Madras Agric. J., 105 (4-6): 229-233, June 2018

Effect of Restricted Umbel Production on Seed Yield and Seed Quality in Onion cv. CO (On) 5 (*Allium cepa* L.)

S. Sivasakthi*, J. Renugadevi, R. Umarani and R. Sivakalai
Department of Seed Science and Technology
Tamil Nadu Agricultural University
Coimbatore - 641 003

Field experiment conducted in onion cv. CO (On) 5 to study the effect of manual restriction of umbel orders as two, four, six and eight umbels plant^{-1} revealed that the yield contributing characters *viz.,* umbel diameter (6.6 cm), number of capsules (166.4), seed set per cent (85.3 %) and seed yield umbel^{-1} (1.97 g) were maximum for the plant with two umbels and these were reduced when the number of umbel orders increased. The quantitative and qualitative characters were found to be optimum upto sixth order umbel and beyond that the reduction in both parameters were observed. Hence the maximum of six umbels plant^{-1} could be maintained in onion cv. CO (On) 5 to get maximum quantity of quality seeds.

Key words: Onion, Umbel orders, Seed yield, Seed quality

Onion (*Allium cepa* L.) is an important commercial vegetable and one of the major bulb crop under the family of Alliaceae (2n=16 chromosome). It is one of the oldest vegetables known to human kind and being consumed worldwide. On global scale onion is a minor bulb crop, however in South East Asia especially in India; it is highly remunerative crop (Saraswathi *et al.,* 2017). Like other condiments it is widely used in culinary preparations as a flavouring agent. It is very important in cookery and known as 'Queen of Kitchen'.

Onion is being grown in 1.27 million hectares with an annual production of 21.56 million tones and productivity of 16.97 tones ha^{-1} (INDIASTAT, 2017). In the world, India ranked second in cultivated area, production and export next to china (ICAR-DOGR, 2017). In India, Maharashtra state has the prominent position in respect to onion production accounting 37.12 per cent of area and 31.4 per cent of national production. Other major onion growing states are Karnataka, Madhya Pradesh, Rajasthan, Bihar, Gujarat, Andhra Pradesh, Tamil Nadu and Haryana. Tamil Nadu ranks 8th in cultivated area (0.34 lakhs hectares), 13th in annual production (3.47 lakhs tones) and 23rd in productivity (10.18 tones ha^{-1}) (INDIASTAT, 2017).

In Tamil Nadu major onion growing districts are Perambalur, Trichy, Coimbatore, Tiruppur, Namakkal, Dindugal, Erode, Tirunelveli and Thoothukudi. It was exported to Srilanka, Malaysia, gulf countries. Normally aggregatum onion varieties do not flower and set seed and hence propagated through bulblets. The major constraint in cultivation of aggregatum onion is large quantity of seed bulbs are needed for planting. The cost of the planting material occupies 50 per cent of the total production cost. The alternative way to reduce the cost of production is using seed as planting material. Production of quality seed is an important factor for successful onion cultivation. The demand for the quality seed is increasing among the farmers and specific technologies are needed for enhancement of seed yield and quality seed production in onion variety CO (On) 5. The main reason for low quality of onion seeds is due to long flowering period resulted in different stages of seed maturity in the umbel. The seeds collected from early formed umbels recorded superior quantitative and qualitative characters than the later formed umbels. Hence optimization of number of umbels plant^{-1} is to be determined for the quality seed production in onion cv. CO (On) 5. With this background, the present study was conducted to find out the effect of differential number of umbels on seed yield and quality.

*Corresponding author's email: sivasarathii@gmail.com

Material and Methods

The field experiment was conducted in field No. TB 2, at Department of Vegetable Crops, Horticultural College and Research Institute, Tamil Nadu Agricultural University, Coimbatore during November to April, 2017 - 2018 with onion variety CO (On) 5. The sowing was taken on 15th of November, 2017. The crop was maintained by following recommended package of practices (Crop Production Guide -2013 Dept. of Horticulture, Tamil Nadu).

The treatment imposed was restriction of umbel numbers in plants, manually. The umbels that emerged for the pre-determined number were maintained and the umbels that emerged subsequently were manually removed. The experiment was laid out in Randomized Block Design (RBD) in a plot size of 2 x 1 m under irrigated condition with five treatments and four replications. The treatment details are as follows:

T_1- Control (without umbel restriction)

T_2- Only first and second order umbels retained

T_3- Only first to fourth order umbels retained

T_4- Only first to sixth order umbels retained

T_5- Only first to eighth order umbels retained.

