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Effect of Plant Spacing on the Reproductive Development and Yield of Seed Onion¹

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ABSTRACT

This study was initiated to determine the effects of plant spacing on the growth and reproductive development of onion (*Allium cepa* L.) grown for seed by the bulb to seed method. Bulbs were spaced 12, 24, 48, and 72 cm in single rows on 1m beds. The resulting plants were observed for number of scapes produced per plant, display of umbels in the canopy, reproductive development, seed yield and quality.

Bulb spacings greater than 12 cm produced plants which exhibited between 15 and 18% lodging of scapes. This was attributed to a wider horizontal display of the umbels within the canopy. The vertical display of umbels within the canopy was relatively unaffected by bulb spacing. The time at which the umbels emerged from the capsule sheath was delayed as bulb

spacings decreased. Anthesis was also delayed with closer bulb spacings.

The number of scapes produced by each bulb was unaffected by plant population. Increasing plant spacing resulted in a greater number of scapes per unit of area which increased final seed yield. There was no effect of plant population on seed quality.

Additional index words: anthesis, canopy display, lodging, quality.

INTRODUCTION

An understanding of the fundamental agronomic factors which contribute to final seed production of a crop such as onion (*Allium cepa* L.) is necessary in order to maximize yield and profit to the grower. It was established nearly five decades ago that seed yield is increased as the planting density is increased when producing seed by the bulb to seed method (Jones and Emsweller, 1939). This fact has not changed and this is reflected in the present recommendations for plant spacings which range from 5 to 15 cm (Duncan, 1965; Voss, 1979). However, the methods for harvesting onion seed have

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changed to reduce labor costs, reduce harvest time, and increase efficiency (Howell and Waller, 1971).

Many fields are now harvested by some mechanical means rather than by hand. Both the umbel and a portion of the scape are gathered by a variation of a windrower which cuts the scape and then conveys the plant material into a cart (Howell and Waller, 1971). It would be preferable that the onion seed crop not lodge and the umbels be displayed in a uniform position within the canopy to facilitate their gathering prior to drying.

The purpose of this experiment was to determine the effect of differing plant populations on crop development as related to positioning of the umbels in the canopy, flowering, and seed yield and quality for onion grown by the bulb to seed method.

MATERIALS AND METHODS

Onion (*Allium cepa* L.), variety 'Gala', bulbs approximately 10 to 12 cm in diameter were transplanted into shaped beds 1 m apart on 20 September 1984. The soil was a coarse loamy, mixed, nonacid, thermic Typic Xerothent. The bulbs were spaced either 12, 24, 48, or 72 cm apart and arranged in a randomized complete block design with four blocks. Each experimental unit consisted of three beds 8 m in length. The soil was prepared for planting by preplant incorporating 45 kg ha⁻¹ of nitrogen in the form of 11-55-0. To control weeds, Treflan E.C. applied at 0.946 l ha⁻¹ was incorporated at the time of bed shaping and 0.11 kg ha⁻¹ of Goal 1.6E as a top-dress once the crop was established. The established crop was cultivated and irrigated as necessary.

The stage of umbel development was scored on 26 April 1985. Five randomly selected plants were rated for the degree of emergence from the umbel sheath. The umbels were rated as: not opened, partially opened, and completely opened.

On 2 May 1985 each experimental unit was evaluated for stage of anthesis development by selecting five plants at random and scoring each umbel for percent of florets in anthesis. The scoring classes were: 0, 1-25, 26-50, 51-75, and 75-100%.

Five plants selected at random from each experimental unit were measured for position of the umbels within the canopy and percent of scapes lodged on 13 June 1985. The height display was measured as the lowest and highest position of the umbels while the horizontal width display represented the range of distance of canopy. Three m of plant row were

harvested for seed yield on 26 June 1985. The umbels were dried in paper bags, threshed, and then cleaned. The clean seed was weighed and then tested for viability according to the rules of the AOSA (1981). Seedling vigor was measured as seedling root length, fresh weight, and dry weight at 12 days of growth.

RESULTS AND DISCUSSION

Increasing plant density had no effect on the number of scapes produced per plant (Table 1). This confirms the report by Roberts and Struckmeyer (1951) that the number of scapes produced by large bulbs such as those used in this study is dependent upon environmental conditions. The resulting effect of increasing plant population was to increase the number of umbels produced per unit of area and, therefore, an increase in seed yield. This is in agreement with the findings of Jones and Emsweller (1939).

Similarly, no difference was found in seed quality as measured by standard germination or seedling vigor which was measured by seedling root length, fresh weight, and dry weight. It was, therefore, advantageous to increase the population of bulbs planted to optimize seed yield without reducing seed quality under these experimental conditions.

