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Effect of planting geometry and organic sources of nutrients on keeping quality of onion (*Allium cepa* L.) cv. BELLARY RED

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ABSTRACT : The results obtained in the experiment revealed that, the minimum PLW and rotting (17.33 and 21.94%, respectively at 120 DAS) was recorded with the application of 50 per cent FYM (12.50 t ha^{-1}) + 50 per cent VC (2 t ha^{-1}) + biofertilizers (*Azospirillum* and phosphate solubalizing bacteria @ 5 kg ha^{-1} each) with 15 cm x 10 cm spacing and sprouting was less when crop provided with 50 per cent FYM (12.50 t ha^{-1}) + 50 per cent VC (2 t ha^{-1}) with 15 cm x 10 cm spacing. However, with respect to bulb quality parameters, application of 50 per cent FYM (12.50 t ha^{-1}) + 50 per cent VC (2 t ha^{-1}) + biofertilizers (*Azospirillum* and phosphate solubalizing bacteria @ 5 kg ha^{-1} each) with 15 cm x 10 cm spacing recorded maximum values (13.27, 13.36 and 49.28 % of TSS, dry matter and marketable bulbs at 120 DAS, respectively) followed by the crop nourished with 50 per cent FYM (12.50 t ha^{-1}) + 50 per cent VC (2 t ha^{-1}) + biofertilizers (*Azospirillum* and phosphate solubalizing bacteria @ 5 kg ha^{-1} each) with 15 cm x 15 cm spacing.

KEY WORDS : PSB, FYM, PLW, TSS, *Azospirillum*, Geometry, Onion

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Onion (*Allium cepa* L.) is the oldest known and most important commercial vegetable and spice crop grown in India. At present in India, it is grown in an area of 8.34 lakh hectares with an annual production of 135.65 lakh tonnes (Anonymous, 2010). India ranks second in the world after China by contributing 12.30 per cent to the world production. It is estimated that over 30 to 50 per cent of the onion produced in India valued at more than Rs.600 crores is lost annually during transportation and storage. The farmers knowledge about curing and other post-harvest management practices is very poor. Post-harvest handling has its own impact on keeping quality of onion. There are more chances of rotting, sprouting, physiological loss of weight and loss of chemical constituents when the bulbs are stored in high temperature and humidity. The most appropriate causes for this heavy losses are due to improper nutrient management practices and maintenance of plant population. In view of increased awareness about organic farming, residue free food production and sustainable production, investigation on these aspects were under taken during *Rabi* season to assess their effect on quality and post harvest storage life of onion.

RESEARCH METHODS

A field experiment was carried out at Agricultural Research Station, Hagari (University Agricultural Sciences, Dharwad) during *Rabi* 2006-07 to study the influence of different sources of nutrients and planting geometry on shelf life of onion cv. BELLARY RED. The experiment was laid out in a Factorial Randomized Block Design with three replications. The treatments comprised of two organic nutrient sources and six different spacings *viz.*, organic nutrient sources - O_1 - 50 per cent FYM (12.50 t ha^{-1}) + 50 per cent vermicompost (2 t ha^{-1}) and O_2 - 50 per cent FYM (12.50 t ha^{-1}) + 50 per cent vermicompst (2 t ha^{-1}) + biofertilizers (*Azospirillum* and PSB each @ 5 kg ha^{-1}) with different spacings *viz.*, S_1 - 20 cm x 15 cm, S_2 - 20 cm x 10 cm, S_3 - 20 cm x 7.5 cm, S_4 - 15 cm x 15 cm, S_5 - 15 cm x 10 cm, S_6 - 15 cm x 7.5 cm.

After harvest of the crop, cured onion bulbs were sorted out and five kg healthy bulbs from each treatment were selected and stored in well ventilated room for shelf life studies. Observations like physiological loss of weight, sprouting, rotting, dry matter, TSS, moisture, phosphorus and sulphur content and marketable bulbs were recorded at 15 days interval up to 4 months. The data were analyzed statistically and results were interpreted by using methods suggested by Panse and Sukhatme (1967).

