# *Effect of Seed Rate and Sowing Time on the Production of Sets for Kharif Onion Crop*

By

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in partial fulfilment of the requirements for the degree of:

**MASTER OF SCIENCE**

**IN**

**VEGETABLE CROPS**




**College of Agriculture**
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*"Feelings get expressed in words and words express feelings". This statement may be true for day-to-day ordinary feelings but I wonder whether I would be justice if I express my feelings in words for the persons involved in the fulfilment of this maiden research work, In fact, I find myself crippled, the moment I started jotting down my feelings in this regard. Nonetheless, the attempt is inscribed as following:*

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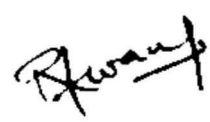

*Hisar*
*(May 27, 2002)*

*(Rajesh Kumar)*

*AFFECTIONATELY*

*DEDICATED*

*TO MY*

*RESPECTED PARENTS*

# CERTIFICATE – I

This is to certify that this dissertation entitled **"Effect of seed rate and sowing time on the production of sets for Kharif onion crop"** submitted for the degree of Master of Science, in the subject of Vegetable Crops of the Chaudhary Charan Singh Haryana Agricultural University, Hisar, is a bonafide research work carried out by Mr. Rajesh Kumar under my supervision and that no part of this thesis has been submitted for any other degree.

The assistance and help received during the course of investigation have been fully acknowledged.

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# CERTIFICATE – II

This is to certify that this dissertation entitled **"Effect of seed rate and sowing time on the production of sets for Kharif onion crop"** submitted by Mr. Rajesh Kumar to the Chaudhary Charan Singh Haryana Agricultural University, Hisar, in partial fulfilment of the requirement for the degree of Master of Science, in the subject of Vegetable Crops, has been approved by the Student's Advisory Committee after an oral examination on the same.

**Head of the Department**

**Major Advisor**

**Dean, Post-Graduate Studies**

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# INTRODUCTION

# 1

# INTRODUCTION

Onion (*Allium cepa* L.) is a major crop of tropical countries highly valued for flavours and nutritional quality of the bulb particularly as a source of minerals and trace elements in the diet. Onion represents the only items of vegetables, where India figures prominently in world production and export. This alliaceous group has gained its importance as a cash crop rather than vegetable crop because of its high export potential (Pandey, 1989).

In India, onion occupies an area of 493.3 thousand hectares, producing 4899.5 thousand metric tonnes having productivity of 9.9 metric tonnes/ha. In Haryana, the area under onion cultivation is 4100 hectares with a total production of 60100 metric tones thus having productivity of 14.7 metric tones/ha (Anonymous, 2001).

Onion is being used as flavouring vegetable in almost all the vegetable preparations throughout the world. Furthermore, onion has been found very beneficial in controlling many human diseases such as fever, bronchitis, colic, scurvy and reduction of blood sugar level in addition to its antiseptic properties.

Onion crop is being grown on large scale mainly as a rabi season crop in North-India. Further, it is not possible to increase the area under

rabi season, as the area under food crops like wheat cannot be reduced because of the compelled necessity. Further, in Indo-Gangetic plains, rabi onion crop is harvested by the first fortnight of June. Crop harvested in June can be stored under ambient conditions up to October. Hence, there is a scarcity of onions until new onion crop is harvested in June; therefore, we are left with only alternative to go for cultivation of kharif onion. kharif onion cultivation, however, is in practice but to a very limited scale, because of the fact that raising of the onion nursery during the months of May and June is a difficult task under the prevailing environmental conditions of our region, due to very high temperature, humidity and fungal diseases. Further establishment of seedlings after transplanting is also poor due to prevailing high temperature at that time.

To overcome such an uncontrollable problem, there is a good scope of raising kharif onion crop through production of onion sets. Information on raising kharif onion from onion sets is scanty. Hence, to start with, there is an urgent need to workout the effective seed rate, time of sowing for the production of sets for raising successful kharif onion crop. Therefore, the present experiments were planned with the following objectives:

1. To see the effect of different seed rates on the production of onion sets
2. To see the effect of different sowing time in nursery on the production of onion sets

# REVIEW OF LITERATURE

# 2

# REVIEW OF LITERATURE

Onion produced during the kharif season is a profitable proposition because of ready market and higher rates. On the other hand, the onion bulbs produced during rabi season are not available for table use form October onward. During this period, onions are transported from South India and are sold at high price. In this chapter, an attempt has been made to review the work done by various research workers on various aspects of raising a successful kharif onion crop as under:-

**Production of sets and raising of seedlings:**

Gupta *et al.* (1999) reported that total yield of onion sets was significantly influenced by sowing that and it was 2268.5, 1736.5, 522 and 305 g/sq.m. for 25$^{th}$ December, 15$^{th}$ January, 5$^{th}$ and 25$^{th}$ February sowings, respectively. Higher yield of large size sets (>1.75 cm diameter) was recorded from seed rate of 15 g/m$^2$ and minimum from seed rate of 45 g/m$^2$. Sowing done on 25$^{th}$ December and 15$^{th}$ January recorded higher plant height. Ratio of bulb to total biomass was noted higher from the sowing done on 25$^{th}$ February with a seed rate of 15 g/m$^2$. Bhatta Rai *et al.* (1998) reported that yield of sets of 1-2 cm in diameter increased significantly as seed rate increased up to 8 g/m$^2$. Tendaj (1996) sowed the seeds of onion cultivars, Rowska, Sochaczeweska and Wolska at 100, 125,

150 and 175 kg/ha. Seeds of three classes based on their germination capacity were compared. Marketable yield of sets from class I seeds averaged 21.5 t/ha. (65.7% of total yield) while that from the poorest quality seeds, it averaged 15.9 t/ha (55.4% of the total yield). Increasing sowing rates from 100-175 kg/ha did not increase the yield of marketable sets to comparable for the use of poorest quality seeds. Bhutani *et al.* (1997) studied the effect of seed rate (15, 30 and 45 g/sq.m) and sowing times (25 December, 15 January and 5 and 25 February) of onion seeds used for the production of sets in nursery on growth and yield of kharif onion crop cv. Agrifound Dark Red. They suggested that for the production of better quality sets, seeds should be sown @ 15g/sq.m. in the last week of December. In one study, seed rate of 5-7.5 kg/200 sq.m. sown in the end of January was found to be the best treatment for obtaining good quality onion sets (Anonymous, 1992). In another study, seed rate of 25g/sq.m. sown between 15$^{th}$ and 30$^{th}$ January has been found superior for better growth and development of onion sets for kharif season (Anonymous, 1995). Bhonde *et al.* (1995) reported a non-significant effect of seed rate on plant height.

Kossowski and Tendaj (1986) recorded the highest yield of commercial grade (11-17 mm diameter) sets from Rowska, a variety of onion. A seed rate of 30 g/sq.m. sown in the nursery recorded maximum height of seedling. While maximum yield of onion sets (3.5 kg/sq.m.) was recorded from a seed rate of 60 g/sq.m. used for the production of onion sets in the nursery (Nandpuri, 1990), but lowest yield of onion sets was recorded from a seed rate of 40 g/sq.m. He further reported that onion sets of highest diameter were recorded from a seed rate of 30 g/sq.m.

Tendaj *et al.* (1997a) observed that seeds of onion cultivars Rowska, Sochaczeweska and Wolska were sown at 100, 125, 150 and 175

kg/ha. Comparison was made between seeds three classes based on germination capacity. Total yield of sets was about 6% higher from seeds of class I than from seeds of class II and 12% higher than from the seeds of the poorest quality.

Tendaj *et al.* (1997b) reported the comparative performance of the seeds in respect of germination capacity (80-85%, 66-74% and 56-62%) with different seed rates of 100, 125, 150 and 175 kg/ha. Seedling emergence and yield of sets declined with decreasing germination capacity. Increasing the seed rate of the poorest quality seeds to 175 kg/ha did not achieve the plant population as achieved by sowing best quality seeds at 100 kg/ha. 1000-bulb weight was greatest from the poorest quality seeds of all cultivars.

