International Journal of Agricultural Sciences
Volume 14 | Issue 1 | January, 2018 | 85-91 ■ e ISSN-0976-5670
☞ DOI:10.15740/HAS/IJAS/14.1/85-91
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RESEARCH PAPER

Influence of solubor, biozyme and triacontanol on leaf and fruit nutrient content of apple cv. RED DELICIOUS

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Abstract : The decreasing trend in apple productivity during the last decade due to changing climate scenario has caused a serious concern to the fruit growers and planners of the country. Several factors like inadequate pollinizer proportion, reduction in natural population of pollinating agents, occurrence of spring frosts, hails and gales, nutrient deficiencies, droughts etc. are the factors leading to poor fruit setting in Delicious apple (Gautam *et al.*, 2004). The present studies on influence of solubor, biozyme and triacontanol on leaf and fruit nutrient content of apple cv. RED DELICIOUS"were carried out in the Division of Fruit Science, SKUAST-Kashmir, Shalimar, Srinagar during the year 2013 and 2014. Twenty five year old apple trees of cv. RED DELICIOUS were selected at the Sher-e-Kashmir University of Agricultural Sciences and Technology, Shalimar, Kashmir. In experiment: chemicals of solubor (0.1 %) biozyme (1.5 ml/lit) and triacontanol (10 ppm) and their combinations were sprayed at three timings: (i) at pink bud stage (ii) three weeks after fruit set of apple (iii) two months after second spray. Two months after second spray, solubor was replaced with 0.5 % $CaCl_2$while going through the results, leaf nitrogen content not significantly influenced by different treatments. However, maximum leaf phosphorus (0.26 %), potassium (2.62 %), calcium (2.46 %) and magnesium (0.88 %) was recorded in solubor + biozyme + triacontanol followed by solubor + biozyme. The leaf boron increased significantly with solubor + biozyme + triacontanol and solubor + biozyme (48.00 and 47.25 ppm) followed by solubor + triacontanol. However, data with respect to leaf nitrogen/ calcium ratio were found to be statistically non-significant. Maximum fruit nitrogen (0.39 %), phosphorus (0.11 %), potassium (0.99 %), calcium (0.049 %), magnesium (0.078 %) and boron (19.82 ppm) was obtained from solubor + biozyme + triacontanol followed by solubor + biozyme. However, N/Ca (17.96) ratio was calculated from control followed by triacontanol (12.33) and biozyme (10.62) and lowest was observed in solubor + biozyme + triacontanol (8.06).While going through the results of both the experiments, it is revealed that the combinations of solubor, biozyme and triacontnaol were best to improve the fruit set and yield of apple fruits. It is clear from results that bio-stimulants increase nutrients through foliar application and thus will improve the fruit yield and quality of apple. In addition bio-stimulants are safe for human and animal and environment to get lower pollution and reduce soil salinity.

Key Words : Apple, Chemicals, urea, Leaf, Fruit nutrient contents

View Point Article : Mohd. Zubair, Hussain, S. S., Munib-u-Rehman, Baba, Jahangir Ah. (2018). Influence of solubor, biozyme and triacontanol on leaf and fruit nutrient content of apple cv. RED DELICIOUS. *Internat. J. agric. Sci.*, **14** (1) : 85-91, **DOI: 10.15740/HAS/IJAS/14.1/85-91.**

Article History : Received : 03.05.2017**; Revised :** 11.11.2017**; Accepted :** 24.11.2017

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INTRODUCTION

Apple is the most important fruit crop of Jammu and Kashmir and accounts for 51 per cent of total production of total area of 2.72 lac hectare under all temperate fruits grown in this state. Average yield of commercially important apple cultivars per unit area in the country ranging between 10-12 tonnes/ha, but it compares poorly to the yields of 20-30 tonnes/ha in horticultural advanced countries of the world. Climate and other agro-ecological factors of Kashmir are ideally suited to the cultivation of many varieties. Alternate bearing, defective pruning and training, use of seedling rootstock of unknown performance, lack of proper nutrition and water management, deficiency of suitable pollinizers/ pollinators and ineffective control of pests and diseases are the main causes of low productivity.