RESEARCH FINDINGS AND DISCUSSION

Physiological loss of weight and rotting of the bulbs in the storage are important parameters which decide the shelf life of onion. In the present study, the bulb showed gradual increase in physiological loss of weight and rotting with the advancement of storage period in all the treatments. Among

Table 1 : Effect of different organic sources of nutrients and planting geometry on physiological loss of weight (%) of onion bulbs stored under ambient conditions during *Rabi* season

Treatments	PLW (%) Days after storage (DAS)							
	15	30	45	60	75	90	105	120
Factor 1 : Organic nutrient sources								
O_1 - 50% FYM + 50% VC	2.13	4.52	7.48	10.63	14.09	17.26	21.33	24.07
O_2 - 50% FYM + 50% VC + Biofertilizers	1.95	3.97	6.26	9.37	12.15	15.37	19.53	21.43
S.E. $\pm$	0.043	0.075	0.083	0.109	0.133	0.159	0.142	0.165
C.D. (P=0.05)	0.127	0.219	0.202	0.321	0.390	0.467	0.417	0.484
Factor 2 : Planting geometry								
S_1 (20 cm x 15 cm)	1.96	4.34	6.67	9.89	13.02	16.39	20.62	23.54
S_2 (20 cm x 10 cm)	2.08	4.46	7.01	9.95	13.35	16.89	20.89	24.08
S_3 (20 cm x 7.5 cm)	1.69	3.64	6.07	9.41	12.37	15.36	19.68	21.78
S_4 (15 cm x 15 cm)	1.77	3.27	6.05	8.86	11.80	14.06	17.94	19.77
S_5 (15 cm x 10 cm)	1.64	3.21	5.28	8.14	11.03	14.05	17.92	19.11
S_6 (15 cm x 7.5 cm)	3.08	6.55	10.10	13.78	17.15	21.13	25.53	28.21
S.E. $\pm$	0.075	0.129	0.143	0.189	0.230	0.276	0.246	0.286
C.D. (P=0.05)	0.22	0.379	0.420	0.555	0.675	0.809	0.722	0.839
Interaction								
O_1S_1	2.13	5.04	7.07	10.40	13.80	17.04	21.86	24.68
O_1S_2	2.11	4.66	7.40	10.23	13.80	17.21	21.38	24.94
O_1S_3	1.73	3.84	6.71	10.25	13.65	16.55	20.64	23.91
O_1S_4	1.79	3.29	6.47	9.12	12.47	14.67	18.37	20.84
O_1S_5	1.68	3.35	6.14	9.06	12.49	16.04	19.36	20.89
O_1S_6	3.32	6.96	11.11	14.75	18.33	22.02	26.37	29.13
O_2S_1	1.80	3.63	6.26	9.38	12.25	15.74	19.38	22.41
O_2S_2	2.05	4.26	6.63	9.66	12.89	16.56	20.40	23.21
O_2S_3	1.65	3.45	5.41	8.57	11.10	14.17	18.72	19.65
O_2S_4	1.74	3.13	5.66	8.60	11.14	13.43	17.52	18.71
O_2S_5	1.61	3.19	4.42	7.22	9.57	12.08	16.48	17.33
O_2S_6	2.84	6.13	9.09	12.80	15.96	20.24	24.69	27.28
Mean	2.04	4.24	6.86	10.00	13.12	16.31	20.43	22.75
S.E. $\pm$	0.106	0.183	0.242	0.268	0.326	0.390	0.348	0.405
C.D. (P=0.05)	NS	0.535	0.594	0.785	0.955	1.145	1.021	1.187

