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Association of non-chemical and chemical approaches for induction of flowering on non-structural carbohydrates and C:N ratio in mango cv. Alphonso

AV Bhuwad, PM Haldankar, BR Salvi, CD Pawar and YR Parulekar

Abstract
Konkan region of Maharashtra is known for best quality mango of cv. Alphonso which is having great demand in domestic as well as international markets. The late harvest of fruits fetches low market price causing huge economic loss to mango growers. Hence an attempt was made to find out association of various non-chemical and chemical approaches in internal content of non-structural carbohydrates and C:N ratio. The experiment was laid out in RBD with three replication and seven treatments *viz*., T_1- removal of new shoots, T_2- removal of old shoots below new, T_3- foliar spray of paclobutrazol @ 500 ppm, T_4- foliar spray of paclobutrazol @ 1000 ppm, T_5- foliar spray of ortho-phosphoric acid @ 0.5%, T_6- foliar spray of ortho-phosphoric acid @ 1% and T_7- control. Among the various non-chemical and chemical approaches T_1 and T_2- recorded highest flowering intensity, non-structural carbohydrates, C:N ratio and maximum yield.

Keywords: Mango, non-chemical and chemical approaches, non-structural carbohydrates, C:N ratio, flowering, yield

Introduction
Konkan region of Maharashtra is known for production of mango cv. Alphonso which is one of the best variety owing to its excellent quality for consumption as a fresh fruit and value addition. It is established on 1,03,960 ha and provide basis for livelihood for large section of farmers in Konkan region (Anon., 2019) [2]. This variety flower in the month of November and harvesting begins from March onwards under the normal set of climatic conditions. In recent years climatic fluctuations especially delay and abnormal rains and variations in temperature especially during flowering period (October- November) adversely affected the performance of crop. As a result instead of flowering vegetative flush appears. It takes 90 to 100 days to mature this flush and produce flowers from it. Hence the flowering is considerably delayed which ultimately results in delayed harvesting. The fruit of late harvest fetch remarkable low rate in market causing heavy financial loss to farmers. For inducing regular flowering in Alphonso mango in Konkan region soil application of paclobutrazol during monsoon is recommended. However inspite of application of paclobutrazol due to climatic fluctuation the flowering is delayed. The non-chemical approaches such as removal of new and old shoots and chemical approaches such as paclobutrazol and ortho-phosphoric acid are reported to help for proper flower induction. The non-structural carbohydrates that reserves in different parts of fruit trees play an important role in growth and development (Priestly, 1962) [20] and their accumulation derive critical growth events which require higher levels of resources than available from current photo-assimilates (Cull, 1991) [5]. The initiation of flowering mainly depends on maintenance of C:N ratio (Singh, 1960) [26] and high endogenous C:N ratio in plants. The low C:N ratio favours vegetative growth (Corbesier *et al*., 2002) [4]. The maturity of terminal shoot at bud break stage and accumulation of carbohydrate in the leaves and shoot apex are in some way associated with the synthesis of the floral stimulus in mango trees (Kumar *et al*., 2013) [11]. A field investigation was conducted to study the association of non-chemical and chemical approaches for induction of flowering on non-structural carbohydrates and C:N ratio in mango cv. Alphonso.

Material and Methods
The investigation was conducted at College of Horticulture (Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli) Dist. Ratnagiri, Maharashtra during 2018-19 and 2019-20.

Uniform mango grafts of variety Alphonso of age 35 years grown under uniform management practices were selected. The selected plants were applied paclobutrazol @ 3 ml/canopy volume through soil during monsoon (July). The experiment was laid out in a randomized block design with three replications and seven treatments *viz.*, T_1- removal of new shoots, T_2- removal of old shoots below new, T_3- foliar spray of paclobutrazol @ 500 ppm, T_4- foliar spray of paclobutrazol @ 1000 ppm, T_5- foliar spray of ortho-phosphoric acid @ 0.5%, T_6- foliar spray of ortho-phosphoric acid @ 1% and T_7- control. In treatment T_1 and T_2 the removal of new and old shoots was done after emergence of new shoots after monsoon in October/November. At this stage the colour of these new shoot was light green. For the treatment T_3, T_4, T_5 and T_6 the first foliar application of paclobutrazol and ortho-phosphoric acid was done after the emergence of new shoots after monsoon in October/November when shoots was dark green in colour. The second foliar application was performed 10 days after first spray.

