Journal of Pharmacognosy and Phytochemistry
Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
JPP 2019; 8(2): 1317-1321
Received: 08-01-2019
Accepted: 11-02-2019

M Dhar
Department of Horticulture and Post Harvest Technology (HPHT), Institute of Agriculture, Visva-Bharati (A Central University), Sriniketan, West Bengal, India

J Mandal
Department of Horticulture and Post Harvest Technology (HPHT), Institute of Agriculture, Visva-Bharati (A Central University), Sriniketan, West Bengal, India

TK Maity
Department of Vegetable Crops, Faculty of Horticulture, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, West Bengal, India

Smaranika Mohanta
Department of Horticulture and Post Harvest Technology (HPHT), Institute of Agriculture, Visva-Bharati (A Central University), Sriniketan, West Bengal, India

Correspondence
J Mandal
Department of Horticulture and Post Harvest Technology (HPHT), Institute of Agriculture, Visva-Bharati (A Central University), Sriniketan, West Bengal, India

Evaluation of *kharif* onion (*Allium cepa* L.) varieties under different planting dates

M Dhar, J Mandal, TK Maity and Smaranika Mohanta

Abstract
In a field experiment the performance of eight onion varieties (Bhima Dark Red, Bhima Super, Bhima Shubhra, Bhima Shweta, Bhima Raj, Bhima Red, Baswant-780 and Agrifound Dark Red) were assessed under four transplanting dates (1st and 15th August and 1st and 15th September) to make off-season onion production a success in western Red & Laterite Zone of West Bengal. Delay in planting from August to September significantly increases the growth and yield parameters of onion varieties. Higher total and marketable bulb yield per hectare was obtained from Bhima Shweta, Baswant-780 and Agrifound Dark Red. Thus, red onion varieties Baswant-780 and Agrifound Dark Red and white onion variety Bhima Shweta may be advocated to grow under Red & Laterite Zone of West Bengal during September month for high marketable yield.

Keywords: *Kharif* onion, variety, planting date, growth and yield

Introduction
Onions (*Allium cepa* L.) have an extensive culinary, dietary, therapeutic, trading, income and employment generation value. Onion has a steady demand worldwide. With a production of 20.93 million metric tons of onion in 2015-16, India is the second largest onion producer in the World after China. In India, the share of Maharashtra in the total onion production is around 31.19% in contrast to West Bengal contributing only 2.6% (Department of Agriculture, Cooperation & Farmers Welfare, 2017) [2]. In West Bengal major produce comes from Hooghly, Murshidabad, Burdwan, Nadia, North 24 Parganas district during the month of March-April mostly as *Rabi* crop (Directorate of Horticulture, 2017) [6]. The production seasons and arrivals of onion in India lead to a typical situation where in the prices tend to peak during September to November and reduces from January to March-April every year. Generally the onion storage filled by *Rabi* onion gets emptied by around August to September beyond which storage loss rises to 30% and above (Samra *et al*., 2006) [16]. In West Bengal, production of onion in *Kharif* and Late *Kharif* season is a new strategy to have continuous supply of onion round the year and thus to minimize dependency on supply of onion from other States (Dhar *et al.*, 2016) [4]. Importance of *Kharif* cultivation of onion to stabilize the prices is well accepted (DOGR, 2013) [7]. Exploitation of scope of *Kharif* onion in uplands of West Bengal particularly in the western Red & 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. Such area having good drainage system is much suitable for the *Kharif* onion crop. Study showed that the overall performance of *kharif* onion under Red and Laterite Zone of West Bengal was highly satisfactory (Mohanta and Mandal, 2014, Mandal *et al.*, 2015 and Meher *et al.*, 2016) [13, 11, 12]. Variety performance and date of planting play an important role in the selection of genotypes for yield improvement and adaptation to particular environmental conditions. Onion is highly sensitive to temperature and photoperiod. Thus, time of planting for *kharif* onion varies from region to region, starting from April-June in Karnataka, Tamil Nadu, Andhra Pradesh as early crop, July-August in Maharashtra, Gujarat, Rajasthan and August-September in Orissa and West Bengal (Samra *et al*., 2006) [16]. Keeping the above points in mind a research work has been formulated to evaluate different varieties of onion and their transplanting time to make off-season onion production a success in western Red & Laterite Zone of West Bengal.

