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Effect of transplanting dates on growth, marketable bulb yield and economics of kharif onion (*Allium cepa* L.) varieties

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ABSTRACT

A field experiment was conducted at research farm of the Department of Vegetable Science, College of Horticulture, Mandsaur (M.P.) during kharif season of 2016 to find out the optimum transplanting dates and varieties of onion suitable for kharif season in this region. The treatments comprising of two transplanting dates i.e., D_1 (10^{th} August) and D_2 (25^{th} August) and eight varieties viz., V_1 (Arka Kalyan), V_2 (Arka Bheem), V_3 (Bhima Red), V_4 (Bhima Raj), V_5 (Bhima Super), V_6 (Bhima Dark Red), V_7 (Bhima Shubhra) and V_8 (Agrifound Dark Red) were tested in a factorial randomized block design with three replications. The results revealed that the fresh and dry weight of shoots increased upto 90 DAT followed by a reduction at harvest. On the other hand, fresh and dry weight of bulb increased upto harvest, irrespective of various treatments. There was a significant effect of transplanting dates on all the parameters studied. Transplanting date D_2 (25^{th} August) recorded maximum fresh weight of shoot, dry weight of shoot, fresh weight of bulb, dry weight of bulb, average weight of bulb, yield of marketable bulb, bolting and B:C ratio. Among the varieties, V_8 (Agrifound Dark Red) recorded maximum fresh weight and dry weight of shoot, fresh weight and dry weight of bulb, average weight of bulb, yield of marketable bulb and B:C ratio. Minimum bolting was recorded in V_4 (Bhima Raj). Combined effect of treatment D_2V_7 (Bhima Shubhra with 25^{th} August transplanting) recorded maximum fresh weight and dry weight of shoot, fresh weight and dry weight of bulb, average weight of bulb, yield of marketable bulbs and B:C ratio. Minimum bolting was recorded in D_1V_4 (Bhima Raj with 10^{th} August transplanting).

Keywords: Kharif onion, varieties, transplanting dates, weight accumulation, marketable bulb yield, bolting, economics

INTRODUCTION

Onion (*Allium cepa* L.) has important place among vegetable crops in India. It is the second most important vegetable crop after tomato in terms of income in the world. Its specific flavour, pungency and culinary properties have made it an indispensable item in every kitchen. Onion is generally grown as rabi season crop in India. Higher humidity and temperature during rainy season encourages sprouting and rotting thereby causes heavy losses to stored onion. This creates shortfall in fulfilling the demand during coming period. Due to shortage of onion often from October onwards the market price increases to a great extent. Kharif onion plays a crucial role to meet this demand-supply gap and thereby reducing the price-rise of onion (Mohanta and Mandal, 2014). The growth and yield of cultivated crop plants is mainly influenced by three principal factors *viz.,* genetic factors, environmental factor and crop management factor. Transplanting dates of onion seedlings alter the effect of edaphic factors and environmental conditions at large scale on growth, bulb yield and bulb quality, which differ widely from region to region. Thus, determining the optimum transplanting dates have a vital role in maximizing growth, bulb yield and its quality of onion (Kandil *et al.* 2013). Bulbing is a combined effect of photoperiod and temperature at a given location (Singh *et al.,* 2011). Successful onion production depends on the selection of varieties that are adapted to different conditions imposed by specific environment. Kharif onion is an off-season cultivation of the crop for which standardization of varieties is of immense utility (Mohanty and Prusti, 2001). Onion is a highly photo-thermo sensitive crop having limited adaptation. Thus onion varieties need to be tested for their performance and stability in the specific environment (Sharma, 2009). Keeping these facts in view an experiment was carried out to assess the performance of different varieties of onion at different dates of transplanting.

