International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
www.chemijournal.com
IJCS 2020; 8(6): 337-339

Received: 19-09-2020
Accepted: 21-10-2020

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Bio efficacy of Yara Vita Zintrac (39.55 Zn) on growth, yield and quality of apple (*Malus domestica*)

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DOI: https://doi.org/10.22271/chemi.2020.v8.i6e.10790

Abstract
The present investigation was carried out at two locations *viz*., RHR&TS, Bajaura (Kullu) and RHR&TS, Mashobra (Shimla) to test the bio-efficacy of YaraVita Zintrac on growth and quality of apple. The experiment was laid out in Randomized Block Design with five treatment and four replications. Results showed that at RHR&TS, Mashobra fruit set, fruit weight and yield were significantly improved by Zinc EDTA @ 3.29 g/l at petal fall and just after harvest (T_3), whereas, fruit firmness, TSS, sugars content were significantly increased by 1.5 ml YaraVita Zintrac/l of water (T_2). At RHR&TS, Bajaura, 1.5 ml YaraVita Zintrac/l of water (T_2) at petal fall and just after harvest was found significantly effective in improving the fruit set, yield and fruit quality of apple.

Keywords: Apple, foliar application, growth, quality, zinc

Introduction
Apple is commercially the most important temperate fruit and is the fourth produced in the world after banana, orange and grape. In India, the area under apple cultivation increased by 54% from 1.95 lakh hectares in 1991-92 to 3.01 lakh hectares (Anonymous, 2019) [1]. It is mostly grown in the states of Jammu & Kashmir, Himachal Pradesh, Uttaranchal, Arunachal Pradesh and Nagaland.

Apple is a predominant fruit crop of Himachal Pradesh and in recent years it has emerged as the leading cash crop amongst fruit crops. It alone accounts for 49 percent of total area under fruit crops and 74 percent of the total fruits production and the production level have gradually touched to 495.36 thousand Mt (Anonymous, 2019) [1]. Most of the orchards in the state are rainfed, raised on poor shallow soil with steep gradient. Heavy rains during July-August coupled with winter rains (January-February) cause's losses of nutrients through leaching and erosion, thereby depleting the fertility status of hill soils. Further, exhaustion of infinite reserve of nutrients of these soils take place with the introduction of high yielding varieties, intensive cultivation, use of high analysis fertilizer, monoculture and adoption of modern technologies. On the other hand, macronutrients tend to get all of the attention, while micronutrients are frequently overlooked when it comes to plant nutrition. When left untreated, micronutrient deficiencies can severely affect plant health. Among, micronutrients zinc is the one whose deficiency not only adversely affects the tree vigour but also the crop yields and consequently the quality of the fruits.

The foliar application of zinc plays a vital role in increasing the yield, improving the quality and comparatively more effective for rapid recovery of plants. The foliar feeding of fruit tree has gained much importance in recent years, as nutrients applied through soil are needed in higher quantity because some amount leaches down and some become unavailable to the plant due to complex soil reactions. Keeping this background in view present investigation was carried out with the objective to study the effect of foliar application of YaraVita Zintrac (39.55 Zn) on growth, yield and quality of Apple (*Malus domestica*).

Material and Methods
Studies were carried out at two locations to test the bio-efficacy of YaraVita Zintrac in apple during the years 2015 and 2016.

The trials were carried out at RHR&TS, Bajaura (Kullu) and RHR&TS, Mashobra (Shimla).

The experiment comprised of the five treatment and four replications following a randomized block design. The treatment combinations were set as: YaraVita Zintrac @ 1.0 ml/l at petal fall and just after harvest (T_1), YaraVita Zintrac @ 1.5ml/l at petal fall and just after harvest (T_2), Zinc EDTA @ 3.29 g /l at petal fall and just after harvest (T_3), Zinc EDTA @ 4.93 g /l at petal fall and just after harvest (T_4) and water application (control) at petal fall and just after harvest (T_5). In all treatments, uniform cultural practices were followed as per the Package of Practices for apple production.

The chemical was YaraVita Zintrac provided by the Yara Fertiliser India Pvt. Ltd., Gurugram, Haryana.