FYM - Farm Yard Manure (50% FYM-12.50 t ha^{-1}), VC – Vermicompost (50% VC-2 t ha^{-1}),
Bio fertilizers - *Azospirillum* and PSB @ 5 kg ha^{-1}each, NS - Non significant

the treatments, O_2S_5 - 50 per cent FYM (12.50 t ha^{-1}) + 50 per cent VC (2 t ha^{-1}) + biofertilizers with 15 cm x 10 cm (17.33 and 21.94 % PLW and rotting, respectively at the end of storage period) noted lowest PLW and rotting followed by O_2S_4 - 50 per cent FYM (12.50 t ha^{-1}) + 50 per cent VC (2 t ha^{-1}) + biofertilizers with 15 cm x 15 cm (Table 1 and 2). Whereas, the values with regard to PLW and rotting of the stored bulbs were maximum (24.94 and 28.31% PLW and rotting, respectively at the end of storage period) in O_1S_2. The minimum PLW and rotting in O_2S_5 treatment was due to higher uptake of nutrients which has lead to maximum accumulation of dry matter and TSS in the bulbs. This might be due to reduced respiration and transpiration rates because of medium bulb size. Singh *et al*. (2002) also opined that the planting of onion with 15 cm x10 cm spacing has resulted in obtaining minimum PLW and rotting as compared to the bulbs obtained from wider spacing. Katung *et al*. (2005) reported lowest PLW and rotting in onion during five month storage

Table 2 : Effect of different organic sources of nutrients and planting geometry on rotting (%) of onion bulbs stored under ambient conditions during *Rabi* season

Treatments	Rotting (%) Days after storage (DAS)						
	30	45	60	75	90	105	120
Factor 1 : Organic nutrient sources							
O_1 - 50% FYM + 50% VC	2.45	4.54	7.87	11.31	16.47	20.91	27.40
O_2 - 50% FYM + 50% VC + Biofertilizers	2.14	4.10	7.17	10.37	15.45	19.78	25.92
S.E. ±	0.046	0.078	0.067	0.107	0.090	0.111	0.141
C.D. (P=0.05)	0.136	0.228	0.198	0.313	0.264	0.325	0.415
Factor 2 : Planting geometry							
S_1 (20 cm x 15 cm)	2.45	4.50	7.75	10.90	16.87	20.96	27.75
S_2 (20 cm x 10 cm)	2.11	4.10	7.22	9.84	15.86	19.24	27.16
S_3 (20 cm x 7.5 cm)	2.67	4.62	8.08	11.36	17.26	21.83	27.95
S_4 (15 cm x 15 cm)	1.80	3.64	6.66	9.88	14.70	18.62	24.50
S_5 (15 cm x 10 cm)	1.62	3.38	6.14	9.12	12.22	18.24	23.36
S_6 (15 cm x 7.5 cm)	3.15	5.68	9.28	13.95	18.85	23.18	29.24
S.E. ±	0.080	0.135	0.117	0.185	0.156	0.192	0.245
C.D. (P=0.05)	0.235	0.395	0.342	0.542	0.458	0.536	0.719
Interaction							
O_1S_1	2.63	4.66	8.10	11.54	17.38	21.81	28.15
O_1S_2	2.13	4.16	7.25	9.95	16.00	19.36	28.31
O_1S_3	2.82	4.92	8.44	12.26	17.79	22.21	28.60
O_1S_4	1.89	3.82	6.87	10.17	15.03	19.35	25.22
O_1S_5	1.84	3.71	6.74	9.25	13.19	19.19	24.78
O_1S_6	3.42	5.96	9.86	14.69	19.46	23.51	29.35
O_2S_1	2.27	4.33	7.39	10.25	16.37	20.10	27.34
O_2S_2	2.08	4.04	7.18	9.72	15.72	19.13	26.00
O_2S_3	2.51	4.31	7.73	10.46	16.73	21.45	27.30
O_2S_4	1.70	3.47	6.45	9.59	14.37	17.88	23.79
O_2S_5	1.40	3.04	5.55	8.98	11.25	17.30	21.94
O_2S_6	2.87	5.39	8.69	13.20	18.24	22.84	29.12
Mean	2.30	4.32	7.52	10.84	15.96	20.34	26.66
S.E. ±	0.113	0.190	0.165	0.261	0.221	0.272	0.347
C.D. (P=0.05)	NS	NS	0.484	0.766	0.648	0.797	1.016

FYM - Farm Yard Manure (50% FYM-12.50 t ha^{-1}), VC – Vermicompost (50% VC-2 t ha^{-1})
Bio fertilizers - *Azospirillum* and PSB @ 5 kg ha^{-1}each. NS =Non-significant

by the application of poultry manure.