A seed rate of 5-7.5 kg/200 sq.m. sown in the end of January was found to be the best treatment for obtaining good quality onion sets (Anonymous, 1992). The finding of Chadha and Sidhu (1986) have revealed that 'N-53' variety of kharif onion can be grown successfully during both rabi and kharif seasons. There is recommendation of 8-10 kg seed/ha and 6-7 weeks old seedling for obtaining good quality and yield of onions during kharif season (Anonymous, 1995).

El- Emery (1985) examined the seeds for germination ability in the laboratory and for 1000-seed weight. Field emergence of the seeds was linearly correlated with germination ability. The yield of plot sown with larger seeds was higher in respect of number and weight of onions. The number of medium size onions (most suitable for propagations) also increased with size of seeds.

Kossowski *et al.* (1984) conducted trials for 5 years. Seeds of the cultivars Sochaczeweska, Rowska, and Zytawska were sown in the second half of April @ 100-300 kg/ha and the sets were harvested when the third

of tops were desiccated. The highest yield of commercial grade sets (11-17 mm in diameter) was obtained from the plot sown at 175-225 kg/ha with row spaced 15 cm apart. Rowska was most suitable for sets production.

Islam (1981) and Saha (1982) reported that older seedlings may perform better than younger one's. Moursi *et al.* (1975) emphasized that delayed sowing resulted in reduction in plant height but seed rate did not influence plant height.

*Tronickova (1974) and Pet Kov et al. (1974) reported that sowing* on 28th February produced the highest average yield of bulb. Huton (1984) recorded highest average yield of bulb when sowing was done on 28th June in New Zealand. Guerra (1987) studied the effect of sowing dates. Sowing on 27th November, 26th January and 26th February resulted in mean yield of 36, 29, 36 t/ha, respectively during kharif season.

**Production of kharif onion**

Oldiran and Sangodele (1996) revealed that the transplanting age influenced plant height and was generally higher when six weeks old seedlings were transplanted in the month of August. Thompson and Kelly (1957) reported that early planting helped in the production of larger bulbs and higher yield than later planting. Vale (1992) reported that bulb yield increased as set size increases. Fennel (1984) reported that highest yield of bulb was obtained with sowing on 31st May followed by 1st July in New Zealand. Yamashita and Takase (1988) noted that onion sets of 25 mm in diameter produced higher bulbs and higher yield than smaller sets. Similar findings have been given by Shin *et al.* (1988), Singh *et al.* (1992), Dcka and Shedeque (1994) and Chauhan and Singh (1995). Pandey *et al.* (1992) found that the highest yield of onion bulbs (209.25 q/ha) was obtained with sowing on 1st June. Further they obtained highest

marketable yield and net return from 'N-53' variety with set size of 2.0-2.5 cm during kharif season. Rahim *et al.* (1992) also reported the highest yield from planting of largest sets during rabi season in Bangladesh. Sharma (1992) also reported that bulb yield was higher from sets (33.8 t/ha) than from seedlings (27.7 t/ha) during kharif season cv. 'N-53'. Singh *et al.* (1996) reported that 8 mm to 10 mm size planting material gave higher yield of bulbs of variety Agrifound White under Nasik conditions in Maharashtra. The highest marketable yield was also obtained from 8 mm to 10 mm size of bulbs planted in rabi season.

Shalaby *et al.* (1991) revealed that average bulb weight and unmarketable yield were lowest from 4-8 mm sets although total yield was highest from 6-24 mm sets during kharif season (cv. Giza-6, Mahassan). Dragland and Berentsen (1991) concluded that sets with diameter of 15-21 mm performed better in relation to yield of bulb in different grades during rabi season.

# MATERIALS AND METHODS

The data on meteorological observation during the growing season of the experiment were collected from the meteorological observatory, Department of Agrometeorology, Chaudhary Charan Singh Haryana Agricultural University, Hisar and are presented in Table I.

**Table 1:** Meteorological observation* during the growing season of the experiment.

| Month | Temperature $^0$C | | R. H. (%) | | Evaporation (mm) |
|---|---|---|---|---|---|
| | Max. | Min. | Morning | Evening | |
| December-2000 | 24.4 | 3.1 | 86.0 | 29.0 | 2.4 |
| January-2001 | 18.2 | 3.0 | 94.3 | 55.2 | 1.4 |
| February– 2001 | 24.5 | 5.6 | 88.0 | 33.0 | 3.0 |
| March-2001 | 30.0 | 9.5 | 82.0 | 29.0 | 4.4 |
| April-2001 | 35.6 | 16.4 | 59.0 | 24.0 | 7.9 |
| May-2001 | 40.2 | 22.9 | 58.0 | 28.0 | 10.4 |

*Location: Latitudes-29$^0$ 10', Longitudes-75$^0$ 46', Altitudes-215.2 m.

**Soil**

Composite soil was taken from the experimental plot from 0-15 cm depth before layout of the experiments and subjected to mechanical and chemical analyses. The results of these analyses are given below in Table 2:

# 3

# MATERIALS AND METHODS

## Experimental site

The present investigation entitled "Effect of seed rates and sowing time on the production of onion sets for kharif onion crop cv. Agrifound Dark Red was conducted during kharif season of 2000-2001 at the Vegetable Research Farm and the laboratory of the Department of Vegetable Crops of Chaudhary Charan Singh Haryana Agricultural University, Hisar, Haryana, India.

The details of the materials used and methods followed in the experiment are given below:

### 1. Plant materials

Onion cultivar Agrifound Dark Red was grown during the year 2000-2001.

### 2. Climate and meteorological data

At Hisar, winters are fairly cold and temperature some times reaches as low as 0 °C during December and January. On the other hand, summers are very hot with a temperature touching 48 °C in the month of May – June. Hot and dry winds are common features during summer months.

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**Soil**

Composite soil was taken from the experimental plot from 0-15 cm depth before layout of the experiments and subjected to mechanical and chemical analyses. The results of these analyses are given below in Table 2:

**Table 2:** Physiochemical analysis of the soil

| | |
|---|---|
| Texture | Sandy loam |
| pH | 8.00 |
| Organic carbon (%) | 0.42 |
| Electrical conductivity ($dSm^{-1}$) | 0.73 |
| Available $P_2O_5$ (kg/ha) | 95.00 |
| Available $K_2O$ (kg/ha) | 884.00 |

It is evident from the above data that soil of the field was sandy in texture, medium in organic carbon, high in phosphorus and potash

## 3. Experimental techniques

Field was well ploughed after adding well rotten F.Y.M. and recommended doses of phosphorus and nitrogen. The nitrogen was applied in the form of urea and phosphorus in the form of single super phosphate. Experiment-wise details are given below:

**Experiment I: Effect of different seed rates on the production of onion sets**

(a) **Seed rates:** There were nine seed rates (g/sq.m.) viz. 5.0, 7.5, 10.0, 12.5, 15.0, 17.5, 22.5 and 25.0

(b) **Replication and experimental design:** Treatments were replicated three times and arranged in Randomized Block Design (RBD).

(c) **Plot size:** Plot size was 2m X 1m

(d) **Date of sowing:** 7th January.

(e) **Harvesting:** Onion sets were harvested on 16th May, 2001.

**Experiment-II: Effect of different sowing time on the production of onion sets.**

**(a) Sowing dates:** There were eight sowing dates viz. 1st December, 11th December, 21st December, 31st December, 10th January, 20th January, 30th January and 10th February.

**(b) Seed rate:** 10.0g/sq.m.

**(c) Replication and experimental design:** Treatments were replicated three times and arranged in Randomized Block Design (RBD).

**(d) Plot size:** Plot size was 2m X 1m

**Observation Recorded:** The following observations were recorded.

**1. Plant height:** Height of the ten randomly selected plants was measured each time from the base of the plant to the highest points reached by the leaves from every plot and later on average height was calculated.

**2. Bulb and foliage weight and bulb diameter:** The observation was taken by taking randomly ten plants, which had developed bulb at that time. Their bulb and foliage weight was recorded separately. From these data ratio of bulb to total biomass was worked out on fresh weight basis by the formula given below:

$$\text{Ratio of bulb to total biomass} = \frac{\text{Fresh weight of bulbs}}{\text{Fresh weight of whole plant}}$$

Bulb diameter was measured with the help of vernier calipers.