The flowering intensity (%) and Yield (kg/plant) were recorded. The total non-structural carbohydrates and C:N ratio from leaves were examined at three different stages *viz.*, one month before treatment exposure (vegetative stage); two months after treatment exposure (during flowering stage) and four months after treatment exposure (after flowering). The samples for determining were collected, from the 4th leaf which is physiological matured and that occurred on the current year shoots (Yeshitela *et al*., 2010). The total carbohydrate content in fresh leaf was determined according to Duboise *et. al*., (1956) [7] and the mean values were expressed in percentage. The nitrogen was determined by using the modified micro Kjeldahl method. The carbohydrate: nitrogen ratio in leaf was derived by dividing the total carbohydrate content by the total nitrogen content. Genotypic and phenotypic correlation coefficient was estimated according to Prasad and Rao (1989) [19]. The data was analysed by using statistical methods suggested by Panse and Sukhatme (1985) [17].

Result and Discussion

The data on effect non-chemical and chemical means on flowering intensity indicated that treatment T_1 (69.78%) had the maximum flowering intensity which was at par with T_2 (69.00%), T_6 (66.77%) and T_4 (66.55%) (Table 1). It was followed by T_3 (63.78%) and T_5 (59.33%). The minimum flowering intensity was seen in control T_7 (45.39%). During both the years all the non-chemical and chemical approaches resulted in greater flowering intensity over control. According to Rao and Khader, (1980) [22] removal of new shoots bring an optimum cytokinin/gibberellin balance required for flowering. Branch tip pruning showed higher flowering percentage and increased number of fruits in Uba mango (Oliveira *et al*., 2017) [16]. Phosphorus has been reported to be an important component of energy transduction mechanisms which helps maximum induction of flowering (Rains, 1976) [21].

Irrespective of treatments the total non-structural carbohydrates were found non-significant at one month before exposure of treatment (Table 2). After two months of treatment exposure, treatment T_2 (4.37%) had highest NSC content which was at par with T_6 (4.28%) and significantly superior over all other treatments. Treatment T_1 (4.07%) and T_3 (3.86%) were at par with each other. It was followed by T_5 (3.66%) and T_4 (3.65%). The lowest NSC content were noted in control T_7 (1.95%). Similar trend were seen at four month after treatment application. Treatment T_2 recorded the maximum NSC (0.77%) which was followed by T_6 (0.64%), T_1 (0.62%). Treatment T_4 (0.46%), T_3 (0.43%) and T_5 (0.42%) were at par with each other. The minimum NSC content were observed in control T_7 (0.28%). The greater total non-structural carbohydrates in treatments T_2, T_6, T_1 and T_4 can be attributed to increased source sink activity and demand for assimilates (Elkhishen, 2015) [8]. Pruning induce hydrolysis and transport of reserves accumulated in the roots (Eyles *et al*., 2009) [9]. Satoh and Ohyama, (1977) observed the same by pruning in the mulberry and Rom and Ferree, (1985) [2] in peach respectively. According to Phavaphutanon *et al*., (2000) [18] concentration of NSC in leaves of paclobutrazol treated trees was higher than untreated trees in Nam Dok mango.

Irrespective of treatments the C:N ratio was found non-significant at one month before treatment exposure (Table 3). At two months after treatment application T_2 (31.06) had the highest C:N ratio which was at par with T_6 (30.62) which was followed by T_1 (29.23). Treatment T_4 (26.13), T_5 (25.48) and T_3 (25.22) were at par with each other. The lowest C:N ratio was found in control T_7 (20.25). After four months of treatment exposure, T_2 (19.50) contributed the maximum C:N ratio which was at par with T_6 (19.44). It was followed by T_1 (17.02) and T_4 (16.52). Treatment T_5 (16.15) and T_3 (15.51) were at par with each other. The lowest C:N ratio was observed in control T_7 (12.24). Both non-chemical and chemical treatments improved C:N ratio over control. Pruning accelerate bud sprouting causing the shoots to reach maturity earlier and have sufficient time to accumulate carbohydrates (Das and Jana, 2012 [6]; Balamohan and Gopu, 2014) [3] resulting higher C: N ratio. Srilatha *et. al*., (2019) [27] stated that pruning of current season's growth (P_1) enhanced the C: N ratio by 8.29 per cent than unpruned trees in Alphonso mango. Similar increased in C:N ratio by paclobutrazol and ortho-phosphoric acid was reported by Kundu *et al*., (2019) [12] in mango cv. Himsagar and Malshe *et al*., (2020) [14] in Alphonso.