Ten plants in each treatment were selected in all the replication and the following observations were recorded.

Days for 50 per cent flowering and physiological maturity

Number of days taken for 50 per cent flowering and physiological maturity in first, second, third…n^{th} order umbels were recorded and the mean values were expressed in days.

Umbel diameter

The umbels were harvested at physiological maturity and the diameter of the first, second, third……n^{th} order umbels were measured with a scale by keeping it across the stalk at the middle portion of the umbel and the mean values were expressed in centimetre.

Number of capsules per umbel

The total number of capsules in first, second, third……n^{th} order umbels was counted and the mean values were expressed in number.

Seed set percentage

The filled and ill-filled capsules in first, second, third……n^{th} order umbels were counted, the seed set per cent was calculated as follows and the mean values were expressed in percentage.

$$\text{Seed set (\%)} = \frac{\text{Number of filled capsules umbel}^{-1}}{\text{Total number of capsules umbel}^{-1}} \times 100$$

Number of filled and undersized seeds umbel^{-1}

Number of filled and undersized seeds in first, second, third……n^{th} order umbels were counted and the mean values were expressed in number.

Weight of filled and undersized seeds umbel^{-1}

The weight of filled and undersized seeds in first, second, third……n^{th} order umbels were weighed in a digital balance and the mean values were expressed in gram.

Seed yield per umbel

Seed yield of first, second, third……n^{th} order umbels were recorded and mean values were expressed in gram.

Seed yield per plant

The seeds obtained from randomly selected 10 plants were weighed in an electronic balance and the mean values were expressed in gram.

Seeds were assessed for germination (ISTA, 2016), root and shoot length of 12 days old seedlings and dry matter production of seedlings. Seedling vigour index was computed by adopting the formula as suggested by Abdul-Baki and Anderson (1973) and expressed in whole number.

Seedling vigour index = Germination (%) x Mean seedling length (cm)

Results and Discussion

Onion is one of the biennial crops where the bulb to seed production is highly influenced by many factors. Of which, number of umbels assume greater significance (Mital and Srivastava, 1964). The conventional concept that more number of umbels plant^{-1} produce more yield is being replaced by a new plant type concept in which, optimization of umbel order is the objective.

Onion express indeterminate flowering behaviour and in its blooming stage produces flower stalk that contains at a tip an inflorescence known as primary umbel or first order umbel and subsequently produces, second order, third order, fourth order and upto a maximum of fourteen order umbels under favourable climate and soil conditions. The number of umbels per plant mainly depends on management practices. More number of umbels plant^{-1} resulted in reduction of seed yield and quality.

In any onion variety stalk formation appears to be advantageous as it enhances seed yield but it seems to be disadvantageous in giving smaller seed size and poorer germination. In the present study, the influence of umbel number in cv.CO (On) 5 was evaluated for seed yield and seed quality characters by maintaining varying number of umbels plant^{-1} as two, four, six and eight by manual clipping of the additional umbels while plants having unmanaged umbel number served as control. The observation were made on the flowering behaviour as days to 50 per cent flowering, days for attaining physiological maturity and yield attributing characters *viz.,* umbel diameter, number of capsules umbel^{-1}, seed set percentage, number and weight of filled and undersized seeds umbel^{-1}, seed yield umbel^{-1} and seed quality characters *viz.,* germination, seedling length, drymatter production and vigour index were recorded.

The days to first flower stalk initiation was 35 days after sowing, confirming the findings that initiation of flower stalk commenced 35 days after sowing in onion (Geetharani, 2005). Days for flower stalk initiation varied from 37 (2 umbels only) to 47 days (8 umbels only) and was minimum (37) with plant having two umbels plant^{-1} and maximum (54) with control (without umbel clipping), since onion is an indeterminate crop, it produces flowers for longer period of time and late formed umbels take long time for maturation. The days 50 per cent flowering ranges from 65-75 DAS and it took 70 - 79 DAS for completion of flowering. The attainment of physiological maturity varied among the umbel orders, the shortest days of 114 days was recorded by plant with two umbels