**3. Yield of sets:**

The onion sets were harvested from the plot on 16th may 2001 with the help khurpi. Foliage was removed. All the sets harvested from each

plot were graded into four categories namely up to 2 g, >2-5 g, >5-10 g and more than 10 g and counted and weighed separately.

# EXPERIMENTAL RESULTS

# 4

# EXPERIMENTAL RESULTS

The present study consisted of two experiments and conducted during 2000-2001.

**Experiments:**

1. Effect of different seed rates on the production of onion sets
2. Effect of different sowing time on the production of onion sets

The results obtained from these experiments are presented in this chapter.

**Experiment 1:** Effect of different seed rate on the production of onion sets.

**1.1 Plant height**

Plant height was recorded at periodically and data are presented in Table 3. Differences in plant height due to seed rates were not significant except for the observation recorded at 70 days after sowing. On this day, plant height was maximum in 5.0 g (seed rate), which was significantly higher than 7.5 g, 10 g, 15.0 g and 17.5 g seed rates. In this experiment, plant height increased up to 30$^{th}$ March and thereafter it declined slightly. Plant height (mean of all treatments) was 5.64, 11.60, 16.36, 22.41, 29.58, 28.77 and 20.65 cm when recoded at 34, 46, 58, 70, 82, 94 and 106 days

after sowing, respectively. Maximum increment in plant height was obtained between 58 to 82 days after sowing.

**1.2 Foliage weight**

Fresh weight of foliage was recorded at 70, 82, 94 and 106 days after sowing (Table 4). Foliage weight decreased with increase in seed rate and it was highest where seed rate 5.0g/sq. m. and the lowest when seed rate was 25.0 g/sq.m. on all the four dates of observation. Foliage weight increased with increase in crop duration up to 94 days, however, there was slight decline in foliage weight after that. Foliage weight (mean of all the treatments) was 1.22, 3.49, 3.30 and 3.15g/plant when recorded after 70, 82, 94 and 106 days after sowing. Maximum increment in foliage weight was recorded during the period between 70 to 82 days after sowing.

**1.3 Bulb weight**

Fresh weight of bulb was recorded at 70, 82, 94 and 106 days after sowing (Table 5). Bulb weight decreased with increase in seed rate and it was highest when seed rate was 5.0g/sq.m. and lowest when seed rate was 25.0 g/sq.m. on all the four dates of observation. Bulb weight increased with increase in crop duration. It was (mean of all the treatments) 0.36. 1,53, 2.80 and 3.36 g when recorded at 70, 82, 94 and 106 days after sowing, respectively.

**1.4 Diameter of bulb**

Bulb diameter was also recorded at 70, 82, 94 and 106 days of sowing (Table 6). Bulb diameter decreased with increase in seed rate and it was the highest when seed rate was 5.0 g/sq.m. and lowest when seed rate was 25.0 g/sq.m. on all the four dates of observation. Bulb diameter increased with increase in crop duration and mean diameter (mean of all

**TABLE-3:** EFFECT OF SEED RATE ON PLANT HEIGHT (cm) OF ONION SETS

| SEED RATE (g / sq. m) | DAYS AFTER SOWING | | | | | | |
|---|---|---|---|---|---|---|---|
| | 34 | 46 | 58 | 70 | 82 | 94 | 106 |
| 5.0 | 5.53 | 13.00 | 18.50 | 25.23 | 31.36 | 28.66 | 20.06 |
| 7.5 | 5.63 | 11.46 | 14.30 | 18.93 | 29.13 | 24.83 | 21.50 |
| 10.0 | 5.80 | 11.36 | 16.40 | 21.56 | 31.26 | 26.43 | 21.13 |
| 12.5 | 5.50 | 11.16 | 16.20 | 22.96 | 29.63 | 29.53 | 22.13 |
| 15.0 | 6.00 | 11.36 | 15.90 | 22.36 | 27.70 | 22.00 | 19.80 |
| 17.5 | 6.26 | 11.76 | 16.40 | 22.26 | 29.20 | 26.00 | 19.80 |
| 20.0 | 4.90 | 11.40 | 17.00 | 22.76 | 31.20 | 26.03 | 20.90 |
| 22.5 | 6.10 | 11.06 | 16.40 | 22.63 | 28.70 | 24.50 | 20.30 |
| 25.0 | 5.06 | 11.90 | 16.20 | 23.06 | 28.10 | 24.0 | 19.30 |
| C.D. at 5 % | N.S. | N. S. | N. S. | 2.82 | N. S. | N. S. | N. S. |

**TABLE-4:** EFFECT OF SEED RATE ON FOLIAGE WEIGHT (g/plant) OF ONION SETS

| SEED RATE (g / sq. m) | DAYS AFTER SOWING | | | |
|---|---|---|---|---|
| | 70 | 82 | 94 | 106 |
| 5.0 | 1.37 | 3.70 | 3.91 | 3.76 |
| 7.5 | 1.30 | 3.66 | 3.80 | 3.71 |
| 10.0 | 1.29 | 3.65 | 3.83 | 3.70 |
| 12.5 | 1.29 | 3.63 | 3.73 | 3.70 |
| 15.0 | 1.20 | 3.54 | 3.65 | 3.76 |
| 17.5 | 1.26 | 3.38 | 3.63 | 3.43 |
| 20.0 | 1.14 | 3.33 | 3.63 | 3.43 |
| 22.5 | 1.11 | 3.31 | 3.58 | 3.38 |
| 25.0 | 1.07 | 3.24 | 3.53 | 3.21 |
| C.D. at 5 % | 0.03 | N.S. | 0.20 | 0.15 |

**TABLE-5:** EFFECT OF SEED RATE ON BULB WEIGHT (g/plant) OF ONION SETS

| SEED RATE (g / sq. m) | DAYS AFTER SOWING | | | |
|---|---|---|---|---|
| | 70 | 82 | 94 | 106 |
| 5.0 | 0.49 | 1.96 | 3.69 | 5.53 |
| 7.5 | 0.42 | 1.58 | 3.15 | 3.64 |
| 10.0 | 0.41 | 1.54 | 2.90 | 3.51 |
| 12.5 | 0.38 | 1.50 | 2.79 | 3.44 |
| 15.0 | 0.38 | 1.49 | 2.73 | 3.30 |
| 17.5 | 0.31 | 1.48 | 2.61 | 2.85 |
| 20.0 | 0.30 | 1.45 | 2.55 | 2.69 |
| 22.5 | 0.29 | 1.41 | 2.41 | 2.88 |
| 25.0 | 0.27 | 1.41 | 2.39 | 2.44 |
| C.D. at 5 % | 0.01 | 0.02 | 0.06 | 0.07 |

the treatments) was 0.69, 1.01, 1.61 and 1.81 cm when recorded at 70, 82, 94 and 106 days after sowing, respectively.

**1.5 Ratio of bulb to total biomass**

Bulb to total biomass increased with the increased in crop duration (Table 7). Ratio of bulb to total biomass was 0.21, 0.30, 0.40 and 0.47 (mean of all the treatments) when recorded at 70, 82, 94 and 106 days after sowing, respectively. Bulb to total biomass ratio decrease with increased in seed rate and it was highest when seed rate was 5.0 g/sq.m. and the lowest when seed rate was 25.0 g/sq.m. on all the four dates of observation.

