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Performances of some onion (*Allium cepa* L.) cultivars for set production

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ABSTRACT

Eight Kharif onion cultivars (Agrifound Dark Red, Bhima Shakti, Bhima Super, Bhima Raj, Bhima Shubhra, Bhima Shweta, Bhima Dark Red and Baswant-780) were tested for their set / bulblet production ability during spring-summer season of 2016. Considerable varietal difference was noticed for all the studied characters. Growth parameters for almost all the cultivars increased steadily up to 90 days and then started decreasing. Set diameter (both polar and equatorial) was increased as days advanced. All the cultivars produced more number of small sized sets than medium and large sized, though their proportion varied. The cultivars, Baswant-780, Bhima Shweta and Bhima Shrubha recorded maximum set diameter, average set weight and number and weight of total sets. These three cultivars may be selected for producing sets / bulblets for green onion or mature bulb during Kharif season under Red and Laterite Zone of West Bengal.

***Keywords*:** Onion cultivar, set, yield

Onion (*Allium cepa* L.) is an important vegetable as well as spice crop. It can be grown from seeds or from sets or bulbs. Sets or bulblets are small, dry onion bulbs that have been produced from very thickly growing of onion seeds (Khokhar *et al.,* 2002). Early stages of growth and development of onion seedlings are very slow compare to onion set (Ansary *et al.,* 2009). Sets are, therefore, used for early production of green onion or mature bulbs. The sets can be successfully used as an alternative of nursery seedlings, better plant vigour or crop stand than the seedlings. It is also possible to have more uniform spacing using sets than seeds which results in more uniform bulbs. Sets also offer earliest harvest and early yield as compared to propagation by seedlings (Nayee *et al.,* 2009). Thus, there may be a price advantage if the bulbs are sold early in the market. Patil *et al.* (2009) demonstrated a successful *Kharif* onion cultivation *via* set plantation with reasonably good bulb yield potential from the shortest span of 62-73 days which otherwise normally required for seedling nursery.

West Bengal is an onion deficit state. In India, the share of Maharashtra (the leading onion producing state) in the total onion production is around 31.19 per cent in contrast to West Bengal contributing only 2.6 per cent (Department of Agriculture, Cooperation and Farmers Welfare, 2017). In West Bengal, its own produced onion mostly gets emptied by around August to September. Coinciding with the shortage, the prices of onion also tend to peak from September onwards. As West Bengal produces mostly *Rabi* crop, the State extremely depends upon supply from other States during its lean period. This situation leads to explore the scope of *Kharif* onion cultivation in this State (Dhar *et al.,* 2016). West Bengal, thus adopted the strategy for production of onion in *Kharif* and Late *Kharif* season to have continuous supply of onion round the year and thus to minimize dependency on supply of onion from other States. Exploitation of scope of *Kharif* onion in uplands of West Bengal particularly in the western Red and Laterite Zone is a good option as the average productivity of Upland Paddy in this region is very poor which is comparatively less remunerative than *Kharif* onion (Dhar *et al.,* 2016). Previous study also indicated the suitability of *Kharif* onion cultivation under Red and Laterite Zone of West Bengal (Mohanta and Mandal, 2014, Mandal *et al.,* 2015 and Meher *et al.,* 2016).

West Bengal receives heavy downpour at monsoon that make difficulties to raise *Kharif* onion seedlings during June-July months. On the same time, availability of healthy, disease free seedlings is a critical factor for growing onion in *Kharif* season. Green and bulb production of onion during *Kharif* season using sets or small bulblets may be tried in this region. Cultivars reaction to produce set was various (Ansary, 2007). Cultivars variation also noted for green onion and mature bulb production using sets (Khokhar *et al.,* 2001; Ansari *et al.,* 2009) Growing *Kharif* onion through sets or small bulblets as an alternative strategy thus felt necessary under such situation. With this idea a research programme has been conducted with the objective to study the set or bulblet production ability of some *Kharif* onion cultivars under this region. This was the first study on set or bulblet production of *Kharif* onion in this region.