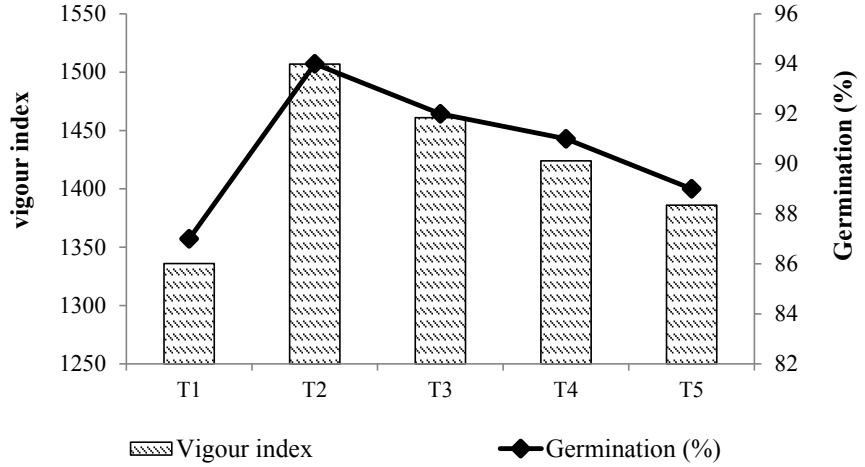
and maximum of 124 days for plants without umbel clipping (control) (Table). Generally in indeterminate crops there is variation in the maturity of the flowers leads to variation in the seed quality. Sundaralingam (1995) and Akilan (1986) reported the variations in maturation and translocation of assimilate from source to sink of different umbel order in carrot and coriander, respectively.

Effect of manual clipping on flowering pattern and yield characters in onion cv. CO (On) 5

Treatment	Growth parameters					Yield parameters						Seed quality parameters		
	Days for 50 per cent flowering	Days for physiological maturity	Umbel diameter (cm)	Number of capsules umbel^{-1}	Seed set (%)	Number of filled seeds umbel^{-1}	Number of undersized seeds umbel^{-1}	Weight of filled seeds umbel^{-1} (g)	Weight of undersized seeds umbel^{-1} (g)	Seed yield umbel^{-1} (g)	Seed yield plant^{-1} (g)	Root length (cm)	Shoot length (cm)	Dry matter production (mg seedlings^{-10})
T_1	79.9	124.3	5.4	93.1	59.8	136.2	27.7	0.477	0.052	0.53	6.32	6.1	9.0	16.5
T_2	65.9	113.7	6.6	166.4	85.3	554.5	13.5	1.941	0.024	1.97	3.93	6.6	9.6	17.9
T_3	69.6	115.9	6.2	143.5	78.1	387.0	18.1	1.354	0.032	1.39	5.55	6.4	9.4	17.4
T_4	73.0	118.9	5.8	129.0	75.2	311.1	20.0	1.089	0.036	1.13	6.78	6.3	9.4	17.4
T_5	74.7	120.2	5.6	116.0	68.6	225.4	22.5	0.789	0.041	0.83	6.63	6.1	9.2	16.9
Mean	72.6	118.6	5.9	129.51	73.4	322.8	20.3	1.13	0.037	1.17	5.84	6.3	9.4	17.2
SEd	1.209	1.537	0.113	1.854	0.545	3.931	0.254	0.018	0.001	0.016	0.079	0.083	0.135	0.164
CD(P=0.05)	2.634	3.348	0.245	4.039	1.188	8.565	0.554	0.038	0.002	0.035	0.171	0.182	0.294	0.358

T_1- Control (Without umbel restriction); T_2 - Only first and second order umbels retained; T_3 - Only first to fourth order umbels retained; T_4- Only first to sixth order umbels retained; T_5- Only first to eight order order umbels retained

The number of umbels had significant influence on umbel diameter, number of capsules umbel^{-1} and seed set percentage. It was found to be significantly decreased with increasing number of umbels. Among the number of umbels, the umbel diameter, number of capsules umbel^{-1} and seed set percentage were highest with two umbels plant^{-1} (6.6 cm, 166.4 and 85.3 %) followed by four umbels plant^{-1} (6.2 cm, 143.5 and 78.1 %) compared to control (5.4 cm, 93.1 and 59.8 %) (Table). This might be due to curtailment of the vegetative growth phase and diversification of photosynthetic materials towards the source *i.e.* umbel at optimum growth stage. These results are in accordance with findings of the Argall and Stewart (1984) in cowpea, Yadav and Dhukia (1994) in cluster bean. In cluster bean manual alteration of decapitation at 70 days after sowing registered significantly highest number of pods plant^{-1} and weight of 1000 seeds (Dholariya *et al.*, 2018).



