Studies on Screening of Onion (*Allium cepa* L.) Genotypes against Bolting Behaviour

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ABSTRACT

In India, onion is grown during *Kharif*, *late Kharif* and *Rabi* season, though Rabi is the main crop. India is the second largest producer of onion in the world after China. The onion is grown as bulb crop, some inflorescence stalks are produced before formation of normal bulbs known as bolting, it is not a desirable because it stop the development of bulbs in bulbing crops. These bulbs become fibrous and light in weight. The study conducted at Nashik and Karnal during *kharif*, 2017, revealed that at Nashik, the highest gross yield (360.71 q/ha) and marketable yield (356.44 q/ha) were recorded in the check variety NHRDF Red-4 and found at par with all the advance lines except L-764, L-705, L-743, L-833 and L-872. Highest total soluble solids (12.07%) and dry matter (13.58%) were noted in check variety NHRDF Red-3, however at Karnal, the highest gross yield (198.36 q/ha) and marketable yield (183.44 q/ha) were recorded in advance line L-883 and found at par with advance lines L-863, L-882 and L-884 in respect of gross yield. Highest total soluble solids (15.01%) was recorded in the advance line L-881 and found at par with the advance lines L-653, L-682 and L-880. It is concluded from the study that the advance lines such as L-883 and NHRDF Red-4, which has highest yield can be utilized for higher yield. Regarding bolting behavior, no bolters were recorded in lines L-705, L-748, L-750, L-831, L-833, L-870, L-888, L-890, L-894 and check NHRDF Red-4, however, these lines can be utilized by onion breeder for developing good quality onion variety for different agroclimatic condition.

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**1. INTRODUCTION**

Onion (*Allium cepa* L.) is a photo-thermo sensitive crop and grown during *Kharif*, *late Kharif* and *Rabi* season, though *Rabi* is the main crop. About 73.23 million tons of onions are produced in the world from 3.65 million ha area. India, being major onion-producing country, produces 20.13 million tons from 1.19 million ha, with a very low productivity of 16.24 t/ha in comparison to Republic of Korea (64.58 t/ha), USA (54.47 t/ha), Spain (53.69 t/ha), Netherland (45.80 t/ha), Japan (42.46 t/ha), Germany (41.86 t/ha) and United Kingdom (41.15 t/ha). The onion with high total soluble solids highly utilized for dehydration purpose such as flakes powder, paste, crush and pickle, etc Singh et al. [1]. About 55-60% of onion comes from *Rabi* season and 40-45% from *Kharif* and *late Kharif* season. Because of its high export potential, it comes under cash crop apart from vegetable [2]. It is predominantly a *Rabi* season crop and most onion cultivars are sensitive to photo period and thus their range of adoption is limited [3].

The onion is grown as bulb crop, some inflorescence stalks are produced before formation of normal bulbs known as bolting, it is not a desirable because it stop the development of bulbs in bulbimg crops. These bulbs become fibrous and light in weight. The bulbs become unfit for consumption and such bulbs do not have long keeping quality because these have hard core and prone to rotting. The factors responsible for bolting such as genotypes, temperature, day length, growing season, planting materials, fertilization/nutrition etc. The onion crop is very much sensitive to weather fluctuations. The response of crop to nutrients and pesticides applied is also seen more in onion compared to many others crops due to which various defects are commonly observed in onion when weather condition become adverse. The crop performance varies in the crop grown in different season or in different areas for the same seed and many times due to unawareness of the farmers about influence of various factors on bulb development, the defects are considered to be only due to seed which is not always true.

In the literature of onions available and as experienced by us while working on this crop, the types of defects which are commonly seen are premature bolting, doubling or splitting of bulb at initial stage of the crop growth as well as after bulb development and also after harvesting, thick necked bulbs, improper bulb development, uneven maturity of bulbs, variations in colour, shape and size as also fast deterioration of bulbs after harvesting or even before harvesting in field itself. All these defects lead to economic losses to the growers and thus need to be properly understood for taking care by the farmers to avoid such defects to the maximum possible extent. The efforts have been made to list out the possible causes of these defects.