Materials and Methods
The experiment was conducted at the Horticulture Farm of Institute of Agriculture, Visva-Bharati, Sriniketan (West Bengal) during 2016-17. The experimental site was situated in the sub-humid, subtropical lateritic belt of West Bengal with the hot summer and moderately cold and short winter in the eastern part of India. The treatment consisted of four different planting dates *viz.*, 1st August (D1), 15th August (D2), 1st September (D3) and 15th September (D4) and

eight onion varieties *i.e.* Bhima Dark Red (V1), Bhima Super (V2), Bhima Shubhra (V3), Bhima Shweta (V4), Bhima Raj (V5), Bhima Red (V6), Baswant-780 (V7) and Agrifound Dark Red (V8). The soil of the experimental site was loamy sand in texture with 6.40 pH and 0.47 % organic carbon. The available nitrogen content was 218.5 kg ha^{-1}, available phosphorus content was 11.6 kg $ha^{-1}$and available potassium content was 72.8 kg ha^{-1}. The meteorological data during the crop season of this experiment were recorded at Meteorological Observatory Centre, Government of India, Sriniketan. The experiment period (including nursery growing) were stretched between June 2016 to January 2017. Among these months, June to August was received maximum rainfall and September received moderate downpour. In contrast, October to January was rarely experienced any rainfall. Similar to rainfall, relative humidity in the atmosphere was goes below 80% from the end of September. Sunshine hours were quite improved from mid September onwards. Both the maximum and minimum temperature was started decreasing with the advancement of months. The experiment was laid in factorial randomized block design with three replications. Onion seedlings were raised on permanent polythene cladded seedbeds. 50 days old seedlings were transplanted for each date of planting. The planting was done in 2.5 m x 1.2 m plots at 15cm x 10cm spacing. Normal agronomic package of practices were adopted to raise the crop successfully. Observations on growth parameters (plant height, number of leaves $plant^{-1}$ and neck diameter) were taken from randomly selected ten plants per replication at 90 days after transplanting. Bulb characters (average bulb weight, polar and equatorial diameter, total and marketable yield) were recorded from randomly selected ten bulbs after harvest. Yield ha^{-1} was calculated from yield $plot^{-1}$. The mean values 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 as suggested by Panse and Sukhatme (1954) [15].

Results and Discussion

Significant effect of transplanting dates, varieties and their interactions on various growth and yield attributes and yield (total and marketable) of onion (except for the interaction effect on number of leaves $plant^{-1}$) was observed from analysis of variance (Table 1). The results of this experiment were discussed as follows:

The maximum plant height was observed on 15th September transplanting date which was significantly superior to other planting dates (Table 2). Whereas the shortest plant height was recorded on 1st August transplanting date. Exposure of late transplanted plants to more congenial weather than that of early transplanted plants was helpful for better growth and development of onion plants. Gautam *et al.* (2006) [8] and Mohanta *et al.* (2017) [14] also observed significant effect of planting date on plant height. Highest significant plant height was noted in Bhima Shweta (Table 3). The smallest plant height was observed for Bhima Super which was at par with Bhima Raj. Santra *et al.* (2017) [17] also recorded varied plant height during evaluation of different *kharif* onion genotypes. It was noted from the interaction effect (Table 4) that planting onion variety Bhima Shweta on mid of September produced tallest plants. Maximum number of leaves $plant^{-1}$ was recorded in September planting. Minimum number of leaves $plant^{-1}$ was observed at 1st August transplanting (Table 2). Sharma *et al.* (2009) [18] recorded variation in number of leaves $plant^{-1}$ in different transplanting dates. Maximum significant number of leaves $plant^{-1}$ was noted in Bhima Shweta which was at par with Baswant-780 (Table 3). The interaction effect between dates of transplanting and variety on number of leaves $plant^{-1}$ was found statistically non-significant. Neck diameter (thickness) of harvested onion bulbs is an important trait determines bulb storage ability. The relatively high neck thickness in all the planting dates and varieties was due to lack of natural neck falls at harvesting, unlike *rabi* onion. However, neck diameter varied significantly among the different transplanting dates. Maximum neck diameter was recorded on mid of September planting. The lowest neck diameter was found on 1st August transplanting. Improved growth of the plants due to congenial weather condition may contribute to thicken neck in late planting. Increase in neck thickness with delayed planting from August to September was also noted by Mohanta and Mandal (2014) [13]. Bhima Dark Red recorded significantly minimum neck thickness which was at par with Bhima Red and Agrifound Dark Red. Maximum neck thickness was observed in Bhima Shweta which was at par with Bhima Shubhra (Table 3). Influence of genotype on neck thickness was reported by Hirave *et al.* (2015) [10]. Interaction study revealed that the minimum neck diameter was obtained in variety Bhima Dark Red, Bhima Super, Agrifound Dark Red and Bhima Red on 1st August transplanting. Similarly, Bhima Shweta recorded maximum neck diameter on 15th September planting which was at par with Bhima Shubhra, Bhima Raj and Bhima Super (Table 4).

