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Seasons' influence on bulb, seed yield and quality of aggregatum onion, *Allium cepa* var *aggregatum*

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ABSTRACT

A field experiment was conducted at the Department of Vegetable Crops, Horticultural College and Research Institute, Tamil Nadu Agricultural University, Coimbatore during September 2010 to April 2011. The study was conducted to evaluate the effect of planting season and genotypes performance on the bulb and seed production and quality of small onion. Four different planting seasons S_1 (September), S_2 (October), S_3 (November) and S_4 (December) and three genotypes G_1 (CO (On) 5), G_2 (Puttarasal type) and G_3 (Santhaipadugai Local) were used in the experiment. Data on different growth, yield and quality parameters were recorded and statistically analyzed. The results revealed that the highest seed and residual bulb yield (807 kg/ha and 8000 kg/ha respectively) was obtained from the September season planting (S_1) in Puttarasal genotype (G_2). Hence early planting season with local varieties is suggested for onion bulb and seed production in Coimbatore conditions.

Keywords: Onion; planting time; genotype; bulb yield; seed yield; quality

INTRODUCTION

Onion, *Allium cepa* L is one of the most important commercial vegetables and spice crops. The area under multiplier onion is being increased in India especially in Tamil Nadu. The total area under onion in Tamil Nadu is 4.01 lakh hectares with a production of 47.27 lakh tonnes (Anon 2014). Normally aggregatum onion varieties do not flower and set seed and hence are propagated through bulblets. Production of quality seed is an important factor in successful onion cultivation (Tomar 2005. With the growing consciousness about the high yielding varieties among the farmers, the demand for the quality seed is increasing resulting in more area under seed crops (Sumanaratne et al 2002).

Cultivar performance and date of planting play an improtant role in the selection of genotypes for yield improvement and adaptation to particular environmental conditions. Onion is highly sensitive to temperature and photoperiod.

Difference in onion yield is caused by different planting times of the year (Boyhan et al 2009). It is grown as a Rabi season crop in northern plains while it is grown as both Kharif and Rabi crop in the southern plains. The time of planting is the most important factor in seed set (Aramirtham 2000).

The major constraint in the cultivation of aggregatum onion is that large quantity of seed bulbs are needed for planting and cost of planting material is quite high. Therefore the alternate way to reduce the cost of production is using seeds as planting material. Taking these aspects into consideration preliminary investigations were carried out to determine the optimum time of planting of bulb of seed setting aggregatum onion genotypes for better seed and residual bulb yield and quality.

MATERIAL and METHODS

The study was conducted at the Department of Vegetable Crop, Horticultural College and Research Institute, Tamil Nadu Agricultural University, Coimbatore during year 2010-2011.

The treatments consisted of combinations of four planting dates as September, October, November and December and three onion genotypes, namely CO (On) 5, Puttrasal type and Santhaipadugai Local. The trial was conducted in plots of 1 x 1 m size using RBD with factorial arrangement of treatments replicated thrice. The soil was brought to fine tilth by giving four deep ploughings and weeds, stubbles, roots etc were thoroughly removed. The raised beds of 20 x 1 m were prepared and the spacing of 75 cm was kept between two beds. The healthy and uniform size bulbs were planted at a spacing of 20 x 15 cm. The experimental plots were kept free of weeds by regular hand weeding depending upon the weed intensity. The first irrigation was given at the time of planting and light irrigation was given on the third day after transplanting and thereafter drip irrigation was given daily for 2 hours. Although all the seed heads did not mature simultaneously they were harvested in one cutting. Harvesting was done sufficiently early to avoid shattering of seeds. Seeds attained maturity (turning of the skin colour from green to bright yellow) in 40-55 days after flowering. The seed heads were cut with 10-15 cm of stem attached to them, completely dried in the sun, thrashed and cleaned. Ten plants in each replication were randomly selected, tagged and the observations were recorded. Data were collected on days to first sprouting, days to complete sprouting, days to 50 per cent flowering, umbels per plant, seed weight per umbel (g), seed yield (kg/ha), residual bulb yield (kg/ha), flowering percentage, seed set percentage, TSS (^{o}Brix) ascorbic acid (mg/100 g) and protein content (%). The data collected were subjected to the statistical analysis in factorial randomized

block design suggested by Panse and Sukhatme (1985).