Nutrients are essential for the productivity and quality fruit of different crops on long term basis. The perennial fruit crops are quite different from the annual and biannual seasonal crops in their nutritional needs due to size, density, rate of growth, root pattern and phenomenon of the fruits bud differentiation in previous season and its relationship with the yield in following years (Bhargava and Singh, 2001). To achieve good yield and quality, nutrient balance has to be maintained. Nutrient imbalance may result in deficiencies, toxicities. This may result in stress to the crop, causing a decrease in quality and yield.

These days for improvement in production and quality of Red Delicious apples, spray of biozyme fruit+ liquid@ 1.5 ml per litre of water at pink bud stage, petal fall stage and fruit setting stage (25 days after 2nd spray) or biovita @ 1.5 per lire of water at pink bud stage, fruit pea stage, fruit set walnut stage and 20 days before harvest or Paushak @ 2.0 ml per litre of water at silver tip stage, fruit setting stage and walnut stage has been used. Application of seaweed extract as an organic bio-stimulant is fast becoming an accepted practice in horticulture (Turan and Kose, 2004). Seaweed extracts are reported to be effective fertilise in many crops including vegetables, fruit trees, flowering plants and grain crops (Ferrra and Lourens, 2004). Many physiological responses shown by crop plants are reported (Singh and Chandel, 2005) due to cytokineins present in the extracts. Triacontanol(TRIA) is a 30-carbon primary alcohol and functions as a plant growth promoter (Ries *et al*., 1978). It plays an active role in the up regulation of many biochemical and physiological processes in plants (Chen *et al.,* 2003). Role of TRIA is well studied not only in whole plants level (Eriksen *et al*., 1981).

Plants usually absorb water and nutrients by their roots, therefore, fertilizers are traditionally applied to soil (Mengel, 2002). While soil application can apply enough nutrients to improve plant protection, it also causes world-wide concern about environmental contamination from nutrients leaching into ground water (Dines *et al*., 2002). Increasing public concern about excessive nutrient loss from agricultural land encourages the search for more efficient ways to apply fertilizers. The ability of plant leaves to absorb nutrients has resulted in foliar application of nutrients in foliar application of nutrients becoming an alternative method for supplying nutrients to plants (Swietlik and Faust, 1984).

Wojicik *et al*. (2010) performed calcium foliar application both in summer and in autumn which resulted to increase calcium concentration of fruit. Mirabdulbhagi (2013) examined the impact of Ca foliar spray treatment on mineral contents and chemical attributes of Apricot (*Prunus armeniaca* L.). Results showed that pre-harvest application of Ca foliar spray increased Ca content at harvest and during storage.

Keeping the above points in view, the present research was carried out at experimental orchard of division of fruit science with the objective : To assess the effect of chemicals on mineral status of apple cv. "RED DELICIOUS".

MATERIAL AND METHODS

The present experiment on influence of solubor, biozyme and triacontanol on leaf and fruit nutrient content of apple cv. RED DELICIOUS was carried out at Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir Shalimar, Srinagar, Jammu and Kashmir during the year 2013 and 2014. The experiment was conducted on twenty five years old trees of uniform size and vigour. The uniform cultural practices as per the package of practices of SKUAST-Kashmir were given to experimental trees.

The Kashmir represents the climatic conditions prevailing in the temperate zone of the Jammu and Kashmir state. The Jammu and Kashmir state is situated at 32°.17' to 37°.05' N latitude and from 72°.40' to 80°.30' E longitude. The altitude of Kashmir valley varies form 1500-2000 meters above mean sea level. The maximum

and minimum temperature of valley during the crop season ranged between 23°C and 29.9 °C and -5.8 °C to 12 °C, respectively with relative humidity of 43.90 per cent and 650-800 mm rainfall mostly which was received from December to April.

The chemicals were applied at three different timings to see the effect of chemicals on fruit set, quality and mineral nutrition of apple. The three timings are:

– At pink-bud stage of apple
– Three weeks after fruit set of apple
– Two months after second spray.