Bulb weight is an important yield attributing character. The maximum bulb weight was obtained on 15th September planting which was at par with 1st September planting. Transplanting on 1st August produced smallest bulb (Table 2). Sharma *et al.* (2009) [18] noted the influence of transplanting dates on average bulb weight in onion. The maximum average bulb weight was recorded with variety Bhima Shweta. On the contrary, lowest bulb weight was found in Bhima Raj (Table 3). Difference in average bulb weight as influenced by varieties was also observed by Halder *et al.* (2009) [9]. With respect to interaction effect of transplanting dates and varieties, the highest bulb weight was obtained in Bhima Shweta, Baswant-780 and Agrifound Dark Red when planted on 1st September which was at par with 15th September transplanting (Table 4). The shape and size of onion depends on polar and equatorial diameter of bulb which is also important yield attributes. Significantly higher polar and equatorial diameter of bulb were recorded when seedling transplanted during September month whereas, minimum value of these two characters were recorded on1st August transplanting. Increased trend of bulb diameters were noted as planting delayed from August to September. Mohanta and Mandal (2014) [13] also observed similar trend in *kharif* onion. Among the varieties, the maximum bulb polar diameter was measured in Bhima Shweta which was at par with Bhima Dark Red, Bhima Shubhra, Bhima Red and Baswant-780. On the other hand, maximum bulb equatorial diameter was measured in Agrifound Dark Red. Variation in bulb diameter in different varieties was also noted by (Dhotre *et al.*, 2010 [5] and Dewangan and Sahu, 2014 [3]. Interaction effect of planting date and variety showed that Baswant-780, Bhima Shweta, Bhima Shubhra, Bhima Dark Red and Bhima Red gave maximum polar diameter when planted on 1st or 15th September. Similarly, Agrifound Dark Red recorded maximum value of equatorial diameter on 1st or 15th September planting (Table 4).

In any performance trial with various factors, yield is the most important character to be taken under special consideration. But on commercial cultivation of onion, marketable bulb yield plays a vital role than total bulb yield. Significant differences for total as well as marketable bulb yield ha^{-1} under different dates of planting and different onion varieties were evident from this study. Maximum total and marketable bulb yield ha^{-1} was recorded in 15th September planting followed by 1st September planting. Minimum total and marketable bulb yield ha^{-1} was observed on 1st August transplanting (Table 2). Data on yield clearly revealed that progressive delay in planting from August to September was benefitted by linear increase in yield. The low yield in early transplanting dates could be due to unfavorable weather conditions. Das *et al*. (2015) [1] recorded significant influence of date of transplanting on yield of onion bulb. Among the varieties, significantly highest total as well as marketable bulb yield ha^{-1} was obtained from Bhima Shweta which was statistically at par with Baswant-780 and Agrifound Dark Red. Lowest total and marketable bulb yield was realized in Bhima Raj (Table 3). Previous studies also indicated the suitability of Agrifound Dark Red and Baswant-780 for *kharif* season cultivation in West Bengal (Santra *et al.,* 2017, Mohanta and Mandal, 2014 and Halder *et al*., 2009) [17, 13, 9]. With respect to interaction effect of transplanting dates and varieties, the maximum total bulb yield was obtained in Baswant-780, Bhima Shweta and Agrifound dark Red when planted on 15th September and Baswant-780 and Agrifound dark Red when planted on 1st September. Similarly, Bhima Shweta, Baswant-780 and Agrifound dark Red on 15th September and Baswant-780 and Agrifound dark Red on 1st September produced maximum marketable bulb. On an average the projected total bulb yield and marketable bulb yield were 25.5 t ha^{-1} and 21.0 t ha^{-1} respectively for the entire study (Table 4).