Plant density also influenced some other factors which may affect other aspects of seed production. Plants spaced 12 cm showed no lodging of the scapes which support the umbels. The spacings of 24, 48, and 72 cm all resulted in similar amounts of lodging (Fig. 1). This effect would have a definite

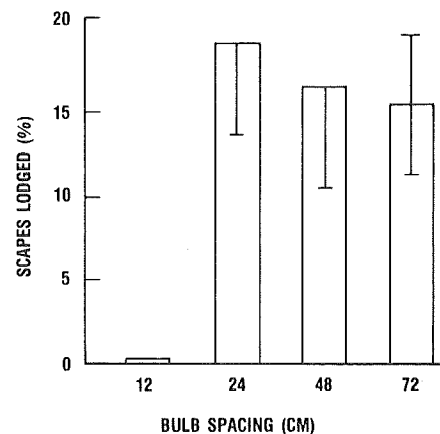


Figure 1. Effect of bulb spacing on percent of scapes lodged. Bars indicate standard error of the mean.

Table 1. Effect of bulb spacing on number of scapes per plant, seed yield, and seed quality.

Spacing (cm)	Scapes (No. plant ⁻¹)	Yield (kg ha ⁻¹)	Germination (%)	Root Length (mm)	Seedling weight	
					Fresh ----- (g seed ⁻¹) -----	Dry
12	5.1	317	91.3	206	.020	.0012
24	4.8	222	83.8	219	.020	.0011
48	5.2	182	83.8	172	.018	.0010
72	5.2	146	86.3	215	.019	.0013
LSD 0.05	NS	29	NS	NS	NS	NS

influence on the effectiveness of mechanical harvest. If a field were to be mechanically harvested, any scapes which were lodged would either not be harvested or would require follow-up hand labor. Therefore, the 12-cm spacing would facilitate mechanical harvest while the other three spacings would not.

Since there is no increase in the number of scapes resulting from wider spacings of the bulbs and lodging is reduced by close spacings, it will benefit seed production to use close spacings even when there is a shortage of bulbs for planting. Depending on the time at which lodging occurs, lodging can also be detrimental to seed development if translocation and transpiration are restricted.

There was no effect of plant spacing on the maximum height position of the umbels vertically within the canopy (Fig. 2). No quantitative trend was found for the minimum level at which the umbels were positioned. The range of heights between the minimum and maximum values were not significant. This indicates that there is no advantage from modifying plant population to centralize umbels in the canopy to facilitate harvest.

An additional effect of plant spacing was its effect on the horizontal display of umbels in the canopy. The scapes supporting the umbels in the 12-cm treatment were in a more erect display within the canopy than the three other spacings (Fig. 2). The maximum distance from the center of the planting row increased as the spacing was widened. This, in addition to the scapes being larger, probably contributed to the presence of lodging in the 24, 48, and 72-cm spacings. Since the scapes in the wider plant spacing treatments were not as erect as the 12-cm treatment, the plants would have to be cut closer to the ground to gather all of the umbels. This would result in more plant material to be dried before the seed could be threshed.

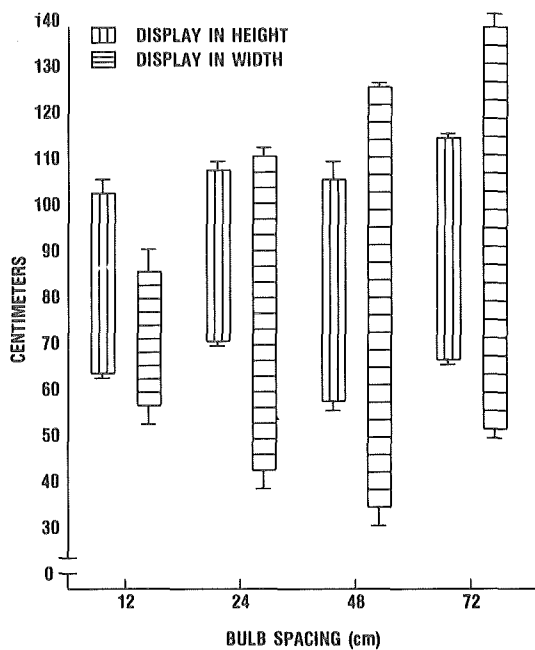


Figure 2. Effect of bulb spacing on the vertical and horizontal display of onion umbels within the canopy. Bars indicate standard error of the mean.