RESULTS and DISCUSSION

Seasonal influence on yield and quality of aggregatum onion

Sprouting of bulbs was observed as initiation and completion to study the periodical growth rate under four different planting seasons. The time taken for sprouting initiation and completion was significantly influenced by season of planting (Table 1). Among four planting seasons, September season took the least time for sprouting initiation (4.23 days) and completion (7.77 days) than the other three seasons. Late planting ie sowing in December took more time for sprouting initiation (7.17 days) and completion (12.10 days). This might be due to optimum soil temperature, relative humidity and rainfall prevailed during the initiation and completion of bulbs. The results are in accordance with finding of Jilani (2004). The days taken for 50 per cent flowering were also earlier for the September season planted crop by about 13.63 days as compared to December season planted crop. Bulbs planted in September season were observed to take minimum number of days for 50 per cent flowering. In this period temperature recorded was between 21.90-28.08°C. It mostly favoured the flowering in aggregatum onion. But in later planting the days increased to 50 per cent flowering as the temperature was above 30°C. Floral initiation in September planted crop coincided with low temperature while that of November and December planted crop coincided with warm temperature. Hence temperature seems to have negative influence on earliness to flowering. The results are in accordance with Joshi et al (1976) and Krishnaveni et al (1990).

Bulbs planted in September recorded more number of umbels/plant (6.76) which got gradually reduced in October plantation and attained less number of umbels/plant in December (5.39). Boyhan et al (2008) revealed that the number of umbels per plant were greater (9.3/plant) on the early sowing date compared with the late sowing date. The weight of seeds/umbel was significantly influenced by seasons. The maximum weight of seeds per umbel (0.306 g) was recorded in September while it gradually reduced from October to December planting season and ranged from 0.290 to 0.163 g.

Bulbs planted in September season recorded maximum seed yield (694.30 kg).

This might be due to more number of umbels per plant recorded during September planting. Thereafter a gradual reduction in seed yield was recorded. These results are in accordance with the findings of Anisuzzaman et al (2009) and Boyhan et al (2009). In the present study the bulbs which were planted during September were subjected to initial mild

Table 1. Influence of seasons and genotypes on yield and quality parameters of aggregatum onion

Treatment	Days to first sprouting	Days to complete sprouting	Days to 50% flowering	Umbels/ plant	Seed weight/ umbel (g)	Seed yield (kg/ha)	Residual bulb yield (kg/ha)	Flowering percentage	Seed set percentage	TSS (°Brix)	Ascorbic acid (mg/ 100 g)	Protein content (%)
S (Season)												
S_1 (September)	4.23	7.77	48.93	6. 76	0.306	694.30	5999	87.82	85.07	13.71	9.27	18.66
S_2 (October)	5.17	8.68	51.52	6.32	0.290	599.66	4816	78.70	80.96	13.12	8.72	18.06
S_3 (November)	6.20	10.59	53.96	5.68	0.181	342.33	3733	65.31	74.31	12.15	8.60	17.56
S_4 (December)	7.17	12.10	56.04	5.39	0.163	293.50	2999	58.16	62.60	11.78	8.18	17.43
SEd	0.060	0.042	0.395	0.022	0.001	2.350	135.770	0.301	0.141	0.145	0.059	0.038
$CD_{0.05}$	0.125	0.088	0.819	0.046	0.003	4.890.	281.581	0.625	0.294	0.306	0.124	0.079
G (Genotype)												
G_1 (Co (on) 5)	5.71	9.91	52.65	5.47	0.216	397.41	3808	66.12	72.45	12.32	8.44	17.59
G_2 (Puttarasal type)	6.80	10.58	57.74	6.69	0.257	585.00	5828	80.37	79.72	12.45	8.60	18.22
G_3 (Santhaipadugai)	4.57	8.83	47.41	5.95	0.231	464.25	3524	71.00	75.02	13.31	9.03	17.97
SEd	0.052	0.036	0.342	0.019	0.001	2.040	117.580	0.261	0.122	0.125	0.051	0.033
$CD_{0.05}$	0.108	0.076	0.709	0.040	0.003	4.230	243.857	0.541	0.254	0.261	0.107	0.069