Table 1: Analysis of variance for different characters in onion

Source	D.F.	Mean Sum of Square							
		Plant height	Number of laves plant^{-1}	Neck diameter	Average Bulb Weight	Polar Diameter	Equatorial Diameter	Total Yield	Marketable Yield
Replication (R)	2	6.67*	1.51	0.58	0.27	2.74	1.69	6.21	8.01
Dates of transplanting (D)	3	670.24**	9.81**	98.66**	8875.09**	106.01**	275.54**	485.66**	463.40**
Variety (V)	7	35.55**	1.13*	6.17**	757.37**	80.17**	77.81**	40.12**	44.37**
Interaction (D x V)	21	10.08**	0.24	0.96*	69.72**	1.68*	8.05**	6.23*	10.39**
Error	62	1.81	0.51	0.49	6.37	0.91	1.09	3.54	2.77

Note:* & ** means significant at 5% & 1% level.

Table 2: Effect of transplanting dates on growth, yield attributes and yield of onion

Dates of Transplanting	Plant Height (cm)	Number of Leaves plant^{-1}	Neck Diameter (mm)	Average Bulb Weight (g)	Polar Diameter (mm)	Equatorial Diameter (mm)	Total Yield (t ha^{-1})	Marketable Yield (t ha^{-1})
1st August (D1)	48.0^{d}	8.2^{c}	11.7^{d}	60.8^{c}	50.7^{c}	51.9^{c}	20.2^{d}	16.1^{d}
15th August (D2)	50.3^{c}	8.7^{b}	12.4^{c}	73.4^{b}	52.5^{b}	53.7^{b}	23.4^{c}	18.4^{c}
1st September (D3)	52.2^{b}	9.4^{a}	13.2^{b}	99.1^{a}	54.8^{a}	58.4^{a}	28.2^{b}	24.0^{b}
15th September (D4)	60.1^{a}	9.6^{a}	16.3^{a}	99.3^{a}	55.2^{a}	58.6^{a}	30.1^{a}	25.3^{a}
S.E. (d)±	0.4	0.2	0.2	0.7	0.3	0.3	0.5	0.5
CD (P=0.05)	0.8	0.4	0.4	1.5	0.5	0.6	1.1	1.0

Note: In a column, means followed by the same letter are not significantly different at the 0.05 level of probability

Table 3: Effect of varieties on growth, yield attributes and yield of onion

Onion varieties	Plant Height (cm)	Number of Leaves plant^{-1}	Neck Diameter (mm)	Average Bulb Weight (g)	Polar Diameter (mm)	Equatorial Diameter (mm)	Total Yield (t ha^{-1})	Marketable Yield (t ha^{-1})
Bhima Dark Red (V1)	52.1^{bc}	8.9^{b}	12.5^{c}	77.4^{e}	54.8^{a}	53.1^{e}	24.6^{cd}	19.6^{d}
Bhima Super (V2)	50.8^{d}	8.9^{b}	13.5^{b}	79.1^{e}	53.4^{bc}	52.5^{e}	24.2^{d}	19.8^{d}
Bhima Shubhra (V3)	53.2^{b}	8.7^{b}	14.1^{ab}	81.5^{d}	54.2^{ab}	56.3^{cd}	26.0^{bc}	21.5^{bc}
Bhima Shweta (V4)	56.3^{a}	9.7^{a}	14.6^{a}	96.9^{a}	54.9^{a}	57.6^{b}	27.6^{a}	23.2^{a}
Bhima Raj (V5)	51.1^{cd}	8.8^{b}	13.6^{b}	70.6^{f}	52.9^{c}	53.0^{e}	22.2^{e}	17.5^{e}
Bhima Red (V6)	52.3^{b}	8.9^{b}	12.8^{c}	84.9^{c}	54.7^{a}	57.1^{bc}	25.1^{cd}	21.0^{cd}
Baswant-780 (V7)	53.2^{b}	9.1^{ab}	13.5^{b}	88.9^{b}	54.3^{a}	55.8^{d}	27.2^{ab}	22.4^{abc}
Agrifound Dark Red (V8)	52.3^{b}	8.9^{b}	12.7^{c}	86.1^{c}	47.1^{d}	59.6^{a}	27.1^{ab}	22.7^{ab}
S.E. (d)±	0.5	0.3	0.3	1.0	0.4	0.4	0.8	0.7
CD (P=0.05)	1.1	0.6	0.6	2.1	0.8	0.9	1.5	1.4

