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Response of guava to foliar spray of zinc, boron and magnesium on growth, development and yield

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Abstract
The present investigation on Guava (*Psidium guajava* L.) cv. G-27 was conducted during the year 2013-14 and 2014-15. Foliar spray of zinc, boron and magnesium was done as Zn_1 = Zinc sulphat @ 0.25%; Zn_2 = Zinc sulphat @ 0.50%; Zn_3 = Zinc sulphat @ 0.75%; Bo_1 = Boric acid @ 0.1%; Bo_2 = Boric acid @ 0.2%; Bo_3 = Boric acid @ 0.3%; Mg_1= Magnesium sulphat @ 0.20%; Mg_2 = Magnesium sulphat @ 0.40%; Mg_3 = Magnesium sulphat @ 0.60%. The result showed that Zn_3 recorded On the basis of results obtained in present investigation. It was found that foliar spray of zinc, boron and magnesium had significantly improved the various yield attributing parameters of guava. From the different concentration Zn_3, B_3 and Mg_3 recorded yield of 75.04 kg plant^{-1}, 71.94 kg plant^{-1} and 74.9 kg plant^{-1}, respectively against 46.75 kg plant^{-1} in control. Diameter of fruit, 7.07 cm, 6.85 cm and 7.07 cm in Zn_3, B_3 and Mg_3, respectively against 5.83 cm in control and maximum no. of fruit plant^{-1} of 682.05, 648.82 and 681.53 in Zn_3, B_3 and Mg_3, respectively against 458.48 in control. These results are on pooled basis of 2013-14 and 2014-15.

Keywords: Guava, zinc, boron, magnesium, foliar spray, yield, fruit.

1. Introduction

Guava (*Psidium guajava* L.), also known as “apple of the tropics” and poor man’s apple, is the most important, highly productive, delicious and nutritious fruit, grown commercially throughout tropical and subtropical regions of India. Its fruits are available throughout the year except during the summer season. It occupies a pride place amongst the important fruits grown in the country and claims to be the fourth most important fruit in area and production after mango, banana and citrus. Guava cultivation is drawing attention of the farmers because of the specific facts, viz., fruiting almost all the year round, simple cultivation with low cost, high yielding, high in nutritive values, resistant to adverse climatic conditions, wide adaptability, rich source of pectin, medicinal values and suitability for preservation. In India, it is grown in wide range of tropical and subtropical areas from north to south, but the most important guava producing states are Maharashtra, Madhya Pradesh, Uttar Pradesh, Bihar, West Bengal, Punjab, Gujarat & Karnataka (NHB, 2015) [8]. The total area under its cultivation in India is 268.2 thousand ha with an annual production of 3667.9 thousand MT, productivity is 13.7 MT/ha, whereas in Madhya Pradesh, the area, production and productivity of guava is 22.4 thousand ha, 841.1 MT and 37.6 MT/ha, respectively (NHB, 2015) [8].

According to Morton (1987), food value of the guava fruit per 100 g of edible portion contains the following substances: Edible portion 100.00%, Calcium 9.1 -17mg, Moisture 77- 86 g, Phosphorus 17.8-30 mg, Protein 0.9-1.0 g, Iron 0.30-0.70mg, Fat 0.1-0.5 g, Vitamin C 350-450 mg, Fibre 2.8-5.5 g, Vitamin B 340 I.U., Carbohydrates 9.5-10 g, Vitamin A 200-400 I.U., Energy 36-50 K. CaI and Pectin 0.52-2.0%.

Micronutrients are required by plants in small quantities and thus, can be applied more safely and easily through foliar application which offers the possibility of quick absorption and supplying the tree with the specific nutrients in a particular quantity directly to the foliage and fruits at times when rapid responses are desired (Stiles, 1982) [12]. To compete in domestic as well as foreign markets, quality fruit production is becoming a major objective of the day in fruit industry. The tree crops, grown under field conditions, are subjected to numerous nutrient deficiencies which influence tree growth, tissue composition, fruit production and quality. The deficiency of different nutrients leads to several disorders in fruits and the resulting produce is not preferred by consumers as they are becoming over conscious of quality fruits. Hence, judicious use of different nutrients plays an important role to improve the quality of fruits to a great extant.

Foliar feeding of nutrients to fruit plants has gained much importance in recent years. It is quite economical and obviously an ideal way of evading the problems of nutrient availability and supplementing the fertilizers to the soil. It has been noticed that guava suffers severely from deficiency of micronutrients specially zinc and manganese which reduce the quality of fruits. Guava fruits response well to zinc, boron, potassium and molybdenum applications (Arora and Singh, 1970b; Singh and Chhonkar, 1983) [1, 11]. However, very little work has been done on the application of these nutrients in guava trees. The response of guava plants to these nutrients may vary from region to region and pocket to pocket. The production of poor quality guava fruits in rainy season is a matter of common experience. It would worthwhile to improve the quality of rainy season crop with foliar feeding of nutrients. The quality of processed products also depends on quality of raw material. Hence, the quality of raw material should be increased. We can increase the production of good quality fruits in terms of fruit size and weight and nutritive value with the help of modified technique of nutrient application, which may be foliar feeding.

