Int.J.Curr.Microbiol.App.Sci (2020) Special Issue-11: 1803-1810

International Journal of Current Microbiology and Applied Sciences
ISSN: 2319-7706 **Special Issue-11 pp. 1803-1810**
Journal homepage: http://www.ijcmas.com

Original Research Article

Effect of Colchicine Treatment on Production of More Juice Content and Lower Fruit Cracking in Cape Gooseberry (*Physalis peruviana* L.)

Ravindra Kumar*, K.P. Singh, V.K. Pandey and Manoj Kumar

Bihar Agricultural University, Sabour, Bhagalpure-813210, India
Department of Horticulture[3], Birsa Agricultural University, Kanke, Ranchi-834006, India

**Corresponding author*

A B S T R A C T

Artificial induction of polyploids has opened a new vista for breeders to improve the quality of fruits in respect of more of juice content and lower of fruit cracking. Several methods are employed to induce polyploidy through colchicine *viz*; seedling apex dip method, cotton plug method and seed treatment as well as lanolin paste. In the present study, an attempt was made to induce polyploids in Cape gooseberry using colchicine with the objective of creating more genetic variability. The colchicine concentrations used were 0.10 % (C_1), 0.20% (C_2) and 0.40% (C_3) for the duration 12 (H_1), 24 (H_2) and 36 (H_3) hours and these were treated with seedling apex dips method (M_1), cotton plug method (M_2) and lanolin paste method (M_3). The plants treated with 0.10 per cent of colchicine by cotton plug method for 12 hours showed the better performance during the years 2017-18 and 2018-19 as well as pooled data also in respect of maximum fruit weight (8.88g), more juice content (70.03%) and higher ratio of juice/rag content (2.94) and minimum fruit cracking (1.76 %) than the untreated plant (5.96 g fruit weight, 64.00 % juice content, 1.88 juice/ rag ratio and 6.67 % of fruit cracking respectively). On the basis of these findings, the application of colchicine @ 0.10 per cent for 12 hours duration with cotton plug method was showed the best and effective treatment for maximum fruit weight, maximum juice and juice / rag ratio and minimum fruit cracking in Cape gooseberry.

Keywords

Cape gooseberry, Colchicine, Insect-pest, Fruit cracking

Introduction

Cape gooseberry (*Physalis peruviana* L.) is a minor and a quick growing fruit which belongs to the family *Solanaceae* is catching the imagination of farmers for improved income during the recent years (Kumar *et al*., 2019). Cape gooseberry is famous for its flavour and having good blend of acid-sugar. The fruits are very attractive in colour at maturity time and if properly packed, it can easily be sent to distant markets. The matured and ripen fruits are good quality for making preparing natura, pies and jams. A number of species in the genus are of horticultural and economic importance due to their high nutritional value of vitamin A, C and B complex, minerals and antioxidants as well as potential of medicinal properties including anti-bacterial, anti-inflammatory and anti-cancer properties**.**

Cape gooseberry plants are cultivated in Rabi season during October to March. The fruit maturity starts in February-March and the same crop continue to produce fruit until last of April, yielding about 200- 500g of fruit per

plant. An important problem in Cape gooseberry is insect pest incidence and fruit cracking during the fruit growth and development. This problem makes it difficult for growers to produce the quality fruits. This type of situation is more or less the same for all the growers; it results at the time of harvesting with poor quality of fruits to market with low price.

Present day possibility for the artificial induction of polyploids has opened a new vista for breeders. Several methods are employed to induce polyploidy through colchicine *viz*; seedling apex dip method, cotton plug method and seed treatment as well as lanolin paste. It is generally noted that with increase in chromosome number the adaptability and variability of species increases progressively. The duplication of chromosome number, in general is associated with increased plant height, thick stem, broader as well as thicker leaves, dark green leaves, bigger stomata size, bigger flowers and flower parts, increased pollen size, delay flowering, late maturity of fruit, bigger fruit size, more vitamin 'C' content and reduced seed number than diploid.

There is no attempts have been reported earlier for "Effect of colchicine treatment on more juice content and lower fruit cracking in Cape gooseberry (*Physalis peruviana* L.)". Thus, in present investigation, apart from parthenocarpy studies, attempt has also been taken to develop tetraploids in this fruit. If this technique may be perfected then the induced tetraploids can be crossed with normal diploids to produce fruits with more juice content and minimum loss of fruit cracking in Cape gooseberry. By keeping the above facts in the mind, the present investigation was carried out with the objectives of increasing the more juice content in fruit along with avoiding the loss of the growers by fruit cracking was made to use of different concentrations of colchicine for many durations by various methods in Cape gooseberry.