temperature of 22.71°C and when they entered the bulbing phase the temperature rose up to 31.07°C and there was further increase as the bulbs had been maturing. On the other hand the crops raised in later season during November and December were subjected to heavy rains during early crop growth phase. Low night temperature and high day temperature induced more bulb yield in September planted set (5999 kg/ha). Mohanty (2002) have reported high bulb yield in early planting depending upon the location of experiment. Hussain et al (2001) recorded higher yield in 29th September sowing.

Flowering and seed set percentage of genotypes differed significantly due to different planting seasons. The maximum flowering and seed set percentage was observed in the bulbs planted in September season (87.82 and 85.07% respectively) followed by October season. The minimum flowering and seed set percentage was observed in bulbs planted on December planting season (58.16 and 62.60% respectively).

In the present investigation TSS content varied significantly from 11.78 (S_4) to 13.71°Brix (S_1). September planted crop was observed with higher total soluble solids content of 13.71°Brix followed by October season (13.1° Brix) and in December planted crop it was recorded 11.78° Brix. The ascorbic acid content varied from 8.18 to 9.27 mg/100 g in planting season. September season crop recorded higher ascorbic acid content (9.27 mg/100) and seed protein content (18.66%)) than all other three season crops. The protein content was influenced by growth environment. Again it may be due to high temperature which might have aided in conversion of photo assimilate into protein for normal growth of the seeds. Geetharani et al (2008) revealed that early planting of onion bulbs recorded significantly higher seed protein percentage than the later planting.

Influence of genotypes

The genotype Santhaipadugai Local took least time for sprouting initiation and completion (4.57 and 8.83 days respectively) followed by CO (On) 5 whereas Puttrassal type took maximum time (6.8 and 10.58 days respectively) (Table 1). The difference in sprouting period among the genotypes may be due to difference in morphological and floral characters.

The difference in time taken for germination by genotypes has been noted by Kimani et al (1993). Similar observation was recorded by Jilani (2004). The difference in sprouting time can be attributed to genetic variation among the cultivars. Likewise Verma et al (1994) reported difference in number of days to 100 per cent sprouting in bulbs of different genotypes. Days taken to 50 per cent flowering were earlier in Santhaipadugai Local (47.41 days) compared to CO (On)

5 (52.65 days) and Puttarasal type (57.74 days). This might be due to the short duration of Santhaipadugai Local than the longer duration of CO (On) 5 and Puttarasal type.

Difference in number of umbels per plant has been found amongst genotypes that ranged from 5.47 to 6.69. The Puttarasal type exceeded in number of umbels per plant (6.69) followed by Santhaipadugai Local (5.95). Mishra (1994) also reported variability in number of umbels per plant. Among the three different genotypes, Puttarasal type recorded the highest seed weight per umbel (0.257 g) followed by Santhaipadugai Local and the lowest seed weight was found in CO (On) 5 (0.216 g).

