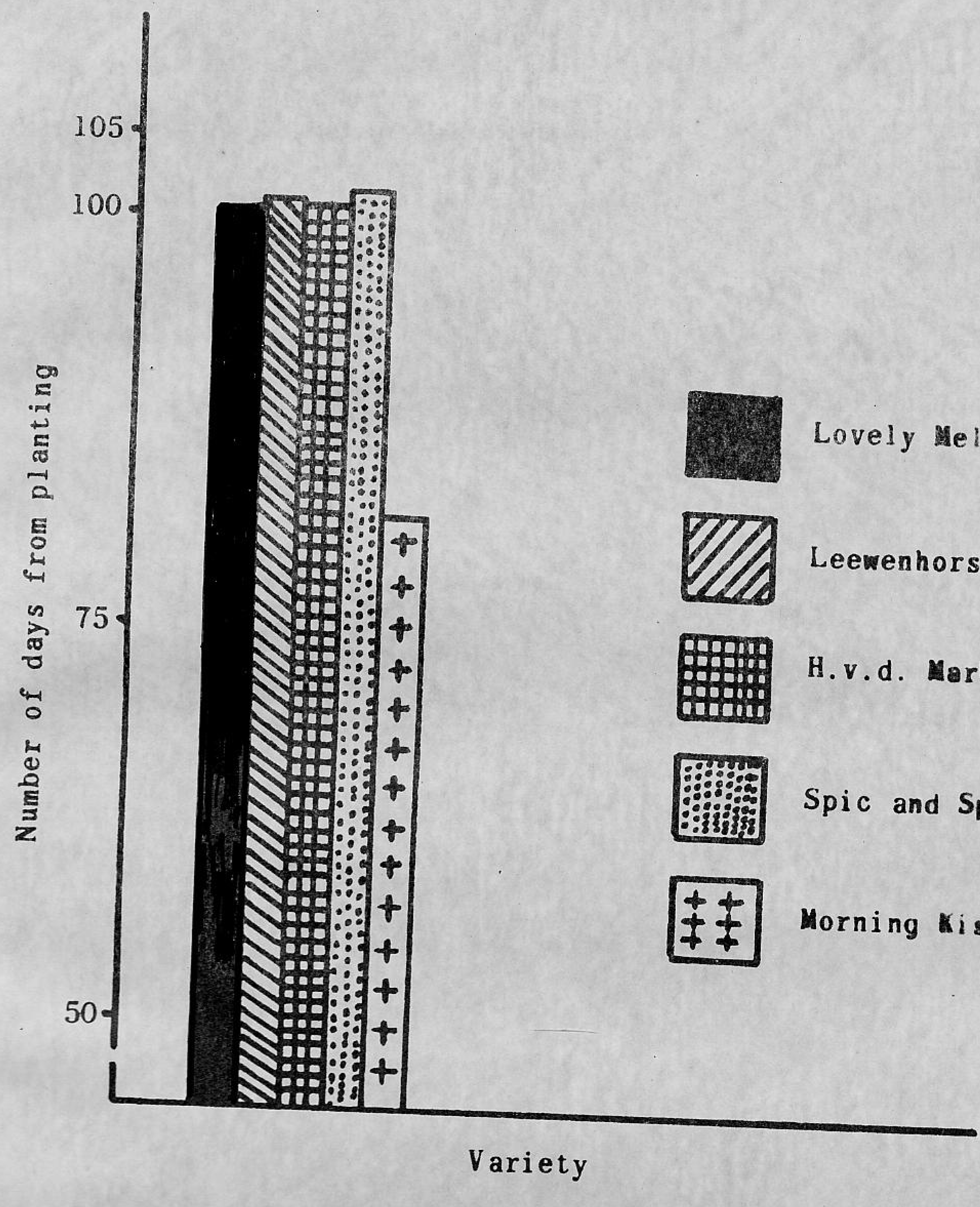


Figure 10. Effect of varieties on average length of growing season of gladiolus in 1966.

## Number of Corms Produced

Data presented in Table 9 includes only corms produced having a diameter of 3 cm or more. Corms less than 3 cm in diameter were discarded. Thus the data presented shows only corms of grade one and two and some of grade three (grade 3 also includes some corms slightly less than three cm in diameter. These were not included). Such a grading system is commonly used in gladiolus corm rating (40, 56).