The onion bulbs are subject to sprout in the storage whenever favourable climatic condition exists because they are metabolically active even after harvest. The treatment comprising of 50 per cent FYM (12.50 t ha^{-1}) + 50 per cent VC (2 t ha^{-1}) along with 15 cm x 10 cm spacing (O_1S_5) recorded lowest sprouting (2.52, 3.73, 7.00 and 9.90 per cent, respectively at 75, 90, 105 and 120 DAS) while the sprouting was maximum in O_2S_1 - 50 per cent FYM (12.50 t ha^{-1}) + 50 per cent VC (2 t ha^{-1}) + Biofertilizers with 20 cm x 15 cm spacing (5.32, 9.93, 12.20, and 16.41 per cent, respectively at 75, 90, 105 and 120 DAS) (Table 3). Singh *et al.* (2002) also observed maximum sprouting of the bulbs in wider spacing. This is because of bigger sized bulbs obtained in the wider spacing due to their high moisture content and rich nutritional content favoured sprouting (Singh and Singh, 1973).

The treatments differed significantly throughout the

Table 3 : Effect of different organic sources of nutrients and planting geometry on sprouting (%) of onion bulbs stored under ambient conditions during *Rabi* season

Treatments	Sprouting (%) Days after storage (DAS)				
	60	75	90	105	120
Factor 1 : Organic nutrient sources					
O_1 - 50% FYM + 50% VC	1.78	3.34	6.50	9.24	12.86
O_2 - 50% FYM + 50% VC+ Biofertilizers	2.02	3.85	7.43	10.21	13.49
S.E ±	0.052	0.063	0.092	0.096	0.111
C.D. (P=0.05)	0.152	0.185	0.269	0.283	0.327
Factor 2 : Planting geometry					
S_1 (20 cm x 15 cm)	2.67	5.05	9.61	11.88	16.10
S_2 (20 cm x 10 cm)	1.89	3.80	7.79	9.97	14.12
S_3 (20 cm x 7.5 cm)	2.10	4.01	8.18	10.60	14.90
S_4 (15 cm x 15 cm)	1.49	2.79	5.22	8.10	11.09
S_5 (15 cm x 10 cm)	1.47	2.72	4.62	7.73	10.16
S_6 (15 cm x 7.5 cm)	1.79	3.20	6.35	10.10	12.68
S.E ±	0.090	0.109	0.159	0.167	0.193
C.D. (P=0.05)	0.264	0.321	0.465	0.490	0.566
Interaction					
O_1S_1	2.44	4.78	9.28	11.55	15.79
O_1S_2	1.85	3.43	7.31	9.67	13.47
O_1S_3	1.89	3.47	7.68	10.15	14.30
O_1S_4	1.42	2.69	4.70	7.89	10.43
O_1S_5	1.36	2.52	3.73	7.00	9.90
O_1S_6	1.75	3.15	6.27	9.19	12.45
O_2S_1	2.90	5.32	9.93	12.20	16.41
O_2S_2	1.93	4.16	8.28	10.26	14.76
O_2S_3	2.32	4.54	8.69	11.05	15.49
O_2S_4	1.52	2.89	5.74	8.31	10.73
O_2S_5	1.62	2.92	5.50	8.46	11.45
O_2S_6	1.83	3.24	6.43	11.00	12.91
Mean	1.90	3.59	6.96	9.73	13.17
S.E. ±	0.127	0.155	0.224	0.236	0.273
C.D. (P=0.05)	NS	0.454	0.658	0.693	0.800

FYM - Farm Yard Manure (50% FYM-12.50 t ha^{-1}), VC – Vermicompost (50% VC-2 t ha^{-1}),
Bio fertilizers - *Azospirillum* and PSB @ 5 kg ha^{-1}each, NS=Non-significant

storage period for TSS and dry matter accumulation in the bulbs and the content increased gradually with the advancement of storage period (Table 4 and 5). This is in conformity with the results obtained by Kukanoor (2005) and Patil and Kale (1998) in onion. Among the treatments, maximum TSS (13.27%) and dry matter content (13.36%) was observed in the bulbs provided with 50% FYM (12.50 t ha^{-1}) + 50% VC (2 t ha^{-1}) + biofertilizers with 15 cm x 10 cm