The highest yield was registered by T_1 (6.93 kg/tree) which was at par with T_2 (60.63 kg/tree) and T_4 (56.76 kg/tree) (table 4). Treatment T_3 (55.95 kg/tree) and T_6 (54.88 kg/tree) were at par with each other. It was followed by T_5 (46.73 kg/tree) whereas lowest yield was obtained in T_7 (29.98 kg/tree). Thus, non-chemical and chemical means improved yield over control. The effect of removal of new shoots was prominent which can be attributed to the sufficient supply of carbohydrates maintaining a proper balance which helped high per cent of flowering panicle (Nath, 1994) [15]. The present findings are in accordance with Warang *et al*., (2019) [29] in mango cv. Alphonso and Nachare (2020) [25] in mango cv. Ratna. The reason attributed to increased yield with foliar spray of paclobutrazol can be contributed to its effect on shifting of assimilates, chlorophyll, mineral elements and soluble proteins in leaves, stems and roots (Tandel and Patel, 2011) [28] in Alphonso, Kesar and Rajapuri. According to Krishna *et al*., (2017) [10] significantly highest number of fruits per tree and yield (19.9% over control) by foliar spray of ortho-phosphoric acid @ 0.5 per cent.

Correlation coefficient analysis for yield and biochemical parameters

The fruit yield kg per tree was significantly and positively correlated with percent flowering (0.809**) (Table 5). NSC analysed at two month after treatment had significant and positive association with yield (0.762**) followed by NSC at four months after treatment (0.372*). C:N ratio examined at two months after treatment had positive correlation with yield (0.657**) which was followed by C;N ratio at four months after treatment (0.600**). It clearly emerged that initiation of flowering mainly depend on higher C/N ratio and non-structural carbohydrates which was altered by non-chemical and chemical approaches through various treatments. Positive association was observed between yield with non-structural carbohydrates and C:N ratio. These findings are close agreement with the findings of Majumder *et al*., (2012) [13] in mango and Abhilash *et al*., (2016) [1] in guava cv. Lucknow-49.

Table 1: Effect of various non-chemical and chemical means on flowering intensity (%) in mango cv. Alphonso

Treatment	Flowering intensity (%)		
	2018-19	2019-20	Pooled
T_1- Removal of new shoots	66.66	72.78	69.78
T_2- Removal of old shoot below new shoots	66.77	71.33	69.00
T_3- PBZ @ 500 ppm foliar application	61.78	65.78	63.78
T_4- PBZ @ 1000 ppm foliar application	62.88	70.22	66.55
T_5- Ortho-phosphoric acid @ 0.5% foliar application	57.22	61.44	59.33
T_6- Ortho-phosphoric acid @ 1% foliar application	67.53	66.00	66.77
T_7- Control	42.22	48.55	45.39
Mean	60.72	65.16	62.94
S.E. ±	1.69	1.80	1.14
C.D. at 5%	5.21	5.56	3.50

Table 2: Effect of various non-chemical and chemical means on total non-structural carbohydrates (%) in mango cv. Alphonso

Treatment	One month before treatment			After two month of treatment			After four month of treatment		
	2018-19	2019-20	Pooled	2018-19	2019-20	Pooled	2018-19	2019-20	Pooled
T_1	2.07	2.16	2.12	4.01	4.12	4.07	0.51	0.74	0.62
T_2	2.35	2.31	2.33	4.43	4.31	4.37	0.70	0.84	0.77
T_3	1.57	1.72	1.65	3.78	3.93	3.86	0.39	0.47	0.43
T_4	1.61	1.79	1.70	3.20	4.10	3.65	0.40	0.51	0.46
T_5	1.76	1.89	1.83	3.29	4.03	3.66	0.38	0.46	0.42
T_6	2.19	2.20	2.19	4.27	4.29	4.28	0.51	0.78	0.64
T_7	0.98	1.44	1.21	1.74	2.16	1.95	0.27	0.29	0.28
Mean	1.79	1.93	1.86	3.53	3.85	3.69	0.45	0.58	0.52
S.E. ±	0.30	0.23	0.22	0.18	0.04	0.09	0.03	0.02	0.02
C.D. at 5%	NS	NS	NS	0.57	0.13	0.28	0.11	0.07	0.07

Table 3: Effect of various non-chemical and chemical means C:N ratio in mango cv. Alphonso.