**2. MATERIALS AND METHODS**

The present investigation was carried out at National Horticultural Research and Development Foundation at Nashik, Maharashtra and Karnal, Haryana during Late *Kharif*-2017. The experiment was laid out in randomized block design with three replications. The Nashik (20° N latitude and 73° E longitudes) is located at altitude of 492 meter above mean sea levels. The minimum and maximum temperature and relative humidity is ranging between 10°C to 40°C and 48% to 80%, respectively, with an annual rain fall around 881 mm. The soil of the trial was clay loam, medium in organic carbon (0.58%), available nitrogen (385.2 kg/ha), phosphorus (45.13 kg/ha) and high in available potash (291.2 kg/ha). The study comprises under present study, a total of 17 genotypes along with three checks NHRDF Red-3, NHRDF Red-4 and L-883 at Nashik, while at Karnal also 14 genotypes along with one check Agrifound Dark Red selected among more than 400 g genotypes evaluated at this centre. The seeds were sown on 8th August 2017 and seedlings were transplanted on 28th September, 2017 at RRS, Nashik, whereas at Karnal seeds were sown on 16th July, 2017 and seedlings were transplanted on 31st August, 2017, however, harvesting was done as per maturity from 26th December, 2017 to 23rd January, 2018 at Nashik and from 30th November, 2017 to 12th December, 2017 at Karnal. Seven to eight-week-old seedlings of each onion genotypes were transplanted in flat beds in the spacing of 15 cm x 10 cm in a plot of 3.6 m x 1.8 m size. The recommended package of practices (100: 50: 50: 30) NPKS, were uniformly followed during whole experiment period to raise a successful crop. Randomly selected ten plants from each plot were taken to record the observations on plant establishment (%), plant height (cm), leaves per plant, neck thickness (cm), equatorial bulb diameter (cm), thickness (cm), equatorial bulb diameter (cm),

*Keywords: Bulb crop; NHRDF Red-3; NHRDF Red-4; Kharif and Rabi season.*
polar bulb diameter, P: E ratio, weight of 20 bulbs (kg), average bulb weight (g), days to bulb maturity, days for harvesting, doubles (%), bolters (%), total soluble solid (%), dry matter content (%), moisture (%), gross yield (q/ha), marketable yield (q/ha) and stemphylium blight intensity. The data were analysed to find out the superior genotypes for development of good quality onion varieties.

3. RESULTS AND DISCUSSION

The data of Nashik presented in Table 1 revealed that the highest plant establishment (93.15%) was recorded in advance line L-704 and found at par with the advance lines L-705, L-743, L-831 and L-872. The highest plant height (53.20 cm) was recorded in the check variety NHRDF Red-4 and was at par with the lines L-743, L-831, L-894 and check variety NHRDF Red-3. The highest number of leaves per plant (8.27) was recorded in the advance line L-870 and was at par with the advance line L-831, L-833, L-882, L-887, L-888, L-890 and check NHRDF Red-4. Thinnest neck (1.21 cm) was recorded in the check L-883 and was at par with advance lines L-704, L-711and L-872. The highest equatorial bulb diameter (4.77 cm) and was recorded in the advance line L-743 and check NHRDF Red-4 and found at par with the advance lines L-704, L-705, L-711, L-748, L-750, L-831, L-833, L-870, L-872, L-894, L-914 and check L-883. The highest polar bulb diameter (3.76 cm) was recorded in the advance line L-833 and found at par with the advance lines L-748, L-831 and L-872. The highest 20 bulb weight (1.08 kg) and average bulb weight (54.10 gm) were recorded in the check NHRDF Red-4 and found at par with all the lines except L-704, L-705, L-743, L-833 and L-872. The significant and highest bulb diameter and bulb weight was recorded in onion variety Agrifound Light Red and others advance lines. Singh [4], Mohanty [5], Patel et al. [6], Sidhu et al. [7], Singh et al. [8], Singh et al. [9] Singh et al. [10] and Singh et al. [11] reported that bulb diameter; size index and weight of bulb had correlated positively and increases the total yield.