Materials and Methods

The present investigation was carried out in the experimental area of the Department of Horticulture, Birsa Agricultural University, Kanke, Ranchi during two successive seasons (2017-18 and 2018-19). The experimental site comes under VIIth Agro-Climatic Region i.e., Eastern Plateau and Hills. It is situated between 23^{0}17' North latitude and 85^{0}19' East longitude and the height from the mean sea level is 625m. The soil of the experimental plot was sandy loam in texture with average fertility and thus considered suitable for cultivation of Cape gooseberry. The Randomized Block Design was adopted for the trial. The number of treatment combinations was 22 with three replication during both the years.

Field preparation

The field was prepared thoroughly. The required area was marked for experiment and land was again prepared thoroughly by spading to bring a fine tilth suitable for Cape gooseberry cultivation. A basal dressing of well rotten farm yard manure at the rate of two tractor trolley full load per acre was applied and was thoroughly incorporated in the soil. The sub-plots were then divided into different blocks according to the layout plan.

Nursery bed

Seeds were sown on the raised bed with suitable mixture of garden soil and well rotten farm yard manure. Germination started visible after nine days of sowing. The seedlings were ready for transplanting after a month of germination. Seedlings attained a height of 5-6 centimeter at the time of transplanting.

Seedling transplanting

Seedlings were transplanted in the field in the afternoon which was done manually in each sub-plot according to the layout plan with a planting distance of 50 cm × 50 cm i.e. row to row and plant to plant respectively. The plot size was maintained 2.00m in both sides with accommodation of 16 seedlings per plot. To overcome the shock of transplanting, the transplanted seedlings were irrigated immediately with the help of a watering rose can. This practice was continued up to seven days in both morning and evening hours.

Treatment details

The colchicine concentrations used were 0.10 %(C_1), 0.20% (C_2) and 0.40% (C_3) for the duration 12 (H_1), 24 (H_2) and 36 (H_3) hours for each concentration with seedling apex dip method (M_1), cotton plug method (M_2) and lanolin paste method (M_3) with total 22 treatment combinations were adopted.

Preparation of chemicals

Colchicine solution

Colchicine solutions of different concentrations were prepared in distilled water. For making 0.10, 0.20 and 0.40 per cent concentration, 100mg, 200mg and 400 mg of colchicine was dissolved in separate glass beaker respectively in small quantity of absolute alcohol and then transferred to 100ml measuring flask and distilled water was added to make required volume. The care was taken to keep the solution in dark place.

Lanolin paste

The required amount of colchicine was measured and transferred to a Petridis containing the required quantity of melted lanolin. Then it was mixed thoroughly with the help of a glass rod. The paste was allowed to cool down before application.

Methods of treatment

Seedlings apex dipping method

Apex of one month old seedlings was dipped in known concentration of colchicine for a specific period. Roots of seedlings were protected by wrapping cotton swab. Water was poured on roots after some interval with the help of a dropper.

Cotton plug method

Small quantity of cotton was soaked in aqueous solution of colchicine of different concentrations with the help of glass rod. Soaked cotton wool in different concentrations was applied over growing apex of young and established seedlings for required duration.

Treatments were repeated by dripping the solution with the help of a dropper after short interval.

Lanolin paste method

The paste containing different concentrations of colchicine was applied to the growing point of seedlings. The hairs and scales were removed from the growing point prior to application.

Observations recorded

Fruit weight

The fully matured fruits were weighed with the help of a physical balance. It was collected from each tagged plant of each replication and it was calculated each time.

Juice content

The same fruit of fruits weight was crushed and collected juice was subtracted from fruit weight to calculate percentage of juice content in each treatment under each replication.

Juice / rag ratio

The juice weight was divided by the weight of seed with rag. Thus this ratio was worked out for each treatment.

Fruit cracking

The fruit cracking percentage was recorded by counting the number of cracked fruits per treatment and replication in one hundred randomly selected fruits and the average value is taken and calculated in percentage.

Results and Discussions

Fruit weight (g)

A careful scrutiny of data reflected that fruits having more weight were obtained under plants treated with different treatments in both the years (2017-18 & 2018-19) of experimentation and as well in their combined analysis is presented in Table-1.