Treatment	One month before treatment			After two month of treatment			After four month of treatment		
	2018-19	2019-20	Pooled	2018-19	2019-20	Pooled	2018-19	2019-20	Pooled
T_1	21.78	24.00	22.89	27.82	30.65	29.23	15.75	18.28	17.02
T_2	22.15	25.29	23.72	29.76	32.36	31.06	18.34	20.66	19.50
T_3	20.15	21.34	20.75	24.16	26.28	25.22	14.52	16.49	15.51
T_4	20.36	22.72	21.54	24.18	28.09	26.13	15.26	17.77	16.52
T_5	21.81	22.94	22.38	24.52	26.44	25.48	15.52	16.77	16.15
T_6	21.49	23.62	22.56	31.74	29.50	30.62	19.53	19.35	19.44
T_7	19.88	20.29	20.09	19.00	21.50	20.25	11.24	13.24	12.24
Mean	21.09	22.89	21.99	25.88	27.83	26.86	15.74	17.51	16.62
S.E. ±	1.53	1.56	1.36	0.42	0.77	0.45	0.22	0.38	0.23
C.D. at 5%	NS	NS	NS	1.31	2.39	1.39	0.69	1.18	0.74

Table 4: Effect of various non-chemical and chemical means on fruits kg per tree in mango cv. Alphonso

Treatment	Fruits kg/tree		
	2018-19	2019-20	Pooled
T_1- Removal of new shoots	48.20	75.67	61.93
T_2- Removal of old shoot below new shoots	48.96	72.30	60.63
T_3- PBZ @ 500 ppm foliar application	44.73	67.18	55.95
T_4- PBZ @ 1000 ppm foliar application	45.74	67.83	56.79
T_5- Ortho-phosphoric acid @ 0.5% foliar application	45.60	47.86	46.73
T_6- Ortho-phosphoric acid @ 1% foliar application	47.61	62.15	54.88
T_7- Control	21.61	36.36	28.98
Mean	43.21	61.34	52.27
S.E. ±	1.23	2.87	1.73
C.D. at 5%	3.79	8.84	5.32

Table 5: Simple correlation coefficient matrix for biochemical parameters and yield of mango cv. Alphonso (Pooled)

	NSC one month before treatment	NSC two month after treatment	NSC four month after treatment	C: N ratio one month before treatment	C: N ratio two month after treatment	C: N ratio four month after treatment	Flowering intensity	Yield
NSC one month before treatment	1							
NSC two month after treatment	0.244	1						
NSC four month after treatment	-0.024	0.723**	1					
C: N ratio one month before treatment	-0.079	0.595*	0.642**	1				
C: N ratio two month after treatment	0.078	0.885**	0.852**	0.794**	1			
C: N ratio four month after treatment	0.193	0.848**	0.848**	0.770**	0.941**	1		
Flowering intensity	0.162	0.818**	0.638*	0.551*	0.790**	0.756**	1	
Yield	0.186	0.762**	0.372*	0.413*	0.657*	0.600*	0.809**	1

Analysis method by Prasad and Rao (1989). * Significant at 5% ** Significant at 1%

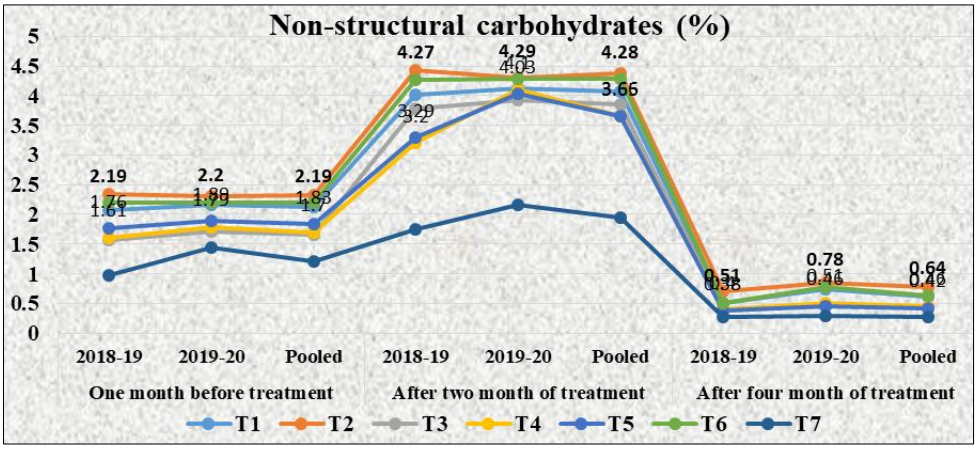

Fig 1: Effect of chemical and non-chemical approaches on non-structural carbohydrates in mango cv. Alphonso