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MATERIALS AND METHODS

A field experiment was conducted at research farm of the Department of Vegetable Science, College of Horticulture, Mandsaur (M.P.) during kharif season of 2016. Sixteen treatment combinations consisting of two transplanting dates i.e., D_1 (10^{th} August) and D_2 (25^{th} August) and eight varieties *viz.,* V_1 (Arka Kalyan), V_2 (Arka Bheem), V_3 (Bhima Red), V_4 (Bhima Raj), V_5 (Bhima Super), V_6 (Bhima Dark Red), V_7 (Bhima Shubhra) and V_8 (Agrifound Dark Red) were tested in a factorial randomized block design with three replications. Healthy seedlings were transplanted on 4 x 0.9 meter raised bed at 15 x 10 cm spacing. The standard package of practices was adopted to raise the crop successfully. Data were recorded on growth parameter viz., fresh and dry weight of shoot, fresh and dry weight of bulb, average weight of bulb, yield of marketable bulb and bolting percentage. For weighing the fresh weight of shoot five plants were randomly uprooted and their underground portion was removed and their weight was recorded. After taking the fresh weight, these shoots of the plants were dried in oven at 65^{o} C temperature till constant weight and final weight was noted. The fresh and dry weight of shoot was recorded at 30, 60, 90 days after transplanting and at harvest. For taking fresh weight of bulb five plants were randomly uprooted and their shoot and root portion was removed and bulb fresh weight was recorded. After taking fresh weight these bulbs were dried in oven at 65° C temperature till constant weight and final weight was recorded. The fresh and dry weight of bulb was recorded at 60, 90 days after transplanting and at harvest. After curing and 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 quintal per hectare. Marketable bulb yield was calculated by discarding the undersized (less than 2.5 cm in diameter), bolter, doubles and rotted bulbs from total bulbs. Economics of various treatments was calculated in terms of gross income, net income and B:C ratio. The data were analysed statistically as per standard procedure.

RESULTS AND DISCUSSION

Fresh and dry weight of shoot

The findings (Table 1) revealed significant effect of date of transplanting, varieties as well as their combined effect on fresh weight and dry weight of shoots at all the stages. In general, there was increase in fresh weight and dry weight of shoots upto 90 DAT (days after transplanting), which was decreased at harvesting stage. Transplanting of onion seedlings at D_2 (25^{th} August) recorded maximum fresh weight and dry weight of shoot at all the stages of plant growth. Minimum values were observed in case of D_1 (10^{th} August) with significant difference. This might be due to the fact that late transplanting provided favourable environmental conditions especially temperature which stimulated vegetative growth for longer period. Similar findings have been reported by Nayee *et al.* (2009) and Mohanta and Mandal (2014) in onion. Maximum fresh weight and dry weight of shoot were recorded with variety V_8 (Agrifound Dark Red) at all the stages of growth, followed by V_7 (Bhima Shubhra) and V_5 (Bhima Super). The difference in behaviour of the varieties could be explained by the variation in their genetic make-up and differential behaviour under different climatic condition. Similar results have also been reported by Dwivedi *et al.* (2012), Mohanta and Mandal (2014) and Bindu and Podikunju (2016) in onion. Combined effect of transplanting dates and varieties showed significant effect on fresh weight and dry weight of shoot. Maximum values of fresh and dry weight were recorded under D_2V_7 (Bhima Shubhra with 25^{th} August transplanting) at all stage of growth which was followed by D_1V_8 and D_2V_8. However, minimum fresh and dry weights of shoot were observed under the combination of D_2V_2 (Arka Bheem with 25^{th} August transplanting). The difference among the varieties could be attributed to the variation in their genetic make-up and differential behaviour under different climatic conditions arised due to transplanting dates.