Note: In a column, means followed by the same letter are not significantly different at the 0.05 level of probability; NS means statistically non-significant.

Table 4: Interaction effects of transplanting dates and varieties in onion.

	Plant Height (cm)	Number of Leaves plant^{-1}	Neck Diameter (mm)	Average Bulb Weight (g)	Polar Diameter (mm)	Equatorial Diameter (mm)	Total Yield (t ha^{-1})	Marketable Yield (t ha^{-1})
D1V1	47.8^{mnop}	8.3	10.5^{k}	55.0^{n}	52.4^{ijk}	48.9^{m}	19.8^{opq}	16.3^{nop}
D1V2	47.2^{nop}	7.9	11.2^{jk}	59.8^{m}	51.4^{klm}	50.1^{lm}	20.7^{mnopq}	17.9^{lmn}
D1V3	47.1^{op}	8.0	12.1^{hij}	53.5^{n}	52.0^{jkl}	52.1^{ijk}	21.4^{mnop}	16.9^{mno}
D1V4	50.0^{ijklm}	8.9	12.9^{fgh}	84.8^{ij}	53.2^{ghij}	54.4^{fgh}	21.9^{lmnop}	17.6^{lmn}
D1V5	46.5^{p}	8.0	11.9^{hij}	44.4^{o}	50.6^{lm}	51.0^{kl}	18.1^{q}	13.7^{pq}
D1V6	49.0^{lmno}	8.4	11.5^{ijk}	63.0^{lm}	52.0^{jkl}	53.6^{fghi}	20.7^{mnopq}	16.1^{nop}
D1V7	48.2^{mnop}	8.4	12.0^{hij}	63.3^{lm}	50.4^{lmn}	51.2^{kl}	18.9^{pq}	14.6^{opq}
D1V8	48.0^{mnop}	7.9	11.3^{ijk}	63.1^{lm}	43.7^{p}	53.5^{ghi}	20.4^{nopq}	16.1^{nop}
D2V1	49.2^{klmno}	8.6	11.8^{hij}	71.7^{k}	54.7^{cdefg}	53.7^{fghi}	23.1^{klmn}	18.6^{klmn}
D2V2	48.0^{mnop}	8.4	12.2^{hij}	66.5^{l}	53.2^{ghij}	51.5^{jkl}	23.6^{jklm}	19.1^{klm}
D2V3	51.0^{ijkl}	8.3	12.9^{fgh}	72.6^{k}	52.8^{hijk}	53.0^{hij}	25.0^{hijkl}	19.8^{jkl}
D2V4	53.3^{h}	9.5	13.5^{efg}	90.8^{gh}	53.9^{fghi}	54.8^{efg}	25.4^{ghijk}	20.2^{ijkl}
D2V5	47.8^{mnop}	8.6	12.2^{hij}	53.4^{n}	51.9^{jklm}	50.5^{klm}	19.3^{opq}	12.9^{q}
D2V6	50.8^{ijkl}	8.7	12.4^{ghi}	74.7^{k}	54.6^{defg}	56.5^{e}	22.4^{klmno}	18.7^{klmn}
D2V7	51.4^{hijk}	9.1	12.8^{fgh}	82.3^{i}	53.1^{ghij}	54.4^{fgh}	23.7^{jklm}	18.6^{klmn}
