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Effect of Seedling/set Sizes and Planting Times on Bulb Yield and Quality in Onion Cultivar Phulkara During Autumn

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Abstract: The effects of seedling/set size and planting times on bulb yield and quality in onion cultivar phulkara were studied during autumn season 2000. The bulbs of seedlings and sets were graded in three sizes of 2.5, 3.5 and 4.5 mm diameter and 7.5, 12.5 and 17.5 mm diameter, respectively and were sown on 15th August and Ist September, 2000. Highest mean marketable bulb yield (21.2 t ha^{-1}) was obtained using 17.5 mm diameter size sets and seedling with 4.5 mm diameter bulbs. However, the crop sown with 17.5 mm diameter sets on 1st September, produced significantly highest marketable bulb yield of 24.6 t ha^{-1} and also gave highest percentage of doubles (17.9 %). Sets with 17.5 mm diameter though produced highest percentage of doubles but also gave highest marketable bulb yield and are therefore recommended for planting autumn season crop in first week of September.

Key words: Onion, sets/seedlings, planting time, bulb yield, storage, weight loss

Introduction

Onion (*Allium cepa* L.) is one of the important condiments which provides flavoring for meats and serves as an ingredient in relishes. Onion is grown in all four provinces of Pakistan in varying volumes and its produce arrives in the market from May to December. However, its supply falls in short of requirements from January onward till arrival of normal seasonal crop. As a result of limited supply during this period, the prices of onion shoot up to more than double compared to that of normal season. In Pakistan onion seedlings are used largely which are transplanted in the field to get bulb onions and onion production through sets is not commonly practiced. Sets are produced by sowing onion seed very thickly so that the plants grow very close together and produce only small bulbs.

In many countries, onions are largely planted as sets. Size of set is closely related to subsequent yield (Colby *et al.*, 1945). Madisa (1993) compared three sizes of onion sets and reported highest bulb yield of 45.4 t ha^{-1} with medium sets (18-25 mm) following large (20-30 mm) and small (12-18 mm) sets producing 37.6 and 30.6 t ha^{-1}, respectively. Highest bulb yield of 43.8 t ha^{-1} with medium sets (16-20 mm) has also been reported (Khokhar *et al.*, 2001). Onion cultivar phulkara have shown good response with regard to bulb development under decreasing day length of autumn season (Khokhar *et al.*, 2001).

The research work was conducted to find out appropriate size of seedlings/sets and suitable planting time for raising autumn season crop of onion variety phulkara which claims largest area under commercial cultivation in Pakistan. For autumn season crop the traditional method of raising onion is through seedlings, which have to be raised in the month of July under hot and humid conditions, thus making it difficult to properly manage nursery seedlings. The sets, on the other hand, are easy to handle and can be directly planted in the field. In the present studies both seedlings and sets were used to make the comparison.

Materials and Methods

The effects of seedling/set size and planting times on bulb yield and quality in onion cultivar phulkara were studied at the Horticultural Sciences Institute, NARC, Islamabad during 2000. Three bulb sizes both of seedlings and sets, measuring 2.5, 3.5 and 4.5 mm diameter and 7.5, 12.5 and 17.5 mm diameter, respectively were sown on 15th August and 1st September, 2000. The seed of cultivar 'phulkara' was sown on 15th November, 1999 to raise sets that were harvested on last week of May 2000. These were graded and packed in net bags and stored at room temperature in a ventilated room till planting in the field. Nursery of phulkara was raised on Ist July, 2000 and seedlings were graded at the time of transplanting on respective dates. The row to row and plant to plant spacing were 30 and 10 cm, respectively. The experiment was designed as a randomized complete block. The data were recorded from each treatment in respect of time to bulb maturity, percentage of doubles, marketable and un-marketable bulb yield. The date was taken when 80 % of the plants showed neckfall (Mondal *et al.*, 1986). After data collection, the weight loss of harvested bulbs from August and September sown crops was also studied. For this purpose four net bags each containing twenty bulbs both from August and September sown crops were placed in well-ventilated room. Before packing the bulbs in the net bags, the fresh weight of bulbs was recorded and thereafter it was recorded at ten days interval. The percentage weight loss was calculated (Karmarkar and Joshi, 1941). The data collected were subjected to analysis of variance technique and means were compared by using Duncan's multiple range test (Steel and Torrie, 1980).