Table A : Trees under control were sprayed with water only

Treatments	Common name	Concentration
T_1	Solubor	0.1 per cent
T_2	Biozyme	1.5 ml/lt
T_3	Triacontanol	10 ppm
T_4 (T_1+ T_2)	Solubor + Biozyme	0.1 per cent + 1.5 ml/lt
T_5 (T_1+T_3)	Solubor + Triacontanol	0.1 per cent + 10 ppm
T_6 (T_2+ T_3)	Biozyme + Triacontanol	1.5 ml/lt +10 ppm
T_7 (T_1+T_2+T_3)	Solubor+Biozyme+ Triacontanol	% +1.5ml/lt+10ppm
T_8	Control	Water spray

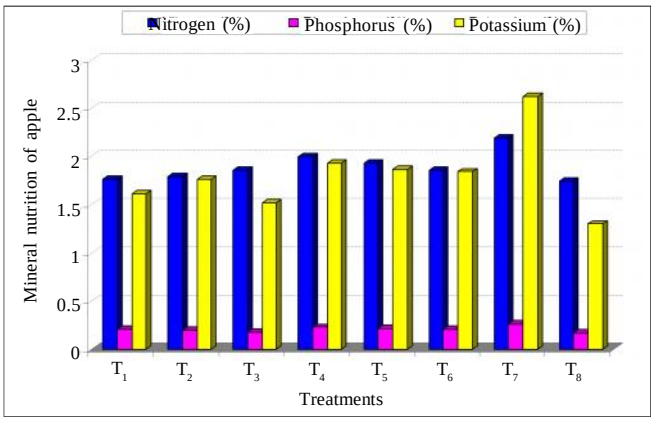
Note : Two months after 2nd spray, solubor was replaced with 0.5 per cent $CaCl_2$

Experimental details :

Number of treatments : 8
Number of replications : 4
Number of trees/replication : 1
Total Number of trees : 4 x 8 = 32
Experimental design : RBD
Observations recorded : N, P, K, Ca, Mg, B.

RESULTS AND DISCUSSION

Consumers and society increasingly value the production of high quality, healthy fruits which at that time, ensures minimal or no adverse impacts on the environment. In conventional apple orchards, pesticides applications, chemical thinning, soil management, irrigation and fertilization are all vital interventions to obtain a profitable production. Nonetheless, excessive chemical inputs cause the transport of xenobiotic compounds to drainage areas, which results in environmental problems such as pollination by persistent chemicals, eutrophication of rivers, lakes and the sea (Levitan *et al.*, 1995). Due to numerous concerns about



T_1 = Solubor*
T_2 = Biozyme
T_3 = Triacontanol
T_4 = Solubor* + Biozyme
T_5 = Solubor* + Triacontanol
T_6 = Biozyme + Triacontanol
T_7 = Solubor* + Biozyme + Triacontanol
T_8 = Control

Fig. 1 : Effect of chemicals on mineral nutrition of apple

Table 1 : Effect of chemicals on leaf nitrogen, phosphorus and potassium content of apple cv. RED DELICIOUS

Treatments		Concentration	Nitrogen (%)			Phosphorus (%)			Potassium (%)		
			2013	2014	Pooled	2013	2014	Pooled	2013	2014	Pooled
T_1	Solubor*	0.1%	1.71	1.80	1.76	0.19	0.22	0.21	1.49	1.73	1.61
T_2	Biozyme	1.5 ml/l	1.77	1.80	1.79	0.17	0.22	0.20	1.72	1.80	1.76
T_3	Triacontanol	10 ppm	1.80	1.89	1.85	0.16	0.20	0.18	1.45	1.58	1.52
T_4	Solubor* + Biozyme	0.1 % + 1.5 ml/l	1.98	2.01	1.99	0.21	0.25	0.23	1.89	1.96	1.93
T_5	Solubor+ Triacontanol	0.1 % + 10 ppm	1.87	1.98	1.93	0.18	0.26	0.22	1.82	1.90	1.86
T_6	Biozym + Triacontanol	1.5 ml/l + 10 ppm	1.83	1.86	1.85	0.19	0.22	0.21	1.80	1.87	1.84
T_7	Solubor* + Biozyme + Triacontanol	0.1% + 1.5 ml/l + 10ppm	2.16	2.21	2.19	0.21	0.30	0.26	2.17	3.07	2.62
T_8	Control	Water	1.72	1.75	1.74	0.15	0.18	0.17	1.21	1.38	1.30
	C.D. ($p \leq 0.05$)		NS	NS	NS	0.01	0.01	0.009	0.55	0.85	0.49

*Two months after 2nd spray, solubor was replaced with 0.5% $CaCl_2$ NS= Non-significant

the indiscriminate application of chemicals, the present tendency is to reduce their excessive use in horticulture (Van Noorduijk and Cadish, 2002). More ever, during organic apple production, the majority of xenobiotic chemicals are banned (Widmer *et al.*, 2008). Various bio-stimulants have been used to overcome the problems. One of them is seaweed extracts and triacontanol.