**1.6 Number of total and different grades of sets**

Number of sets is given in Table 8. Total number of sets obtained ranged from 254.66 to 311.0 per sq.m. (Table 8). It was highest when seed rate was 25.0 g/sq.m. followed by 22.5g/sq.m. and both these treatments were significantly superior to all other seed rates. Number of sets up to 2 g size increased with increase in seed rates, highest number (165.00/sq.m.) of up to 2 g size sets were obtained where seed rate was 25.0 g/sq.m. followed by the seed rate of 22.5 g/sq.m., and both these treatments were significantly superior to all other seed rates. Lowest number of (61.0/sq.m.) of up to 2 g size sets were obtained where seed rate was 5.0 g/sq.m. followed by 7.5 g/sq.m. and both these treatments were also significantly different from all other treatments. Number of sets >2-5 g size ranged from 71.66 to 124.00/sq.m. Highest number of >2-5g size sets were recorded with the seed rate of 15.0g/sq.m. followed by 12.5, 17.5 and 20.0 g/sq.m. and all these treatments were significantly better than the remaining treatments. Highest number (99.66/sq.m.) of >5-10 g size sets were recorded with the seed rate of 5.0 g/sq.m. which was significantly higher than all the treatments. Number of >5-10 g size sets

**TABLE-6:** EFFECT OF SEED RATE ON BULB DIAMETER (cm) OF ONION SETS

| SEED RATE (g / sq. m) | DAYS AFTER SOWING | | | |
|---|---|---|---|---|
| | 70 | 82 | 94 | 106 |
| 5.0 | 0.80 | 1.26 | 1.92 | 2.26 |
| 7.5 | 0.77 | 1.12 | 1.76 | 2.12 |
| 10.0 | 0.73 | 1.08 | 1.67 | 2.00 |
| 12.5 | 0.71 | 1.07 | 1.63 | 1.88 |
| 15.0 | 0.69 | 1.05 | 1.57 | 1.80 |
| 17.5 | 0.67 | 1.03 | 1.54 | 1.70 |
| 20.0 | 0.65 | 1.01 | 1.52 | 1.60 |
| 22.5 | 0.64 | 0.86 | 1.47 | 1.49 |
| 25.0 | 0.62 | 0.63 | 1.44 | 1.46 |
| C.D. at 5 % | 0.04 | 0.08 | 0.03 | 0.12 |

**TABLE-7: EFFECT OF SEED RATE ON RATIO OF BULB TO TOTAL BIOMASS**

| SEED RATE (g / sq. m) | DAYS AFTER SOWING | | | |
|---|---|---|---|---|
| | 70 | 82 | 94 | 106 |
| 5.0 | 0.26 | 0.36 | 0.49 | 0.60 |
| 7.5 | 0.24 | 0.32 | 0.46 | 0.51 |
| 10.0 | 0.24 | 0.31 | 0.41 | 0.47 |
| 12.5 | 0.22 | 0.33 | 0.41 | 0.46 |
| 15.0 | 0.21 | 0.31 | 0.40 | 0.46 |
| 17.5 | 0.20 | 0.30 | 0.39 | 0.45 |
| 20.0 | 0.20 | 0.29 | 0.39 | 0.42 |
| 22.5 | 0.19 | 0.28 | 0.34 | 0.41 |
| 25.0 | 0.15 | 0.27 | 0.31 | 0.39 |
| C.D. at 5 % | 0.03 | 0.02 | 0.04 | 0.01 |

decreased with increase in seed rate. Lowest number (38.00/sq.m.) of >5-10 g size sets were recorded with the seed rate of 25.0 g/sq.m., which was statistically at par with the seed rate of 20.0 and 22.5 g/sq.m. Differences in the number of large size sets (>10 g) due to seed rate were also significant. Number of these sets decreased with increase in seed rates. Highest number of large size sets (22.33/sq.m.) was obtained with the seed rate of 5.0 g/sq.m., which was significantly higher than all the treatments. Lowest number of large size sets (1.33/sq.m.) was obtained where seed rate was 25.0 g/sq.m. However, it was statistically at par with the seed rate of 20.0 and 22.5 g/sq.m.

Proportion of different size sets was also worked out (Table 9) Proportion of up to 2 g size sets increased while that of >5-10 g and >10 g size sets decreased with increase in seed rate. Proportion of up to 2 g size sets was less than 25% when seed rate was 5.0 or 7.5 g/sq.m., respectively. Proportion of >5-10 g size sets were 39.13 and 36.62% for 5.0 and 7.5g seed rates, respectively and it was less than 20% when seed rate was 12.5 g/sq.m. or more. A Proportion of> 10 g size set was 8.76 and 6.84% for the seed rates of 5.0 and 7.5 g/sq.m. and it went down to less than 1% when seed rate was 20.0 g/sq.m. or more.

### 1.7 Yield of total and different size sets

Highest total bulb (sets) yield was 1749.33 g/sq.m. (Table 10) where seed rate was 5.0 g/sq.m. closely followed by 7.5 g/sq.m. and both these treatments were significantly superior to the remaining treatments. Total yield decreased with increase in seed rate and it was lowest (1215.53 g/sq.m.) where seed rate was 25.0 g/sq.m., which was statistically at par with the seed rates of 20.0 and 22.5 g/sq.m. Yield of up to 2 g size sets increased with the increase in seed rate. It was highest (321.0 g/sq.m.) where seed rate was 25.0 g/sq.m. and was significantly

**TABLE-8:** EFFECT OF SEED RATE ON NUMBER OF TOTAL AND DIFFERENT SIZE SETS (per sq. m.)

| SEED RATE (g / sq. m) | SIZE OF SETS | | | | |
|---|---|---|---|---|---|
| | Upto 2 g | > 2 - 5 g | > 5 -10 g | >10 g | Total |
| 5.0 | 61.00 | 71.66 | 99.66 | 22.33 | 254.66 |
| 7.5 | 64.33 | 95.00 | 90.00 | 18.33 | 267.66 |
| 10.0 | 75.00 | 117.33 | 66.00 | 16.16 | 275.00 |
| 12.5 | 104.00 | 120.33 | 54.00 | 12.66 | 291.00 |
| 15.0 | 114.33 | 124.00 | 47.66 | 7.00 | 293.00 |
| 17.5 | 120.33 | 118.33 | 47.00 | 5.00 | 292.00 |
| 20.0 | 130.00 | 117.00 | 42.66 | 2.66 | 292.33 |
| 22.5 | 153.66 | 109.00 | 40.00 | 2.00 | 304.66 |
| 25.0 | 165.00 | 106.66 | 38.00 | 1.33 | 311.00 |
| C.D. at 5 % | 7.50 | 6.10 | 5.12 | 2.32 | 9.41 |

**TABLE-9:** EFFECT OF SEED RATE ON PERCENTAGE OF DIFFERENT SIZE SETS (Number basis)

| SEED RATE (g / sq. m) | SIZE OF SETS | | | |
|---|---|---|---|---|
| | Upto 2 g | > 2 - 5 g | > 5 -10 g | >10 g |
| 5.0 | 23.95 | 28.13 | 39.13 | 8.76 |
| 7.5 | 24.03 | 35.49 | 33.62 | 6.84 |
| 10.0 | 27.27 | 42.66 | 24.00 | 5.87 |
| 12.5 | 35.73 | 41.35 | 18.55 | 4.35 |
| 15.0 | 39.02 | 42.32 | 16.26 | 2.38 |
| 17.5 | 41.20 | 40.52 | 16.09 | 1.72 |
| 20.0 | 44.47 | 40.02 | 14.59 | 0.90 |
| 22.5 | 50.38 | 35.77 | 13.12 | 0.65 |
| 25.0 | 53.05 | 34.29 | 12.21 | 0.42 |

different from all other seed rates. Seed rate of 5.0 g/sq.m. recorded lowest yield (117.66 g/sq.m.) of up to 2 g size sets but was statistically at par with the seed rate of 7.5 and 10.0 g/sq.m. Yield of 2-5g size sets ranged from 325.00 to 610.00 g/sq.m. followed by the seed rate of 12.5 g/sq.m. and there was no statistically difference between these two treatments. Lowest yield of >2-5 g size sets was obtained from the seed rate of 5.0 g/sq.m. which was statistically lower than all other seed rates. A Yield of> 5-10 g size set was highest (983.33 g/sq.m.) where seed rate was 5.0 g/sq.m. closely followed by the seed rate of 7.5 g/sq.m., both these treatments were significantly superior to all the treatments. Yield of >5-10 g size sets decreased with increase in seed rate. Lowest yield (360.00 g/sq.m.) of >5-10 g size a set was recorded where seed rate was 25.0 g/sq.m. Yield of large size sets (>10g) decreased with increase in seed rate. Highest yield (323.3 g/sq.m.) of large size sets was obtained where seed rate was 5.0 g/sq.m. and it was statistically higher than all other seed rates. Seed rates of 7.5 and 10.0 g/sq.m. recorded significantly higher yield of >10g size sets as compared to the seed rates higher than 10.0 g/sq.m. Lowest yield (17.66 g/sq.m.) of large size sets was obtained where highest seed rate (25.0 g/sq.m.) was used and it was statistically at par with the seed rates of 20.0 and 22.5 g/sq.m.