The physical characters of the tree and yield were recorded. Fruit set was recorded three weeks after petal fall and per cent fruit set was calculated by following formula given by Westwood (1993) [5]:

Fruit set (%) = (Number of fruits set/Total number of flowers) x 100

Fruit yield was recorded by removal of crop load standard apple box and latter converted in to q/ha. The weight of fruit was taken with the help of a top pan balance. The unit sample consisted of ten fruits and the results were expressed as weight in grams per fruit. Fruit length and breadth was recorded with the help of Vernier caliper.

Total soluble solids and fruit pressure were determined by using hand refractometer and penetrometer, respectively. Percent titratable acidity in fruit juice was determined according to AOAC (1995) [2] and total sugar in the fruit pulp was determined by phenol sulphuric method according to Dubois *et al*. 1956 [3]. Reducing sugars were determined by Fehling's solution with methylene blue as an indicator (Lane and Eynon, 1923) [4]. Data of both the years were pooled and average mean are given.

Results and Discussion

The data recorded on fruit set, yield and fruit physical quality characteristics of apple at both the locations are presented in Table 1 to 4.

RHR&TS Mashobra (Shimla)

It is evident from the data presented in table 1 that fruit set, fruit length, fruit breadth, fruit weight and fruit yield were significantly affected by different Yaravita Zintrac treatments. The fruit set varied from 24.1 to 36.8 per cent, fruit length varied from 5.7 cm to 7.0 cm, fruit breadth varied from 6.4 cm to 7.7 cm, fruit weight varied from 125 g to 188 g and fruit yield varied 75 kg/tree to 193.3 kg/tree under different treatments. Significantly higher fruit set (36.8 %), fruit weight (188 g) and fruit yield (193.3 kg/tree) was observed with treatment T_3 i.e. application of 3.29 g Zinc EDTA @ 3.29 g/l of water at petal fall and just after harvest. However, maximum fruit size was recorded in trees treated with YaraVita Zintrac @ 1.0 ml/l (T_1) of water. The minimum fruit set (24.1 %), fruit weight (125 g) and fruit yield (75 kg/tree) was observed with in control (T_5) and minimum fruit length and fruit breadth was recorded in T_3.

Table 1: Effect of Yaravita Zintrac on fruit set, yield and fruit physical quality characteristics of apple at RHR&TS, Mashobra

Treatment	Fruit set (%)	Fruit length (cm)	Fruit breadth (cm)	Fruit weight (g)	Fruit yield (kg/tree)
T_1	33.3	7.0	7.7	132.0	144.7
T_2	25.6	6.8	7.1	172.7	95.3
T_3	36.8	5.7	6.4	188.0	193.3
T_4	27.0	6.6	7.3	151.3	109.7
T_5 (Control)	24.1	6.9	7.4	125.0	75.0
Mean	29.4	6.6	7.2	153.8	123.6
CD $_{0.05}$	2.4	0.3	0.2	4.4	4.0

The data presented in table 2 revealed that the total soluble solids of different treatments varied from 12.5 ^{o}Brix to 13.7^o Brix. Maximum total soluble solids (13.7 ^{o}Brix) were observed with treatment T_2 (1.5 ml YaraVita Zintrac/l of water at petal fall and just after harvest) and minimum 12.5 ^{o}Brix total soluble solids were observed with treatment T_3. All the other treatments had statistically different total soluble solids. Maximum reducing sugars (7.8 %) were recorded with treatment T_1 and minimum reducing sugars were recorded with under control (T_5). It is clear from the data that total sugars varied from 7.1 per cent to 7.9 per cent. The maximum TSS was recorded in fruits harvested from trees under T_2 and minimum in control. The significantly higher fruit pressure (4.1 kg/cm^2) was observed with treatment T_2 (1.5 ml YaraVita Zintrac/l of water at petal fall and just after harvest), whereas minimum fruit pressure (3.7 kg/cm^2) was recorded in T_3 and control treatments.