MATERIALS AND METHODS

The experiment was conducted at the Horticulture Farm of Palli Siksha Bhavana (Institute of Agriculture), Visva-Bharati, Sriniketan, West Bengal during spring-

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summer season of 2016. The experimental site was situated in the sub-humid, subtropical laterite belt of West Bengal in the eastern part of India that experiences hot summer and moderately cold and short winter. The meteorological data during the crop season of this experiment (January, 2016 to June, 2016) was obtained from nearby Meteorological Observatory Centre, Government of India, Sriniketan (Fig. 1). The soil of the experimental site was loamy in texture with 5.8 pH and 0.43 % organic carbon. The available phosphorus content was 34.9 kg $ha^{-1}$and available potassium content was 302.7 kg ha^{-1}. Eight *Kharif* onion cultivars (Agrifound Dark Red, Bhima Shakti, Bhima Super, Bhima Raj, Bhima Shubhra, Bhima Shweta, Bhima Dark Red and Baswant-780) were grown in a Randomized Block Design with three replications. The plot size was kept 2.2 × 1m. Ten grams seeds were sown per plot. Seeds were treated with carbendazim @ 2g kg^{-1} of seed before sowing. Line Sowing was done keeping 5cm spacing between the rows. Sowing was done on 7th January 2016. FYM @ 10 t ha^{-1} and N:P:K @ 125:100:100 kg ha^{-1} were applied to raise the crop. Nitrogen, phosphorus and potassium were applied in the form of urea, single super phosphate and muriate of potash. Commercial micronutrient mixture (boron + zinc + molybdenum) was sprayed twice (45 and 75 DAS). Standard intercultural operations were adopted during the crop growing period to ensure proper growth and development of the plants. Irrigation was done when required. Ten plants were selected at random in each plot to record the observations on plant height (cm), leaf number and neck diameter (mm) at 45, 60, 75, 90, 105, 120, 135 and 150 days after sowing. Set or bulblet polar and equatorial diameter was recorded at 120, 135, 150 and 165 days after sowing. Number of onion sets harvested sqm^{-1} and weight of onion sets harvested sqm^{-1} (g) was recorded after harvest. Average set weight (g) of each cultivar was recorded from randomly selected ten harvested sets. Total Soluble Solids (TSS; ^{0}Brix) of the sets was determined after removal of outer skin, maceration of the flesh and putting the obtained juice in hand refractometer (Pocket Refractometer PAL 1, Atago, Tokyo; *www.atago.net/*). The mean values of various traits thus obtained were subjected to statistical analysis. The total variation for different treatments was tested for significance by "F" test using analysis of variance technique following the model suggested by Panse and Sukhatme (1954).

RESULTS AND DISCUSSION

The analysis of variance of eight onion cultivars revealed that the mean sum of squares due to cultivars for the various growth, yield attributes and yield were significant (except for number of leaves and neck diameter at 75 DAS) which indicate the presence of considerable variation among the cultivars for different traits.

Plant height

The plant height is one of the very important parameter influencing the performance of cultivars in terms of growth, vigour and survival in the field. Marketable yield in onion was significantly and positively correlated with plant height (Singh *et al.*, 2011). Data on plant height has been presented in fig. 2. At 45 days after planting, maximum plant height was observed in Bhima Shweta, Bhima Shubhra and Bhima Dark Red. At 60 days after sowing, it was observed that the cultivar Bhima Shweta continued as maximum in plant height (30.12cm), followed by the cultivar Bhima Dark Red, Baswant-780, Bhima Shubhra and Bhima Raj. At 75 days after planting, cultivar Bhima Shweta had the maximum plant height followed by Bhima Shubhra, Bhima Shakti, Bhima Raj and Bhima Dark Red. At 90 days, Bhima Raj being the maximum in its height, followed by Bhima Shakti, Bhima Dark Red, Bhima Shweta, Bhima Super and Baswant-780. At 105 days after planting, Bhima Shweta showed maximum plant height followed by Bhima Shubhra, Baswant-780, Bhima Dark Red, Bhima Raj and Agrifound Dark Red. At 120 days, Bhima Dark Red was found to have maximum plant height followed by Bhima Raj, Bhima Shubhra, Baswant-780 and Bhima Shweta. At 135 days after planting, Bhima Dark Red still continues to have maximum plant height followed by Bhima Shweta, Bhima Shubhra and Baswant-780. At 150 days after planting Bhima Dark Red continued to have the maximum plant height with mean of 14.18 cm and the other cultivars being almost dried up. Mean data revealed that plant height was increased steadily up to 90 days and then started decreasing. This might be due to the proceeding of the plants towards senescence. At 150 days after sowing almost all the plants of all the cultivars dried up indicated ready for harvesting. Mohanta and Mandal (2014) and Ansary (2007) also reported cultivar variation in plant height of onion.