Proportion of up to 2 g and >2-5g size sets increased but of >5-10 g and > 10 g size sets decreased with increase in seed rates (Table 11). Proportion of up to 2 g size sets was less than 10% for the seed rates of 5.0 and 7.5 g/sq.m., while it was around 20% where seed rate was 20.0 g/sq.m. Proportion of >5-10 g size sets was 56.21% at the seed rate of 7.5 g/sq.m., while it was 29.54 to 35.53% for the seed rates between 12.5 to 25.0 g/sq.m. Proportion of >10 g size sets was 18.47, 13.35 and 14.44%

for the seed rates of 5.0, 7.5 and 10.0 g/sq.m., respectively while it was less than 3% where seed rates were 20.0, 22.5 and 25.0 g/sq.m.

**Experiment-2:** Effect of sowing time on the production of onion sets.

**2.1 Plant height**

Plant height was recorded at periodically and the data are presented in Table 12. Significant differences were recorded due to sowing dates. Plant height increased up to 30$^{th}$ march in all the sowing dates and later it slightly decreased. On 30$^{th}$ March maximum plant height (51.70 cm) was recorded on 1$^{st}$ December sowing followed by 11$^{th}$ December, while minimum plant height was recorded from the 10$^{th}$ February (20.03 cm) followed by 30$^{th}$ January (22.46 cm) and 20$^{th}$ January (28.88) sowings and these three treatments were significantly different from all the remaining treatments. In general, plant height decreased with delay in sowing and it was lowest in 10$^{th}$ February on all the dates of observation. On 30$^{th}$ January, plant height was highest in 1$^{st}$ December sowing which was very closely followed by 11$^{th}$ December sowing. Both these treatments were significantly superior to remaining treatments. These two sowing dates maintained their superiority through out the growing season. Maximum increment in plant height in all the treatments was recorded during 6-30 March.

**2.2 Foliage weight**

Foliage weight was recorded on 18$^{th}$ and 30$^{th}$ March and 11$^{th}$ and 23$^{rd}$ April before final harvest on 16$^{th}$ May (Table 13). Where crop was sown on 1$^{st}$, 11$^{th}$, 21$^{st}$ and 31$^{st}$ December, foliage weight increased up to 30$^{th}$ March while in other sowing dates it increased up to 23$^{rd}$ April when last observation was taken. On 18$^{th}$ and 30$^{th}$ march, 11$^{th}$ December sowing

**TABLE-10:** EFFECT OF SEED RATE ON YIELD OF TOTAL AND DIFFERENT SIZE SETS (g /sq. m.)

| SEED RATE (g / sq. m) | SIZE OF SETS | | | | |
|---|---|---|---|---|---|
| | Upto 2 g | > 2 - 5 g | > 5 -10 g | >10 g | Total |
| 5.0 | 117.66 | 325.00 | 983.33 | 323.33 | 1749.33 |
| 7.5 | 120.66 | 423.33 | 886.66 | 226.66 | 1697.33 |
| 10.0 | 141.66 | 560.00 | 646.66 | 227.66 | 1576.00 |
| 12.5 | 204.00 | 586.66 | 533.33 | 176.66 | 1500.66 |
| 15.0 | 225.00 | 610.00 | 453.33 | 96.66 | 1395.00 |
| 17.5 | 235.00 | 576.66 | 463.33 | 70.00 | 1345.00 |
| 20.0 | 256.66 | 576.66 | 413.33 | 35.66 | 1282.31 |
| 22.5 | 265.00 | 536.66 | 386.66 | 25.66 | 1213.98 |
| 25.0 | 321.00 | 520.00 | 360.00 | 17.66 | 1218.66 |
| C.D. at 5 % | 30.38 | 24.47 | 49.79 | 27.94 | 72.29 |

**TABLE-11:** EFFECT OF SEED RATE ON PERCENTAGE OF DIFFERENT SIZE SETS (Weight Basis)

| SEED RATE (g / sq. m) | SIZE OF SETS | | | |
|---|---|---|---|---|
| | Upto 2 g | > 2 - 5 g | > 5 -10 g | >10 g |
| 5.0 | 6.72 | 18.57 | 56.21 | 18.47 |
| 7.5 | 7.10 | 24.94 | 52.23 | 13.35 |
| 10.0 | 8.98 | 43.88 | 41.03 | 14.44 |
| 12.5 | 13.59 | 39.09 | 35.53 | 11.77 |
| 15.0 | 16.12 | 43.72 | 32.49 | 6.92 |
| 17.5 | 17.47 | 42.87 | 34.44 | 5.20 |
| 20.0 | 20.01 | 44.97 | 33.00 | 2.78 |
| 22.5 | 21.82 | 44.20 | 31.85 | 2.11 |
| 25.0 | 26.34 | 40.66 | 29.54 | 1.45 |

**TABLE-12:** EFFECT OF SOWING TIME ON PLANT HEIGHT (cm) OF ONION SETS

| DATE OF SOWING | DATE OF OBSERVATION | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 29/1 | 10/2 | 22/2 | 6/3 | 18/3 | 30/3 | 11/4 | 23/4 |
| 01, DECEMBER | 10.40 | 11.76 | 22.63 | 28.5 | 38.96 | 51.70 | 46.16 | 38.50 |
| 11, DECEMBER | 9.07 | 10.93 | 21.23 | 30.1 | 39.03 | 51.23 | 43.10 | 36.23 |
| 21, DECEMBER | 6.80 | 9.96 | 16.43 | 22.3 | 29.76 | 38.03 | 30.56 | 25.23 |
| 31, DECEMBER | 4.80 | 6.00 | 14.56 | 19.2 | 24.50 | 32.60 | 27.66 | 20.13 |
| 10, JANUARY | 1.70 | 5.96 | 11.46 | 16.0 | 21.46 | 31.43 | 24.80 | 20.46 |
| 20, JANUARY | - | 2.06 | 7.66 | 13.50 | 19.16 | 28.86 | 22.90 | 19.90 |
| 30, JANUARY | - | - | 5.16 | 9.50 | 16.03 | 22.46 | 20.16 | 19.76 |
| 10, FEBRUARY | - | - | 1.90 | 8.60 | 14.30 | 20.03 | 15.00 | 14.00 |
| C.D. at 5 % | 1.38 | 1.02 | 2.09 | 2.09 | 5.49 | 1.27 | 0.76 | 0.63 |

recorded highest foliage weight, closely followed by 1st December sowing. However, on 11th and 23rd April, foliage weight was highest in 1st December sowing closely followed by 11th December sowing. Both these treatments were significantly superior all the remaining sowing dates on all the four dates of observation. Foliage weight decreased with delay in sowing and it was lowest in 10th February sowing on all the four dates of observation and it was significantly lower than all the remaining sowing dates and on all the four observations except on 18th March where it was statistically at par with 30th January sowing but significantly lower than the remaining sowing dates.

**2.3 Bulb weight**

Bulb weight was recorded on 18th and 30th March and 11th and 23rd April before final harvest on 16th May (Table 14). On the 18th and 30th March, 11th December sowing recorded highest bulb weight and was very closely followed by 1st December sowing while on 11th and 23rd April, 1st December sowing recorded highest bulb weight followed by 11th December and both these treatments were significantly superior to all the remaining sowing dates. Bulb weight decreased with successive delay in sowing. Sowing on 10th February recorded lowest bulb weight on all the four dates of observation followed by 30th and 20th January sowings. These three treatments were significantly different from the remaining sowing dates on all the four dates of observation. Status of the 21st December sowing regarding bulb weight was 3rd on all the dates of observation. Bulb weight in all the treatments increased with increase in duration of crop.