Table 2: Effect of Yaravita Zintrac on fruit quality characteristics of apple at RHR&TS, Mashobra

Treatment	TSS^o Brix	Acidity (%)	Reducing sugars (%)	Total sugars (%)	Fruit Pressure (kg/cm^2)
T_1	12.9	0.2	7.8	7.9	4.0
T_2	13.7	0.2	7.4	7.8	4.1
T_3	12.5	0.2	7.2	7.6	3.7
T_4	12.8	0.2	6.9	7.6	3.8
T_5 (Control)	12.6	0.2	6.8	7.1	3.7
CD $_{0.05}$	0.3	NS	0.5	0.4	0.1

Plants under each treatment were in good health, leaves were dark green and there was no incidence of any phytotoxicity and disorder.

RHR&TS Bajaura (Kullu)

It is evident from the data presented in table 3 that fruit set varied from 22.9 to 36.4 per cent, fruit length varied from 5.4 cm to 6.8 cm, fruit breadth varied from 6.2 cm to 7.5 cm, fruit weight varied from 120 gm to 184 gm and fruit yield of apple

under different treatments varied from 73 kg/tree to 188 kg/tree. Maximum fruit set (36.4 %), fruit weight (184 g) and fruit yield (188 kg/tree) was observed with treatment T_2 (YaraVita Zintrac @ 1.5 ml/l at petal fall and just after harvest). However, minimum fruit set (22.9%), fruit weight (120 g) and fruit yield (73 kg/tree) were observed with control.

Table 3: Effect of Yaravita Zintrac on fruit set, yield and fruit physical quality characteristics of apple at RHR&TS, Bajaura

Treatment	Fruit set (%)	Fruit length (cm)	Fruit breadth (cm)	Fruit weight (gm)	Fruit yield (kg/tree)
T_1	33.2	6.8	7.5	127	140
T_2	36.4	5.4	6.2	184	188
T_3	25.0	6.7	7.0	171	94
T_4	26.7	6.5	7.1	147	105
T_5 (Control)	22.9	6.8	7.1	120	73
CD $_{0.05}$	2.1	0.2	0.1	3.9	5.6

The data presented in table 4 revealed that the total soluble solids of different treatments varied from 12.2 ^{o}Brix to 13.2^o Brix. Maximum total soluble solids (13.2 ^{o}Brix) were observed with treatment T_2 (1.5 ml YaraVita Zintrac/l of water at petal fall and just after harvest) and minimum 12.2^o Brix total soluble solids were observed with treatment T_3. All the other treatments had statistically different total soluble solids. Maximum reducing sugars (7.6%) were recorded with treatment T_1 and minimum reducing sugars (6.7%) was recorded with treatment control. It is clear from the data that total sugars varied from 7.0 per cent to 7.9 per cent. Maximum total sugars (7.9 % and fruit pressure (4.0 kg/cm^2) were observed with treatment T_2 (1.5 ml YaraVita Zintrac/l of water at petal fall and just after harvest). The minimum total sugars content and fruit firmness were recorded in control. However, titratable acidity was not influenced by different treatments.

Table 4: Effect of Yaravita Zintrac on fruit quality characteristics of apple at RHR&TS, Bajaura

Treatment	TSS ^{o}Brix	Acidity (%)	Reducing sugars (%)	Total sugars (%)	Fruit Pressure (kg/cm^2)
T_1	12.5	0.2	7.6	7.8	3.9
T_2	13.2	0.2	7.2	7.9	4.0
T_3	12.2	0.2	7.1	7.4	3.5
T_4	12.6	0.2	6.8	7.4	3.6
T_5 (Control)	12.6	0.2	6.7	7.0	3.5
Mean	12.5	0.2	7.0	7.4	3.7
CD $_{0.05}$	0.2	NS	0.4	0.1	0.1

Plants under each treatments shown good health and leaves were dark green in colour; however, there was no incidence of any diseases and disorders.

Conclusion

From the above studies it is concluded that at RHR&TS, Mashobra fruit set, fruit weight and yield were significantly improved by Zinc EDTA @ 3.29g/l at petal fall and just after harvest (T_3), whereas, fruit firmness, TSS, sugars content were significantly increased by 1.5 ml YaraVita Zintrac/l of water (T_2). At RHR&TS, Bajaura, 1.5 ml YaraVita Zintrac/l of water (T_2) at petal fall and just after harvest was found significantly effective in improving the fruit set, yield and fruit quality of apple.

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