Number of leaves

The number of leaves in the eight cultivars were observed and counted starting from 45 days after sowing till 150 days (Fig. 3). At 45 days, it was observed that except Bhima Raj all the cultivars were similar for this trait. At 60 days, the cultivar Bhima Dark Red showed maximum number of leaves (2.84) than the other cultivars. At 75 days, all the cultivars were noticed similar for leaf numbers with mean value of 2.86. At 90 days, maximum leaf number was found in the cultivar Bhima Shweta with a mean of 2.96. At 105 days, the cultivar Bhima Shweta continued to have the maximum number

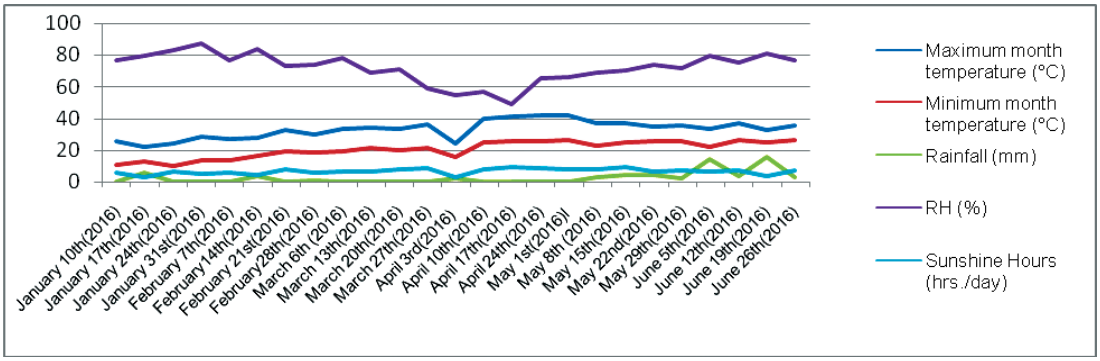

Fig. 1: Meteorological data taken during the crop growing period

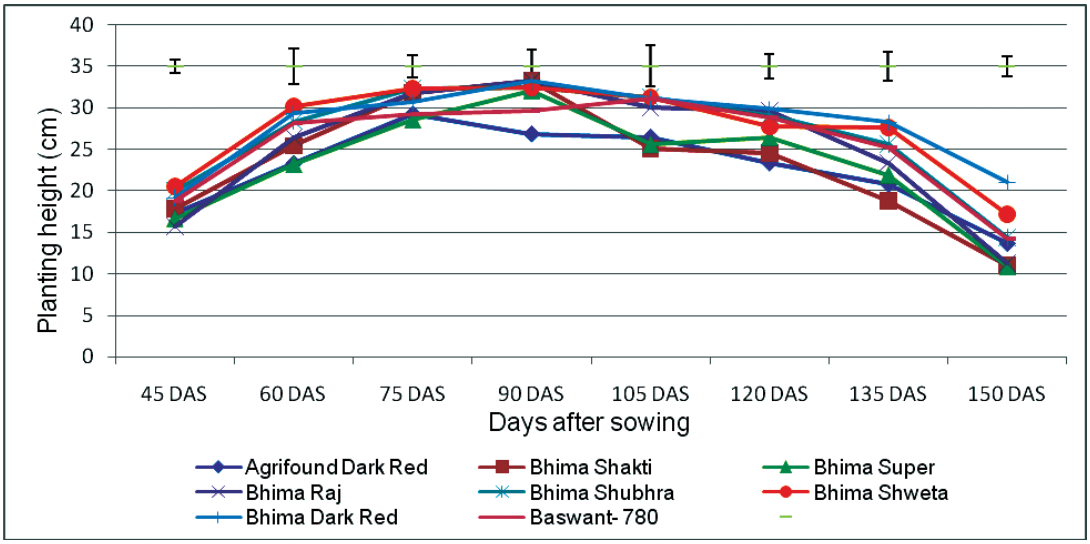

Fig. 2: Plant height (cm) of onion cultivars at different days after sowing

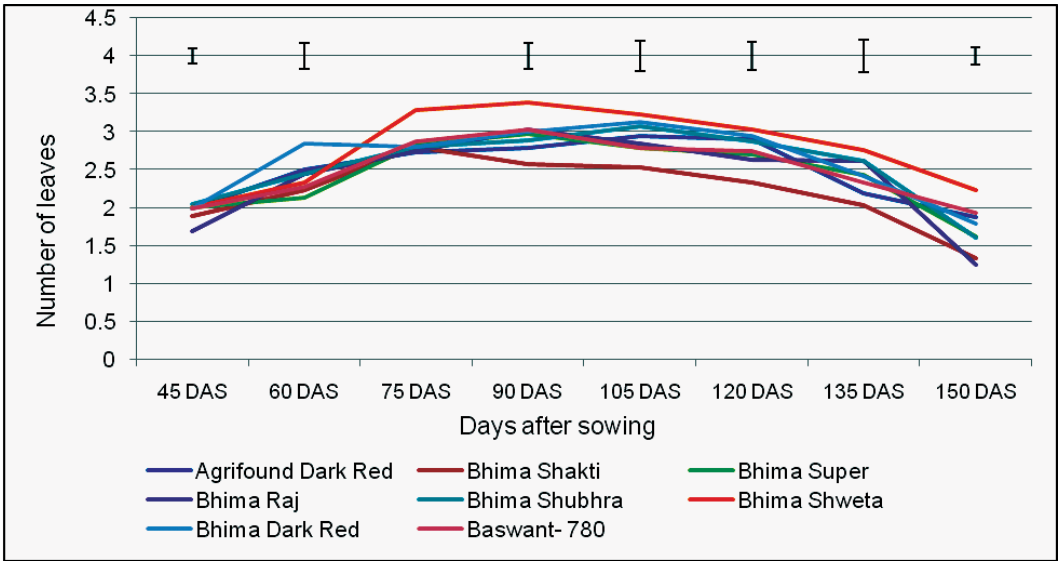