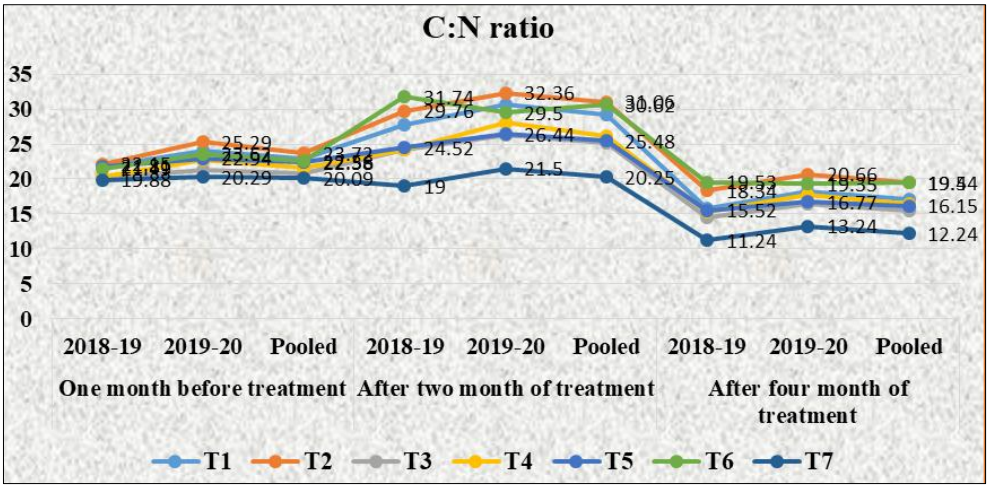

Fig 2: Effect of chemical and non-chemical approaches on C:N ratio in mango cv. Alphonso

Conclusion: The present investigation concluded that non-chemical and chemical approaches were beneficial for improve the biochemical status at various stages of mango cv. Alphonso which play an important role in flower induction at appropriate time and also contributed for highest yield. Therefore, the present studies indicated that all the parameters had positive direct effect on fruit yield per plant.

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Reference

1. Abhilash L, Suresh Kumar T, Raja Goud CH, Girwani A, Narendar Reddy S. Correlation studies in fruit characters of guava (*Psidium guajava* L.) cv. Lucknow – 49,