**2.4 Diameter of bulb**

Bulb diameter in this experiment was also recorded on 18th and 30th March and 11th and 23rd April (Table 15). 1st December sowing recorded

**TABLE-13:** EFFECT OF SOWING TIME ON FOLIAGE WEIGHT (g/plant) OF ONION SETS

| DATE OF SOWING | DATE OF OBSERVATION | | | |
|---|---|---|---|---|
| | **18/3** | **30/3** | **11/4** | **23/4** |
| 01, DECEMBER | 3.56 | 7.13 | 7.00 | 6.50 |
| 11, DECEMBER | 4.23 | 8.00 | 6.66 | 5.70 |
| 21, DECEMBER | 2.66 | 4.70 | 4.43 | 4.33 |
| 31, DECEMBER | 2.20 | 3.86 | 3.80 | 3.75 |
| 10, JANUARY | 2.06 | 3.33 | 3.53 | 3.76 |
| 20, JANUARY | 1.53 | 3.10 | 3.36 | 3.50 |
| 30, JANUARY | 0.60 | 1.93 | 3.16 | 3.36 |
| 10, FEBRUARY | 0.46 | 1.43 | 1.66 | 1.96 |
| C.D. at 5 % | 0.27 | 0.34 | 0.21 | 0.21 |

**TABLE-14:** EFFECT OF SOWING TIME ON BULB WEIGHT (g/plant) OF ONION SETS

| DATE OF SOWING | DATE OF OBSERVATION | | | |
|---|---|---|---|---|
| | **18/3** | **30/3** | **11/4** | **23/4** |
| 01, DECEMBER | 1.33 | 3.70 | 7.60 | 14.66 |
| 11, DECEMBER | 1.43 | 4.36 | 7.46 | 12.63 |
| 21, DECEMBER | 0.86 | 2.90 | 4.60 | 9.50 |
| 31, DECEMBER | 0.73 | 2.33 | 3.60 | 7.63 |
| 10, JANUARY | 0.43 | 1.66 | 3.30 | 5.36 |
| 20, JANUARY | 0.16 | 1.23 | 2.90 | 4.46 |
| 30, JANUARY | 0.13 | 0.69 | 1.90 | 3.40 |
| 10, FEBRUARY | 0.08 | 0.60 | 1.03 | 2.46 |
| C.D. at 5 % | 0.10 | 0.39 | 0.16 | 0.33 |

highest diameter of bulb on 18th March and 23rd April and very closely followed by 11th December sowing. However, on 30th March and 11th April, bulb diameter was highest on 11th December sowing, very closely followed by 1st January sowing. Both these sowing dates were significantly superior to all the remaining sowing dates on all the dates of observation. Bulb diameter decreased with delay in sowing and it was lowest in 10th February sowing on all the dates of observation, followed by 30th and 20th January sowings and these three sowing dates were significantly inferior to the remaining sowing dates on all the four dates of observation. Bulb diameter increased with increase in duration of the crop in all the treatments up to 23rd April when last observation on diameter was recorded.

**2.5 Ratio of bulb to total biomass**

Ratio of bulb to total biomass is presented in Table 16. On 18th and 23rd April, ratio of bulb to total biomass was highest in 1st December sowing followed by 11th and 21st December sowings. While on 30th March and 11th April it was highest from 11th December sowing followed by 1st and 21st December sowings and these three treatments were significantly superior to 10th, 20th and 30th January and 10th February sowings on all the four dates of observation. Ratio of bulb to total biomass decreased with successive delay in sowing and it was lowest in 10th February sowing on all the four dates of observation. Ratio of bulb to total biomass increased with increase in duration of the crop.

**2.6 Number of total and different size sets**

Data on number of total and different size sets recorded at harvest on 16th May are presented in Table 17. Total number of sets ranged from 140.33/sq.m. in 10th February sowing to 349.33/sq.m. in 11th December sowing. Differences in total number of sets between the sowing dates of

**TABLE-15:** EFFECT OF SOWING TIME ON BULB DIAMETER (cm) OF ONION SETS

| DATE OF SOWING | DATE OF OBSERVATION | | | |
|---|---|---|---|---|
| | **18/3** | **30/3** | **11/4** | **23/4** |
| 01, DECEMBER | 1.28 | 2.04 | 2.63 | 3.46 |
| 11, DECEMBER | 1.18 | 2.06 | 2.76 | 3.13 |
| 21, DECEMBER | 1.04 | 1.70 | 2.30 | 2.73 |
| 31, DECEMBER | 0.85 | 1.43 | 2.03 | 2.56 |
| 10, JANUARY | 0.78 | 1.23 | 1.80 | 2.30 |
| 20, JANUARY | 0.58 | 0.93 | 1.40 | 2.03 |
| 30, JANUARY | 0.25 | 0.86 | 1.30 | 1.73 |
| 10, FEBRUARY | 0.21 | 0.56 | 0.83 | 1.23 |
| C.D. at 5 % | 0.06 | 0.10 | 0.15 | 0.13 |

**TABLE-16:** EFFECT OF SOWING TIME ON RATIO OF BULB TO TOTAL BIOMASS OF ONION SETS

| DATE OF SOWING | DATE OF OBSERVATION | | | |
|---|---|---|---|---|
| | 18/3 | 30/3 | 11/4 | 23/4 |
| 01, DECEMBER | 0.27 | 0.35 | 0.51 | 0.71 |
| 11, DECEMBER | 0.25 | 0.37 | 0.52 | 0.69 |
| 21, DECEMBER | 0.24 | 0.36 | 0.51 | 0.68 |
| 31, DECEMBER | 0.23 | 0.34 | 0.49 | 0.65 |
| 10, JANUARY | 0.17 | 0.32 | 0.48 | 0.58 |
| 20, JANUARY | 0.13 | 0.28 | 0.46 | 0.55 |
| 30, JANUARY | 0.10 | 0.27 | 0.43 | 0.52 |
| 10, FEBRUARY | 0.08 | 0.26 | 0.39 | 0.49 |
| C.D. at 5 % | 0.02 | 0.03 | 0.02 | 0.02 |

1st December and 10th January were not significant. Total number of sets recorded from 10th February sowing were significantly lower than all the remaining sowing dates. Sowing on 30th January also recorded significantly lower number of sets compared with all the sowing dates before it. Number of sets up to 2 g size increased with delay in sowing. It was lowest (31.66/sq.m.) when sowing was done on 1st December. Number of sets up to 2 g size was highest (140.33/sq.m.) when sowing was done on 10th February, closely followed by sowings done on 30th, 20th and 10th January. Sowing 10th February produced sets of the size of up to 2 g only. Number of >2-5 g size sets was highest (134.0/sq.m.) in 10th January sowing followed by 31st December and 20th January sowings. Lowest number of >2-5 g size sets were produced in 1st December sowing. Number of >5-10 g size sets was lowest (26.16/sq.m.) when sowing was done on 30th January followed by 20th January and 10th January sowings. Highest (151.00/sq.m.) number of >5-10 g size sets were recorded in the 1st December sowing. Number of >5-10 g size sets decreased with each delay in sowing. Number of >10 g size sets was highest (80.0/sq.m.) when sowing was done on 1st December, very closely followed by the sowing done on 11th December and both these treatment were significantly superior to all the remaining treatments. Number of sets more than 10 g size were only 5.66, 7.66, 11.00 and 12.00/sq.m. where sowing was done on 30th, 20th and 10th January and 31st December, respectively and these four treatments were significantly inferior to the sowings done on 1st, 11th and 21st December. With each delay in sowing, there was a significant decrease in number of >0.5-10 g size sets.

Proportion of different size sets was worked out and data are presented in Table 18. Proportion of up to 2 g size sets increased with delay in sowing while proportion of > 5-10 g size and > 10 g size sets

decreased with delay in sowing. Proportion of up to 2 g size sets in 1st December sowing was 9.37% and in 11th December sowing, it was 13.30%. While in 20th January, 30th January and 10th February sowings it was 41.72, 51.28 and 100%, respectively. On the other hand, proportion of >5-10 g size sets was 45.12 and 41.87% in 1st December and 11th December sowings, respectively. While in 20th and 30th January sowings, its proportion was 21.07 and 9.84%, respectively. Similarly, proportion of >10 g sets was about 20% in 1st and 11th December sowings, while it was less than 5% when sowing was done on 31st December or after that.