2. Material and Methods

The present investigation was conducted at in the University Fruit orchard, Department of Horticulture, College of Agriculture, Gwalior (M.P.), during 2013-14 and 2014-15.

2.1 Treatments and their combinations

The experiment consisted of 28 treatment combinations of 3 levels of each zinc, boron and magnesium and spray of plain tap water as control. It is basically to find the difference between control and the rest besides it, individual effect of zinc, boron and magnesium and their interactions were also studied.

2.2 Experimental materials

Twelve-year-old bearing guava trees of cultivar Gwalior-27 of uniform vigour and size were selected for the present study. All the trees were maintained under uniform cultural schedule during the course of investigation.

The chemical was used as followed *i.e.* Zn_1 = Zinc sulphat @ 0.25%; Zn_2 = Zinc sulphat @ 0.50%; Zn_3 = Zinc sulphat @ 0.75%; Bo_1 = Boric acid @ 0.1%; Bo_2 = Boric acid @ 0.2%; Bo3 = Boric acid @ 0.3%; Mg1= Magnesium sulphat @ 0.20%; Mg_2 = Magnesium sulphat @ 0.40%; Mg_3 = Magnesium sulphat @ 0.60%.

The experiment was laid out in Randomized Block Design (RBD). Eighty four twelve-year-old bearing guava trees of cultivar Gwalior-27 of uniform vigour and size, planted at 6 x 6 m distance were selected for the present study. All the trees were maintained under uniform cultural schedule during the course of investigation and each tree formed as a unit of treatment. All the treatments were replicated thrice. All the trees selected for the experiments were previously labeled as per layout of experiment and the sprays under treatment were done on rainy season crop (Ambe bahar) at full bloom stage and one month after the first spray (in both the years) in the early morning with the help of foot sprayer @ five liters per tree to ensure the maximum absorption of nutrients through the leaves. Each tree was sprayed thoroughly in such a way as to completely drench it with the spray solution.

2.3 Observations

Observations recorded on diameter of fruit (cm), volume of fruit (ml), specific gravity, pulp %, seed %, pulp: seed, no. of fruits $plant^{-1}$, fruit weight (g), yield $plant^{-1}$ (kg).

3. Result

The results obtained during the course of investigation have been described in this study under appropriate headings. The mean value on pooled basis are only sown here the detailed values are presented in Table 1, 2 and 3 for the different observations. The interaction effect of zinc x boron, zinc x magnesium and boron x magnesium was found non-significant, so only the significant data is described here, however the value of specific gravity was also found non-significant but the value obtained from the main effect are presented here.

3.1 Diameter of fruit: It is evident from the table 4.1, it is clear that diameter of fruit was significantly affected due to different levels of zinc, boron and magnesium over the control. The mean maximum diameter of fruit as pooled basis (7.07 cm) was recorded under treatment Zn_3 (Zinc sulphat @ 0.75%), which was significantly superior to the other levels viz. Zn_2 and Zn_1 (Zinc sulphat @ 0.5% and Zinc sulphat @ 0.25%, respectively). Different boron levels also significantly affected the diameter of fruit. Maximum value was found 6.85 cm in B_3 (Boric acid @ 0.3%), which was significantly superior to the other levels viz. B_2 (Boric acid @ 0.2%) and B_1 (Boric acid @ 0.1%). In case of magnesium, Mg_3 (Magnesium sulphat @ 0.6%) noted the maximum diameter of fruit of 7.07 cm followed by Mg_2 (Magnesium sulphat @ 0.4%) and Mg_1 (Magnesium sulphat @ 0.2%), whereas the minimum diameter of fruit 5.83 cm was recorded under control.

3.2 Volume of fruit: It is evident from the table 4.1, it is clear that volume of fruit was significantly affected due to different levels of zinc, boron and magnesium over the control. The mean maximum volume of fruit as pooled basis (216.52 ml) was recorded under treatment Zn_3 (Zinc sulphat @ 0.75%), which was significantly superior to the other levels viz. Zn_2 and Zn_1 (Zinc sulphat @ 0.5% and Zinc sulphat @ 0.25%, respectively). Different boron levels also significantly affected the volume of fruit. Maximum value was found 203.58 ml in B_3 (Boric acid @ 0.3%), which was significantly superior to the other levels viz. B_2 (Boric acid @ 0.2%) and B_1 (Boric acid @ 0.1%). In case of magnesium, Mg_3 (Magnesium sulphat @ 0.6%) noted the maximum volume of fruit of 216.35 ml followed by Mg_2 (Magnesium sulphat @ 0.4%) and Mg_1 (Magnesium sulphat @ 0.2%), whereas the minimum volume of fruit 138.51 ml was recorded under control.

3.3 Specific gravity: It was found non- significant (Table 4.1), due to different levels of zinc, boron and magnesium individually in both year but CONTROL VS. REST, it was found significant. The value for the control and rest was recorded as 1.052 and 1.021, respectively.