Considering the effect of different treatments on the first year (2017-18) of experiment, it was evident that $C_1M_2H_1$ and $C_1M_2H_3$ produced fruits with maximum weight of 8.70 g, which was found on the same footing value, whereas; treatment $C_1M_1H_1$ was found at par with these treatments with having value of 8.20 g . The minimum fruit weight of 5.92 g was recorded under the treatment control ($C_0M_0H_0$). In the second year (2018-19) of investigation, more or less similar trend of the results were observed as in previous year. The maximum fruit weight of 9.07 g was recorded by effect of the treatment $C_1M_2H_1$, which was found statistically at par with the treatments $C_1M_1H_1$ and $C_1M_2H_3$ with having same footing value of 8.10 g and 8.33 g respectively. The minimum of 6.00 g was noted under the treatment control ($C_0M_0H_0$). The pooled analysis of the two years data (2017-18 & 2018-19) showed that treatments differed significantly in increasing the weight of fruit. The maximum of 8.88 g fruit weight was registered in C_1M_2H, which was found statistically at par with the treatment $C_1M_2H_3$ (8.52g). The minimum fruit weight of 5.96 g was observed under the treatment control ($C_0M_0H_0$).

Increasing in fruit weight (8.88g) in comparison to control (5.96 g) is due to increase in cell size; cell number and volume of inter cellular space in the flesh which have enabled the maximum accumulation of water and food substances by the lower application of colchicine. Further, mixoploidy *Cannabis sativa* induced by colchicine treatment showed better growth compared to tetraploids plants. It is well known that polyploidy leads to an increase in organ size, which may be caused by changes in activities of cell division and expansion as the result of the duplication of gene loci and increase in nuclear DNA content. Further, increase in fruit weight due to colchicine application indicates that colchicine concentrations bring about certain change in the metabolism of fruit which are reflected in more accumulation of food constituents in the fruit and thus increased in fruit weight of individual fruit as well as fruit yield per plant. It was supported by the researchers Amiri *et al.* (2010) in Datura, Glowacka *et al*. (2010) in *Miscanthus* species, Hayashi and Yoshida (1988) in *Dendranthema indicum*, Lindayani *et al.* (2010) in *Zingiber ofjicinale*, Liu *et al*. (2007) in pumpkin, Manawadu (2016) in radish, Nezhad and Mansouri (2017) in *Dunaliella salina,* Sugiyama (2005) in

Cannabis sativa and Vijayalakshmi and Singh (2011) in cluster bean.

Juice content (%)

The perusal of the data in table 1 reflected that application of colchicine during the both years (2017-18 & 2018-19) had helped in increasing the juice content in fruits over control. The critical analysis of the data for the first year (2017-18) clearly indicated that juice percentage was appreciably enhanced by the application of colchicine in different concentrations for variable period and by different methods. The highest 70.13 per cent was found in the fruits of treated with $C_1M_2H_1$ and statistically all the treatments were found at par with this treatment. The minimum 63.90 per cent was obtained in control ($C_0M_0H_0$). The scrutiny of data for the second year (2018-19) of observation exhibited that increase in number of chromosome can cause variable effects on increasing of juice percentage during this year. The maximum of 71.93 per cent juice content was received by the treatment $C_1M_2H_1$ and it was found statistically at par with treatments $C_1M_1H_1$, $C_2M_1H_1$, $C_1M_1H_2$, $C_2M_1H_2$, $C_1M_1H_3$, $C_1M_2H_2$, $C_1M_2H_3$ and $C_2M_2H_3$ with the value of 70.00 per cent, 67.00per cent, 66.80 per cent, 67.89 per cent, 66.90 per cent, 69.80 per cent and 66.80 per cent respectively whereas; the minimum of 64.10 per cent juice content was obtained under the treatment control ($C_0M_0H_0$).

The pooled analysis of the data for the both years (2017-18 & 2018-19) of investigation also registered the more or less similar results. The maximum of 70.03 per cent juice content per fruits was recorded in the treatment $C_1M_2H_1$ which was registered at par with the treatments $C_1M_1H_1$, $C_2M_1H_1$, $C_1M_1H_3$, $C_1M_2H_2$, $C_1M_2H_3$ and $C_2M_2H_3$ with value of 69.90 per cent, 66.78 per cent, 69.40 per cent, 66.86 per cent, 66.58 per cent, 69.37 per cent and 66.70 per cent respectively. The minimum juice content of 64.00 per cent per fruit was noted under the treatment control ($C_0M_0H_0$).