Table 1: Fresh and dry weight of shoot of kharif onion as affected with transplanting dates and varieties

Treatment	Fresh weight of shoot (g)				Dry weight of shoot (g)			
	30 DAT	60 DAT	90 DAT	At harvest	30 DAT	60 DAT	90 DAT	At harvest
Transplanting dates (D)								
D_1	2.37	13.38	44.99	32.68	0.27	1.33	3.78	3.28
D_2	2.63	15.83	50.47	35.42	0.31	1.57	4.20	3.55
S.Em ±	0.05	0.37	1.17	0.89	0.01	0.04	0.09	0.06
CD (P=0.05)	0.16	1.06	3.40	2.58	0.02	0.10	0.27	0.18
Varieties (V)								
V_1	1.89	10.61	38.57	28.03	0.22	1.07	3.16	3.07
V_2	1.70	9.51	33.78	24.22	0.19	1.03	2.70	2.86
V_3	2.72	15.76	51.22	35.72	0.31	1.62	4.49	3.53
V_4	2.50	12.31	45.89	32.50	0.27	1.36	3.92	3.29
V_5	2.82	17.14	53.72	36.83	0.34	1.64	4.47	3.61
V_6	2.41	14.41	46.24	32.50	0.29	1.36	3.96	3.36
V_7	2.94	17.30	55.44	41.22	0.34	1.66	4.51	3.79
V_8	3.02	19.82	57.00	41.39	0.37	1.83	4.73	3.80
S.Em ±	0.11	0.73	2.36	1.77	0.02	0.07	0.19	0.12
CD (P=0.05)	0.33	2.12	6.81	5.12	0.05	0.21	0.54	0.36
Interaction (D x V)								
D_1V_1	1.78	10.29	34.02	27.33	0.20	1.03	2.87	2.91
D_1V_2	1.87	10.37	35.67	27.56	0.22	1.04	3.00	2.93
D_1V_3	2.66	15.49	48.44	34.67	0.29	1.59	4.38	3.36
D_1V_4	2.36	11.39	45.67	31.00	0.25	1.17	3.67	3.27
D_1V_5	2.70	15.58	52.89	36.00	0.33	1.58	4.28	3.51
D_1V_6	2.01	10.79	38.26	28.00	0.24	1.08	3.28	3.04
D_1V_7	2.59	12.71	46.11	33.22	0.26	1.32	4.06	3.31
D_1V_8	3.02	20.43	58.89	43.67	0.39	1.81	4.73	3.88
D_2V_1	2.01	10.93	43.11	28.72	0.24	1.12	3.46	3.22
D_2V_2	1.53	8.66	31.89	20.89	0.17	1.02	2.40	2.79
D_2V_3	2.79	16.03	54.00	36.78	0.33	1.64	4.60	3.70
D_2V_4	2.64	13.23	46.11	34.00	0.29	1.56	4.17	3.32
D_2V_5	2.94	18.70	54.56	37.67	0.35	1.70	4.66	3.71
D_2V_6	2.80	18.02	54.22	37.00	0.34	1.65	4.64	3.67
D_2V_7	3.29	21.89	64.78	49.22	0.42	2.00	4.97	4.27
D_2V_8	3.01	19.21	55.11	39.11	0.35	1.80	4.72	3.73
S.Em ±	0.16	1.04	3.34	2.53	0.02	0.10	0.26	0.17
CD (P=0.05)	0.47	2.99	9.63	7.30	0.07	0.29	0.76	0.50

Fresh and dry weight of bulb

The data recorded on fresh and dry weight of bulb (Table 2) indicated gradual increase with the advancement of age up to harvest under all the treatments. Transplanting of onion seedlings at D_2 (25^{th} August) recorded maximum fresh weight and dry weight of bulb, which was significantly higher than D_1 (10^{th} August) transplanted onion. Increasing trend in yield attributes as noted with delayed transplanting might be due to more congenial climate for superior growth during later transplanting. These results are in agreement with the findings of Gautum *et al.* (2006), Devulkar and Jethava (2014) and Mohanta and Mandal (2014) in onion. Maximum fresh weight and dry weights of bulb were observed under V_8 (Agrifound Dark Red) followed by V_7 (Bhima Shubhra), V_5 (Bhima Super) and V_3 (Bhima Raj). Lowest values of above parameter were recorded in variety V_2 (Arka Bheem). Each variety has its own specific characteristics and accordingly variation in these parameters may be attributed to genetic difference of varieties. This type of varietal difference was also reported by Sharma (2009), Tripathy *et al.* (2014), Mohanta and Mandal (2014) and Hirave *et al.* (2015) in onion. Combined effect of