No doubles were noted in any advance line except L-743, L-882, L-884, L-887, and L-894. Bolters were recorded nil in lines L-705, L-748, L-750, L-831, L-833, L-870, L-888, L-890, L-894 and check NHRDF Red-4. Kharif et al. [12] reported that incidence of premature bolting was significantly higher in rangda crop compared to Kharif and Rabi crop. Similarly, dark red Kharif onion cultivars were observed to be more susceptible for premature bolting than the Light Red Rabbi onion cultivar during late Kharif season Bhonde et al. [13] and Warade et al. [14]. The advance lines which showed nil and minimum bolters and doubles can be utilized for good quality onion bulb variety. Bhonde et al. [15] also recorded similar range of bolting in their study of different varieties. The highest gross yield (360.71 q/ha) and marketable yield (356.44 q/ha) were recorded in the check NHRDF Red-4 and found at par with all the advance lines except L-704, L-705, L-743, L-833 and L-872. Highest total soluble solids (12.07%) was recorded in the check NHRDF Red-3 and found at par with the advance line L-914 and check NHRDF Red-4. The highest dry matter (13.58%) was recorded in the check NHRDF Red-4 and found at par with the lines L-914 and check NHRDF Red-3. The lowest moisture (86.60%) was recorded in the check NHRDF Red-3 and found at par with all the lines except L-748, L-914 and check NHRDF Red-4. The early maturity and early harvesting were noted in the check L-883.

The data of Karnal presented in Table 2, revealed that highest plant establishment (92.92%) was observed in the advance line L-882 and found at par with the advance line L-683, L-861, L-863, L-864, L-884, L-883 and check Agrifound Dark Red. The highest number of leaves per plant (6.50) was recorded in the advance line L-653 and found at par with the advance lines L-682, L-683, L-705, L-743, L-864, L-880, L-881, L-883 and check Agrifound Dark Red. Highest equatorial bulb diameter (4.85 cm) and polar bulb diameter (4.20 cm) were recorded in the advance lines L-883 and L-683 and found at par with the advance lines L-683, L-863, L-882, L-705, L-743, L-864, L-880, L-881, L-883 and L-884. No double bulbs were observed in the advance line L-683, whereas, bolting was nil in the advance lines L-682, L-683, L-705, L-743, L-864, L-866, L-880, L-881, L-882 and L-884. Pungency is one of the important traits which considered as per the consumers preferences. It is suggested that the line which have high total soluble solid and dry matter content can be used for dehydration purpose. Similar findings were also reported by Verma et al. [16].
### Table 1. Performance of red onion genotypes against bolting behaviour at Nashik during late kharif, 2017