Juice / Rag ratio

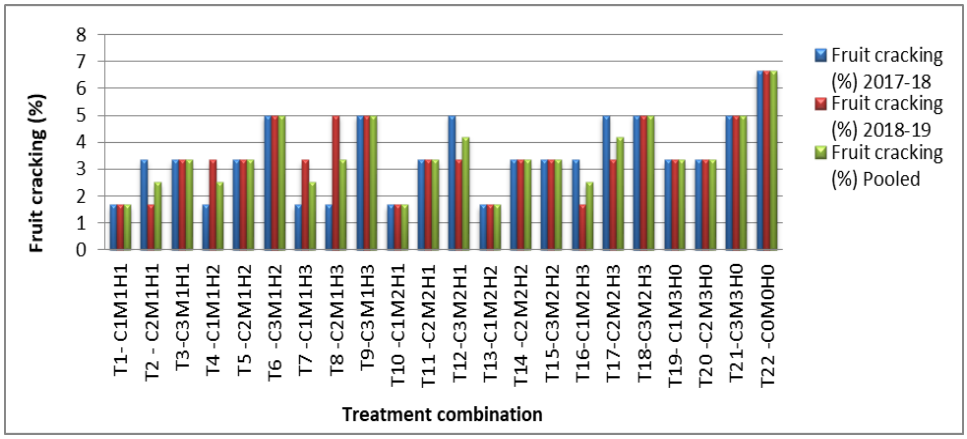
The higher ratio indicates the better fruit quality. By observing the data in table 1 indicates that application of colchicine treatment enhanced the value of juice rag ratio during the both the years (2017-18 &2018-19). In the first year (2017-19) of investigation, the maximum ratio of 2.88 was found in the treatment $C_1M_2H_1$, which was showed statistically at par with the treatments $C_1M_1H_1$ and $C_1M_2H_3$ with the ratio 2.61 and 2.58 respectively, whereas; the minimum ratio of 1.85 was recorded under the control($C_0M_0H_0$). During the second year (2018-19) of observations, juice rag ratio of 2.99 was registered under the treatment $C_1M_2H_1$and it was found statistically at par with the treatment $C_1M_1H_1$ with value of 2.92 juice/ rag ratio. The minimum juice rag ratio of 1.91 was noted under the treatment control ($C_0M_0H_0$). The combined results of the both years (2017-18 & 2018-19) also exhibited the similar trend of the previous both years. The maximum juice rag ratio of 2.94 was obtained by the treatment $C_1M_2H_1$ followed by the treatment $C_1M_1H_1$ with juice / rag ratio 2.77, whereas; the minimum of 1.88 was noted under the treatment control ($C_0M_0H_0$). The results obtained for this character clearly indicated that the application of colchicine had responded significantly towards improvement of juice rag ratio.

Improvement of juice percentage (70.03 %) and juice/ rag ratio (2.94) in colchicine treatment in comparison to control (64.00 % and 1.88 ratio respectively) has been observed in the present investigation. The increase in juice per cent is due to more increase in pulp as compared to that of the seed. In another way, it may be explained that the treatments have exerted the more influence on the flesh of the fruit.

Table.1 Effect of colchicine on fruit weight and juice content (%)

