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## Assessment of growth, yield and quality of onion genotypes under red and laterite zone of West Bengal

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### Abstract

The experiment was conducted at the Horticulture Farm of Institute of Agriculture, Sriniketan. Twenty four short day onion cultivars were assessed in randomized block design with three replications. The observations on various traits were recorded from ten randomly selected competitive plants in each treatment and replication. Data recorded on plant height, number of leaves, leaf length, leaf diameter and neck diameter in three occasions (30, 60 and 90 days after transplanting). Bulb polar diameter, equatorial diameter, bulb weight, no of rings, TSS, total sugar and reducing sugar was taken after harvesting of bulb. Bulb yield per hectare was computed from the yield obtained per plot. Thus, the top performing varieties were found Bhima Shakti, Kadam (F<sub>1</sub>), N-53, Indam Gulab, Bhima Shweta and Sukhsagar. It may be assumed that Sukhsagar has well adaptability in entire West Bengal and thus performed well. Other five identified varieties, excluding Sukhsagar, were also equally good. Among them Kadam (F<sub>1</sub>) and Indam Gulab were from private seed companies. Farmers may not have easy access to the seed material. Again, as these varieties are F<sub>1</sub> hybrid, farmers would not be able to multiply the seeds of their own. Thus, rest three cultivars, N- 53, Bhima Shweta and Bhima Shakti may be the other option to the onion growers of this region. However, N- 53 is a Kharif season cultivar. Again, it is an old cultivar and in many areas it was replaced by new varieties. Finally, Bhima Shakti and Bhima Shweta with their production level of 24.21 and 21.23 t ha<sup>-1</sup> respectively. Onion cultivars Bhima Shakti and Bhima Shweta along with Sukhsagar may be suggested to the onion grower of Red and Laterite Zone of West Bengal during *rabi* season for higher productivity.

**Keywords:** yield, quality of onion, genotypes

### Introduction

Onion (*Allium cepa* L.) is one of the most important commercial vegetable crops grown throughout the world. It is said to be native of Central Asia and Mediterranean region. It is a monocot and belongs to the economically important family *Alliaceae*, sub-family *Allioideae*, and order *Asparagales* having chromosome number, 2n=16. There are different types of onion, viz., Bulb onions, Multiplier onions, Shallot (most of the types in the markets are *Allium cepa*), Potato onion, Yellow onion, Sweet onion, Welsh onion, Tree onions or Egyptian onions. It also known as Piyaz (Urdu) locally. It is an indispensable item in every kitchen as vegetable and condiment used to flavor many of the food stuffs. Therefore, onion is popularly referred as "Queen of Kitchen". Onion bulb and greens both are rich in vitamin C, potassium, dietary fibre, minerals and folic acid. It also contains calcium, iron and has a high protein quality and is low in sodium and no fat content. It used for cuisine, *salad* and culinary purpose or in preserved form. The nutritive value of the onion vary with varieties and generally 100g of edible bulb portion contain moisture (86.8 g), carbohydrates (11.0 g), protein (1.2 g), fiber (0.6 g) and mineral like calcium (180 mg), phosphorus (50 mg) and iron (0.7 mg); potassium, dietary fibre, minerals and folic acid, nicotinic acid (0.4 mg) and trace of thiamine. Onions have always held a place in folklore and folk medicine, but recently biochemists have revealed its anti-bacterial properties, particularly against *Helicobacter pylori*, the ulcer-forming microorganism. Besides, the more pungent onions exhibit strong anti-platelet and blood thinning activities in human blood, potentially adding protection against arteriosclerosis, cardiovascular disease, stroke, diabetes, osteoporosis and heart attack. Globally China stands first in production (226.00 lakh MT) and second in area (10.25 lakh hectares) of onion. India is the second largest producer of onion in the world and occupies 8.34 million hectare area with a production of 13565.0 MT and productivity of 16.3 MT/ha. In productivity Gujarat is the leading state followed by Haryana, Karnataka, Andhra Pradesh, Madhya Pradesh and Chhattisgarh. However, in Maharashtra stands first in area (4.68 lakh ha) and in production (58.64 lakh tones) of onions with a productivity of 12.5 MT/ha (NHB, 2015). In West Bengal area coverage of onion is 31.90 lakh ha with production of 63.46 lakh tones and productivity

of 19.89 t/ha (NHRDF, 2016).