| Entries  | % Plant establishment | Plant height (cm) | Number of leaves/plant | Neck thickness (cm) | Equatorial bulb diameter (cm) | Polar bulb diameter (cm) | 20 bulb weight (kg) | Average bulb weight (g) | % Doubles |
|----------|-----------------------|-------------------|------------------------|---------------------|-----------------------------|--------------------------|--------------------|--------------------------|-----------|
| 704      | 93.15                 | 46.41             | 6.07                   | 1.28                | 4.68                        | 3.50                     | 0.77               | 38.37                    | 0.00      |
| 705      | 82.79                 | 44.33             | 6.53                   | 1.34                | 4.71                        | 3.49                     | 0.88               | 43.83                    | 0.00      |
| 711      | 72.75                 | 44.33             | 7.53                   | 1.29                | 4.69                        | 3.53                     | 1.06               | 52.77                    | 0.00      |
| 743      | 84.43                 | 50.33             | 7.13                   | 1.45                | 4.77                        | 3.53                     | 0.80               | 40.07                    | 0.90      |
| 748      | 71.83                 | 43.20             | 7.40                   | 1.42                | 4.65                        | 3.58                     | 1.06               | 52.97                    | 0.00      |
| 750      | 79.26                 | 48.27             | 7.00                   | 1.40                | 4.71                        | 3.54                     | 0.97               | 48.60                    | 0.00      |
| 831      | 85.33                 | 49.67             | 7.87                   | 1.44                | 4.69                        | 3.70                     | 0.99               | 49.70                    | 0.00      |
| 833      | 80.71                 | 44.13             | 7.67                   | 1.36                | 4.50                        | 3.76                     | 0.83               | 41.63                    | 0.00      |
| 870      | 80.76                 | 48.27             | 8.27                   | 1.39                | 4.65                        | 3.44                     | 0.99               | 49.70                    | 0.00      |
| 872      | 87.62                 | 42.53             | 6.27                   | 1.29                | 4.64                        | 3.64                     | 0.81               | 40.67                    | 0.00      |
| 882      | 77.86                 | 49.47             | 7.67                   | 1.39                | 4.22                        | 3.45                     | 0.99               | 49.57                    | 2.93      |
| 884      | 76.68                 | 47.27             | 7.60                   | 1.49                | 4.47                        | 3.46                     | 1.04               | 51.87                    | 0.80      |
| 887      | 67.04                 | 42.75             | 7.80                   | 1.37                | 4.53                        | 3.36                     | 1.06               | 53.20                    | 1.73      |
| 888      | 72.16                 | 45.87             | 7.67                   | 1.43                | 4.42                        | 3.52                     | 1.03               | 51.47                    | 0.00      |
| 890      | 77.26                 | 47.47             | 7.80                   | 1.45                | 4.54                        | 3.45                     | 1.05               | 52.43                    | 0.00      |
| 894      | 75.17                 | 49.87             | 7.60                   | 1.42                | 4.71                        | 3.48                     | 0.95               | 50.70                    | 2.08      |
| 914      | 76.73                 | 41.27             | 6.20                   | 1.35                | 4.64                        | 3.43                     | 1.00               | 50.03                    | 0.00      |
| NHRDF Red-3 (C) | 73.50             | 52.43             | 7.20                   | 1.32                | 4.52                        | 3.50                     | 1.06               | 52.87                    | 0.00      |
| NHRDF Red-4 (C) | 64.78             | 53.20             | 7.80                   | 1.41                | 4.77                        | 3.50                     | 1.08               | 54.10                    | 0.00      |
| L-883 (C) | 78.67             | 49.27             | 7.20                   | 1.21                | 4.72                        | 3.42                     | 1.02               | 50.87                    | 0.00      |
| S.Em± CD at % 5% | 5.21             | 1.81              | 0.36                   | 0.04                | 0.10                        | 0.10                     | 0.08               | 4.09                     | 0.10      |
| CV %     | 8.20                 | 4.71              | 5.99                   | 3.20                | 2.69                        | 3.45                     | 10.11              | 10.26                    | 28.96     |