**2.7 Yield of total and different size sets**

Bulb harvested on 16th May were graded into four categories and data for yield of total and different size sets are presented in Table 19. Total bulb yield was highest (2953.33 g/sq.m.) in 1st December sowing closely followed by 11th December sowing and both these treatment were significantly superior to all the remaining treatments. Bulb yield decreased with successive delay in sowing. Sowing on 10th February recorded total bulb yield of only 282.00 g/sq.m. followed by 30th January sowing and both these treatments were significantly inferior to all the remaining treatments. The size of sets produced is very important from planting point of view. Yield of up to 2 g size sets increased with delay in sowing in nursery. Highest yield (282.00 g/sq.m.) of up to 2 g size sets was obtained when sowing was done on 10th February followed by 30th January, 20th January and 10th January sowings. These four treatments were significantly different from the remaining four sowing dates. Lowest yield (62.33 g/sq.m.) of up to 2 g size sets was obtained when sowing was done on 1st December. Yield of >2-5 g size sets were highest (658.33 g/sq.m.) when sowing was done on 10th January followed by 31st December and 21st December. Sowing done on 10th February produced

**TABLE-17:** EFFECT OF SOWING TIME ON NUMBER OF TOTAL AND DIFFERENT SIZE SETS (per sq. m)

| DATE OF SOWING | SIZE OF SETS | | | | |
|---|---|---|---|---|---|
| | Upto 2 g | > 2 - 5 g | > 5 -10 g | >10 g | Total |
| 01, DECEMBER | 31.66 | 72.00 | 151.00 | 80.00 | 334.66 |
| 11, DECEMBER | 45.00 | 84.00 | 141.66 | 67.66 | 338.32 |
| 21, DECEMBER | 92.33 | 102.33 | 118.00 | 25.00 | 337.66 |
| 31, DECEMBER | 112.00 | 121.66 | 101.66 | 12.00 | 347.33 |
| 10, JANUARY | 126.00 | 134.00 | 75.00 | 11.00 | 346.00 |
| 20, JANUARY | 132.00 | 110.00 | 66.66 | 7.66 | 316.33 |
| 30, JANUARY | 136.33 | 97.66 | 26.16 | 5.66 | 265.81 |
| 10, FEBRUARY | 140.33 | 0.00 | 0.00 | 0.00 | 140.33 |
| C.D. at 5 % | 6.19 | 6.84 | 5.73 | 4.47 | 15.48 |

**TABLE-18:** EFFECT OF SOWING TIME ON PERCENTAGE OF DIFFERENT SIZE SETS (Number Basis)

| DATE OF SOWING | SIZE OF SETS | | | |
|---|---|---|---|---|
| | Upto 2 g | > 2 - 5 g | > 5 -10 g | >10 g |
| 01, DECEMBER | 9.37 | 21.51 | 45.12 | 23.90 |
| 11, DECEMBER | 13.30 | 24.82 | 41.87 | 19.99 |
| 21, DECEMBER | 24.34 | 30.30 | 34.94 | 7.40 |
| 31, DECEMBER | 32.24 | 39.99 | 29.26 | 3.45 |
| 10, JANUARY | 36.41 | 38.72 | 21.67 | 3.17 |
| 20, JANUARY | 41.72 | 34.74 | 21.07 | 2.42 |
| 30, JANUARY | 51.28 | 36.32 | 9.84 | 2.12 |
| 10, FEBRUARY | 100 | 00 | 00 | 00 |

sets of up to 2 g size only. Yield of >5-10 g size sets decreased significantly with each delay in sowing. Sowing on 1st December recorded highest yield (1496.00 g/sq.m.) of >5-10 g size sets. Lowest yield (251.00 g/sq.m.) of >5-10 g size sets was recorded in 3oth January sowing, which was significantly lower than all other sowing dates. Yield of >10 g size sets also decreased with each delay in sowing. It was highest (1040.00 g/sq.m.) in 1st December sowing closely followed by 11th December (863.33 g/sq.m.) and 21st December (343.33 g/sq.m.) sowings and these three treatments were significantly superior to all the remaining sowing dates. Lowest yield (68.33 g/sq.m.) of >10 g size sets was obtained when sowing was done on 10th January, however, it did not differ significantly from 31st December, 20th and 30th January sowings.

Data for proportion of different size sets on weight basis are presented in Table 20. Proportion of up to 2 g and >2-5 g size sets increased while that of >5-10 g and > 10 g size sets decreased with delay in sowing. Proportion of up to 2 g size sets in 1st December sowing was only 2.11% and in 11th December sowing, it was 3.30% while its proportion in 20th and 30th January sowings was 16.90 and 25.37%, respectively. Sowing on 10th February produced sets of only up to 2 g size. Proportion of >2-5 g size sets was 12.02% in 1st December sowing and 15.24% in 11th December sowing while for sowings between 31st December to 30th January, its proportion was more than 30%. Proportion of >5-10 g size sets was about 50% when sowing was done during December. Proportion of >10 g size sets was 35.21% for sowing on 1st December and 31.48% for the sowing on 11th December, while for sowing on 31st December onward its proportion was less than 10%.

**TABLE-19:** EFFECT OF SOWING TIME ON YIELD OF TOTAL AND DIFFERENT SIZE SETS (g/ sq. m)

| DATE OF SOWING | SIZE OF SETS | | | | |
|---|---|---|---|---|---|
| | Upto 2 g | > 2 - 5 g | > 5 -10 g | >10 g | Total |
| 01, DECEMBER | 62.33 | 355.00 | 1496.00 | 1040.00 | 2953.33 |
| 11, DECEMBER | 90.66 | 418.00 | 1370.00 | 863.33 | 2741.99 |
| 21, DECEMBER | 180.66 | 502.00 | 1166.66 | 343.33 | 2192.65 |
| 31, DECEMBER | 217.64 | 635.00 | 988.33 | 165.00 | 2005.97 |
| 10, JANUARY | 250.00 | 658.33 | 733.66 | 151.66 | 1793.65 |
| 20, JANUARY | 264.66 | 555.00 | 651.00 | 95.00 | 1565.66 |
| 30, JANUARY | 268.00 | 469.00 | 251.00 | 68.33 | 1056.33 |
| 10, FEBRUARY | 282.00 | 0.00 | 0.00 | 0.00 | 282.00 |
| C.D. at 5 % | 13.70 | 18.06 | 24.05 | 99.84 | 239.41 |

**TABLE-20:** EFFECT OF SOWING TIME ON PERCENTAGE OF DIFFERENT SIZE SETS (Weight Basis)

| DATE OF SOWING | SIZE OF SETS | | | |
|---|---|---|---|---|
| | Upto 2 g | > 2 - 5 g | > 5 -10 g | >10 g |
| 01, DECEMBER | 2.11 | 12.02 | 50.65 | 35.21 |
| 11, DECEMBER | 3.30 | 15.24 | 49.96 | 31.48 |
| 21, DECEMBER | 8.23 | 22.89 | 53.20 | 15.65 |
| 31, DECEMBER | 10.84 | 31.63 | 49.20 | 8.22 |
| 10, JANUARY | 13.94 | 36.70 | 40.90 | 8.46 |
| 20, JANUARY | 16.90 | 35.45 | 41.58 | 6.07 |
| 30, JANUARY | 25.37 | 44.39 | 23.76 | 6.46 |
| 10, FEBRUARY | 100.00 | 0 | 0 | 0 |

# DISCUSSION

# 5

# DISCUSSION

The field experiments, results of which have been reported in the previous chapter, were conducted to find out the effect of seed rate and sowing time on the production of sets for kharif onion crop during the year 2000-2001. The experimental findings presented there revealed several points of interest, which are discussed here in conjunction with the findings of other workers.

Differences in height due to varying seed rates used for nursery raising were very little and were significant only on one occasion. Moussi *et al.* (1978) and Bhonde *et al.* (1995) also reported that differences in plant height due to differential seed rates were not significant. Similar findings also have been reported by Gupta (1997). Maximum increment in plant height in all the treatments was recorded for the period between 6-30 March (58-82 days after sowing). It may be that environmental conditions during this period were much conductive for the growth of seedlings.