Results and Discussion

Days to bulb maturity: The time to bulb maturation decreased significantly with decreasing size of seedlings/sets (Table 1). The small size seedlings/sets took relatively shorter time (148.2 days) for bulbs to mature compared with either medium or large sizes which took 151.9 and 155.8 days, respectively. These results are in conformity with those of Khokhar *et al.* (2001) who reported delayed maturity of onion bulbs by large sets. However, results of these studies differ with those of Heath and Holdsworth (1948) and Jones and Mann (1963), who reported that large sets accelerate maturity. The sets used by Heath and Holdsworth (1948) were larger than those used in this study and early maturity reported by them might be due to competition for assimilates as result of higher number of shoots normally produced by large bulbs/sets. In this study all sizes of seedlings/sets produced single shoots and it could be that no competition between shoots for nutrient/water supply occurred and as a result large sets took relatively longer time to mature than small sets/seedlings. September sown crop by sets took significantly longer time to mature (161.9 days). Interactions between size of seedlings/sets and planting times were also significant. August sown crop through seedlings took minimum time to mature (143 days). The maturity of bulbs occurred earlier in August sown crop raised either by seedlings or sets compared with that of September sown crop.

Percentage of doubles/splitted bulbs: The onion bulb consists of a short underground stem with fleshy scale leaves which develop the terminal bud. Lateral buds either remain dormant during the vegetative phase of the plant life cycle, or they develop into multihearted bulbs which sometimes double i.e., divide into

Table 1: Data regarding days to maturity of onion cultivar phulkara during autumn

	Maturity days seedlings		Maturity days sets		
Size of seedling/set	15th Aug.	Ist Sep.	15th Aug.	Ist Sep.	Means
S1	139Bd	153.7Cb	143.0Cc	157.0Ca	148.2C
S2	144Ad	157.0Bb	145.7Bc	160.7Ba	151.9B
S3	146Ad	159.0Ab	150.0Ac	168.0Aa	155.8A
Means	143d	156.6b	146.2c	161.9a	

Table 2: Percentage of doubles of onion cultivar phulkara during autumn

	Percentage of doubles seedlings		Percentage of doubles sets		
Size of seedling/set	15th Aug.	Ist Sep.	15th Aug.	Ist Sep.	Means
S1	0	I.0	4.4Bb	13.5a	4.5B
S2	0	0.0	6.7Abb	16.2a	5.7B
S3	0	3.3c	8.9Ab	17.9a	7.5A
Mean	0	1.1c	6.7b	15.8a	

Table 3: Marketable bulb yield (t ha^{-1}) of onion cultivar phulkara during autumn

	Bulb yield (t ha^{-1}) seedlings		Bulb yield (t ha^{-1}) sets		
Size of seedling/set	15th Aug.	Ist Sep.	15th Aug.	Ist Sep.	Means
S1	14.2Cc	15.6Cb	15.7Bb	17.7Ca	15.8C
S2	15.7Bc	17.4Bb	16.3Bc	20.6Ba	17.5B
S3	17.2Ad	22.7Ab	20.5Ac	24.6Aa	21.2A
Means	15.7d	18.6b	17.5c	21.0a	

Table 4: Unmarketable bulb yield of onion cultivar phulkara during autumn

	Bulb yield (t ha^{-1}) seedlings		Bulb yield (t ha^{-1}) sets		
Size of seedling/set	15th Aug.	Ist Sep.	15th Aug.	Ist Sep.	Means
S1	0.56Bc	1.53Bb	1.39Bb	2.23Ca	1.43C
S2	0.97Abc	1.81Abb	2.15Ab	3.00Ba	1.98B
S3	1.39Ac	2.15Ab	2.42Ab	3.55Aa	2.38A
Means	0.97c	1.83b	1.99b	2.93a	

S_1, S_2 and S_3 represents small, medium and large seedling/sets, respectively. Values followed by the different letters (Capital letters for columns and small letters for rows) are significantly different at $P<.0.01$ and 0.05, respectively

Table 5: Percentage of rotten and sprouted bulbs of onion cultivar phulkara during autumn

Bulbs	August sown crop	September sown crop
Rotten	5b	9.2a
Sprouted	10Ns	11.7NS

Values followed by different letters are significantly different at $p<0.01$ NS: Non-significant