*CD at 5%*
| Entries      | % Bolters | Gross yield (q/ha) | Marketable yield (q/ha) | % TSS | % Dry matter | Days to maturity | Days to Harvest | % Moisture |
|--------------|-----------|--------------------|-------------------------|-------|--------------|-----------------|----------------|------------|
| 704          | 1.47      | 6.95               | 255.92                  | 252.09| 9.51         | 10.88           | 107            | 117        | 89.12     |
| 705          | 0.00      | 0.00               | 292.12                  | 289.20| 10.31        | 11.58           | 97             | 111        | 88.42     |
| 711          | 0.83      | 5.24               | 351.70                  | 348.13| 9.64         | 10.94           | 91             | 107        | 89.06     |
| 743          | 0.43      | 3.77               | 267.06                  | 263.31| 10.71        | 11.91           | 83             | 97         | 88.09     |
| 748          | 0.00      | 0.00               | 353.19                  | 349.41| 11.58        | 12.83           | 102            | 118        | 87.17     |
| 750          | 0.00      | 0.00               | 323.99                  | 320.37| 9.71         | 11.05           | 84             | 98         | 88.95     |
| 831          | 0.00      | 0.00               | 331.39                  | 327.84| 8.83         | 10.02           | 98             | 115        | 89.98     |
| 833          | 0.00      | 0.00               | 277.67                  | 274.62| 10.85        | 12.20           | 98             | 115        | 87.80     |
| 870          | 0.00      | 0.00               | 331.32                  | 327.76| 9.91         | 11.17           | 102            | 115        | 88.93     |
| 872          | 0.83      | 5.24               | 271.06                  | 268.47| 9.74         | 11.01           | 90             | 105        | 88.99     |
| 882          | 4.71      | 12.49              | 330.33                  | 303.26| 9.89         | 11.17           | 82             | 95         | 88.83     |
| 884          | 1.57      | 7.19               | 345.51                  | 332.90| 9.78         | 11.04           | 82             | 95         | 88.96     |
| 887          | 3.50      | 10.78              | 354.57                  | 336.74| 9.27         | 10.51           | 82             | 97         | 89.49     |
| 888          | 0.00      | 0.00               | 343.11                  | 339.41| 9.15         | 10.45           | 92             | 105        | 89.55     |
| 890          | 0.00      | 0.00               | 349.43                  | 345.73| 10.11        | 11.52           | 95             | 107        | 88.48     |
| 894          | 0.00      | 0.00               | 337.93                  | 327.08| 10.40        | 11.70           | 95             | 107        | 88.30     |
| 914          | 4.26      | 11.85              | 333.34                  | 319.09| 11.65        | 13.02           | 87             | 101        | 86.98     |
| NHRDF Red-3  | 0.87      | 5.34               | 352.41                  | 346.78| 12.07        | 13.40           | 103            | 118        | 86.60     |
| NHRDF Red-4  | 0.00      | 0.00               | 360.71                  | 356.44| 12.02        | 13.58           | 103            | 118        | 86.42     |
| L-883 (C)    | 3.13      | 10.19              | 339.01                  | 331.04| 10.51        | 11.84           | 77             | 90         | 88.16     |
| S.Em±        | 0.29      | 0.40               | 27.26                   | 27.07 | 0.55         | 0.55            | -              | -          | 0.56      |
| CD at 5%     | 0.59      | 0.81               | 55.21                   | 54.82 | 1.11         | 1.11            | -              | -          | 1.13      |
| CV %         | 32.49     | 12.48              | 10.27                   | 10.43 | 6.61         | 5.85            | -              | -          | 0.78      |

Note: Data in the parenthesis shows arcsine transformed values.
Table 2. Performance of red onion genotypes against bolting behaviour at Karnal during late kharif, 2017