During 2014-2015, 1086071.85MT of onion exported worth Rs 200994.53 lakhs (NHRDF, 2016).

### Materials and Methods

The experiment was conducted at the Horticulture Farm of Institute of Agriculture, Sriniketan. Twenty four short day onion cultivars were assessed in randomized block design with three replications. The observations on various traits were recorded from ten randomly selected competitive plants in each treatment and replication. Data recorded on plant height, number of leaves, leaf length, leaf diameter and neck diameter in three occasions (30, 60 and 90 days after transplanting). Bulb polar diameter, equatorial diameter, bulb weight, no of rings, TSS, total sugar and reducing sugar was taken after harvesting of bulb. Bulb yield per hectare was computed from the yield obtained per plot.

#### Details of Treatments

Sl. No	Variety	Sl. No	Variety
V <sub>1</sub>	Pusa Madhavi	V <sub>13</sub>	NHRDF Red 2
V <sub>2</sub>	Pusa Ridhi	V <sub>14</sub>	NHRDF Red 3
V <sub>3</sub>	Pusa White Flat	V <sub>15</sub>	Bhima Shakti
V <sub>4</sub>	Pusa White Round	V <sub>16</sub>	Bhima Kiran
V <sub>5</sub>	Sel-126	V <sub>17</sub>	Bhima Shweta
V <sub>6</sub>	Early Grano	V <sub>18</sub>	Agrifound Dark Red
V <sub>7</sub>	Arka Kalyan	V <sub>19</sub>	Agrifound Light Red
V <sub>8</sub>	Arka Niketan	V <sub>20</sub>	Sukhsagar
V <sub>9</sub>	Arka Kirtiman	V <sub>21</sub>	Superior Light Red
V <sub>10</sub>	Arka Pragati	V <sub>22</sub>	Kadam (F <sub>1</sub> )
V <sub>11</sub>	N-53	V <sub>23</sub>	Indam Gulab
V <sub>12</sub>	NHRDF Red	V <sub>24</sub>	Indam-4(F <sub>1</sub> )

### Growth parameters

#### Plant height (cm)

The plant height was measured from soil surface up to the tip of fully opened leaves with the help of measuring scale and average was worked out. Height of the five randomly selected and tagged plant was measured at 30, 60, 90 days after transplanting and at harvesting stage.

#### Number of leaves per plant

The number of leaves per plant was counted in five randomly selected and tagged plants at 30, 60, 90 days after transplanting.

#### Leaf length (cm)

The average length of leaves per plant in all five randomly selected and labeled plants were recorded at 30, 60 and 90 days after sowing and mean was computed and expressed in centimeters (cm).

#### Leaf diameter (mm)

The diameter of leaf for five plants were recorded in centimeter at the centre of leaf, when holds horizontally and the average width of leaf was worked out at 30, 60 and 90 days after sowing, and expressed in millimeter (mm).

#### Neck diameter (mm)

The neck diameter below the joint of leaf lamina for five plants was measured with the help of Vernier caliper at 30, 60 and 90 days after sowing, averaged and the measurements were expressed in millimeter (mm).

### Yield parameters and yield

#### Polar diameter of bulb (mm)

The polar diameter of ten bulbs from each plot was measured

by using vernier caliper at harvesting stage. Average were worked out and expressed in millimeter.

#### Equatorial diameter of bulb (mm)

The equatorial diameter of ten bulbs from each plot was measured by using vernier caliper at harvesting stage and the means were worked out and expressed in millimeter.

#### Number of rings

The number of rings was calculated by cutting the bulb horizontally from five individual bulb taken from each plot.

#### Average weight of bulb (g)

To calculate the average weight of bulb in each plot, five plants were randomly selected and weighed on electronic balance after cutting the leaves from 2-2.5 cm above the neck. Finally, average weight of bulb in each plot was calculated in grams.

