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Effect of spacing and nutrients on the phenotypic characters, flowering and bulb characters in multiplier onion (*Allium cepa* L. var. *aggregatum* Don.)

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Abstract

Trials were conducted at Horticultural College and Research Institute, Coimbatore and Krishi Vigyan Kendra, Kundrakudi to study the effects of different spacing and nutrient levels on *Allium cepa* L. var. *aggregatum* Don. with respect to phenotypic characters such as plant height, number of leaves and number of shoots, days taken for flower initiation, days to 50 per cent flowering, shape index, bulb diameter and bulb length. Three spacings *viz.*, 45 x 5 cm (M1), 45 x 10 cm (M2), and 45 x 15 cm (M3) formed as main plot (M) treatments. The sub plot treatments (S) consisted of 10 combinations involving three levels of Nitrogen and Phosphorus (20,40 and 60 kg ha^{-1}), constant level of K (30 Kg ha^{-1}) along with FYM (Farm Yard Maure) at 25 t ha^{-1}, *Azospirillum* at 2 kg ha^{-1} and *Phosphobacteria* at 2 kg ha^{-1}. A control without nutrients was also adopted. The experiment was laid out in split plot design with 10 treatments replicated thrice. The maximum plant height showed an increased trend with increasing level of nutrients. Interaction effect recorded the higher plant height (48.5 cm) at 100th and 135th day of sowing with the application of 60:60:30 Kg NPK ha^{-1} along with FYM at 25 t ha $^{-1}$, *Azospirillum* at 2 kg ha^{-1} and *Phosphobacteria* of 2 kg ha^{-1} with the closest spacing of 45 x 5 cm. The increase in length of bulb and shape index was higher at closest spacing of 45 x 5 cm, whereas, the wider spacing of 45 x 15 cm registered the greater bulb diameter. The treatments had significant influence on the bulb characters, which increased with increasing level of nutrients. Spacing and nutrients had no influence on the days taken for flower initiation and days to 50 per cent flowering. Higher bulb length (5.70 cm) and shape index (1.09 %) was recorded from the application of 60: 60: 30 kg NPK ha^{-1}, FYM @ 25 t ha^{-1}, *Azospirillum* @ 2 kg ha^{-1} and *Phosphobacteria* @ 2 kg ha^{-1} along with the closest spacing of 45 x 5 cm.

Keywords: aggregatum onion, planting density, bulb development, flowering, spacing, nutrients

INTRODUCTION

Aggregatum onion (*Allium cepa* L. var. *aggregatum*) is an unique pungent spice crop. It requires large quantities of readily available nutrients (Patil *et al.*, 1984). An optimum plant density is important for the higher utilization of applied nutrients (Pall and Padda, 1972). Study of the responses of aggregatum onion to population density and various levels of nutrients would provide a basis for assessing the optimum plant density and levels of nutrients. Further, earliness in flowering would help reduce duration of the cropping period and so it could be an idicator of positive response of the plant. The present study was conducted to find out the responses of aggregatum onion to different spacing and levels of organic, inorganic nutrient sources and biofertilizers with regard to plant height, number of leaves, number of shoots, days taken for flower initiation, days to 50 per cent flowering, bulb diameter, bulb length and shape index.

MATERIALS AND METHODS

Experiments were conducted at Horticultural College and Research Institute, Coimbatore and Krishi Vigyan Kendra, Kundrakudi, Tamil Nadu, South India during June to September 2006 in split plot design with 10 treatments replicated thrice. The spacing *viz.*, 45 x 5 cm (M1), 45 x 10 cm (M2) and 45 x 15 cm (M3) were the main plot treatments. The subplot (S) treatments consisted of 10 combinations and were formulated as follows

S1 - Control – No organic manure, no biofertilizer and no inorganic fertilizers.