D2V8	51.0^{ijkl}	8.5	11.8^{hij}	75.4^{k}	45.7^{o}	54.9^{efg}	24.6^{ijkl}	19.1^{klm}
D3V1	51.6^{hij}	9.3	12.3^{hij}	88.1^{hi}	55.7^{abcde}	54.6^{fgh}	26.9^{fghi}	20.8^{ijk}
D3V2	48.4^{mnop}	9.8	13.5^{efg}	95.3^{ef}	54.0^{fghi}	53.9^{fgh}	25.0^{hijkl}	20.9^{ijk}
D3V3	52.1^{hi}	9.0	13.9^{def}	100.8^{cd}	55.7^{abcde}	60.1^{bcd}	27.9^{defgh}	23.9^{efgh}
D3V4	55.9^{g}	9.9	14.2^{de}	106.8^{a}	56.1^{abcd}	60.6^{b}	30.4^{bcd}	26.1^{bcde}
D3V5	49.4^{jklmn}	8.9	12.8^{fgh}	92.7^{fg}	54.7^{cdefg}	55.3^{ef}	24.8^{hijkl}	21.2^{hijk}
D3V6	51.9^{hi}	9.7	12.9^{fgh}	101.6^{bcd}	56.3^{abc}	59.3^{bcd}	27.1^{efghi}	24.1^{efg}
D3V7	56.5^{fg}	9.5	13.5^{efg}	104.8^{abc}	56.6^{ab}	58.5^{d}	32.0^{ab}	27.9^{abc}
D3V8	52.0^{hi}	9.6	12.7^{gh}	102.9^{abcd}	48.9^{n}	64.8^{a}	31.3^{abc}	27.4^{abcd}
D4V1	59.7^{cd}	9.3	15.5^{bc}	95.1^{ef}	56.2^{abcd}	55.2^{efg}	28.5^{cdefg}	22.7^{fghi}
D4V2	59.5^{cde}	9.8	17.2^{a}	94.9^{fg}	55.0^{bcdef}	54.6^{fgh}	27.5^{defghi}	21.1^{ijk}
D4V3	62.7^{b}	9.5	17.4^{a}	99.2^{de}	56.3^{abc}	60.2^{bcd}	29.7^{bcdef}	25.4^{cdef}
D4V4	66.1^{a}	10.4	17.9^{a}	105.0^{ab}	56.6^{ab}	60.5^{bc}	32.6^{ab}	29.0^{a}
D4V5	60.7^{bc}	9.8	17.4^{a}	91.9^{fgh}	54.4^{efgh}	55.2^{efg}	26.6^{fghij}	22.2^{ghij}
D4V6	57.4^{efg}	8.9	14.4^{cde}	100.2^{d}	55.9^{abcde}	58.8^{cd}	30.1^{bcde}	25.0^{def}
D4V7	56.8^{fg}	9.5	15.7^{b}	105.3^{ab}	57.1^{a}	59.2^{bcd}	34.0^{a}	28.7^{ab}
D4V8	58.3^{def}	9.6	15.0^{bcd}	103.1^{abcd}	50.3^{mn}	65.3^{a}	32.0^{ab}	28.1^{abc}
Mean	52.7	9.0	13.4	83.2	53.3	55.6	25.5	21.0
S.E. (d)±	1.1	0.6	0.6	2.1	0.8	0.9	1.5	1.4
CD (P=0.05)	2.2	NS	1.1	4.1	1.6	1.7	3.1	2.7

Note: In a column, means followed by the same letter are not significantly different at the 0.05 level of probability; NS means statistically non-significant.