Fig. 3: Number of leaves of onion cultivars at different days after sowing

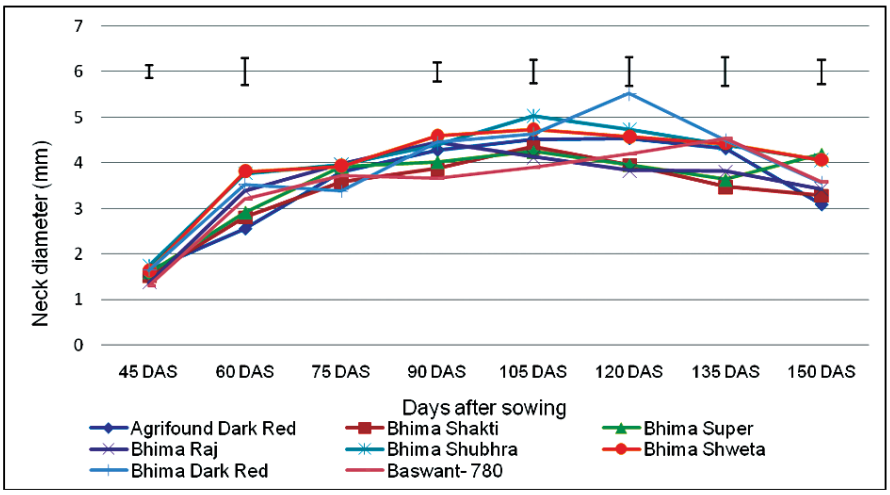

Fig. 4: Neck diameter (mm) of onion cultivars at different days after sowing

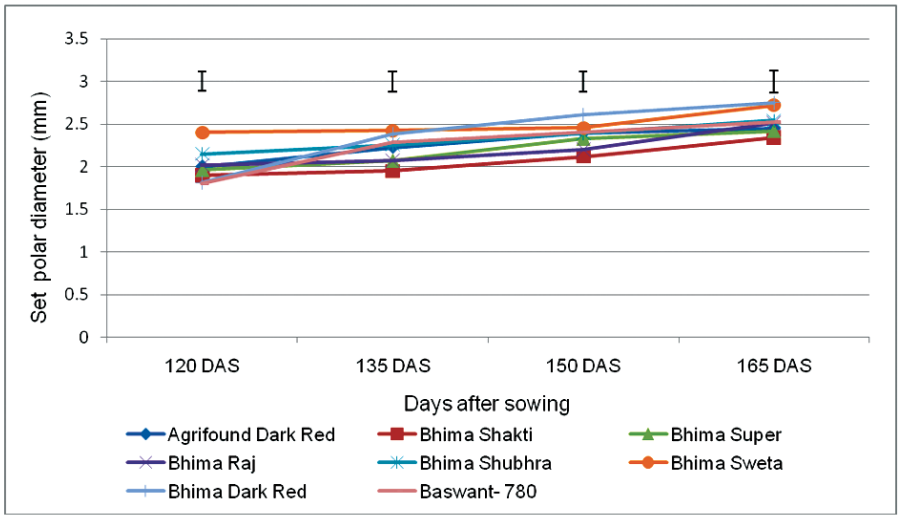

Fig. 5: Set polar diameter (cm) of onion cultivars at different days after sowing

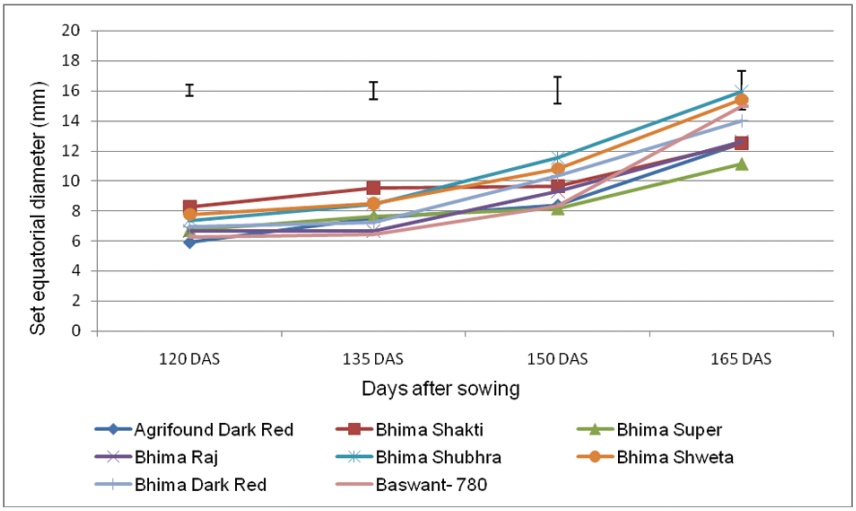

Fig. 6: Set equatorial diameter (mm) of onion cultivars at different days after sowing