S2 - 60 : 60 : 30 NPK ha $^{-1}$ (Recommended doses of fertilizers)[RDF]

S3 - 60: 60: 30 kg NPK + 25 t FYM + 2 kg *Azospirillum* + 2 kg phosphobacteria ha $^{-1}$

S4 - 40: 60: 30 kg NPK + 25 t FYM + 2 kg *Azospirillum* + 2 kg *Phosphobacteria* ha $^{-1}$

S5 - 20: 60: 30 kg NPK + 25 t FYM + 2 kg *Azospirillum* + 2 kg *Phosphobacteria* ha $^{-1}$

S6 - 60: 60: 30 kg NPK + 2 kg *Azospirillum* + 2 kg *Phosphobacteria* ha $^{-1}$

S7 - 60: 20: 30 kg NPK + 2 kg *Azospirillum* + 2 kg *Phosphobacteria* ha $^{-1}$

S8 - 40: 40: 30 kg NPK + 2 kg *Azospirillum* + 2 kg *Phosphobacteria* ha $^{-1}$

S9 - 20: 20: 30 kg NPK + 2 kg *Azospirillum* + 2 kg *Phosphobacteria* ha $^{-1}$

S10 - Organic alone (25t FYM + 2 kg *Azospirillum* + 2 kg *Phosphobacteria* ha $^{-1}$

(NPK- Nitrogen, Phosphorus, Potassium; FYM – Farm Yard Manure)

Farm Yard Manure (FYM) @ 25 t ha^{-1}, *Azospirillum* and *Phosphobacteria* each @ 2 kg ha $^{-1}$ were applied during

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field preparations. Five randomly selected plants in each replication were tagged for recording observations. The height of the plant, number of leaves and number of suckers were counted on 65th, 100th and 135th day of sowing. The mean data were statistically analysed. Further, observations were recorded and statistically analyzed for the traits on days taken for flower initiation, days to 50 per cent flowering, shape index, bulb diameter and bulb length .

RESULTS AND DISCUSSION

The results on the Effect of plant density and nutrients on phenotypic characters in seed propagated multiplier onion (*Allium cepa* L. var. *aggregatum* Don.) at three stages *viz.*, 65th, 100th and 135th day of sowing are presented in the tables 1, 2 and 3.

The results in the tables 1, 2 and 3 revealed that the closer spacing of 45 X 5 cm registered the tallest plants irrespective of stages *viz.*, 65th, 100th and 135th day of sowing. Further, the plant height showed an increasing trend with increase in the level of nutrients. The interaction effect revealed that application of 60:60: 30 kg NPK ha $^{-1}$ along with FYM @ 25t ha $^{-1}$, *Azospirillum* @ 2 kg ha $^{-1}$ and *Phosphobacteria* @ 2 kg ha $^{-1}$ with closest spacing of 45 x 5 cm recorded the higher plant height

Table 1 Effect of spacing and nutrients on plant height (cm) at three stages of aggregatum onion, *A. cepa* L. var. *aggregatum* Don.

Treat	65th day				100th day				135th day			
ments	M1	M2	M3	Mean	M1	M2	M3	Mean	M1	M2	M3	Mean
S1	14.12	14.92	10.19	13.08	20.17	18.93	15.25	18.11	29.11	28.35	26.20	27.89
S2	17.04	18.01	15.08	16.74	25.17	22.18	19.92	22.42	35.38	33.35	32.46	33.73
S3	23.97	21.53	20.60	22.03	35.17	32.77	30.31	32.75	48.53	46.12	44.79	46.48
S4	22.67	20.28	19.54	20.83	32.65	30.15	28.23	30.46	45.87	43.75	42.58	44.07
S5	22.62	20.51	19.61	20.91	30.52	28.85	26.37	28.58	44.63	41.14	40.41	42.06
S6	21.49	19.14	18.41	19.68	28.44	26.38	24.08	26.30	40.94	38.45	37.39	38.93
S7	21.54	19.11	18.63	19.76	27.61	25.26	23.33	25.40	38.53	36.50	35.22	36.75
S8	19.30	18.09	16.29	17.89	26.33	23.33	21.02	23.52	37.67	35.89	34.56	36.04
S9	16.43	17.19	13.33	15.65	24.63	21.27	18.96	21.62	31.13	32.40	30.55	32.36
S10	15.08	15.96	12.04	14.36	23.01	20.01	15.93	19.65	30.39	30.37	28.44	29.73
Mean	19.44	18.47	16.37	18.09	27.37	24.93	22.34	24.88	38.52	36.63	35.26	36.80
	SE	CD			SE	CD			SE	CD		
S	0.03	NS			0.05	0.12			0.05	0.13		
M	0.17	NS			0.28	0.56			0.31	0.63		
S X M	0.30	NS			0.24	1.00			0.55	NS		
M X S	0.29	NS			0.46	0.93			0.46	NS		

Main Plot – Spacing (M) Sub Plot – Nutrients (S) NS - Not Significant ($p > 0.05$)

Table 2 Effect of spacing and nutrients on number of leaves at three stages of aggregatum onion, *A. cepa* L. var. *aggregatum* Don.