Treatment combination	Fruit weight (g)			Juice content (%)			Juice / Rag Ratio		
	2017-18	2018-19	Pooled	2017-18	2018-19	Pooled	2017-18	2018-19	Pooled
T_1- $C_1M_1H_1$	8.20	8.10	8.15	69.80	70.00	69.90	2.61	2.92	2.77
T_2 - $C_2M_1H_1$	7.10	7.17	7.13	66.57	67.00	66.78	2.21	2.26	2.24
T_3-$C_3M_1H_1$	7.05	6.97	7.01	65.80	66.00	65.90	2.19	2.26	2.23
T_4 -$C_1M_1H_2$	7.45	7.90	7.68	69.00	69.80	69.40	2.35	2.37	2.36
T_5 -$C_2M_1H_2$	7.30	7.17	7.23	65.67	66.80	66.23	2.13	2.26	2.19
T_6 -$C_3M_1H_2$	7.20	7.07	7.13	64.20	65.80	65.00	2.03	2.19	2.11
T_7 -$C_1M_1H_3$	7.30	7.13	7.22	65.83	67.89	66.86	2.03	2.16	2.09
T_8 -$C_2M_1H_3$	7.25	7.17	7.21	65.60	65.80	65.70	2.09	2.08	2.08
T_9-$C_3M_1H_3$	7.15	7.07	7.11	64.80	65.40	65.10	2.06	2.10	2.08
T_{10} -$C_1M_2H_1$	8.70	9.07	8.88	70.13	71.93	70.03	2.88	2.99	2.94
T_{11} -$C_2M_2H_1$	7.05	7.23	7.14	65.20	65.40	65.30	2.16	2.30	2.23
T_{12}-$C_3M_2H_1$	7.05	7.20	7.13	65.40	65.60	65.50	2.23	2.18	2.21
T_{13}-$C_1M_2H_2$	7.00	7.17	7.08	66.26	66.90	66.58	1.98	2.23	2.11
T_{14} -$C_2M_2H_2$	6.95	7.13	7.04	65.50	65.70	65.60	2.03	2.13	2.08
T_{15}-$C_3M_2H_2$	6.80	7.07	6.93	64.10	64.30	64.20	2.00	2.16	2.08
T_{16}-$C_1M_2H_3$	8.70	8.33	8.52	68.93	69.80	69.37	2.58	2.46	2.52
T_{17}-$C_2M_2H_3$	7.15	7.17	7.16	66.60	66.80	66.70	2.19	2.41	2.30
T_{18}-$C_3M_2H_3$	7.15	7.07	7.11	65.60	65.80	65.70	1.98	2.19	2.09
T_{19}- $C_1M_3H_0$	7.05	7.13	7.09	65.40	65.60	65.50	2.06	2.16	2.11
T_{20} -$C_2M_3H_0$	7.05	7.03	7.04	65.30	65.50	65.40	1.97	2.13	2.05
T_{21}-$C_3M_3H_0$	6.95	7.03	6.99	64.35	65.60	64.98	2.03	2.00	2.02
T_{22} -$C_0M_0H_0$	5.92	6.00	5.96	63.90	64.10	64.00	1.85	1.91	1.88
SEm ±	0.34	0.38	0.23	2.18	1.83	1.27	0.16	0.18	0.11
CD (P=0.05)	0.97	1.09	0.64	6.23	5.22	3.57	0.45	0.51	0.31
CV%	8.11	9.08	7.71	5.68	4.78	4.73	12.69	13.61	12.07

Fig.1 Effect of colchicine on minimum fruit cracking (%) in Cape gooseberry



CD(5%) Fruit cracking (%):2017-18 (1.19):2018-19 (1.09): Pooled (0.71).

Probable explanation for this may be more absorption of water and food substances in the elongated cell and increased volume of intercellular space in the flash. It was confirmed the present study of various earlier reporters as Amato and Durante (2003), Igor (2014) in gooseberry, Nezhad and Mansouri (2017) in *Dunaliella salina* and Wu *et al.* (2012) in kiwifruit.

Fruit cracking

The fruit cracking percentage was recorded by counting the number of cracked fruits among one hundred randomly selected fruits in per treatment and every replication and the average value is taken and calculated in percentage. The fruit cracking of Cape gooseberry fruits under different treatments was analyzed and recorded data in this respect are presented in Fig-1. The critical examination of the data for the year (2017-18) clearly indicated that the fruit cracking appreciably decreased by the application of colchicine with the various methods and in different concentrations for variable periods. The minimum fruit cracking was recorded under the treatments $C_1M_1H_1$, $C_1M_1H_2$, $C_1M_1H_3$, $C_2M_1H_3$, $C_1M_2H_1$ and $C_1M_2H_2$ with same footing value of 1.67 per cent whereas; maximum of 6.67 per cent was observed in the treatment control ($C_0M_0H_0$). In the next year (2018-19) of experiment, the similar trend was observed as previous year. The minimum fruit cracking was registered under the treatments of $C_1M_1H_1$, $C_2M_1H_1$, $C_1M_2H_1$, $C_1M_2H_2$ and $C_1M_2H_3$ with same footing value of 1.67 per cent whereas; the maximum of 6.67 per cent was noticed in the treatment control ($C_0M_0H_0$). The combined analysis of the data of two the years (2017-18 & 2018-19) also disclosed that all the treatments applied had decreased the fruit cracking. The minimum cracking of fruits was recorded with the treatments of $C_1M_1H_1$, $C_1M_2H_1$ and $C_1M_2H_2$ with same footing value of 1.67 per cent whereas; the maximum of 6.67 per cent was noted in fruits of Cape gooseberry under control ($C_0M_0H_0$). The fruit cracking percentage was observed minimum (1.67%) in the colchicine treated plant in comparison to maximum in control (6.67%). This might be due to an increase in organ size in the fruit, which may be caused by changes in activities of cell division and expansion as the result of the duplication of gene loci and increase in nuclear DNA content in the polyploidy plant (Sugiyama, 2005). Further, it was observed that different polyploidy level in algae have significantly response to a biotic stress (Nezhad and Mansour, 2017).