#### Total yield of bulb (t ha<sup>-1</sup>)

After cutting the leaves (2-2.5 cm above the neck), bulbs were weighed on electronic balance and bulb yield per net plot was recorded in kilogram which was converted into tone per hectare as given below:

$$\text{Bulb yield (t ha}^{-1}\text{)} = \frac{\text{Bulb yield (kg/plot)} \times 10,000}{\text{Net area of plot (m}^2\text{)} \times 100 \times 10}$$

### Quality parameters

#### T.S.S. of bulb (<sup>o</sup>Brix)

Total soluble solid content of five randomly selected bulbs of each plot was determined with the help of hand refractometer at the time of harvesting of bulbs. Thereafter, averages were calculated for each treatment.

#### Total sugars content (%)

5gm Sample was crushed with little distilled water. 5ml juice was collected after straining and 2-3 drop of concentrated HCl was added. Sample was heated for 2 minute until slight colour changed. Sample was cooled and 1N NaOH was added to neutralize the sample (neutralization was confirmed by checking the solution with the litmus paper). Volume made up to 50 ml with distilled water. Fehling solution was prepared by adding 2 ml Fehling A, 2 ml Fehling B and 15 ml distilled water. Fehling solution was heat titrated with the sample after adding 2-3 drop of methylene Blue indicator. End point was noted when brick red colour material precipitated.

$$\text{Reducing sugar (\%)} \text{ in the juice (i.e. g of glucose/100 g of juice)} = \frac{20}{x}$$

Where, x= burette reading

#### Reducing sugar (%)

5gm Sample was crushed with little distilled water. 5ml juice was collected after straining and volume made up to 50 ml with distilled water. Fehling solution was prepared by adding 2 ml Fehling A, 2 ml Fehling B and 15 ml distilled water. Fehling solution was heat titrated with the sample after adding 2-3 drop of 1% phenolphthalein indicator. End point was noted when brick red colour material precipitated.

$$\text{Reducing sugar (\%)} \text{ in the juice (i.e. g of glucose/100 g of juice)} = \frac{20}{x}$$

Where, x= burette reading

## Results and Discussion

### Plant height

The data revealed that the plant height was significantly differed among onion varieties at 30, 60, and 90 days after transplanting (Table No.1).

The range of plant height at 30 DAT was 45.4 cm to 31.0 cm. Maximum plant height was recorded in Bhima Shakti (45.4 cm) followed by N-53 (44.6 cm), Early Grano (43.7 cm), Sel-126 (43.6 cm), Bhima Shweta (42.5 cm), Sukhsagar (42.2 cm), Kadam (F<sub>1</sub>) (41.6 cm), Pusa Ridhi (40.8 cm), Agrifound Dark Red (40.5 cm), Indam Gulab (40.4 cm), Agrifound Light Red (40.3 cm), Bhima Kiran (40.2 cm) and Pusa White Flat (37.6 cm). These cultivars were statistically at par with each other.

The range of plant height at 60 DAT was 74.0 cm to 61.0 cm. The maximum plant height was recorded in variety Bhima Shakti (74.0 cm) followed by Bhima Shweta (73.8 cm), Bhima K iran (72.0 cm), N-53 (71.1 cm), Agrifound Light Red (70.6 cm), Kadam (F<sub>1</sub>) (69.6 cm), Early Grano (69.4 cm), NHRDF Red (69.3 cm), Arka Kalyan (68.4 cm), Arka Pragati (68.3 cm), Sel-126 (67.6 cm), Sukhsagar (66.8 cm) and Arka Niketan (66.7 cm). These cultivars were statistically at par with each other.

The range of plant height at 90 DAT was 80.2 cm to 68.6 cm. The result revealed that the maximum plant height was recorded in Arka Pragati (80.2 cm) followed by Early Grano (78.6 cm), Indam-4(F<sub>1</sub>) (78.3 cm), NHRDF Red 2 (78.0 cm), Bhima Shakti (77.4 cm), Bhima Kiran (76.8 cm), Arka Kirtiman (76.7 cm), Arka Kalyan (76.6 cm), Bhima Shweta (76.5 cm), Agrifound Light Red (75.9 cm), NHRDF Red 3 (73.9 cm) and Kadam (F<sub>1</sub>)(73.7 cm). These cultivars were statistically at par with each other.