Treat	65th day				100th day				135th day			
ments	M1	M2	M3	Mean	M1	M2	M3	Mean	M1	M2	M3	Mean
S1	10.03	10.89	12.36	11.09	12.15	12.96	14.43	13.18	19.31	21.93	25.54	22.26
S2	11.92	13.01	12.07	12.33	15.93	17.49	19.54	17.65	26.14	28.05	29.06	27.75
S3	17.06	17.67	18.71	17.81	28.75	30.67	32.69	30.70	4089	42.77	44.53	42.73
S4	15.53	16.33	17.63	16.49	26.19	28.01	30.40	28.23	36.25	38.36	39.99	38.20
S5	15.07	16.42	17.37	16.28	23.94	26.67	28.41	26.34	34013	36.80	38.64	36.52
S6	14.44	15.22	16.21	15.29	23.06	24.89	27.04	25.00	33.06	34.13	37.03	34.74
S7	14.18	14.98	16.32	15.16	22.74	22.93	25.41	23.69	30.36	33.49	36.41	33.42
S8	13.14	14.43	15.60	14.39	20.70	21.09	23.00	2.60	26.99	32.06	34.79	31.28
S9	13.27	14.17	15.11	14.18	17.53	18.37	19.98	18.63	26.45	30.42	32.90	29.92
S10	12.96	11.93	12.92	12.60	11.89	15.33	15.94	14.39	24.26	25.84	28.37	26.16
Mean	13.76	14.50	15.43	14.56	20.29	21.85	23.68	21.94	29.78	32.38	34.73	32.30
	SE	CD			SE	CD			SE	CD		
S	0.51	NS			0.05	0.13			0.22	0.53		
M	0.28	NS			0.10	0.20			0.38	0.78		
S X M	0.49	NS			0.55	1.12			0.67	2.04		
M X S	0.46	NS			0.58	1.05			0.64	1.28		

Main Plot – Spacing (M) Sub Plot – Nutrients (S) NS - Not Significant ($p > 0.05$)

Table 3 Effect of spacing and nutrients on number of suckers per side shoots at 3 stages of aggregatum onion, *A. cepa* L. var. *aggregatum* Don.

Treat	65th day				100th day				135th day			
ments	M1	M2	M3	Mean	M1	M2	M3	Mean	M1	M2	M3	Mean
S1	1.20	1.11	1.39	1.23	2.17	1.95	4.25	2.79	2.09	2.03	5.35	3.15
S2	2.26	2.12	2.28	2.22	4.01	4.19	7.25	5015	5.11	5.06	8.06	6.07
S3	3.42	3.63	3.66	3.57	7.72	8.83	10.84	9.13	8.81	10.81	12.86	10.82
S4	2.20	3.22	3.38	2.93	6.46	7.56	9.56	7.86	7.25	8.63	11.53	9.13
S5	2.27	2.38	3.27	2.64	6.13	7.28	9.27	7.56	6.95	8.38	11.27	8.86
S6	2.07	2.37	2.17	2.20	5.35	6.39	8.26	6.67	6.25	7.43	10.41	8.03
S7	1.17	2.14	2.22	1.84	5.17	6.05	8.10	6.44	6.13	7.04	10.24	7.80
S8	1.22	2.02	2.08	1.77	4.19	5.54	6.19	5.31	5.44	6.29	9.14	6.95
S9	2.37	2.41	2.02	2.26	3.88	3.12	5.16	4.05	3.44	4.41	7.26	5.003
S10	1.09	2.22	1.05	1.45	2.23	2.23	4.13	2.86	2.17	3.07	6.17	3.80
Mean	1.92	2.36	2.35	2.21	4.73	5.31	7.30	5.78	5.36	6.31	9.22	6.96
	SE	CD			SE	CD			SE	CD		
S	0.01	NS			0.01	0.04			0.02	0.06		
M	0.07	NS			0.10	0.21			0.14	0.28		
S X M	0.12	NS			0.18	NS			0424	0.50		
M X S	0.11	NS			0.17	NS			0.23	0.46		

Main Plot – Spacing (M) Sub Plot – Nutrients (S) NS - Not Significant ($p > 0.05$)

(35.17 cm and 48.5 cm at 100th and 135th days of sowing, respectively).