T_1- Control (Without umbel restriction); T_2 - Only first and second order umbels retained; T_3 - Only first to fourth order umbels retained; T_4- Only first to sixth order umbels retained; T_5- Only first to eight order order umbels retained

Effect of manual clipping on germination percentage and vigour index in onion cv. CO (On) 5

Number of filled seeds umbel^{-1} and weight of filled seeds umbel^{-1} were maximum (554.5 and 1.941g) in plant having two umbels followed by four umbels (387.0 and 1.354 g) compared to the plants maintained with eight umbels (225.4 and 0.789 g) and control (136.2 and 0.052 g). The increased number of filled seeds and weight of filled seeds in plant with minimum number of umbel was due to the effective utilization of assimilates by the restricted the number of umbels. Number of undersized seeds and weight

of undersized seeds recorded were minimum (13.5 and 0.024g respectively) with plant having two umbels followed by four umbels (18.1 and 0.032 g respectively) and six umbels (20.0 and 0.036 g respectively) and was maximum with plants having eight umbels (22.5 and 0.041g respectively) and control (27.7 and 0.052 g respectively). The restriction of umbel orders resulted with reduction of undersized seeds percentage in plants with minimum umbels than the plants with maximum umbels. The per cent reduction of undersized seeds was 40 per cent for the plants with the two umbels than the plant with eight umbels and which was 51 per cent than the control. Similar findings were reported by Sadras, (1995) in cotton, the removal of both early and late season flowers provided the least boll numbers but the largest boll weight, indicating that the intensity of decrease in boll number or increase in boll weight depended on the level of flower removal.

The seed yield umbel^{-1} was the highest with two umbels (1.97 g) followed by plants with four (1.39 g) and six umbels (1.13 g) but the seed yield plant^{-1} was higher in plants with six umbels (6.78 g) and eight umbels (6.63 g). This revealed that umbel number contributed more to increase the seed yield. Mital and Srivastava (1964) observed that the increase in the number of flower stalks gave corresponding increase in seed yield in onion. However the optimum number of umbel per plant resulted in the production of more quantity of quality seeds, since, the quantity and as well as quality of the seeds were reduced beyond retention of six umbels per plant. In the present study, the plants with two and four umbels out performed over plants with six and eight umbels. The plants with six umbels recorded an increased percentage of 39 for number of capsules, 26 for seed set per cent, 7 for seed yield plant^{-1} than the control. The per cent improvement of seed set, seed yield umbel^{-1} and seed yield plant^{-1} was 10, 36 and 2 for plants with six umbels than the plants with eight umbels respectively. This was supported by spollen *et al.,* (1986) reported in soybean, the early formed flowers had a higher pod set than the later, this might be due to that most of the carbohydrates produced by the leaf is used for filling of pods. Saitoh *et al.,* (1994) also reported that in soybean with increasing number of flowers per receme reduced the rate of pod set. Mondal, (2011) also reported that the assimilates sink strength of early formed pods will be greater than the later formed ones and helps in producing higher rate of pod set in mung bean, thereby giving higher yields.

The seed quality analysis on physiological parameters of all the umbel orders revealed that the germination percentage, seedling length, drymatter production and vigour index were found to be significantly decreased with increasing number of umbels. The seeds from plants of two umbels recorded the highest germination, drymatter production and vigour index (94 %, 17.9 mg and 1507) followed by four (92 %, 17.4 mg and 1461) and six umbels (91 %, 17.4 mg and 1424) compared to the seeds of eight umbels per plant (89 %, 16.9 mg and 1386) and control (87 %, 16.5 and 1336) (Table) (Fig.). This may be due to that the initial vigour of seed was more in early formed umbels due to greater distribution of source to limited sink and the lesser competition faced by such umbels per unit area. This was supported by Geetharani (2005) that the plants with minimum of six umbels recorded maximum seed yield and quality than the plants with more number of umbels.

The seed production is a unique venture where yield with quality is focussed and this phenomenon fetches much importance in low volume high value seeds of crop like onion. In the present study, the plants maintained with six umbels plant^{-1} recorded higher seed set percentage and seed quality characters than the plants with eight umbels.