Present studies reveal that leaf and fruit N, P, K, Ca, B, Ca and Mg were highest in apples treated with solubor + biozyme + triacontanol. Data presented in Tables 1 and 4 showed that there was non-significant differences among the treatments on nitrogen percentage in the leaves but in the fruits it was significant.

Perusal of pooled data reveal that highest leaf phosphorus (0.26 %), potassium (2.62 %) calcium (2.46 %) magnesium (0.88 %), boron (48.00 ppm) content was recorded in solubor + biozyme + triacontanol treatment followed by solubor + biozymephosphorus (0.23 %), potassium (1.93 %), calcium (2.28 %), magnesium (0.73 %), boron (47.25 ppm) The data on leaf nutrient content are delineated in the Table 1,2,3. Different chemicals demonstrated their influence on apple cv. RED DELICIOUS during course of study.

The pooled data with respect to fruit nitrogen/ calcium ratio presented in Table 3 depict that the differences between treatments were found to be statistically non-significant

Similarly, the fruit N, P, K, Ca, Mg were increased by solubor + biozyme + triacontanol treatment followed by solubor + biozyme. The pooled data with respect to fruit nutrient content are presented in Table 3, 4 and 5.

The pooled data presented in Table 6 show that all the treatments had a significant influence on fruits N/Ca ratio during the course of study. Higher (17.96) ratio was obtained from control, which was followed by triacontanol (12.33) and biozyme (10.62) and lower (8.06) fruit N/ Ca ratio was observed in solubor + biozyme + triacontanol. Different chemicals influenced on N/Ca ratio of fruit during both the years of study. Maximum (19.41 and 116.50) ratio was noted in control and the

Table 2 : Effect of chemicals on leaf calcium and magnesium content of apple cv. RED DELICIOUS

Treatments		Concentration	Calcium (%)			Magnesium (%)		
			2013	2014	Pooled	2013	2014	Pooled
T_1	Solubor*	0.1%	1.76	1.89	1.83	0.49	0.63	0.56
T_2	Biozyme	1.5 ml/l	1.73	1.82	1.78	0.39	0.55	0.47
T_3	Triacontanol	10 ppm	1.49	1.69	1.59	0.22	0.57	0.40
T_4	Solubor* + Biozyme	0.1 % + 1.5 ml/l	2.26	2.30	2.28	0.60	0.86	0.73
T_5	Solubor + Triacontanol	0.1 % + 10 ppm	1.94	2.00	1.97	0.66	0.78	0.72
T_6	Biozyme+Triacontanol	1.5 ml/l + 10 ppm	1.87	1.94	1.91	0.67	0.74	0.71
T_7	Solubor*+ Biozyme + Triacontanol	0.1% + 1.5 ml/l + 10ppm	2.42	2.50	2.46	0.86	0.90	0.88
T_8	Control	Water	1.33	1.53	1.43	0.50	0.53	0.52
	C.D. ($p \leq 0.05$)		0.01	0.03	0.004	0.01	0.01	0.008

*Two months after 2nd spray, solubor was replaced with 0.5% $CaCl_2$

Table 3 : Effect of chemicals on leaf boron content and nitrogen/calcium ratio of apple cv. RED DELICIOUS

Treatments		Concentration	Boron (ppm)			Nitrogen/calcium ratio		
			2013	2014	Pooled	2013	2014	Pooled
T_1	Solubor*	0.1%	35.00	36.00	35.50	0.97	0.95	0.96
T_2	Biozyme	1.5 ml/l	31.00	34.00	32.50	1.02	0.99	1.01
T_3	Triacontanol	10 ppm	30.00	30.00	30.00	1.21	1.12	1.17
T_4	Solubor* + Biozyme	0.1 % + 1.5 ml/l	46.50	48.00	47.25	0.87	0.89	0.88
T_5	Solubor* + Triacontanol	0.1 % + 10 ppm	40.50	41.50	41.00	0.96	1.02	0.99
T_6	Biozyme + Triacontanol	1.5 ml/l + 10 ppm	34.00	37.75	35.88	0.94	0.99	0.97
T_7	Solubor* + Biozyme +Triacontanol	0.1% + 1.5 ml/l + 10ppm	48.00	48.00	48.00	0.89	0.91	0.90
T_8	Control	Water	31.50	32.00	31.75	1.29	1.32	1.31
	C.D. ($p \leq 0.05$)		1.28	1.11	0.82	NS	NS	NS

*Two months after 2nd spray, solubor was replaced with 0.5% $CaCl_2$ NS= Non-significant

minimum (8.84 and 7.27) ratio was observed in solubor + biozyme + triacontanol treatment.