Table 4 : Effect of different organic sources of nutrients and planting geometry on total soluble solids (%) of onion bulbs stored under ambient conditions during *Rabi* season

Treatments	TSS (%) Days after storage (DAS)							
	15	30	45	60	75	90	105	120
Factor 1 : Organic nutrient sources								
O_1 - 50% FYM + 50% VC	9.85	10.04	10.22	10.45	10.73	10.83	11.06	11.26
O_2 - 50% FYM + 50% VC + Biofertilizers	10.19	10.37	10.66	10.85	11.02	11.27	11.46	11.78
S.E. $\pm$	0.100	0.082	0.060	0.097	0.080	0.109	0.090	0.080
C.D. (P=0.05)	0.293	0.241	0.177	0.284	0.235	0.320	0.265	0.233
Factor 2 : Planting geometry								
S_1 (20 cm x 15 cm)	9.90	10.09	10.22	10.53	10.75	10.93	11.19	11.42
S_2 (20 cm x 10 cm)	10.17	10.44	10.64	10.91	11.10	11.28	11.20	11.78
S_3 (20 cm x 7.5 cm)	9.69	9.82	10.00	10.15	10.38	10.50	10.73	10.92
S_4 (15 cm x 15 cm)	10.45	10.64	11.00	11.10	11.36	11.57	11.86	12.04
S_5 (15 cm x 10 cm)	10.72	10.92	11.35	11.60	11.79	12.00	12.33	12.59
S_6 (15 cm x 7.5 cm)	9.21	9.35	9.44	9.62	9.85	10.04	10.25	10.39
S.E. $\pm$	0.173	0.142	0.105	0.168	0.139	0.189	0.156	0.138
C.D. (P=0.05)	0.508	0.417	0.307	0.492	0.408	0.554	0.459	0.404
Interaction								
O_1S_1	9.72	9.96	10.01	10.38	10.61	10.79	11.01	11.26
O_1S_2	10.06	10.36	10.55	10.85	11.04	11.21	11.45	11.72
O_1S_3	9.53	9.62	9.78	9.93	10.58	10.30	10.51	10.74
O_1S_4	10.39	10.54	10.72	10.96	11.14	11.41	11.53	11.72
O_1S_5	10.41	10.62	11.03	11.14	11.33	11.44	11.72	11.90
O_1S_6	9.00	9.14	9.27	9.42	9.68	9.86	10.11	10.24
O_2S_1	10.07	10.21	10.44	10.67	10.89	11.07	11.37	11.58
O_2S_2	10.27	10.51	10.73	10.96	11.16	11.34	10.94	11.84
O_2S_3	9.84	10.02	10.21	10.37	10.18	10.71	10.94	11.10
O_2S_4	10.51	10.74	11.28	11.24	11.58	11.72	12.18	12.36
O_2S_5	11.03	11.21	11.67	12.05	12.25	12.57	12.93	13.27
O_2S_6	9.41	9.55	9.62	9.83	10.03	10.22	10.38	10.54
Mean	10.02	10.21	10.44	10.65	10.87	11.05	11.26	11.52
S.E. $\pm$	0.245	0.201	0.148	0.237	0.197	0.267	0.221	0.195
C.D. (P=0.05)	NS	NS	NS	NS	NS	NS	0.648	0.571

FYM - Farm Yard Manure (50% FYM-12.50 t ha^{-1}), VC – Vermicompost (50% VC-2 t ha^{-1}),
Bio fertilizers - *Azospirillum* and PSB @ 5 kg ha^{-1}each, NS - Non significant.