The mature leaves of the crop are the source and the growing organs are the sink. The movement of photosynthates from the source to the sink, on the one hand, depends on the capacity to produce photosynthates at the source and on the other hand, is dependent on the capacity of the sink to consume the photosynthates (Fatemeh Marzban, 2011). If there is an imbalance between source and sink, the yield obtained will decrease. In order to improve the relationship between sink and source, the seed filling pattern was managed so as to attain increase in the yield of onion. In the present experiment removal of umbels at different number has been found to re-transport nutrients (sources) to the formation of filled seeds (sink) and thereby helped to increase the yield potential of the onion. Hence, the present study clearly indicated that it could be recommended to maintain up to six umbels for harvesting maximum quantity of quality seeds in onion cv. CO (On) 5.

References

Abdul-Baki, A.A. and Anderson, J.D. 1973. Vigor determination in soybean seed by multiple criteria 1. *Crop Science,* **13(6):** 630-633.

Akilan, V. 1986. Studies on seed production, processing and viability testing in coriander *(Coriandrum sativum* L.) M.Sc. (Ag) Thesis, Tamil Nadu Agricultural University, Coimbatore.

Argall, J. and K. Stewart. 1984. Effects of decapitation and benzyladenine on growth and yield of cowpea (*Vigna unguiculata* L.). *Annals of Botany,* **54(3)**: 439-444.

Dholariya, N. Acharya, R. Akbari, V. and I. Delvadiya. 2018. Effect on Growth, Seed Yield and Quality of Cluster Bean (*Cyamopsis tetragonoloba* L.) Seed cv.'Pusa Navbahar'through Decapitation and Pgr's. *Int. J. Pure App. Biosci,* **6(1)**: 537-542.

Marzban, F. Yasari, E. Chapi, O.G. and H.R. Mobasser. 2011. Effects of changes in source-sink relation in different planting dates on yield and yield components of soybean cultivars. *International Journal of Biology* **3 (3)**: 90.

Geetharani, P. 2005. Investigations on seed production, processing and storage technique in onion cv. CO (On) 5 (*Allium cepa var. aggregatum* L.) M.Sc. (Ag) Thesis, Tamil Nadu Agricultural University, Coimbatore.

ICAR-DOGR. (2017). http://www.dogr.res.in/

INDIASTAT. 2017. Statewise area, production and productivity of onion in India. *http://indiastat.com*

ISTA. 2016. International rules for seed testing. switzerland: The International Seed Testing Association (ISTA). https://www.seedtest.org

Mital, S.P. and G. Srivastava. 1964. Seed yield in relation to bulb size and number of seed stalks in onion (*Allium cepa* L.). *Ind. J. Hort*., **21 (3-4):** 264-269.

Mondal, M.M.A., Fakir, M.S.A. Juraimi, A.S. Hakim, M.A. Islam, M.M. and A.T.M. Shamsuddoha. 2011. Effects of flowering behaviour and pod maturity synchrony on yield of mungbean (*Vigna radiate* L.). *Australian J. Crop Sci.,* **5**: 945-953.

Sadras, V.O. 1995. Compensatory growth in cotton after loss of reproductive organs. *Field Crop Research* **40 (1)**: 1-18.

Saitoh, K. Isobe, S. and T. Kuroda. 1999. Intraraceme variation in the number of flowers and pod set in field grown soybean. *Japanese J. Crop Sci.,* **68**: 397- 400.

Saraswathi, T. Sathiyamurthy, V. Tamilselvi, N. and S. Harish. 2017. Review on Aggregatum Onion (*Allium cepa L. var. aggregatum Don*.). *Int. J. Curr. Microbiol. App. Sci,* **6(4)**: 1649-1667.

Spollen, W.G. Wiebold, W.J. and D. Scott Glenn. 1986. Intraraceme Competition in Field Grown Soybean 1. *Agronomy journal* **78 (2**): 280-283.

Sundaralingam, K. 1995. Seed technological studies in carrot (*Daucus carota.* L.) cv. Zino M.Sc. (Ag.) Thesis, Tamil Nadu Agricultural University, Coimbatore.

Yadav, R. and R. Dhukia. 1994. Effect of clipping on seed yield and its attributes of clusterbean (*Cyamopsis tetragonoloba* L.) under late-sowing condition. *Indian Journal of Agronomy,* **39(2)**, 339-341.

Received : May 02, 2018; Revised : May 21, 2018; Accepted : June 14, 2018