The Puttarasal type (585 kg/ha) gave the highest seed yield followed by Santhaipadugai Local (464.25 kg/ha) while the lowest seed yield was in CO (On) 5 (397.41 kg/ha). Similar results were reported by Jilani (2004) and Adagale (2010) in onion. Similar findings regarding genotype variation for different attributes were reported by Sumanaratne et al (2002) and Tomar (2005). Significant variation existed among the genotypes with respect to residual bulb yield/ha. The genotype Puttarasal type proved superior in this regard by producing 5828 kg/ha bulb yield followed by CO (On) 5 which produced total yield of 3808 kg/ha. Varietal difference with respect to bulb yield has been reported by Krishnaveni et al (1990) and Pandey et al (1994).

The maximum flowering and seed set percentage was counted in Puttarasal type (80.37% and 71.00% respectively) followed by Santhaipadugai Local (79.72% and 75.02% respectively). These results are in accordance with the finding of Ud-deen (2008).

TSS content varied significantly from 12.32 to 13.31°Brix in genotypes. Among the genotypes, Santhaipadugai Local was observed with higher total soluble solids content of 13.31°Brix followed by Puttarasal type (12.45°Brix). Vadivel (1979) recorded a range of 12.36 to 15.90°Brix for TSS content among the different genotypes of aggregatum onion. Similar findings were also reported by Gowda et al (2007) in garlic. The ascorbic acid content varied from 8.44 to 9.03 mg/ 100 g in genotypes. Santhaipadugai Local recorded higher ascorbic acid content (9.03 mg/100 g) followed by Puttarasal type and CO (on) 5. This finding is in conformity with the results of Borah (1994) and Padmavathy (1995). Among the genotypes, Puttarasal type recorded higher protein content (18.22%) than the other two genotypes. Similar findings were also reported by Geetharani et al (2008).

Interaction of seasons and genotypes

Days taken for sprouting initiation and completion were recorded earlier in Santhaipadugai Local planted during September by 3 days and completion by 7.17 days. Puttrasal type planted during

December season recorded delayed sprouting initiation (8.20 days) and completion by 13.70 days (Table 2). Similar observations were recorded by Jilani (2004). Likewise Verma et al (1994) reported difference in number of days to 100 per cent sprouting in bulbs of different genotypes. Time taken for 50 per cent flowering was recorded earlier in Santhaipadugai Local planted during September of 43.33 days, followed by S_1G_1 and Puttarasal type planted during December season recorded delayed flowering of 60.01 days. The lower temperature prevailed during early crop growth period in September planting would have favoured the production of hormones like gibberellins which could have created an induction in the terminal bud to transform it into reproductive one thereby favouring early flowering.

The umbels/plant play an important role in the production of seed. The higher number of umbels/plant (7.50) was recorded in Puttarasal type planted during September season. Aramiratham (2000) and Anisuzzaman et al (2009) reported that maximum number of umbels/plant was observed in the early planted crop in common onion gives support to the present findings. Within the interaction effect, Puttarasal type planted during September season (S_1G_2) increased the weight of seeds/umbel with the higher value of 0.319 g followed by S_2G_2.

The interactions between seasons and genotypes were highly significant on seed yield. Maximum seed yield was noted from Puttarasal planted during September season recording more yield/hectare (807 kg) followed by Puttarasal type planted during October season. It is interesting to note that yield attributing characters like plant height, umbels per plant and flowers per umbel were higher in September season crop than in late planting from October to December season crop. This might be the reason for the increase in the seed yield/ plant in September planting season which ultimately increased the yield per unit area. These results are in accordance with the finding of Aramiratham (2000), Boyhan et al (2008) and Anisuzzaman et al (2009) in onion.