The variation in plant height among different cultivars may be due to their different genetic makeup and adaptation ability to a particular environment (Khan *et al.*, 2001). The variation in plant height also reported by Qureshi *et al.* (2004), Jilani *et al.* (2010)<sup>[8]</sup>, Chandrika and Reddy (2011), Dewangan and Sahu (2011), Shah *et al.* (2012)<sup>[13]</sup>, Azoom *et al.* (2014)<sup>[4]</sup> and Hirave *et al.* (2015)<sup>[6]</sup>.

### Number of leaves /plant

The number of leaves is an important yield component as leaves through photosynthesis make food and transfer it down to stores it in the bulbs. The data presented in the Table No. 1 revealed that the number of leaves per plant was significantly differing among different onion varieties at 30 and 60 days after transplanting (DAT). However, at 90 DAT the genotypes were found statistically at par with each other.

The range of number of leaves per plant at 30 DAT was 5.7 to 4.7. The maximum number of leaves per plant was recorded in variety Kadam (F<sub>1</sub>) (5.7) followed by N-53 (5.5), Indam Gulab (5.5), Indam-4(F<sub>1</sub>) (5.5), Pusa White Round (5.4), Early Grano (5.4), Arka Kalyan (5.4), Bhima Kiran (5.4), Sukhsagar (5.4), Pusa Madhavi (5.3), Pusa Ridhi (5.3), Sel-126 (5.3), Bhima Shakti (5.3), Bhima Shweta (5.3), Agrifound Dark Red (5.3), Arka Pragati (5.1), NHRDF Red (5.1), NHRDF Red 3 (5.1), which were statistically at par with each other.

The range of number of leaves per plant at 60 DAT was 8.6 to 6.1. The maximum number of leaves per plant was recorded in variety Arka Kirtiman (8.6) followed by Arka Kalyan (8.2), however, all treatments were statistically at par with each other.

Similar results were reported by Jilani *et al.* (2010)<sup>[8]</sup>, Shah *et al.* (2012)<sup>[13]</sup>, Azoom *et al.* (2014)<sup>[4]</sup>, Tripathy *et al.* (2014)

<sup>[15]</sup>, Hirave *et al.* (2015)<sup>[6]</sup>.

### Leaf length

The mean length of leaves recorded for each cultivar has been presented in Table No. 1. The results from analysis of variance showed that leaf length was significantly differed among cultivars at 30, 60, and 90 days after transplanting. At 30 DAT the leaf length varied from 40.7 cm to 29.1 cm. The maximum leaf length (40.7 cm) was noted in Bhima Shakti followed by Bhima Shweta (40.3cm), N-53 (4.1 cm), Sel-126 (39.7 cm), Early Grano (39.0 cm), Pusa Ridhi (38.1 cm), Kadam (F<sub>1</sub>) (37.8 cm), Pusa White Round (37.6 cm), Sukhsagar (37.3 cm), Agrifound Dark Red (37.2 cm) and Indam Gulab (36.6 cm), which were statistically at par with each other.

At 60 DAT the leaf length among the genotypes was found not significant.

At 90 DAT the leaf length varied from 62.0 cm to 49.4 cm. The maximum leaf length was noted in Early Grano (62.0 cm) followed by Arka Kirtiman (60.4 cm), NHRDF Red 2 (60.3 cm), Arka Pragati (60.2 cm), Bhima Kiran (59.9 cm), Indam-4(F<sub>1</sub>) (58.4 cm), Bhima Shakti (58.3 cm), Arka Kalyan (58.2 cm), Bhima Shweta (57.6 cm) and N-53 (57.5 cm), which were noted statistically at par with each other. The variation in leaf length might be due to the genetical variation among different onion cultivars. Similar result was also reported by Jilani *et al.* (2010)<sup>[8]</sup>, Shah *et al.* (2012)<sup>[13]</sup>, Azoom *et al.* (2014)<sup>[4]</sup>.

### Leaf diameter

The data on leaf diameter has been taken at 30, 60, and 90 days after transplanting has been presented in Table No. 1.

The mean leaf diameter of onion plant at 30 DAT was ranged from 7.6 to 4.7 mm. The maximum leaf diameter was recorded in variety N-53 (7.6 mm) followed by Kadam (F<sub>1</sub>) (7.3 mm), Bhima Shakti (7.2 mm), Sel-126 (7.1 mm), Pusa White Round (6.9 mm), Agrifound Light Red (6.8 mm), Early Grano (6.7 mm), Bhima Kiran (6.6 mm), Agrifound Dark Red (6.6 mm), Indam Gulab (6.6 mm) and Bhima Shweta (6.5 mm), which were statistically at par with each other.