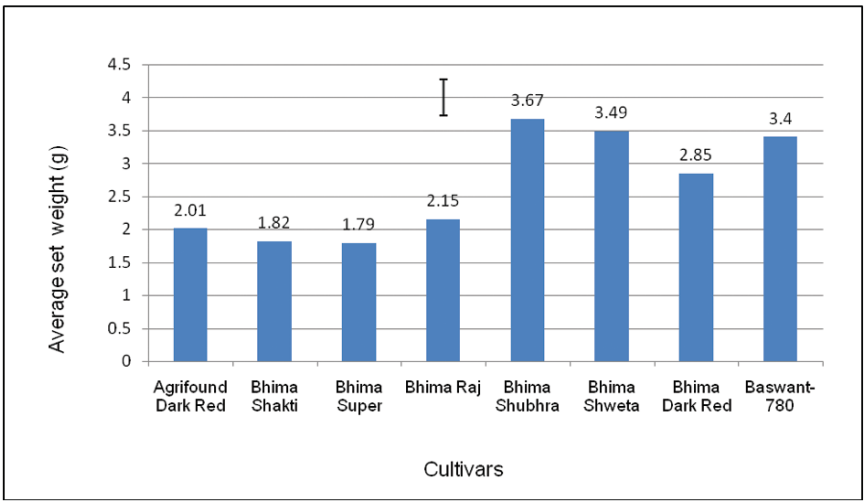

Fig. 7: Average set weight (g) of onion cultivars

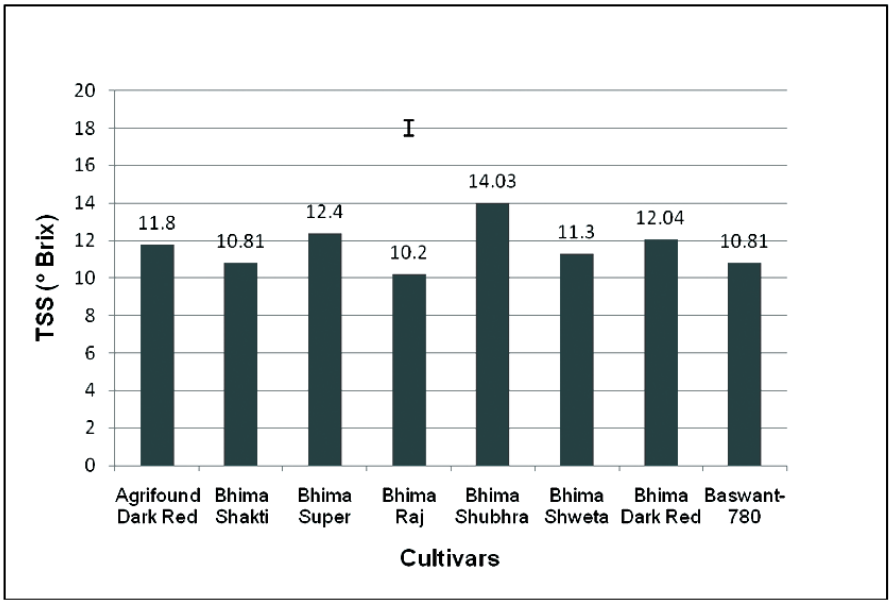

Fig. 8: TSS (° Brix) of sets of onion cultivars

Table 1: Number and weight (g) of set harvested per square meter

Cultivars	Number of set harvested sq m^{-1}				Weight of set harvested sqm^{-1} (g)			
	Small	**Medium**	**Large**	**Total**	**Small**	**Medium**	**Large**	**Total**
Agrifound Dark Red	91.33	49.33	34.00	174.67	53.47	47.15	68.26	168.88
Bhima Shakti	83.67	76.67	43.00	203.33	44.02	52.20	61.57	157.80
Bhima Super	134.00	76.33	47.00	257.33	74.10	77.30	82.99	234.39
Bhima Raj	184.00	98.67	75.33	358.00	125.54	111.25	190.00	426.79
Bhima Shubhra	140.33	103.67	92.67	336.67	138.69	161.14	269.10	568.92
Bhima Shweta	186.33	65.33	96.67	348.33	166.99	98.88	323.27	589.14
Bhima Dark Red	108.33	71.33	61.67	241.33	121.29	112.01	182.47	415.78
Baswant- 780	147.67	133.00	89.33	370.00	220.63	195.72	330.98	747.34
LSD (0.05)	**27.30**	**19.11**	**9.84**	**33.75**	**16.82**	**26.16**	**32.93**	**51.55**

of leaves followed by Bhima Dark Red, Bhima Shubhra, Agrifound Dark Red and Bhima Raj. At 105 days onwards it was found that the leaf numbers in most of the cultivars were gradually decreasing. At 120 days, maximum leaf number was noted in Bhima Shweta followed by Bhima Dark Red, Agrifound Dark Red, Bhima Shubhra, Baswant-780 and Bhima Super. At 135 days after sowing, Bhima Shweta continued to have the maximum number of leaves followed by Bhima Shubhra, Bhima Raj, Bhima Super, Bhima Dark Red and Baswant-780. At 150 days, Bhima Shweta still continued to have the maximum number of leaves with mean of 2.23, while other cultivars were proceed towards senescence. Variation in number of leaves in different onion cultivars for set production also reported by Musa and Nourai (2010).