Two final effects of the plant spacings which affected the reproductive development of the seed onion crop were the time of appearance of the immature umbel from the sheath cap and the time of anthesis. The umbels emerged from the sheath cap sooner in the plant spacings (Fig. 3). This effect carried over to the time of anthesis whereby the wider spaced plants started anthesis sooner than the closer spaced plants (Fig. 4). Spacing did not affect final seed maturity. A possible benefit of earlier flowering would be to avoid heat blasting of

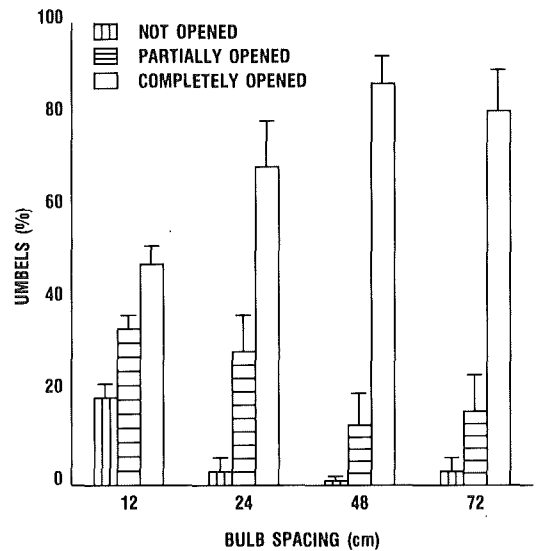


Figure 3. Effect of bulb spacing on the emergence of onion umbels from the sheath capsule, 26 April 1985. Bars indicate standard error of the mean.

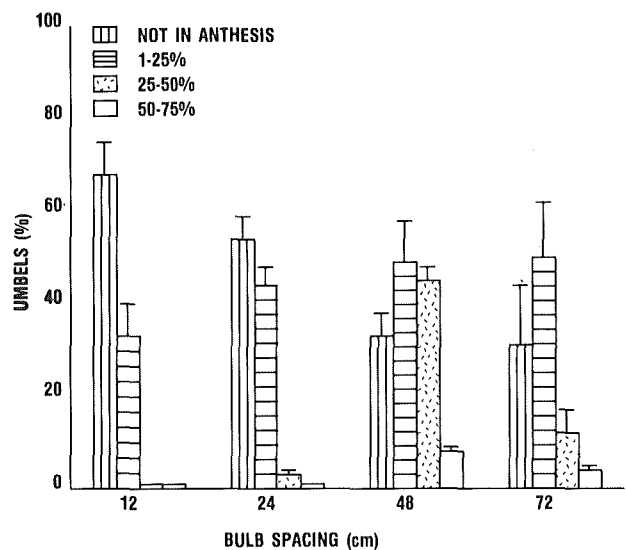


Figure 4. Effect of bulb spacing on the percentage of umbel florets in anthesis, 2 May 1985. Bars indicate standard error of the mean.

the florets during pollination and early seed development. If such an effect were significant, this would be an apparent trade-off with the beneficial effect of higher plant density which increases overall seed yield. More detailed investigation is needed to determine whether the timing of anthesis can be modified to significantly alter seed set.

The results of this study show that close spacings of onion bulbs planted for seed production by the bulb to seed method are necessary to maximize seed production per unit of area. Since the number of scapes produced per bulb is unaffected by spacing, there is no advantage from wider plant spacing. This confirms much of the standard practices used in industry today. However, even higher populations may be more advantageous for facilitating mechanical harvest by reducing lodging and centralizing the positioning of umbels within the canopy.

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Investigations on the Interaction Between Level of Nitrogen Application in the Autumn and Time of Nitrogen Application in the Spring to Various Grasses Grown for Seed

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ABSTRACT

In 1979-84 studies were conducted on several grass species to study the effect of time of spring nitrogen, 50 and 100 kg N ha⁻¹, combined with 0 and 50 kg ha⁻¹ in the autumn on seed production.

In all species studied, except Italian ryegrass (*Lolium multiflorum*), a delayed spring nitrogen application reduced the number of fertile tillers per unit area, regardless of the level of autumn nitrogen application. With Kentucky bluegrass (*Poa pratensis*), red fescue (*Festuca rubra*), and cocksfoot (*Dactylis glomerata*) the delay also resulted in reduced seed yield. The reduction was especially great where no nitrogen was applied in the autumn. With meadow fescue (*Festuca pratensis*) the late nitrogen application caused a significant decrease in seed yield if no nitrogen had been given in the autumn, but no decrease if the

opposite was the case. The seed yield of Italian ryegrass was not influenced by the time of spring nitrogen application. With timothy (*Phleum pratense*) a delay caused an increased seed yield in all cases. A delay in nitrogen application resulted in an increased seed weight and an increased number of seeds per fertile tiller, except in Italian ryegrass.

The later spring nitrogen application is delayed, the greater the positive effect of a nitrogen application in the autumn. On the contrary, the influence of increasing the nitrogen rate in the spring from 50 to 100 kg ha⁻¹ declined the later the nitrogen was applied. When producing seed of Kentucky bluegrass, red fescue and cocksfoot under Danish conditions it is recommended to apply nitrogen at the beginning of March as soon as it is possible to drive on the ground without risk of damaging the grass. An early application is especially important if the grass was under-supplied with nitrogen in the autumn. For meadow fescue, perennial ryegrass, and Italian ryegrass it is recommended that nitrogen be applied at the first of April and at the end of April for timothy.

Additional index words: seed production, Kentucky bluegrass, red fescue, cocksfoot, meadow fescue, timothy, Italian ryegrass

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