The mean leaf diameter of plant at 60 DAT was ranged from 12.7 to 9.1 mm. The maximum leaf diameter was recorded in variety Bhima Shakti (12.7 mm) followed by Bhima Shweta (12.0 mm), Pusa White Round (11.7 mm), Kadam (F<sub>1</sub>) (11.7 mm), Pusa Madhavi (11.5 mm), Bhima Kiran (11.5 mm) and Agrifound Light Red (11.2 mm), which were statistically at par with each other.

The mean leaf diameter of plant at 90 DAT was ranged from 11.8 to 9.7 mm. The maximum leaf diameter was recorded in variety Bhima Shweta (11.8 mm) followed by Bhima Shakti (11.5 mm), N-53 (11.4 mm), Arka Kalyan (11.3 mm), Pusa White Round (11.1 mm), NHRDF Red 2 (10.9 mm), Bhima Kiran (10.9 mm), Agrifound Dark Red (10.9 mm), Sukhsagar (10.9 mm), Kadam (F<sub>1</sub>) (10.9 mm), Pusa Ridhi (10.8 mm), Indam-4 (F<sub>1</sub>) (10.8 mm), Pusa Madhavi (10.7 mm), NHRDF Red (10.7 mm). The difference in leaf diameter among these cultivars may be due their varied genetic architecture. Dewangan and Sahu (2011) reported the similar result.

### Neck diameter

The thickness of leaves recorded in different genotypes has been presented in Table No. 1. The range of neck diameter at 30 DAT was 7.7 mm to 5.3 mm. The maximum neck diameter was recorded in variety Bhima Shakti (7.7 mm) followed by N-53 (7.5 mm), Kadam (F<sub>1</sub>) (7.3 mm), Bhima Kiran (7.3

mm), Pusa White Round (7.2 mm), Sel-126 (7.0 mm), Agrifound Dark Red (6.9 mm), Bhima Shweta (6.8 mm), Agrifound Light Red (6.8 mm), Sukhsagar (6.8 mm), Early Grano (6.8 mm), Pusa Madhavi (6.6 mm), Pusa Ridhi (6.6 mm), Arka Kalyan (6.6 mm), Indam Gulab (6.6 mm) and Indam-4(F<sub>1</sub>) (6.5 mm), which were statistically at par with each other.

The range of neck diameter at 60 DAT was 14.6 mm to 10.3 mm. The maximum neck diameter was recorded in variety Bhima Shakti (14.6 mm) followed by Bhima Shweta (14.5 mm), Pusa Madhavi (14.3 mm), Kadam (F<sub>1</sub>) (13.9 mm), Early Grano (13.8 mm), Agrifound Light Red (13.7 mm), Pusa White Round (13.7 mm), Bhima Kiran (13.7 mm), N-53 (13.4 mm), Pusa Ridhi (13.1 mm), Arka Kalyan (12.6 mm) and Pusa White Flat (12.6 mm), which were statistically at par with each other.

At 90 DAT the neck diameter was found statistically not significant.

Variation in neck diameter in onion also reported by Singh *et al.* (2011) [14], Pardesi and Wasker (2012) [11], Hirave *et al.* (2015) [6].

#### Polar diameter of bulb

The data on polar diameter of bulb recorded in different genotypes has been presented in Table No. 2. The polar diameter of bulb varied from 55.4 to 36.9 mm. The result indicated that the maximum polar diameter was recorded in Sukhsagar (55.4 mm), which was statistically superior to other genotypes. Similar result was reported by Singh *et al.* (2011) [14], Dewangan and Sahu (2011) Addai *et al.* (2014) [1] and Tripathy *et al.* (2014) [15].

#### Equatorial diameter of bulb

Data on equatorial diameter has presented in Table No. 2. The equatorial diameter of bulb varied from 57.5 to 43.3 mm. Maximum equatorial diameter recorded in variety Bhima Shakti (57.5 mm) followed by N-53 (55.6 mm), which were statistically at par with each other. Similar finding was also reported by Dewangan and Sahu (2011) Addai *et al.* (2014) [1] and Tripathy *et al.* (2014) [15].