Biozyme a seaweed extract is able to enhance nutrient uptake by the roots and plant tolerance to drought (Spinelli *et al*., 2006). Biozyme is derived from the alga (*Ascophillum nodosum*). Seaweeds are a known source of plant regulators (Jamsen, 1993), organic osmulites (e.gbetaines), amino acids, mineral nutrients, vitamins and vitamin precursors (Berlyn and Russo, 1990). This bio-stimulant, unlike some earlier seaweed extracts, provides a constant and balanced formulation containing kahydrin, alginic acid and betaine which contribute synergistically

Table 4 : Effect of chemicals on fruit nitrogen, phosphorus and potassium content of apple cv. RED DELICIOUS

Treatments		Concentration	Nitrogen (%)			Phosphorus (%)			Potassium (%)		
			2013	2014	Pooled	2013	2014	Pooled	2013	2014	Pooled
T_1	Solubor*	0.1%	0.30	0.31	0.31	0.05	0.08	0.07	0.81	0.84	0.83
T_2	Biozyme	1.5 ml/l	0.31	0.36	0.35	0.07	0.09	0.08	0.84	0.85	0.85
T_3	Triacontanol	10 ppm	0.33	0.33	0.32	0.05	0.06	0.06	0.82	0.82	0.82
T_4	Solubor* + Biozyme	0.1 % + 1.5 ml/l	0.37	0.40	0.39	0.08	0.10	0.09	0.99	0.90	0.95
T_5	Solubor* + Triacontanol	0.1 % + 10 ppm	0.36	0.38	0.37	0.07	0.08	0.08	0.92	0.94	0.93
T_6	Biozyme + Triacontanol	1.5 ml/l + 10 ppm	0.36	0.37	0.37	0.07	0.08	0.08	0.88	0.95	0.92
T_7	Solubor* + Biozyme + Triacontanol	0.1% + 1.5 ml/l + 10ppm	0.38	0.40	0.39	0.10	0.11	0.11	0.99	1.00	0.99
T_8	Control	Water	0.33	0.33	0.33	0.03	0.08	0.06	0.79	0.80	0.80
	C.D. ($p \leq 0.05$)		NS	0.01	0.005	0.01	0.01	0.008	0.01	0.26	0.13

*Two months after 2nd spray, solubor was replaced with 0.5% $CaCl_2$ NS= Non-significant

Table 5 : Effect of chemicals on fruit calcium, magnesium content of apple cv. RED DELICIOUS

Treatments		Concentration	Calcium (%)			Magnesium (%)		
			2013	2014	Pooled	2013	2014	Pooled
T_1	Solubor*	0.1%	0.028	0.039	0.034	0.059	0.060	0.060
T_2	Biozyme	1.5 ml/l	0.030	0.033	0.032	0.052	0.059	0.056
T_3	Triacontanol	10 ppm	0.023	0.032	0.028	0.050	0.055	0.053
T_4	Solubor* + Biozyme	0.1 % + 1.5 ml/l	0.039	0.043	0.041	0.064	0.070	0.067
T_5	Solubor* + Triacontanol	0.1 % + 10 ppm	0.038	0.042	0.040	0.061	0.067	0.064
T_6	Biozyme + Triacontanol	1.5 ml/l + 10 ppm	0.034	0.038	0.036	0.060	0.064	0.062
T_7	Solubor* + Biozyme + Triacontanol	0.1% + 1.5 ml/l + 10ppm	0.043	0.055	0.049	0.077	0.078	0.078
T_8	Control	Water	0.017	0.020	0.019	0.044	0.051	0.048
	C.D. ($p \leq 0.05$)		NS	0.001	0.06	0.001	0.002	0.01