Accordingly, the height of the plant was found to be maximum at closer spacing of 45 x 5 cm at 100th and 135th day of sowing. The closer spacing would have led to the greater inter competition among plants for available nutrients and thereby encouraged the apical dominance resulting in the tallest plants as reported by Pall and Padda, (1972) for onion and Banko(1984) for ornamentals.

An improvement in plant height was more pronounced with enhancement in nutrient levels as evidenced in the treatment (M3) at 100th and 135th day of sowing involving combination of organic manure FYM (25t ha^{-1})inorganic fertilizers (60:60:30 kg NPK ha^{-1}), *Azospirillum* at 2 kg ha^{-1} and *Phosphobacteria* 2 kg ha^{-1}. This might be due to sufficient quantity of nutrients made available in the treated plots and also increased level of uptake of nutrients, which resulted in better growth The findings are in accordance with results of Wilox, (1967) in tomato and Kundu and Gaur, (1980) in potato. Bhardwaj, (1991) and Singh *et al.* (1992) also recorded similar responses in the plant height of onion due to addition of nutrients.

However, wider spacing of 45 x 15cm accounted for the higher number of leaves and number of shoots at 100th and 135th day of sowing in the present study, which are in accordance with the results of Singh *et al.* (1993), who also recorded increased number of leaves and number of shoots at wider spacing of 45X15 cm at 100th and 135th day of sowing. These results might be due to overcrowding and mutual shading of plants.

The treatment M3, namely, 60:60:30 kg NPK +25 t FYM + 2kg *Azospirillum* + 2 kg *Phosphobacteria* ha^{-1} also exhibited an increase in number of leaves and number of shoots per plant with higher levels of nutrient application followed by the treatment combination of 40:60:30 kg NPK +25t FYM + 2 kg *Azospirillum* + 2 kg *Phosphobacteria* ha^{-1}(T4). This might be due to an enhanced rate of release of nitrogen from urea, FYM and fixation of atmospheric nitrogen by *Azospirillum* which, in turn might have resulted in the increased production of leaves. This finding corroborated the results of Parthiban *et. al.* (1992) in tuberose and Paramaguru and Natarajan (1992) in chilli.

The results on the effect of spacing and nutrients on flowering and shape index of multiplier onion are presented in table 4. The plant density and nutrient combinations did not influence significantly the commencement of flowering and days taken to 50 per cent flowering of bulbs. The influence of nutrients on delaying the initiation of flowering was due to prolonged vegetative phase. These results are in accordance with the findings of Shanthi and Balakrishnan (1989) and Baloch *et.al.*(1991) in onion.

The wider spacing of 45 x 15 cm recorded greater bulb diameters. The treatment S3 (60:60:30 kg NPK ha^{-1}, FYM@25t ha^{-1}, *Azospirillum* @ 2kg ha^{-1} and *Phosphobacteria* @ 2 kg ha^{-1}) recorded maximum bulb diameter. The higher spacing between plants (45 x 15 cm) help lower plant population because of less nutrient competition and free aeration which would have promoted better growth of plants and higher bulb diameter. While reporting similar findings in onion Barker (1975) and Patil *et al.* (1984) suggested that this might be due to the presence of better source sink relationship, which would

have diverted and stored the photosynthesis in the bulbs leading to higher yield.

An increase in bulb length and shape index of bulb were obtained in the treatments planted with closer spacing of 45x5 cm (M1) (Tables 4 and 5). Among them, higher bulb length and shape index were registered in the plots applied with the nutrients *viz.*, 60: 60: 30 Kg of NPK, 25 t of FYM+2kg of *Azospirillum* and 2 kg of *Phosphobacteria* per hectare (S3). The closer spacing with optimal supply of nutrients might have helped increasing the growth of leaves which in turn might have enhanced photosynthesis and produced more metabolites and photo assimilates and their further diversion to the developing bulbs might have resulted in increased bulb length and shape index (Gurubatham, 1989). Similar findings were observed by Chinnasamy (1967) and Singh *et al.* (1993) in onion which proved further that this could be due to better nourishment and efficient utilization of nutrients.

The results on the effect of spacing and nutrients on

Table 4 Effect of spacing and nutrients on flowering and shape index of multiplier onion, *A. cepa* L. var. *aggregatum* Don.