#### Average bulb weight

Bulb weight is an important yield attributing character. Bulb weight of onion varieties differed significantly among each other (Table No. 2). Average bulb weight of all genotypes under study ranged from 82.5 to 50.2 g. The maximum weight of bulb recorded in variety Arka Pragati (82.5 g) followed by Bhima Kiran (75.7 g) and Sukhsagar (74.3 g), which were statistically at par with each other. Bulb weight variation among different cultivars of onion has been reported by Singh *et al.* (2011) [14] and Tripathy *et al.* (2014) [15].

#### Bulb Yield

Onion bulbs yield was significantly differed among the varieties (Table No. 2). The total bulb yield varied from 24.21 to 17.78 t/ha. Maximum total yield was recorded in Bhima Shakti (24.21 t/ha) followed by Kadam (F<sub>1</sub>) (22.00 t/ha), N-53 (21.95 t/ha), Indam Gulab (21.72 t/ha), Bhima Shweta (21.23 t/ha) and Sukhsagar (21.09 t/ha), which were statistically at par with each other. Variation in yield among different onion varieties was reported by Singh *et al.* (2011) [14], Shah *et al.* (2012) [13] and Hirave *et al.* (2015) [6].

#### Number of rings

Number of rings has been significantly differed among the

onion varieties at harvest (Table No. 2). Average number of rings of all genotypes under study ranged from 10.0 to 7.3. The maximum number of rings recorded in variety Arka Pragati and Agrifound Light Red (10.00) followed by Pusa Madhavi (9.7), Arka Kalyan (9.7), NHRDF Red 3 (9.7), Sukhsagar (9.3), Superior Light Red (9.3), Indam-4(F<sub>1</sub>) (9.3), Pusa White Round (9.3), Arka Niketan (9.0), NHRDF Red 2 (9.0), Bhima Shweta (9.0), Kadam (F<sub>1</sub>) (9.0), Indam Gulab (9.0) and Pusa White Flat (8.7), which were statistically at par with each other.

#### TSS

The Total Soluble Solids (TSS) of onion bulb recorded for each genotypes has been presented in Table No. 2. The TSS of onion bulb ranged from 14.83 to 7.10 °B. The maximum TSS was noted in Sel-126 (14.83 °B) followed by NHRDF Red 2 (12.63 °B) and Arka Niketan (12.43 °B), which were statistically at par with each other.

Similar finding were also reported by Jadhav *et al.* (1990) the highest TSS content (14.8 %) obtained in N 257-9-1 during rabi season, Yadav *et al.* (2010) [16] and Dewangan and Sahu (2011).

#### Total Sugar

The total sugar of onion bulb recorded for each genotype has been presented in Table No. 2. The total sugar of onion bulb ranged from 6.92 to 4.06 (%). The maximum total sugar was noted in NHRDF Red 3 (6.92 %) followed by Sel-126 (6.46 %), Pusa Madhavi (6.70 %), Agrifound Light Red (6.69 %), NHRDF Red (6.67 %), Pusa Ridhi (6.46 %), Sukhsagar (6.32 %), Agrifound Dark Red (5.93 %), Bhima Kiran (5.92 %), N-53 (5.87 %), Bhima Shakti (5.71 %), Superior Light Red (5.66 %), NHRDF Red 2 (5.65 %) and Bhima Shweta (5.59 %), which were statistically at par with each other.

Similar finding were also reported by Quadir and Boulton (2001).

#### Reducing Sugar

The reducing sugar of onion bulb recorded for each genotypes have been presented in Table No. 2. The reducing sugar of onion bulb ranged from 1.96 to 1.10 (%). The maximum reducing sugar was noted in Bhima Shakti (1.96 %) followed by Sukhsagar (1.93 %), Bhima Kiran (1.88 %), Pusa Ridhi (1.88%), Arka Niketan (1.86 %), NHRDF Red 2 (1.78 %), NHRDF Red 3 (1.76 %) and Pusa White Round (1.70%), which were statistically at par with each other.

#### Conclusion

Onion cultivars Bhima Shakti and Bhima Shweta along with Sukhsagar may be suggested to the onion grower of Red and Laterite Zone of West Bengal during rabi season for higher productivity.

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