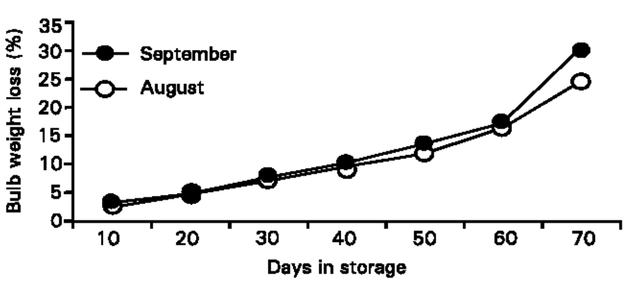

Fig. 1: Periodic weight loss (%) of onion bulbs stored at ambient temperature

shoots. Such plants finally produce two or more separated bulbs of irregular shape. Statistical analysis of the data (Table 2) depicted that size of set/seedlings had significant effect on percentage of doubles. Percentage of doubles increased with increasing set/seedling size. Highest percentage of doubles was recorded in a large size of sets/seedlings (7.5 %). These results are in agreement with those of Chipman and Thorpe (1977) and Thompson (1934), who reported that large sets produce a crop with a greater percentage of double bulbs than those of small sets. Large sets/seedlings are prone to splitting/bolting. Highest percentage of doubles (15.8 %) was noted in set crop sown on 1st September (Table 3). The results are in accordance with the observations of Rabinowitch (1979) who reported that environmental conditions changing with planting times affected the tendency for axillary shoot development leading to multihearted and double bulbs. The higher percentage of doubles might be due to the relatively longer period of cooler conditions that the late sown September crop experienced during the bulb development phase causing the bulbs to split.

Un-marketable bulb yield: The studies indicate that size of seedlings/sets had a significant effect on un-marketable bulb yield (Table 4). Interaction between size of seedlings/sets and planting times were also significant. Large size seedlings (4.5mm diameter) and sets (17.5 mm diameter) produced significantly higher un-marketable bulb yield (2.38 t ha^{-1}) than small and medium size seedlings/sets with un-marketable bulb yields of 1.43 and 1.98 t ha^{-1}, respectively. The reason for higher un-marketable bulb yield in large size could be due to higher percentage of double/splitted bulbs, which lowered their marketable appeal. Significantly highest un-marketable bulb yield (2.93 t ha^{-1}) was recorded in crop sown with sets on 1st September, 2000. The reason for this could be due to relatively greater amount of cold stimulus that the late sown sets received and as a result of this caused the bulbs to split and bolt, ultimately affecting their consumable appeal. This tendency of axillary shoot development with changing environmental conditions and increasing set size leads to double bulbs which are undesirable for consumption. This has been confirmed by Thompson (1934), Chipman and Thorpe (1977) and Rabinowitch (1979).

Marketable bulbs yield: Statistical analysis of the data (Table 3) revealed that size of seedlings/sets, planting times and their interaction had significant effects on the marketable bulb yield. Maximum mean marketable bulb yield (21.2 t ha^{-1}) was obtained using 17.5 mm diameter size sets and seedlings with 4.5 mm diameter bulbs. The reason for higher bulb yield in these sizes could be due to late maturation that prolonged their growth period and enhanced the bulb yield. The results agreed with those of Heath *et al.* (1947), Madisa (1993) and Khokhar *et al.* (2001), who observed that size of set affected the subsequent yield in onion. Significantly highest bulb yield (21.0 t ha^{-1}) was recorded in crop sown with sets on 1st September 2000 and this was followed by the crop transplanted with seedlings on the same date (18.6 t ha^{-1}). The September sown crop with 17.5 mm diameter sets produced significantly highest marketable bulb yield (24.6 t ha^{-1}). It is worth mentioning that the September sown crop did not ripen properly under relatively cooler climatic conditions and the bulbs thus harvested had high moisture contents that resulted in higher bulb weight and yield. The low yields of August sown crop can be attributed to relatively low moisture contents of bulbs due to better ripening.

Bulb weight loss during storage: The percentage of final bulb weight loss in August and September sown crops recorded seventy days after storage was 24.3 and 29.9 %, respectively (Fig.1). An increase of 5.6% bulb weight loss in September sown crop over that of August sown crop was recorded. This increase in bulb weight loss in September sown crop could be attributed to higher moisture contents of bulbs due to improper ripening of bulbs which resulted in comparatively higher bulb weight loss during storage.

Incidence of rotten and sprouted bulbs during storage: The percentage of rotten bulbs from September sown crop was significantly higher (9.2%) than August sown crop (5%) (Table 5). This might also be due to improper ripening and relatively higher moisture contents of bulbs obtained from September sown crop that resulted in higher rotten bulb percentage compared with that of August sown crop. The incidence of sprouted bulbs harvested from August and September sown crop was 10 and 11.7 %, respectively which was statistically non-significant.

It can be inferred from this study that sets with 17.5 mm diameter are suitable for planting autumn season crop in first week of September to obtain highest marketable bulb yield.

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