The estimated residual bulb yield/ ha (8000 kg) was recorded under the treatment combination Puttarasal type planted during September season followed by S_2G_2. The lowest residual bulb yield/ha (3524 kg) was obtained under Santhaipadugai local planted during December season. The findings of Ud-deen (2008) supported that increased yield may be because of difference in yield components as bulb volume, average weight of the bulbs and crop stand. Secondly it may be because of the bulbs planted early in the season getting established in field earlier. Consequently, early planting resulted in early continued swelling of the bulbs till

Table 2. Interaction effect on yield and quality parameters of aggregatum onion

Treatment	Days to first sprouting	Days to complete sprouting	Days to 50% flowering	Umbels/ plant	Seed weight/ umbel (g)	Seed yield (kg/ha)	Residual bulb yield (kg/ha)	Flowering percentage	Seed set percentage	TSS (°Brix)	Ascorbic acid (mg/ 100 g)	Protein content (%)
$S_1 G_1$	4.0	7.95	48.90	6.21	0.292	603.00	5333	80.56	82.50	13.70	9.11	18.09
$S_1 G_2$	5.3	8.38	54.56	7.50	0.319	807.00	8000	97.90	88.73	13.08	9.26	19.00
$S_1 G_3$	3.0	7.00	43.33	6.59	0.308	673.00	4666	85.00	84.00	14.37	9.43	18.90
$S_2 G_1$	5.03	8.70	51.23	5.70	0.268	483.00	3667	72.00	78.03	12.78	8.53	17.80
$S_2 G_2$	6.20	9.20	57.27	7.03	0.315	726.00	6664	86.10	84.18	13.00	8.60	18.30
$S_2 G_3$	4.25	8.00	46.06	6.22	0.287	587.00	4116	78.00	80.68	13.58	9.03	18.10
$S_3 G_1$	6.53	10.50	53.50	5.15	0.158	270.00	3550	59.93	71.00	11.56	8.35	17.30
$S_3 G_2$	7.06	11.70	59.11	6.33	0.208	467.00	4434	72.00	78.50	12.23	8.45	17.90
$S_3 G_3$	5.00	9.59	49.26	5.56	0.177	320.00	3733	64.00	73.43	12.65	9.00	17.50
$S_4 G_1$	7.30	12.50	57.00	4.81	0.146	233.66	2682	52.00	58.30	11.23	7.79	17.20
$S_4 G_2$	8.20	13.07	60.01	5.92	0.189	370.00	4216	65.50	67.50	11.50	8.10	17.70
$S_4 G_3$	6.00	10.75	51.00	5.45	0.153	277.00	2100	57.00	62.00	12.63	8.66	17.40
SEd	0.104	0.073	0.684	0.039	0.002	4.080	235.169	0.522	0.245	0.251	0.103	0.066
$CD_{0.05}$	0.216	0.152	1.419	0.081	0.006	8.470	487.714	1.082	0.509	0.522	0.215	0.138

the crop matured for harvesting. During late planting the bulb size could not be developed which depended on temperature and day length. In this case the production assimilate would have been translocated towards developing sink (seeds) rather bulbs. In want of sufficient metabolites the bulbs remained underdeveloped.

The highest flowering and seed set percentage (97.90 and 88.73% respectively) were recorded under the treatment combination Puttarasal type planted during September season followed by S_2G_2. The lowest flowering and seed set percentage (52.00 and 58.30 per cent) were obtained under CO (On) 5 planted during December season. These results are in accordance with the finding of and Uddeen (2008).

The higher TSS (14.37° Brix) was recorded under treatment combinations Santhaipadugai local planted during September season followed by S_1G_1. Similar findings were also reported by Gowda et al (2007) in garlic. The highest ascorbic acid content (9.43 mg 100/g) was recorded under the treatment combination Santhaipadugai Local planted during September season .The maximum seed protein content (19.00%) was recorded under the treatment combination Puttarasal type planted during September season followed by Santhaipadugai Local planted during September. The minimum protein content (17.20%) was recorded in the treatment combination CO (On) 5 planted during December.

The study depicts that the yield of onion seed was significantly affected by the interaction effects of planting season and genotypes. The yield attributes and quality of onion bulbs and seeds were found to be gradually increased with the early planting season. Genotypes also greatly influenced the yield and quality of onion. However September season planted Puttarasal genotype registered the highest bulb and seed yield per unit area with the greatest seed yield attributing traits and seed quality.

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