| Entries | % Plant establishment | Plant height (cm) | Number of leaves/plant | Neck thickness (cm) | Equatorial bulb diameter (cm) | Polar bulb diameter (cm) | 20 bulb weight (kg) | % Doubles |
|---------|-----------------------|-------------------|------------------------|-------------------|-------------------------------|------------------------|-------------------|-----------|
| L-653   | 53.75                 | 69.80             | 6.50                   | 1.58              | 4.75                          | 3.94                   | 0.71              | 0.63 (4.56) |
| L-682   | 64.58                 | 71.60             | 6.10                   | 1.60              | 4.28                          | 3.90                   | 0.64              | 1.56 (7.18) |
| L-683   | 88.89                 | 70.10             | 6.10                   | 1.59              | 4.85                          | 4.20                   | 0.72              | 0.00 -     |
| L-705   | 47.92                 | 69.90             | 6.00                   | 1.62              | 4.42                          | 3.85                   | 0.83              | 6.44 (14.70) |
| L-743   | 60.42                 | 67.40             | 6.20                   | 1.51              | 4.26                          | 3.78                   | 0.67              | 5.56 (13.63) |
| L-861   | 73.96                 | 66.30             | 5.70                   | 1.39              | 4.17                          | 3.69                   | 0.68              | 1.43 (6.86) |
| L-863   | 86.46                 | 62.30             | 5.80                   | 1.25              | 4.78                          | 3.77                   | 0.71              | 7.23 (15.60) |
| L-864   | 74.58                 | 66.90             | 6.10                   | 1.31              | 4.75                          | 3.70                   | 0.67              | 8.95 (17.40) |
| L-866   | 61.46                 | 70.40             | 5.90                   | 1.58              | 4.32                          | 3.89                   | 0.76              | 5.06 (12.83) |
| L-880   | 63.54                 | 70.80             | 6.20                   | 1.62              | 4.30                          | 3.77                   | 0.55              | 6.41 (14.67) |
| L-881   | 54.58                 | 68.70             | 6.40                   | 1.54              | 4.78                          | 3.88                   | 0.72              | 2.86 (9.60)  |
| L-882   | 92.92                 | 65.70             | 5.80                   | 1.24              | 4.63                          | 4.06                   | 0.76              | 2.24 (8.56)  |
| L-884   | 82.50                 | 63.20             | 5.80                   | 1.31              | 4.61                          | 3.99                   | 0.77              | 4.04 (11.60) |
| L-883   | 85.00                 | 64.50             | 6.20                   | 1.29              | 4.85                          | 4.20                   | 0.80              | 1.47 (6.86)  |
| ADR (C) | 81.67                 | 66.00             | 6.00                   | 1.37              | 4.90                          | 3.79                   | 0.71              | 10.38 (18.79)|
| S.Em±   | 6.6                   | 2.41              | 0.17                   | 0.1               | 0.21                          | 0.13                   | 0.06              | - 1.04      |
| CD at 5%| 21.95                 | NS                | 0.57                   | 0.33              | NS                            | 0.43                   | NS                | - 3.46      |
| CV %    | 10.17                 | 3.93              | 3.17                   | 7.42              | 5.07                          | 3.66                   | 8.79              | - 10.57     |

| Entries | % Bolters | Gross yield (q/ha) | Marketable yield (q/ha) | % TSS | Days to harvest | Stemphylium Blight intensity |
|---------|-----------|--------------------|--------------------------|-------|-----------------|------------------------------|
| L-653   | 0.63      | (4.56)             | 85.00                    | 67.78 | 14.67           | 110                          | 7.45              | (15.84)     |
| L-682   | 0.00      | -                  | 87.50                    | 65.28 | 14.35           | 110                          | 7.85              | (16.26)     |
| L-683   | 0.00      | -                  | 118.70                   | 96.85 | 14.18           | 110                          | 8.45              | (16.90)     |
| L-705   | 0.00      | -                  | 113.47                   | 92.22 | 14.00           | 110                          | 7.10              | (15.45)     |
| L-743   | 0.00      | -                  | 97.64                    | 75.97 | 13.83           | 110                          | 7.25              | (15.62)     |
| L-861   | 0.00      | -                  | 105.56                   | 89.44 | 14.00           | 110                          | 8.55              | (17.00)     |
| L-863   | 3.63      | (10.98)            | 181.81                   | 149.44 | 13.17          | 104                          | 7.15              | (15.51)     |
| L-864   | 0.57      | (4.35)             | 138.00                   | 102.56 | 12.17          | 104                          | 9.05              | (17.50)     |
| L-866   | 0.00      | -                  | 109.31                   | 76.25 | 14.00           | 110                          | 7.25              | (15.62)     |
|     |     |     |     |     |     |     |     |     |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| L-880 | 0.00 | 91.81 | 63.19 | 14.84 | 110 | 8.05 | (16.48) |
| L-881 | 0.00 | 78.00 | 61.11 | 15.01 | 110 | 9.40 | (17.85) |
| L-882 | 0.91 | (5.47) | 179.11 | 150.78 | 12.17 | 104 | 7.50 | (15.89) |
| L-884 | 1.01 | (5.77) | 177.17 | 154.33 | 11.84 | 104 | 7.95 | (16.36) |
| L-883 | 1.47 | (6.86) | 198.36 | 183.44 | 12.67 | 104 | 8.30 | (16.73) |
| ADR (C) | 5.15 | (13.10) | 165.06 | 116.78 | 13.34 | 104 | 7.90 | (16.32) |
| S.Em± | - | 0.47 | 10.49 | 8.42 | 0.23 | - | - | 1.01 |
| CD at 5% | - | 1.56 | 34.89 | 28 | 0.76 | - | - | NS |
| CV % | - | 15.18 | 9.00 | 9.01 | 1.85 | - | - | 13.63 |