Advances in Life sciences. 2016;5(17):6924-6926.
2. Anonymous. Area, Production and productivity of mango in India. Indian Horticulture Database; c2019.
3. Balamohan Gopu P, Soman TNP, Jeyakumar P. Canopy management in mango (*Mangifera indica* L.) cv. Alphonso with reference to flowering, yield and quality characters under ultra-high density planting. Journal of Applied Horticulture. 2014;16(1):50-53.
4. Corbesier L, Bernier G, Perilleux C. C: N ratio increases in the phloem sap during floral transition of the long-day plants, Sinapis alba and Arabidopsis thaliana. Plant Cell Physiol. 2002;43:684-688.
5. Cull BW. Mango crop management. Acta Horticulture 1991;291:154-173.
6. Das B, Jana BR. Journal of Food and Agricultural Environment. 2012;10(3&4):328-331.
7. Duboise MF, Smith KA, Gillers JK, Hamilton PA, Smith F. Colorimetric method for determination of sugars and related substances. Anal. Chem. 1956;28:350-356.
8. Elkhishen MA. Enhancing flowering and fruiting attributes of mango (*Mangifera indica*) cv. Zebda in the off year by binary application of KNO3, ethrel and paclobutrazol. Journal of Horticultural Science & Ornamental Plants. 2015;7(3):87-93.
9. Eyles A, Pinkard EA, Mohammed C. Shifts in biomass and resource allocation patterns following defoliation in *Eucalyptus globulus* growing with varying water and nutrient supplies. Tree Physiol. 2009;29(6):753-764.
10. Krishna Golla Vijay, Bhagwa A, Raj Kumar M, Siva Shankar A. Flowering and Production Improvement Studies of Mango cv. Banganpalli in Relation to Plant Growth Regulators and Chemicals. International Journal Current Microbiology, Applied Science. 2017;6(8):481-493.
11. Kumar M, Ponnuswami V, Jeyakumar P, Richard Kennedy R, Saraswathy S. Studies on influence of season for biochemical parameters in mango cultivars. African J Agric. Res. 2013;8(49):6394-6400.
12. Kundu S, Mishra J, Nandi P, Swamy Sekhar R, Adhikary T. Induction of flowering in mango cv. Himsagar. Journal of Crop and Weed. 2019;15(1):29-34.
13. Majumder DAN, Hasan L, Rahim MA, Kabir MA. Correlation and path coefficient analysis of mango (*Mangifera indica* L.), Bangladesh Journal of Agricultural Research. 2012;37(3):493-503.
14. Malshe KV, Patil SS, Haldankar PM. Effect of Foliar Nutrients on Shoot Carbon and Nitrogen Content at Various Phenological Stages in Mango cv. Alphonso. Int. J Curr. Microbiol. App. Sci. 2020;9(1):2475-2486.
15. Nath JC. Effect of pruning on growth, yield and quality of Assam Lemon (*Citrus limon* Burm.). Haryana J Hort. Sci. 1994;23(4):281-285.
16. Oliveira GP, Siqueira DL, Salomao LCC, Paulo R, Machado DLM. Paclobutrazol and branch tip pruning on the flowering induction and quality of mango tree fruits, Agropec. Trop., Goiania. 2017;47(1):7-14.
17. Panse VG, Sukhatme PV. Statistical methods for Agricultural Workers. ICAR Rev. Ed. By Sukhatme, P. V. and Amble, V. N. c1995. p. 97-156.
18. Phavaphutanon L, Krisanapook K, Pichakum A, Jutamanee K. Changes of total non-structural carbohydrates within shoots of 'Nam Dok Mai' mango after paclobutrazol application. Acta Horticulturae 2000;509:559-565.
19. Prasad MBNV, Rao GSP. Genetic variability, correlations and path coefficient analysis for some morphological and biochemical constituents of acid lime fruit. Scientia Hort. 1989;41:43-53.
20. Priestley CA. Carbohydrate resources within the perennial plant. *Tech. Commun. Commw. Bur. Hort. Plantn*. Crops 27; 1962.
21. Rains DW. Mineral metabolism in: Plant Biochemistry (ed.) *Bonner J and Varner J E third edition*, Academic press, London; c1976.
22. Rao VNM, Khader JBMMA. Effect of pruning and thinning of young shoot culsters of mango. Sc. & Cult. 1980;46:71-72.
23. Rom CC, Ferree DC. Time and severity of summer pruning influences on young peach tree net photosynthesis, transpiration, and dry weight distribution, J Am. Soc. Hortic. Sci. 1985;110:455-461.
24. Satoh M, Ohyama K. Studies on photosynthesis and translocation of photosynthates in mulberry tree. VI: Changes in amylase activity and in amount of carbohydrates in a storage organ after shoot pruning. Proc. Crop. Sci. Soc. Japan. 1977;46:499-503.
25. Sayali Nachare, Haldankar PM, Parulekar YR, Dalvi VV, Dalvi NV. Effect of various non-chemical means on induction of flowering, fruit set and yield of mango cv. Ratna. A M. Sc. thesis submitted to College of Horticulture, DBSKKV, Dapoli; c2020.
26. Singh RN. Studies on the differentiation and development of fruit buds in mango (*Mangifera indica* L.) Periodical changes in the chemical composition of shoots and their relation with flower bud differentiation. Hort. Adv. 1960;4:48-59.
27. Srilatha V, Reddy YTN, Upreti KK. Morpho-physiological and biochemical responses of rootstock, pruning and paclobutrazol in mango (*Mangifera indica* L.) cv. Alphonso. International Journal of Agriculture Sciences. 2019;11(22):9223-9230.
28. Tandel YN, Patel NL. Effect of chemicals on growth, yield and economics of mango (*Mangifera indica* L.). Karnataka J Agric. Sci. 2011;24(3):362-365.
29. Warang OS, Haldankar PM, Parulekar YR, Salvi BR, Chavan SA, Dalvi NV, *et al*., Non-chemical approaches for induction of appropriate flowering in mango cv. Alphonso. Bull. Env. Pharmacol. Life Sci. 2019 November;8(1):58-62.