(O_2S_5) followed by O_2S_4 - 50% FYM (12.50 t ha^{-1}) + 50% VC (2 t ha^{-1}) + biofertilizers with 15 cm ´ 15 cm (12.36 and 12.90% TSS and dry matter, respectively) at the end of storage period. This was attributed to the fact that there was better accumulation of phosphorous and sulphur in the bulbs which might be due to metabolic process and enzymatic activities in presence of *Azospirillum*, PSB and vermicompost. Increased accumulation of TSS and dry matter

Table 5 : Effect of different organic sources of nutrients and planting geometry on dry matter (%) content of onion bulbs stored under ambient conditions during *Rabi* season

Treatments	Dry matter (%)							
	Days after storage (DAS)							
	15	30	45	60	75	90	105	120
Factor 1 : Organic nutrient sources								
O_1 - 50% FYM + 50% VC	10.43	10.64	10.80	11.04	11.31	11.59	11.78	11.93
O_2 - 50% FYM+50% VC+Biofertilizers	10.66	11.00	11.15	11.37	11.64	11.94	12.14	12.31
S.E. ±	0.067	0.043	0.056	0.053	0.058	0.042	0.048	0.04
C.D. (P=0.05)	0.197	0.127	0.165	0.155	0.171	0.124	0.141	0.11
Factor 2 : Planting geometry								
S_1 (20 cm x 15 cm)	10.22	10.37	10.46	10.71	10.98	11.29	11.47	11.58
S_2 (20 cm x 10 cm)	10.10	10.49	10.64	10.84	11.11	11.39	11.61	11.78
S_3 (20 cm x 7.5 cm)	10.43	10.64	10.70	10.95	11.22	11.50	11.72	11.85
S_4 (15 cm x 15 cm)	10.96	11.20	11.46	11.71	11.98	12.27	12.49	12.68
S_5 (15 cm x 10 cm)	11.13	11.66	11.84	12.04	12.31	12.57	12.74	12.94
S_6 (15 cm x 7.5 cm)	10.44	10.57	10.75	10.97	11.24	11.55	11.72	11.90
S.E. ±	0.116	0.075	0.098	0.092	0.101	0.073	0.084	0.066
C.D. (P=0.05)	0.342	0.220	0.286	0.269	0.296	0.214	0.245	0.194
Interaction								
O_1S_1	10.17	10.25	10.36	10.61	10.88	11.19	11.31	11.43
O_1S_2	10.03	10.47	10.62	10.76	11.03	11.30	11.52	11.66
O_1S_3	10.39	10.55	10.61	10.86	11.13	11.37	11.59	11.66
O_1S_4	10.72	10.96	11.22	11.47	11.74	12.05	12.27	12.45
O_1S_5	10.87	11.13	11.31	11.56	11.83	12.08	12.30	12.53
O_1S_6	10.42	10.51	10.70	10.95	11.22	11.54	11.65	11.83
O_2S_1	10.26	10.49	10.56	10.81	11.08	11.40	11.62	11.73
O_2S_2	10.18	10.50	10.66	10.91	11.18	11.48	11.70	11.90
O_2S_3	10.47	10.72	10.79	11.04	11.31	11.63	11.85	12.03
O_2S_4	11.20	11.44	11.70	11.95	12.22	12.50	12.72	12.90
O_2S_5	11.38	12.19	12.36	12.52	12.79	13.06	13.18	13.36
O_2S_6	10.46	10.64	10.80	10.98	11.25	11.56	11.78	11.96
Mean	10.55	10.82	10.98	11.20	11.47	11.76	11.96	12.12
S.E. ±	0.165	0.106	0.138	0.130	0.143	0.103	0.118	0.094
C.D. (P=0.05)	NS	0.312	0.405	0.381	0.419	0.303	0.346	0.275

FYM - Farm Yard Manure (50% FYM-12.50 t ha^{-1}), VC – Vermicompost (50% VC-2 t ha^{-1}),
Bio fertilizers - *Azospirillum* and PSB @ 5 kg ha^{-1}each, NS - Non significant.