Table 9. Effect of dates of planting on production of corms for the five varieties used in 1966.

| Treatments | Average number of corms produced (3 cm and over) in each lot (8 plants). | | | | | | |
|---|---|---|---|---|---|---|---|
| | Lovely Melody | Leewen-horst | H.v.d. Mark | Spic and Span | Morning Kiss | Total | Average |
| April 15 | 6.6 | 5.0 | 6.0 | 4.6 | 7.0 | 29.2 | 5.8 |
| May 15 | 5.3 | 4.6 | 4.3 | 4.3 | 4.6 | 23.1 | 4.6 |
| June 15 | 5.3 | 4.2 | 3.6 | 5.0 | 7.6 | 25.7 | 5.1 |
| Total | 17.2 | 13.8 | 13.9 | 13.9 | 19.2 | | |
| Average[x] | 5.7 | 4.6 | 4.6 | 4.6 | 6.4 | | |

[x] L.S.D. 5% 1.63.

Dates of planting had no significant effect on the number of corms produced (Table 9). However, significant varietal differences existed. Morning Kiss significantly outyielded all other varieties in the average number of corms produced except Lovely Melody.

It is possible that date of planting had no effect on the number of corms produced because of the effect of storage temperature of corms which has been found in many cases to affect the number of corms produced.

According to Pridham and Ratsek (59), more corms were produced if the planted corms were stored at 30$^{o}$F (-1.1$^{o}$C) than if they were stored at 70$^{o}$F (21.1$^{o}$C) and according to the 1954 results of Stuart et al. as referred to by Nanny and Waters (50), corms stored at 40$^{o}$F (4.4$^{o}$C) produced a higher number of corms than did those stored at 50$^{o}$F (10$^{o}$C). Nanny and Waters (50) themselves have found that corms stored at 70$^{o}$F (21.1$^{o}$C) produced more corms than those stored at 55$^{o}$F (12.8$^{o}$C). Jenkins (30) reported that the highest yield of number one corms of the variety Snow Princess and Valeria was obtained from corms stored at 80$^{o}$F (26.7$^{o}$C) for 15 days prior to planting. However, Apte (6), reported that storage temperature of the corms had no effect on the number of corms produced in the following season.

Since the corms of this study were obtained from a local agent in Beirut and since the storage records concerning the planted corms are not available, a proper interpretation of the results is impossible.

## V. SUMMARY AND CONCLUSIONS

### Summary

The study was undertaken to evaluate the effect of three dates of planting on the quality, quantity (yield), percent and duration of sprouting, length of growing season and the number of corms produced of five varieties of gladioli. The trial was conducted at the Agricultural Research and Education Center (A.R.E.C.) of the American University of Beirut located in the Northern Beqa'a Plain of Lebanon.

The three dates of planting were as follows: April 15th, May 15th, and June 15th, respectively. Each date of planting was replicated three times. Five varieties were used namely: Lovely Melody, Leewenhorst, H.v.d. Mark, Spic and Span, and Morning Kiss.

The highest yield and quality was obtained from the third planting (June 15th), the lowest was obtained from the second planting (May 15th), while the first planting (April 15th) was intermediate between the two. The quality included only the length and weight of the spikes and the diameter of the florets. As to the number of florets per spike, the earliest and the latest plantings produced almost the same number of florets per spike. However, the intermediate planting produced the least number of florets per spike. The longest duration of sprouting was obtained from the first planting and the shortest was obtained from the third planting, while the

second planting was intermediate between the two.

Date of planting had no significant effect on the percent of sprouting, length of growing season and number of corms produced.

Varietal differences existed. H.v.d. Mark outstripped all other varieties in the percent of sprouting, duration of sprouting (least number of days) and number of spikes produced. Spic and Span was the second in the production of spikes. With regard to number of florets per spike, H.v.d. Mark and Lovely Melody exceeded all other varieties. Leewenhorst produced the heaviest spikes with largest florets but was the poorest in production. Morning Kiss was the earliest; the spikes were harvested after 84.6 days while the other varieties required an average of over 100 days. Morning Kiss also outyielded all other varieties in the number of corms produced. However, both varieties Leewenhorst and Morning Kiss were the poorest in the production of spikes.

## Conclusions

The results obtained indicate that either early or late planting is recommended for gladiolus in order to obtain a higher quality and yield of flower spikes in the North Beqa'a Plain of Lebanon. However, late planting is preferred. It seems that the date of planting is mainly associated with air and soil temperatures especially during flower spike's development. Therefore, further study should be continued in order to determine how early or how late the gladiolus can be planted since the interval between each date of planting in the present study was a month.