In the light of above findings it may be concluded that minimum concentration of colchicine @ 0.10 per cent by cotton plug method for 12 hours showed the best performance in respect of increasing of more juice content along with minimum fruit cracking percentage in comparison to untreated plant.

References

Amato, D. and Durante M.F. (2003). "Polyploidy". Online encyclopaedia of life sciences, John Wiley & Sons. http://onlinelibrary.wiley.com.

Amiri, S., Kazemitabaar, S.K., Ranjbar, G. and Azadbakht, M. (2010).The Effect of Trifluralin and Colchicine Treatments on Morphological Characteristics of Jimsonweed (*Datura stramonium* L.).*Trakia Journal of Sciences*, 8(4):47-61.

Glowacka, K., Owski, S.J. and Kaczmarek, Z. (2010). In vitro induction of polyploidy by colchicine treatment of shoots and preliminary characterization of induced polyploids in two *Miscanthus* species. *Industrial Crops and Products*, 32: 88–96.

Grosser JW, Kainth D, Dutt M. (2014). Production of Colchicine induced Autotetraploids in Pummelo (*Citrus grandis* Osbeck) through Indirect. *Horticultural Science*, 49(7):944–948.

Hannweg K, Visser G, Jager KD, Bertling I. (2016). In vitro-induced polyploidy and its effect on horticultural characteristics, essential oil composition and bioactivity of *Tetradenia riparia*. *South African Journal of Botany*, 106:186–191.

Hayashi, T. and Yoshida, K. (1988). Cell expansion and single-cell separation induced by colchicine in suspension-cultured soybean cells. *Proceedings of the National Academy of Sciences, USA*, 85: 2618-2622.

Kazi NA. (2015,a) Polyploidy in Solanaceous Crops. Asian Journal of Multidisciplinary Studies, 3(4):69-73.

Kumar R, Jha K,K., Sengupta, S., Misra, S., Mahto, C.S., Chakravarty. M.K., Narayan, S.C., Saha, D.P., Yadav, M. (2019). Impact of plant growth regulators and emasculation on insect-pest incidence and fruit cracking in cape gooseberry (*Physalis peruviana* L.). *Journal of Entomology and Zoology Studies*, 7(6):211-216.

Lindayani, N.K., Ibrahim, H. and Rahman, N.A. (2010). Effect of colchicine on tissue culture derived plants *of Zingiber ofjicinale* Rose, and *Zingiber ofjicinale* var. *rubrum* Theilade. *Journal of Science and Technology in the Tropics*, 6: 11-16.

Liu, Z.F., Min, Z. Y., Sun, X. W., Cheng, J. and Hu, Y.H. (2007). Study on induction and characterization of tetraploid plants in pumpkin. *Journal of North China Agricultural University*, 30(5): 125-129.

Manawadu, I.P., Dahanayake, N. and Senanayake, S.G.J.N.(2016). Colchicine induced tetraploids of radish (*Raphanus sativus* L.). *Tropical Agricultural Research & Extension*, 19 (1): 173-183.

Nezhad, F.S. and Mansouri, H.(2017). Effects of polyploidy on response of *Dunaliella salina* to salinity. *bioRxiv print online*, tp://dx.doi.org/10.1101/219840 doi:

Sugiyama, S.I. (2005). Polyploidy and cellular mechanisms changing leaf size: comparison of diploid and autotetraploid populations in two species of lolium. *Annals of Botany*, 96, 931–938.

Vijayalakshmi, A. and Singh, A. (2011).Effect of colchicine on cluster bean [*Cyamopsis tetragonoloba* (L.) Taub.]. *Asian Journal of Environmental Science*, 6 (2):171-174.

Wu, J.H., Ferguson, A.R., Murray, B.G., Jia, Y., Datson, P.M. and Zhang, J. (2012). Induced polyploidy dramatically increases the size and alters the shape of fruit in *Actinidia chinensis.* Annals of Botany, 109: 169 – 179.

Yildiz M. (2013). Plant Responses at Different Ploidy Levels. *Current Progress in Biological Research, 16*: 363-385.