Conclusion

Thus, in a nutshell, it may be stated that September planting of onion ensures good harvest. Bhima Shweta, Agrifound Dark Red and Baswant-780 that gave higher marketable bulb yield per hectare, may be suggested to the farmers' for successful off season onion cultivation under Red and Laterite Zone of West Bengal

References

1. Das R, Thapa U, Chattopadhyay N, Mandal AR. Performance of *kharif* onion genotypes under different dates of planting for productivity and economics in Gangetic Plains of West Bengal. Annals Plant and Soil Research. 2015; 17:19-23.
2. Department of Agriculture, Cooperation & Farmers Welfare. Monthly Report of Onion for September 2017-Horticulture Statistics Division, Department of Agriculture, Cooperation & Farmers Welfare, Ministry of Agriculture & Farmers Welfare, Government of India, New Delhi, 2017. (www.agricoop.nic.in/)
3. Dewangan SR, Sahu GD. Evaluation of different *kharif* onion genotypes in Chhattisgarh plains. Agrotechnol. 2014; 2(4):145.
4. Dhar M, Mandal J, Mohanta S. Prospects of onion cultivation (*Allium cepa* L.) in West Bengal. In: Rural Health Women empowerment and Agriculture Issue and Challenges: Chattopadhyay, P.K. and Kushwaha, D.S. (Eds), New Delhi Publishers, New Delhi, 2016, 257-275.
5. Dhotre M, Allolli TB, Hulihalli UK, Athani SI. Genetic diversity studies in *kharif* onion (*Allium cepa* var. *cepa* L.). Karnataka Journal of Agricultural Sciences. 2010; 23(5): 811-812.
6. Directorate of Horticulture. Directorate of Horticulture, Government of West Bengal, 2017.
7. DOGR. IVth Annual Workshop of All India Network Research Project on Onion and Garlic at Bidhan Chandra Krishi Vishwavidayalya (BCKV), Kalyani on 18-19 April, 2013. (www.dogr.res.in)
8. Gautam IP, Khatri B, Paudel GP. Evaluation of different varieties of onion and their transplanting times for off-season production in mid hills of Nepal. Nepal Agric. Res. J. 2006; 7:21-26.
9. Halder A, Karak C, Naik A, Samanta MK, Hazra P. Identification of suitable early *Rabi* onion varieties under West Bengal condition. Journal of Crop and Weed. 2009; 5(1):124-29.

10. Hirave PS, Wagh AP, Alekar AN, Kharde RP. Performance of red onion varieties in *Kharif* season under Akola conditions. The Ecoscan - An International Quarterly Journal Environment Science. 2015; VIII:381-384.
11. Mandal J, Sharma A, Mandal S. Growth attributes of *Kharif* onion (*Allium cepa* L.) as influenced by combination of organic and inorganic nutrients. HortFlora Research Spectrum. 2015; 4(3):288-290.
12. Meher R, Mandal J, Saha D, Mohanta S. Effect of sulphur application in onion (*Allium cepa* L.). Journal of Crop and Weed. 2016; 12(3):86-90.
13. Mohanta S, Mandal J. Growth and yield of *Kharif* onion (*Allium cepa* L.) as influenced by dates of planting and cultivars in Red and Laterite Zone of West Bengal. HortFlora Research Spectrum. 2014; 3(4):334-338.
14. Mohanta S, Mandal J, Dhakre DS. Growth of *kharif* onion (*Allium cepa* L.) in response to planting dates and cultivars. HortFlora Research Spectrum. 2017; 6(4):262-267.
15. Panse VG, Sukhatme PV. Statistical methods for agricultural workers, Indian Council of Agriculture Research Publication, New Delhi, 1954, 166-175.
16. Samra JS, Ramakrishna YS, Desai S, Subba Rao AVM, Rama Rao CA, Reddy YVR, Rao GGSN, Victor US, Vijaya Kumar P *et al*. Impact of excess rains on yield, market availability and prices of onion. Information Bulletin – Hyderabad: Central Research Institute for Dryland Agriculture (ICAR), 2006, 22-24.
17. Santra P, Manna D, Sarkar HK, Maity TK. genetic variability, heritability, and genetic advance in *Kharif* onion (*Allium cepa* L.). Journal of Crop and Weed. 2017; 13(1):103-106.
18. Sharma AK, Bhatia RS, Raina R. Effect of planting dates, size of setts and methods of planting on *Kharif* onion (*Allium cepa* L.) under submountain low hill conditions of Himachal Pradesh. Vegetable Science. 2009; 36(1):74-76.