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# APPENDICES

Table 10. Analysis of variance for percentage of sprouting.

| Source of variation | D.F. | S.S. | M.S.S. | F | Tabulated F 5% | Tabulated F 1% |
|---|---|---|---|---|---|---|
| Between varieties | 4 | 100.74 | 25.19 | 10.28 | 3.84 | 7.01 |
| Between treatments | 2 | 10.42 | 5.21 | 2.13 | 4.46 | 8.65 |
| Error | 8 | 19.63 | 2.45 | | | |
| Total | 14 | 130.79 | | | | |

Table 11. Analysis of variance for duration of sprouting.

| Source of variation | D.F. | S.S. | M.S.S. | F | Tabulated F 5% | Tabulated F 1% |
|---|---|---|---|---|---|---|
| Between varieties | 4 | 117.63 | 29.41 | 17.82 | 3.84 | 7.01 |
| Between treatments | 2 | 10.09 | 5.05 | 3.06 | 4.46 | 8.65 |
| Error | 8 | 13.22 | 1.65 | | | |
| Total | 14 | 140.94 | | | | |

Table 12. Analysis of variance for number of the spikes produced.

| Source of variation | D.F. | S.S. | M.S.S. | F | Tabulated F 5% | Tabulated F 1% |
|---|---|---|---|---|---|---|
| Between varieties | 4 | 680.9 | 170.2 | 43.64 | 3.84 | 7.01 |
| Between treatments | 2 | 111.6 | 55.8 | 14.31 | 4.46 | 8.65 |
| Error | 8 | 31.1 | 3.9 | | | |
| Total | 14 | 823.6 | | | | |

Table 13. Analysis of variance for length of the spikes.

| Source of variation | D.F. | S.S. | M.S.S. | F | Tabulated F 5% | Tabulated F 1% |
|---|---|---|---|---|---|---|
| Between varieties | 4 | 139.55 | 34.89 | 1.89 | 3.84 | 7.01 |
| Between treatments | 2 | 857.38 | 428.69 | 23.17 | 4.46 | 8.65 |
| Error | 8 | 148.05 | 18.5 | | | |

Table 14. Analysis of variance for weight of spikes.

| Source of variation | D.F. | S.S. | M.S.S. | F | Tabulated F 5% | Tabulated F 1% |
|---|---|---|---|---|---|---|
| Between varieties | 4 | 260.77 | 65.19 | 3.68 | 3.84 | 7.01 |
| Between treatments | 2 | 1096.88 | 548.44 | 30.99 | 4.46 | 8.65 |
| Error | 8 | 141.4 | 17.7 | | | |
| Total | 14 | 1499.05 | | | | |

Table 15. Analysis of variance for number of florets produced per spike.

| Source of variation | D.F. | S.S. | M.S.S. | F | Tabulated F 5% | Tabulated F 1% |
|---|---|---|---|---|---|---|
| Between varieties | 4 | 9.411 | 2.353 | 2.44 | 3.84 | 7.01 |
| Between treatments | 2 | 27.364 | 13.682 | 14.16 | 4.46 | 8.65 |
| Error | 8 | 7.745 | 0.966 | | | |
| Total | 14 | 44.52 | | | | |

Table 16. Analysis of variance for diameter of florets.

| Source of variation | D.F. | S.S. | M.S.S. | F. | Tabulated F 5% | Tabulated F 1% |
|---|---|---|---|---|---|---|
| Between varieties | 4 | 6.60 | 1.65 | 9.71 | 3.84 | 7.01 |
| Between treatments | 2 | 11.44 | 5.72 | 33.65 | 4.46 | 8.65 |
| Error | 8 | 1.32 | 0.17 | | | |
| Total | 14 | 19.36 | | | | |

Table 17. Analysis of variance for the length of growing season.

| Source of variation | D.F. | S.S. | M.S.S. | F | Tabulated F 5% | Tabulated F 1% |
|---|---|---|---|---|---|---|
| Between varieties | 4 | 773.78 | 193.45 | 1.75 | 3.84 | 7.01 |
| Between treatments | 2 | 377.41 | 188.71 | 1.71 | 4.46 | 8.65 |
| Error | 8 | 884.24 | 110.53 | | | |
| Total | 14 | 2035.43 | | | | |

Table 18. Analysis of variance for number of corms produced.

| Source of variance | D.F. | S.S. | M.S.S. | F | Tabulated F 5% | Tabulated F 1% |
|---|---|---|---|---|---|---|
| Between varieties | 4 | 8.18 | 2.05 | 2.73 | 3.84 | 7.01 |
| Between treatments | 2 | 3.75 | 1.88 | 2.51 | 4.46 | 8.65 |
| Error | 8 | 6.03 | 0.75 | | | |
| Total | 14 | 17.96 | | | | |