transplanting dates and varieties showed significant effect on fresh weight and dry weight of bulb at 90 DAT and harvest but 60 DAT. Maximum values were recorded with D_2V_7 (Bhima Shubhra with 25th August transplanting) which was followed by D_1V_8 and However, minimum values of above parameters were observed under D_2V_2 (Arka Bheem with 25th August). Higher growth parameters consequently resulted in highest dry matter accumulation with D_2V_7 which was followed by D_1V_8, D_2V_8, D_2V_5, D_1V_3 and D_2V_3 in descending order with non significant difference. These results are corroborated with the findings of Mohanty (2001) and Mohanta and Mandal (2014) in onion.

Table 2: Fresh and dry weight of bulb of kharif onion as affected with transplanting dates and varieties

Treatment	Fresh weight of bulb (g)			Dry weight of bulb (g)		
	60 DAT	90 DAT	At harvest	60 DAT	90 DAT	At harvest
Transplanting dates (D)						
D_1	9.85	38.20	79.13	1.05	10.89	14.21
D_2	10.77	40.27	85.50	1.12	12.34	15.33
S.Em ±	0.25	0.70	1.37	0.02	0.29	0.30
CD (P=0.05)	0.72	2.03	3.97	0.07	0.84	0.88
Varieties (V)						
V_1	8.81	33.45	70.56	1.00	9.38	12.29
V_2	8.16	28.51	60.44	0.95	7.93	11.23
V_3	10.82	41.83	88.33	1.11	12.90	15.55
V_4	9.70	40.55	83.83	1.07	11.71	14.43
V_5	11.28	42.47	89.50	1.13	13.25	16.24
V_6	10.11	40.56	80.61	1.07	10.99	14.43
V_7	11.49	43.17	90.00	1.18	12.74	16.81
V_8	12.13	43.32	95.22	1.20	14.00	17.31
S.Em ±	0.50	1.40	2.75	0.05	0.59	0.61
CD (P=0.05)	1.45	4.06	7.94	0.14	1.69	1.76
Interaction (D x V)						
D_1V_1	8.34	28.51	60.44	0.93	8.24	10.99
D_1V_2	8.78	31.72	62.22	0.98	8.52	11.56
D_1V_3	10.38	41.00	88.22	1.08	12.71	15.50
D_1V_4	9.30	40.11	81.00	1.06	10.79	14.46
D_1V_5	10.87	41.72	88.33	1.08	12.81	15.87
D_1V_6	8.83	38.33	72.67	1.01	8.57	12.94
D_1V_7	9.76	40.78	84.78	1.06	11.42	14.72
D_1V_8	12.57	43.41	95.22	1.22	14.05	17.67
D_2V_1	9.27	38.39	80.67	1.07	10.51	13.60
D_2V_2	7.53	25.30	58.67	0.92	7.34	10.90
D_2V_3	11.26	42.67	88.44	1.13	13.10	15.36
D_2V_4	10.10	40.99	86.67	1.09	12.64	14.40
D_2V_5	11.69	43.22	90.67	1.18	13.70	16.62
D_2V_6	11.38	42.78	88.56	1.13	13.41	15.92
D_2V_7	13.23	45.56	95.33	1.29	14.06	18.89
D_2V_8	11.70	43.22	95.11	1.18	13.95	16.96
S.Em ±	0.71	1.99	3.89	0.07	0.83	0.86
CD (P=0.05)	2.05	5.75	11.23	NS	2.40	2.49

Yield parameters and yield

Transplanting of onion seedlings at D_2 (25th August) recorded maximum average weight of bulb and yield of marketable bulbs which was significantly higher than D_1 (10th August) transplanted onion (Table 3). Increasing trend in yield attributes as noted with delayed transplanting might be due to more congenial climate for superior growth during later transplanting. These results are in agreement with the findings of Devulkar and Jethava (2014) Mohanta and Mandal (2014) and Sharma and Dogra (2017).