Neck diameter

Neck diameter of harvested onion bulbs or bulblets is an important trait determines its storage ability. Neck diameter of the onion sets were measured several times from 45 days after planting till 150 days (Fig. 4). At 45 days, maximum neck diameter was noted in Bhima Shubhra followed by in Bhima Dark Red, Agrifound Dark Red, Bhima Shweta, Bhima Super and Bhima Shakti. At 60 days, Bhima Shweta had maximum neck diameter followed by Bhima Shubhra, Bhima Dark Red and Bhima Raj. At 75 days, neck diameter was found statistically non-significant with mean of 3.78mm. At 90 days, Bhima Shweta registered maximum neck diameter followed by Bhima Raj, Bhima Dark Red, Bhima Shubhra and Agrifound Dark Red. At 105 days, Bhima Shubhra showed maximum neck diameter followed by Bhima Shweta and Bhima Dark Red. After 105 days the cultivars started showing decrease in their neck diameter. At 120 days after planting, Bhima Dark Red showed the maximum neck diameter with mean 5.52mm, while other cultivars decreasing in their neck diameter. At 135 days after planting, Baswant-780 showed the maximum neck diameter followed by Bhima Dark Red, Bhima Shweta, Bhima Shubhra and Agrifound Dark Red. At 150 days after planting, Bhima Super showed maximum neck diameter followed by Bhima Shubhra and Bhima Shweta which were found to have the almost same neck diameters. These cultivars were found to be statistically similar, while other cultivars have almost dried up having decreased neck diameters. Ansary (2007) reported cultivar variation in sets for this trait in onion.

Set diameters

Data on set polar and equatorial diameter at 120, 135, 150 and 165 days after sowing has been presented in the fig. 5 and 6 respectively. Mean data revealed that bulblet polar diameter increased linearly as plants matured. At 120 days, Bhima Shweta registered maximum set polar diameter (2.40 cm). At 135 days, Bhima Shweta followed by Bhima Dark Red, Baswant-780 and Bhima Shubhra recorded maximum value for this trait. At 150 days, maximum set polar diameter was noted in Bhima Dark Red, Bhima Shweta, Baswant-780, Bhima Shubhra and Agrifound Dark Red. At 165 days, Bhima Dark Red, Bhima Shweta, Bhima Shubhra, Baswant-780 and Bhima Raj registered the maximum value. Similar to bulblet polar diameter, mean data revealed that set equatorial diameter increased steadily as plants matures. At 120 days, maximum value for this trait was observed in Bhima Shakti (8.26mm) and Bhima Shweta (7.76mm). At 135 days, Bhima Shakti followed by Bhima Shweta and Bhima Shubhra recorded maximum set equatorial diameter. At 150 days, Bhima Shubhra, Bhima Shweta and Bhima Dark Red registered the maximum value. At 165 days, Bhima Shrub followed by Baima Shweta, Baswant-780 and Bhima Dark Red recorded the maximum value. Ansary (2007) reported cultivar variation in onion set diameter. Mohanta and Mandal (2014) reported variation in bulb polar and equatorial diameter of *Kharif* onion.

Average set weight

Set or Bulblet weight is an important yield attribute. Data on average bulblet weight has been presented in fig. 7. Among the eight cultivars, set weight were found maximum in Bhima Shubhra (3.67g) followed by Bhima Shweta (3.49g) and Baswant-780 (3.40g) respectively. These cultivars were found statistically at par. The mean bulblet weight was noted 2.65g. The range of data was noted 6.37g (Bhima Shubhra) to 1.79g (Bhima Super). Variation in onion set weight was reported by Ansary (2007) and Musa and Nourai (2010).

Number of sets harvested

The numbers of bulblets or sets harvested per square meter of the eight cultivars has been presented in the table 1. After harvest, the sets were grouped into small, medium and large sizes. Mean number of small, medium and large bulblets were registered 134.46, 84.29 and 67.46 respectively. The maximum numbers of sets for small sized were found in the cultivar Bhima Shweta followed by Bhima Raj. Baswant-780 produced maximum medium sized sets (133.00). On the other hand, maximum large size bulblet was registered in Bhima Shweta (96.67) followed by Bhima Shubhra (92.67) and Baswant-780 (89.33) respectively. These cultivars were found statistically similar to each other. Maximum total number of sets harvested in Baswant-780, followed by Bhima Raj, Bhima Shweta and Bhima

Shubhra respectively. Average 286.21 numbers of bulbs was produced per square meter. Musa and Nourai (2010) reported significantly difference in total number of sets ha^{-1} in different onion cultivars.