Note-Data in the parenthesis shows arcsine transformed values
4. CONCLUSION

It is concluded from the study that the advance lines such as L-883 and NHRDF Red-4, which has highest yield can be utilized for higher yield. Regarding bolting behavior, no bolters were recorded in lines L-705, L-748, L-750, L-831, L-833, L-870, L-888, L-890, L-894 and check NHRDF Red-4, however, these lines can be utilized by onion breeder for developing good quality onion variety for different agroclimatic condition.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Singh DK, Singh L, Pandey UB. Nutritional and medicinal values of onion and garlic. NHRDF, News Letter. 2004;24(2):4-10.
2. Pandey UB. Onion (Allium cepa L.). Indian Horticulture. 1989;33-34:58-62.
3. Gupta RP, Singh RK. Onion production in India. Published by Director, National Horticultural Research and Development Foundation Chitegaon Phata, Post-Darna Sangavi, Taluka-Niphad, Dist- Nashik, Maharashtra. Malhotra Publishing House, B-6, DSIDC Complex, Kirti Nagar, New Delhi. 2010;1-88.
4. Singh L, Singh SP, Mishra PK. Evaluation of onion varieties at Karnal. Nat. Hort. Res. Develop. Foundation News Letter. 1991;6(3):3-4.
5. Mohanty BK. Genetic variability, inter relationship and path analysis in onion. J. Tropical Agriculture. 2001;39:17-20.
6. Patel RP, Prasad M, Sharma RP. Studies on inter relationship between bulb yield and important plant character of onion. Veg. Sci. 1985;12(1):7-10.
7. Sidhu AS, Singh S, Thakur MR. Variability and correlation studies in onion. Indian J. Hort. 1986;43:260-264.
8. Singh RK, Dubey BK, Bhonde SR, Gupta RP. Estimates of genetic variability, heritability and correlation in red onion (Allium cepa L.) advance lines. Indian J. Agric. Sci. 2010a;80(2):160-163.
9. Singh RK, Bhonde SR, Gupta RP. Performance studies on onion promising lines for yield and quality. Green farming. Int. J. Agric. Hort. Appl. Sci. 2010b;2(2):170-172.
10. Singh RK, Bhonde SR, Gupta RP. Studies on performance of onion (Allium cepa L.) hybrids for higher yield. Allium and Umbelliferae Improv. News Lett. 2011a;20:21-26.
11. Singh RK, Dubey BK, Singh SK, Bhonde SR. Selection of high yielding and good keeping quality variety in red onion. Prog. Hort. 2011b;43(2):243-247.
12. Khar AK, Devi A, Lawande KE. Performance studies in resealed onion varieties. Ann. Rep. NRC for Onion and Garlic. 1999;12-15.
13. Bhonde SR, Srivastava KJ, Pandey UB. Evaluation of varieties growing ‘rangda’ crop of onion (Allium cepa L) in Nashik area of Maharashtra. Maharashtra J. Hort. 1992;6(2):39-42.
14. Warade SD, Desale SB, Shinde KG. Evaluation of onion cultivars for yield and storability for ragada season. J. Maharashtra Agric. Univ. 1996;21(1):48-49.
15. Bhonde SR, Shrivastava KJ, Singh KN. Evaluation of varieties for late Kharif (Rangda) crop of onion in Nashik area. Associated Agricultural Development Foundation News Letter. 1991;12(1):1-2.
16. Verma LR, Pandey UB, Bhonde SR, Shrivastava KJ. Quality evaluation of different onion varieties for dehydration. NHRDF News Letter. 1999;19(2&3):1-6.

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