Maximum average weight of bulb and yield of marketable bulbs were observed under V_8 (Agrifound Dark Red) followed by V_7 (Bhima Shubhra), V_5 (Bhima Super) and V_3 (Bhima Raj). Lowest values of above parameter were observed in variety V_2 (Arka Bheem). Higher growth and yield parameters with Agrifound Dark Red consequently resulted in higher bulb yield. The highest yield produced by Agrifound Dark Red might be an indication of its suitability to grow in kharif season. Similar findings were reported by Sharma (2009), Tripathy *et al.* (2014), Mohanta and Mandal (2014) and Hirave *et al.* (2015) in onion. Combined effect of transplanting dates and varieties showed significant effect on average weight of bulb and yield of marketable bulbs. Maximum values were founded with D_2V_7 (Bhima Shubhra with 25th August transplanting) which was followed by D_1V_8 and However, minimum values of above parameters were observed under D_2V_2 (Arka Bheem with 25th August). Higher growth and yield parameters consequently resulted in highest marketable bulb yield with D_2V_7 which was followed by D_1V_8, D_2V_8, D_2V_5, D_1V_3 and D_2V_3 in descending order with non significant difference. These results are corroborated with the findings of Mohanty (2001), Mohanta and Mandal (2014) and Sharma and Dogra (2017).

Table 3: Yield and economics of kharif onion as affected with transplanting dates and varieties

Treatment	Average weight of bulb (g)	Marketable bulbs (qha^{-1})	Bolting (%)	Gross income (Rs.ha^{-1})	Net income (Rs.ha^{-1})	B:C ratio
Transplanting dates (D)						
D_1	71.83	261.59	1.21 (1.09)*	242232	186404	3.34
D_2	78.09	292.28	1.31 (1.23)	270656	214828	3.85
S.Em ±	1.42	7.98	0.03	6464.8	6464.8	0.12
CD (P=0.05)	4.10	20.16	0.10	18672	18672	0.33
Varieties (V)						
V_1	63.26	226.95	1.52 (1.81)	210151	154323	2.76
V_2	53.14	171.41	1.09 (0.69)	158727	102899	1.84
V_3	81.03	307.76	1.01 (0.56)	284982	229154	4.10
V_4	76.53	291.54	0.94 (0.42)	269962	214134	3.84
V_5	82.20	310.47	1.47 (1.74)	287493	231665	4.15
V_6	73.31	254.22	1.41 (1.60)	235410	179582	3.22
V_7	83.48	315.63	1.42 (1.53)	292274	236446	4.24
V_8	86.70	337.53	1.21 (0.97)	312553	256725	4.60
S.Em ±	2.84	13.96	0.07	12930	12930	0.23
CD (P=0.05)	8.19	40.32	0.19	37343	37343	0.67
Interaction (D x V)						
D_1V_1	53.14	177.49	1.54 (1.94)	164352	108524	1.94
D_1V_2	54.92	187.88	1.07 (0.69)	173980	118152	2.12
D_1V_3	80.92	309.35	0.85 (0.28)	286457	230629	4.13
D_1V_4	73.70	282.93	0.77 (0.14)	261990	206162	3.69
D_1V_5	81.03	298.41	1.19 (0.97)	276326	220498	3.95
D_1V_6	65.37	206.45	1.54 (1.94)	191172	135344	2.42
D_1V_7	77.48	289.65	1.50 (1.81)	268217	212389	3.80
D_1V_8	88.03	340.57	1.19 (0.97)	315364	259536	4.65
D_2V_1	73.37	276.40	1.49 (1.67)	255950	200122	3.58
D_2V_2	51.37	154.94	1.11 (0.69)	143474	87646	1.57
D_2V_3	81.14	306.16	1.17 (0.83)	283506	227678	4.08
D_2V_4	79.37	300.15	1.11 (0.69)	277934	222106	3.98
D_2V_5	83.37	322.53	1.75 (2.50)	298660	242832	4.35
D_2V_6	81.26	302.00	1.27 (1.25)	279648	223820	4.01
D_2V_7	89.48	341.61	1.34 (1.25)	316330	260502	4.67
D_2V_8	85.37	334.49	1.23 (0.97)	309742	253914	4.55
S.Em ±	4.01	19.75	0.09	18285	18285	0.33
CD (P=0.05)	11.59	57.03	0.27	52812	52812	0.95