*Two months after 2nd spray, solubor was replaced with 0.5% $CaCl_2$ NS= Non-significant

Table 6 : Effect of chemicals on fruit boron content and nitrogen/calcium ratio of apple CV. RED DELICIOUS

Treatments		Concentration	Boron (ppm)			Nitrogen/calcium ratio		
			2013	2014	Pooled	2013	2014	Pooled
T_1	Solubor*	0.1%	15.90	16.10	16.00	10.71	7.95	9.33
T_2	Biozyme	1.5 ml/lt	14.80	16.50	15.65	10.33	10.91	10.62
T_3	Triacontanol	10 ppm	14.88	15.00	14.94	14.35	10.31	12.33
T_4	Solubor* + Biozyme	0.1 % + 1.5 ml/lt	16.65	17.80	17.23	9.49	10.31	9.90
T_5	Solubor* + Triacontanol	0.1 % + 10 ppm	16.78	17.00	16.89	9.47	9.05	9.26
T_6	Biozyme + Triacontanol	1.5 ml/lt + 10 ppm	16.58	17.08	16.83	10.59	10.28	10.44
T_7	Solubor* + Biozyme + Triacontanol	0.1% + 1.5 ml/lt + 10ppm	18.88	20.75	19.82	8.84	7.27	8.06
T_8	Control	Water	12.43	13.00	12.72	19.41	16.50	17.96
	C.D. ($p \leq 0.05$)		1.11	1.10	0.86	0.001	1.25	0.61

*Two months after 2nd spray, solubor was replaced with 0.5% $CaCl_2$

to the efficacy of the product (Vernieri *et al*., 2006). Kahydrin is a derivative of vitamin K_1 and by influencing the efficiency of protein pumps, enhances nutrient uptake by the roots. Hassan *et al*. (2010) also demonstrated in 'Hollywood" plum that the leaf N, P and K contents were significantly increased with spraying of liquid organic fertilizer (Aminfort) and or GA_3 when compared with control. On the other hand, the increased status of nutrient in the plants resulted from spraying different solutions might be attributed to quick absorption via leaves and the limited loss of the nutrients when they were sprayed (Marscher, 1995). These results could be due to increase as organ ability to function as a nutrient sink with GA_3 application (Addicott and Addicott, 1982).

Algae extract as a new bio-fertilizer containing N, P, K, Ca, Mg and S as well as Zn, Fe, Mn, Cu, Mo and Co, some growth regulators, polyamines and vitamins is applied to improve vegetative growth, yield and fruit quality in different orchard as well as vineyards (Eman *et al*., 2008 and Spinelli *et al*., 2009).

Boron was increased in all treatments and their combinations. This could be due to solubor application. All treatments generally increased B concentration occurred as a result of B sprays after bloom except for the latter treatment. Also, B treatment helped to increase Ca concentration in apple fruits. Boron spraying before bloom had no effect on Ca concentration in apple fruit compared to control. However, B sprays after bloom and soil application increased Ca concentration in apple fruits each year (Wojick *et al*.,1999). Foliar sprays of solubor during the dormant season, pre-pink and early bud stages will ensure an adequate supply of boron during the critical stages of flowering and fruit development. Khalifa *et al*. (2009) indicated that nitrogen, phosphorus, potassium, calcium and magnesium concentrations in apple leaves were significantly affected due to the interactions between boric acid and calcium chloride. Interaction between the boric acid and calcium chloride significantly increased the concentrations of iron, magnese, zinc and boron of apple leaves. Results of (Mirabdulbhagi, 2013) showed that pre-harvest application of Ca foliar spray increased Ca content and firmness at harvest and during cold storage of the studied apricot cultivars compared to control. The study revealed that N/Ca ratio was lower in solubor + biozyme + triacontanol treatment. Direct application of calcium to the fruit is the effective method for increasing fruit calcium content (Conway *et al*., 2007). The best is to spray trees with calcium fertilizers.

Conclusion:

While going through the results of both the experiments, it is revealed that the combinations of solubor, biozyme and triacontnaol were best to improve the fruit set and yield of apple fruits. It is clear from results that bio-stimulants increase nutrients through foliar application and thus, will improve the fruit yield and quality of apple. In addition bio-stimulants are safe for human and animal and environment to get lower pollution and reduce soil salinity.

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