Weight of the sets harvested

The weight of sets harvested per square meter of the eight cultivars has been presented in the table 1. The harvested sets of the cultivars were weighed according to their size group (small, medium and large). Mean weight per square meter of small, medium and large sets were registered 118.09 g, 106.96 g and 188.58 g respectively. The maximum weights of the small and medium sets or bulblets were noted for the cultivar Baswant-780 than the other cultivars. While for the large sized sets, the cultivar Baswant-780 had the maximum weight followed by Bhima Shweta. Maximum total weight of the sets harvested was found in the cultivar Baswant-780 (747.34 g) and this was statistically superior to other cultivars. Bhima Shweta and Bhima Shubhra produced 589.14 g and 568.92 g of total sets from similar area and were the next best after Baswant-780. Average 413.63 g bulblet was harvested per square meter area. Cultivar variation for set yield in onion was reported by Ansary (2007) and Musa and Nourai (2010).

Total soluble solids

Data on Total Soluble Solids (TSS) of eight onion cultivars has been presented in the fig. 8. Maximum TSS content was noted in cultivar Bhima Shubhra (14.03 ^{0}Brix) which was noted statistically superior to other cultivars. Bhima Super, Bhima Dark Red and Agrifound Dark Red also registered good amount of TSS and they were statistically at par with each other. Mean TSS value was recorded 11.67 ^{0}Brix. Mohanta and Mandal (2014) reported cultivar variation for TSS content in *Kharif* onion.

Onion cultivation using set or bulblet is not a common practice in West Bengal particularly for common onion (*Allium cepa* L.). Sporadically, however, some multiplier onion (*A. cepa* var. *aggregatum*) grown through bulblets by separating them from cluster. Onion cultivation during *Kharif* months is an off-season practice offers lucrative market return. However, this venture is often proved risky due to adverse weather condition. Eastern India including West Bengal receive heavy downpour during July-August coinciding its cultivation time. Healthy disease free planting material, therefore, is the prerequisite for low mortality, better crop stand and good production of *Kharif* onion. Growing onions from bulblets or sets offers the growers an easiest way to plant onion escaping nursery. Patil *et al.* (2009) and Khokhar *et al.* (2001) demonstrated successful *Kharif* onion cultivation through set plantation. Present experiment revealed that it is possible to produce set or bulblets of *Kharif* onion in West Bengal condition. However, considerable varietal difference was noticed for all the studied characters. Ansari (2007) received varied reaction of onion cultivars to produce set. All the cultivars took 165 days plus from seed sowing to harvest. The crop received rains at regular interval in the months of May and June that hampered bulb maturity (Fig. 1). Perhaps this was the reason that harvesting time stretched beyond expectation. Again, hailstorm before harvesting also damaged the crop considerably and that affected final bulblet yield. It was noted that all the growth traits for almost all the cultivars increased steadily from sowing and reached its peak at 90 days and then declined gradually. Above ground portion of many of the cultivars begins to dry after 150 days of sowing. Variation among the cultivars on top fall was also visible (data not recorded). Among the yield parameters, bulblet diameter (both polar and equatorial) was increased as days advanced. All the cultivars produced more number of small sized bulblets than medium and large sized, though their proportion varied. However, for all the cultivars, total weight of the large sized bulblets was more than small and medium sized. Among the cultivars, Baswant-780, Bhima Shweta and Bhima Shubhra produced maximum number and weight of larger size bulbs. Workers reported that onion sets of medium and large size produced bigger bulbs and higher yields than smaller sets (Pandey *et al.*, 1992, Khokhar *et al.*, 2001, Matimati *et al.*, 2006). The cultivars, Baswant-780, Bhima Shweta and Bhima Shubhra recorded maximum set diameter (both polar and equatorial), set weight and number and weight of total sets. These three best performing cultivars need further field testing for green onion or mature bulb production using sets during *Kharif* season.

From the present investigation it may be stated that the set or bulblet production of *Kharif* onion cultivars is possible under Red and Laterite Zone of West Bengal. Baswant-780, Bhima Shweta and Bhima Shubhra may be selected for producing sets or bulblets targeting green onion or mature bulb production during *Kharif* season under Red and Laterite Zone of West Bengal.

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