** Original values are given in parentheses*

Bolting (%)

There was significant effect of transplanting dates, varieties and their combined effect on bolting in onion (Table 3). Transplanting date D_2 (25th August) recorded maximum bolting (1.23%) which was significantly higher than transplanting on D_1 (10th August). The higher bolting per cent in later transplanting might be due to low temperature with short day length during bulb growth and development. These results are corroborated with the findings of Nayee *et al.* (2009) in onion. Among the varieties, maximum bolting (1.81%) was observed in case of V_1 (Arka Kalyan) which was followed by V_5 and V_7. Minimum bolting (0.42%) was recorded in V_4 (Bhima Raj) at harvest. It may be due low temperature prevalence at crop maturation and varietal character. These results are in accordance with the findings of Hirave *et al.* (2015) in onion. Combined effect exerted significant effect on bolting. Maximum bolting (2.50%) was recorded under D_2V_5 (Bhima Super with 25th August transplanting) which was followed by D_1V_1 and D_1V_6. Minimum bolting (0.14%) was observed with D_1V_4 (Bhima Raj with 10th August transplanting).

Economics

Transplanting of onion seedling at D_2 (25th August) resulted in maximum gross income (270655.62 Rs.ha^{-1}), net income (214827.62 Rs.ha^{-1}) and B: C ratio (3.85) which were significantly higher than D_1 (10th August). These results are in close agreement with the findings of Misra *et al.* (2015) in onion. Amongst varieties, maximum gross income (312552.68 Rs.ha^{-1}), net income (256724.68 Rs.ha^{-1}) and B: C ratio (4.60) were obtained with variety V_8 (Agrifound Dark Red) which was followed by V_7, V_5 and V_3. Minimum gross income (158727.18 Rs.ha^{-1}), net income (102899.18 Rs.ha^{-1}) and B: C ratio (1.84) were realized with variety V_2 (Arka Bheem). Higher marketable yield due to suitability of variety for under the prevailing environment resulted in higher returns. Similar results have also been reported by Sharma *et al.* (2015) and Bindu and Podikunju (2016) in onion. Combined effect of transplanting dates and varieties denoted significant influence on gross income, net income and B: C ratio (Table 3). Maximum gross income (316329.80 Rs.ha^{-1}), net income (260501.80 Rs.ha^{-1}) and B: C ratio (4.67) were recorded under D_2V_7 (Bhima Shubhra with 25th August transplanting) which was followed by D_1V_8, D_2V_8, D_2V_5, D_1V_3, D_2V_3, D_2V_6, D_2V_4, D_1V_5, and D_1V_7 with non significant difference. Whereas D_2V_2 (Arka Bheem with 25th August transplanting) exhibited minimum values. These findings could be ascribed to the increase in yield due to combined effect of transplanting dates and varieties which resulted in higher gross income consequently higher net income and B: C ratio.

Based on the findings of the present experiment, it may be concluded that transplanting date D_2 (25th August) was most suitable as it recorded maximum fresh and dry weight of shoot, fresh and dry weight of bulb, average weight of bulb, yield of marketable bulb, bolting and B:C ratio. Among the varieties, V_8 (Agrifound Dark Red) had excelled for various parameters under study. Combined effect revealed that D_2V_7 (Bhima Shubhra with 25th August transplanting) recorded maximum fresh and dry weight of shoot, fresh and dry weight of bulb, average weight of bulb, yield of marketable bulbs and B:C ratio. It had non significant difference with D_2V_8 (Agrifound Dark Red with 25th August transplanting).

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