Plant height increased up to 30$^{th}$ March in all the sowing dates and later it slightly decreased, it is because of the fact that higher temperature during the month of April forced the maturity of the nursery and there was burning of the tips. Forced maturity had more effect on latter sown crop

and hence the height attained by the onion seedlings sown on 10th February was the poorest among the eight treatments. Differences in height due to date of sowing were significant. Higher height was recorded from early sowings and they were significantly superior to later sowing dates. Results are in agreement with the findings of Moussi *et al.* (1975).

Foliage and bulb weight and bulb diameter in the experiment on seed rate were measured of the seedlings, which had initiated bulb. Bulb weight and bulb diameter decreased with increase in seed rate because of increased competition for light and nutrients. It appears from the present investigation that period between 6th to 30th March (58-82 days after sowing) was most suitable for growth as maximum increment in foliage as well as total weight was recorded during this period. Decline in foliage weight at later stages may be due to drying of tips and translocation of some assimilates from foliage to bulb.

In the December sown nursery, there was no increment in foliage weight after 30th March, indicating that all assimilates produced after 30th March were used for the growth of bulb, however, where sowing was done during January and February, foliage growth continued up to 22nd April when last observation on growth was taken. 1st and 11th December sown nursery availed higher crop duration than other sowing dates and therefore, recorded higher foliage weight, bulb weight and bulb diameter on all the four dates of observation. Since 10th February sowing availed the minimum period for growth and thus had a lowest foliage weight and bulb weight and bulb diameter. Since relative growth rate of a seedling depends upon the size of seedling, therefore, within a given span of time, older seedlings, in other words, larger seedlings recorded more increment in foliage and bulb weight and bulb diameter compared with younger or smaller seedlings.

Ratio of bulb to total biomass decreased slightly with increase in seed rate per unit area in nursery. Similar results have been reported by Gupta (1997). This is because of the fact that increase in seed rate per unit area in nursery resulted in increased competition for foliage growth and therefore, the allocation of assimilates for bulb growth was reduced.

Ratio of bulb to total biomass increased with increase in duration of nursery and therefore decreased with delay in sowing on a given date of observation. Gupta (1997) also reported increase in ratio of bulb to total biomass with increase in the crop duration. It also indicates that with increase in crop duration, assimilates being utilized for the growth of bulb also increase.

Number of bulb that finally developed, increased with increase in seed rates, while yield of sets decreased. Earlier, Gupta (1997) reported significant reduction in the yield of sets when seed rate was increased from 30 to 45 g/sq.m. Kossowski *et al.* (1984) obtained higher yield of commercial grade (11-17 mm in diameter) sets with the seed rate of 175-222 kg/ha. It may be due to the reason that some assimilates at higher seed rate were used by the plants which did not develop into bulb and thus reducing the availability of assimilates for bulb growth at higher seed rate, therefore proportion of >5-10 g and >10 g size sets decreased and up to 2 g and >2-5 g size sets increased with increase in seed rate. Similar results were reported by Nandpuri (1990), Anonymous (1992) and Tendaj (1992).

Since with delay in sowing, crop duration decreased and thus assimilates produced over a short season also decreased, therefore, total bulb yield was highest in 1$^{st}$ December sowing closely followed by 11$^{th}$ December sowing and thereafter bulb yield decreased with successive delay in sowing. Sowing done on 10$^{th}$ February recorded lowest total bulb

yield. Earlier findings have also sown that yield of sets decreased with delay in sowing, where four sowing dates viz. 25th December, 15th January, 5th and 25th February were compared (Gupta, 1997). Similar results have been reported by Shemetuk and Antonento (1987), Pandey *et al.* (1992) and Anonymous (1992) in onion crop. In this experiment, number of bulbs per unit area was similar in all the treatment except last three sowing dates. It may be that in late sowing, some plants did not develop bulb as crop duration was reduced. In case of 10th February sown nursery bulb weight did not exceeds even 2 g. Since total number of bulbs per unit area are almost same and with delay in sowing there is a decrease in crop duration and thus total light intercepted by the late sown crop is reduced and hence assimilates available for growth of individual plant decreased with delay in sowing and due to this, yield as well as proportion of >5-10 g and >10 g size sets decreased with delay in sowing. However, proportion as well as yield of up to 2 g size sets increased with delay in sowing indicating the incomplete development of bulbs due to forced maturity.

It may be concluded that for obtaining higher yield of medium size onion sets (>2-10 g), optimum seed rate is 7.5 g/sq.m. and optimum sowing time is 1st fortnight of December.

# SUMMARY

# 6

# SUMMARY

The present investigation entitled "Effect of seed rate and sowing time on the production of sets for kharif onion crop" was conducted at the Research Farm of the Department of Vegetable Crops, CCS Haryana Agricultural University, Hisar, during the year 2000-2001 to achieve the following objectives:

(1) To see the effect of different seed rates on the production of onion sets

(2) To see the effect of different sowing time on the production of onion sets

**Experiment I:** Effect of different seed rates on the production of onion sets. In this experiment, there were nine seed rates (5.0, 7.5, 10.0, 12.5, 15.0, 17.5, 22.5, and 25.0 g/sq.m).

**Experiment II:** Effect of different sowing time on the production of onion sets. This experiment includes eight sowing dates viz. 1st December, 11th December, 21st December, 31st December, 10th January, 20th January, 30th January and 10th February.

In both the experiments, observations were recorded on periodical plant height, foliage weight, bulb weight, bulb diameter and ratio of bulb to total biomass and final yield of sets in different grades.

Critical findings obtained from the present investigations conducted during 2000-2001 are summarized and concluded below:

1. Differences in plant height due to seed rates were not significant except for the observation recorded on 18th March. Height of plants increased up to 30th March in all the sowing dates, later it slightly decreased. Plant height decreased with delay in sowing and minimum plant height was recorded in the10th February sowing followed by 30th January sowing.

2. Foliage weight increased with increase in crop duration up to 12th April for all the seed rates. Foliage weight per plant decreased with increase in seed rates. It was highest where seed rate was 5.0 g/sq.m. and lowest where seed rate was 25.0 g/sq.m. Foliage weight decreased with delay in sowing and it was lowest in the10th February sowing on all the dates of observation. In December sown crop, foliage weight increased up to 30th March while in January and February sown crop it showed increment up to 22nd April.

3. Bulb weight decreased with increase in seed rate and it was lowest where seed rate was 25.0 g/sq.m. and highest where seed rate was 5.0 g/sq.m. on all the four dates of observation. On the other hand, bulb weight in all the treatments increased with increase in duration of the crop. Bulb weight in 1st and 11th December sowing was higher than other sowing dates on all the four dates of observation. Sowing on 10th February recorded lowest bulb weight on all the four dates of observation followed by 30th and 20th January sowings.

4. Bulb diameter decreased with increase in seed rates. On the other hand, bulb diameter increased with increase in duration of the crop in all the treatments but decreased with delay in sowings.

5. Ratio of bulb to total biomass decreased with increase in seed rates. Ratio of bulb to total biomass decreased with successive delay in sowing and it was lowest in 10th February on all the four dates of observation. Ratio of bulb to total biomass increased with increase in crop duration.

6. Total number of sets obtained from different seed rates ranged from 254.66/sq.m. (5.0 g) to 311.0/sq.m. (25.0 g). Total number of sets ranged from 140.33/sq.m. in 10th February sowing to 347.33/sq.m. in 31st December sowing. Total number of sets recorded from 10th February sowing was significantly lower than that of all other sowing dates. Proportion (on number basis) of up to 2 g size sets increased while that of >5-10 g and >10 g size sets decreased with delay in sowing as well as increase in seed rate.

7. Highest total bulb yield was 1749.33 g/sq.m. where seed rate was 5.0 g/sq.m. and lowest 1213.98 g/sq.m. where seed rate was 22.5 g/sq.m.

Proportion (on weight basis) of up to 2 g size sets increased while that of >5-10 g and > 10 g size sets and total yield decreased with increase in seed rate or delay in sowing.

Maximum yield of >2-10 g (medium size) size sets was obtained where seed rate was 7.5 g/sq.m. was used for raising of sets. Sowing on 1st December recorded highest yield of medium size sets.

It may be concluded that for obtaining higher yield of medium size onion sets (>2-10 g), optimum seed rate is 7.5 g/sq.m. and optimum sowing time is 1st fortnight of December.

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# REFERENCES


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