Treatments	Days to flower initiation				Days to 50% flowering				Shape index			
	M1	M2	M3	Mean	M1	M2	M3	Mean	M1	M2	M3	Mean
S_1	98.15	101.91	104.54	101.53	105.56	101.83	105.92	114.44	0.87	0.89	0.76	0.59
S_2	104.13	106.35	107.12	105.87	110.81	105.07	115.75	110.54	0.85	0.85	0.65	0.79
S_3	114.47	118.50	127.25	120.07	130.75	129.50	127.50	129.25	1.09	1.12	0.97	1.06
S_4	108.02	109.22	109.58	108.94	117.15	109.75	109.51	112.14	0.87	0.88	0.76	0.83
S_5	105.84	105.13	105.38	105.45	108.08	108.00	106.12	107.40	0.85	0.85	0.66	0.78
S_6	108.05	107.35	109.50	108.30	107.57	108.00	106.72	107.43	0.82	0.81	0.62	0.75
S_7	103.63	105.89	106.08	105.20	106.50	103.50	104.29	104.76	0.80	0.78	0.57	0.71
S_8	107.10	107.32	107.52	107.65	107.91	101.15	101.84	103.63	0.77	0.73	0.52	0.67
S_9	103.59	104.28	106.27	104.71	105.32	101.92	101.43	102.89	0.76	0.70	0.48	0.64
S_{10}	105.43	106.95	106.38	106.25	101.75	101.52	101.83	101.70	0.70	0.64	0.44	0.84
Mean	105.84	107.29	109.06	107.40	111.14	108.02	109.09	109.42	0.84	0.82	0.64	0.77
	SE	CD			SE	CD			SE	CD		
Main plot(M)	2.32	NS			0.68	NS			0.005	0.010		
Sub plot (S)	0.32	NS			0.25	NS			0.003	0.007		
M X S	3.84	NS			1.15	NS			0.009	0.019		
S XM	5.58	NS			1.85	NS			0.012	0.010		

Main Plot – Spacing (M) Sub Plot – Nutrients (S) NS - Not Significant (P > 0.05)

Table 5 Effect of spacing and nutrients on bulb length and bulb diameter of multiplier onion, *A. cepa* L. var. *aggregatum* Don.

Treatments	Bulb length(cm)				Bulb diameter(cm)			
	M1	M2	M3	Mean	M1	M2	S3	Mean
S_1	2.41	2.42	2.23	2.35	2.73	2.51	2.63	2.62
S_2	3.68	3.35	2.82	3.28	3.98	6.50	8.75	6.41
S_3	5.70	4.47	4.18	4.78	5.77	8.41	10.85	8.34
S_4	4.85	4.56	3.92	4.44	5.02	7.55	10.52	7.69
S_5	4.62	4.24	3.54	4.13	4.82	7.24	9.68	7.24
S_6	4.63	4.32	3.53	4.16	4.85	7.33	9.66	7.28
S_7	3.61	3.33	3.62	3.52	3.85	6.87	9.21	6.64
S_8	3.72	3.33	3.10	3.38	3.99	6.74	8.97	6.56
S_9	3.44	3.04	2.61	3.03	3.76	6.21	8.60	6.19
S_{10}	3.50	2.91	2.55	2.98	3.88	5.38	8.63	5.96
Mean	4.01	3.59	3.11	3.60	4.26	6.47	8.75	6.49
	SE	CD			SE	CD		
Main plot (M)	0.14	0.29			0.14	0.29		
Sub plot(S)	0.02	0.05			0.02	0.05		
M X S	0.24	NS			0.24	NS		
S X M	0.25	NS			0.25	NS		

Main Plot – Spacing (M) Sub Plot – Nutrients (S) NS - Not Significant (P > 0.05)

bulb length and bulb diameter of multiplier onion are presented in the table 5. All the treatments exerted significant influences on the bulb characters, which exibited an increasing trend with enhancements in the level of nutrients. But, the interaction effect of spacing and nutrients exhibited no significant influence on the days taken for flower initiation and days to 50 per cent flowering. While studying the interaction effect, it revealed that application of 60: 60: 30 kg NPK ha^{-1}, FYM @ 25 t ha^{-1}, *Azospirillum* @ 2 kg ha^{-1} and *Phosphobacteria* @ 2 kg ha^{-1} along with the closest spacing of 45x5 cm recorded greater bulb length (5.70cm) and shape index (1.09%). In general, the closest spacing (45 x5 cm) registered the maximum bulb length and shape index, while the widest spacing (45 x15 cm) recorded the greater bulb diameter.

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