Table 6 : Effect of different organic sources of nutrients and planting geometry on marketable bulbs (%) of onion bulbs stored under ambient conditions during *Rabi* season

Treatments	Marketable bulbs (%) Days after storage (DAS)							
	15	30	45	60	75	90	105	120
Factor 1 : Organic nutrient sources								
O_1 - 50% FYM + 50% VC	97.87	93.02	87.98	79.76	71.26	59.78	48.52	35.67
O_2 - 50% FYM +50% VC+Biofertilizers	98.05	93.89	89.66	81.40	73.63	61.75	50.47	39.17
S.E. $\pm$	0.030	0.092	0.124	0.151	0.192	0.228	0.168	0.231
C.D. (P=0.05)	0.089	0.269	0.364	0.443	0.563	0.667	0.494	0.678
Factor 2 : Planting geometry								
S_1 (20 cm x 15 cm)	98.04	93.22	88.84	79.71	71.03	57.13	46.55	32.61
S_2 (20 cm x 10 cm)	97.92	93.43	88.89	80.95	73.02	59.46	49.90	34.66
S_3 (20 cm x 7.5 cm)	98.31	93.69	89.33	80.41	72.26	59.20	47.89	35.37
S_4 (15 cm x 15 cm)	98.24	95.00	90.29	83.00	75.60	66.03	55.71	45.56
S_5 (15 cm x 10 cm)	98.36	95.11	91.34	84.14	77.07	69.10	55.74	46.44
S_6 (15 cm x 7.5 cm)	96.92	90.31	84.22	75.29	65.71	53.67	41.20	29.88
S.E. $\pm$	0.053	0.159	0.215	0.261	0.333	0.394	0.292	0.400
C.D. (P=0.05)	0.155	0.466	0.630	0.766	0.976	1.156	0.855	1.174
Interaction								
O_1S_1	97.87	92.34	88.27	79.11	69.88	56.30	44.78	31.38
O_1S_2	97.89	93.21	88.44	80.67	72.81	59.47	49.59	33.28
O_1S_3	98.27	93.34	88.37	79.43	70.62	57.98	47.00	33.18
O_1S_4	98.21	94.82	89.71	82.67	74.84	65.60	55.28	43.52
O_1S_5	98.32	94.81	90.14	82.78	75.57	67.04	53.56	43.59
O_1S_6	96.68	89.62	82.92	73.90	63.83	52.26	40.92	29.07
O_2S_1	98.20	94.10	89.41	80.32	72.18	57.96	48.31	33.84
O_2S_2	97.95	93.66	89.33	81.23	73.23	59.44	50.21	36.03
O_2S_3	98.35	94.04	90.28	81.38	73.89	60.42	48.78	37.56
O_2S_4	98.26	95.17	90.87	83.32	76.35	66.45	56.14	47.60
O_2S_5	98.39	95.41	92.54	85.50	78.56	71.16	57.92	49.28
O_2S_6	97.16	90.99	85.52	76.67	67.59	55.09	41.47	30.69
Mean	97.96	93.46	88.82	80.58	72.45	60.76	49.50	37.42
S.E. $\pm$	0.075	0.225	0.304	0.370	0.471	0.557	0.412	0.566
C.D. (P=0.05)	0.219	0.659	0.891	1.084	1.380	1.635	1.210	1.660

FYM - Farm Yard Manure (50% FYM-12.50 t ha^{-1}), VC – Vermicompost (50% VC-2 t ha^{-1}),
Bio fertilizers - *Azospirillum* and PSB @ 5 kg ha^{-1}each.

was also due to closer spacing, wherein bulbs are small and possibly minimum transpiration and respiration activities in the storage resulting in better quality bulbs. Similar findings were also reported by Shanti and Balakrishnan (1989) in onion and Balasubramani (2006) in tomato.

Among the different treatments studied O_2S_5 - 50% FYM (12.50 t ha^{-1}) + 50% VC (2 t ha^{-1}) + biofertilizers with 15 cm x 10 cm recorded highest marketable bulbs (98.39, 95.41, 92.54, 85.50, 78.56, 71.16, 57.92 and 49.28 per cent, respectively at 15, 30, 45, 60, 75, 90, 105 and 120 DAS) throughout the storage period (Table 6). The reason is due to better quality parameters like TSS and dry matter content in the bulbs as well as least rotting and sprouting losses in the storage. Srivastava *et al.* (1995) also observed highest marketable bulbs with closer spacing (10 cm x 10 cm) in onion.

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