3.4 Pulp %: It is evident from the table 4.2, it is clear that pulp % was significantly affected due to different levels of zinc, boron and magnesium over the control. The mean maximum pulp % as pooled basis (96.26 %) was recorded under treatment Zn_3 (Zinc sulphat @ 0.75%), which was significantly superior to the other levels viz. Zn_2 and Zn_1 (Zinc sulphat @ 0.5% and Zinc sulphat @ 0.25%, respectively). Different boron levels also significantly affected the pulp %. Maximum value was found 95.48 % in B_3 (Boric acid @ 0.3%), which was significantly superior to the other levels viz. B_2 (Boric acid @ 0.2%) and B_1 (Boric acid @ 0.1%). In case of magnesium, Mg_3 (Magnesium sulphat @ 0.6%) noted the maximum pulp % of 95.65 followed by Mg_2 (Magnesium sulphat @ 0.4%) and Mg_1 (Magnesium sulphat @ 0.2%), whereas the minimum pulp % of 91.87 was recorded under control.

3.5 Seed %: It is evident from the table 4.2, it is clear that seed % was significantly affected due to different levels of zinc, boron and magnesium over the control. The mean minimum seed % as pooled basis (3.72 %) was recorded under treatment Zn_3 (Zinc sulphat @ 0.75%), which was significantly superior to the other levels viz. Zn_2 and Zn_1 (Zinc sulphat @ 0.5% and Zinc sulphat @ 0.25%, respectively). Different boron levels also significantly affected the seed %. Minimum value was found 10 % in B_3 (Boric acid @ 0.3%), which was significantly superior to the other levels viz. B_2 (Boric acid @ 0.2%) and B_1 (Boric acid @ 0.1%). In case of magnesium, Mg_3 (Magnesium sulphat @ 0.6%) noted the minimum seed % of 10.43 % followed by Mg_2 (Magnesium sulphat @ 0.4%) and Mg_1 (Magnesium sulphat @ 0.2%), whereas the maximum seed % of 20222 cm was recorded under control.

3.6 Pulp: seed: CONTROL VS. REST, it was found significant for pulp: seed (Table 4.2). The value for the control and rest was recorded as 11.5: 1 and 22: 1, respectively, besides it, only the various zinc levels was also noted significant. The highest pulp: seed was recorded 26.76: 1 under treatment Zn_3 (Zinc sulphat @ 0.75%), which was significantly superior to the other levels viz. Zn_2 and Zn_1 (Zinc sulphat @ 0.5% and Zinc sulphat @ 0.25%, respectively).

3.7 No. of fruits tree^{-1}: It is evident from the table 4.3, it is clear that no. of fruits tree^{-1} was significantly affected due to different levels of zinc, boron and magnesium over the control. The mean maximum no. of fruits tree^{-1} as pooled basis (682.05) was recorded under treatment Zn_3 (Zinc sulphat @ 0.75%), which was significantly superior to the other levels viz. Zn_2 and Zn_1 (Zinc sulphat @ 0.5% and Zinc sulphat @ 0.25%, respectively). Different boron levels also significantly affected the no. of fruits tree^{-1}. Maximum value was found 648.82 in B_3 (Boric acid @ 0.3%), which was significantly superior to the other levels viz. B_2 (Boric acid @ 0.2%) and B_1 (Boric acid @ 0.1%). In case of magnesium, Mg_3 (Magnesium sulphat @ 0.6%) noted the maximum no. of fruits tree^{-1} of 681.53 followed by Mg_2 (Magnesium sulphat @ 0.4%) and Mg_1 (Magnesium sulphat @ 0.2%), whereas the minimum no. of fruits tree^{-1} of 458.48 was recorded under control.

3.8 Fruit weight: It is evident from the table 4.3, it is significantly affected due to different levels of zinc, boron and magnesium over the control. The mean maximum fruits weight as pooled basis (219.13 g) was recorded under treatment Zn_3 (Zinc sulphat @ 0.75%), which was significantly superior to the other levels viz. Zn_2 and Zn_1 (Zinc sulphat @ 0.5% and Zinc sulphat @ 0.25%, respectively). Different boron levels also significantly affected the fruits weight. Maximum value was found 206.45 g in B_3 (Boric acid @ 0.3%), which was significantly superior to the other levels viz. B_2 (Boric acid @ 0.2%) and B_1 (Boric acid @ 0.1%). In case of magnesium, Mg_3 (Magnesium sulphat @ 0.6%) noted the maximum fruits weight of 218.97 g followed by Mg_2 (Magnesium sulphat @ 0.4%) and Mg_1 (Magnesium sulphat @ 0.2%), whereas the minimum fruits weight of 145.82 g was recorded under control.

3.9 Yield plant^{-1}: It is evident from the table 4.3, it is significantly affected due to different levels of zinc, boron and magnesium over the control. The mean maximum yield plant^{-1} as pooled basis (75.04 kg) was recorded under treatment Zn_3 (Zinc sulphat @ 0.75%), which was significantly superior to the other levels viz. Zn_2 and Zn_1 (Zinc sulphat @ 0.5% and Zinc sulphat @ 0.25%, respectively). Different boron levels also significantly affected the yield plant^{-1}. Maximum value was found 71.94 kg in B_3 (Boric acid @ 0.3%), which was significantly superior to the other levels viz. B_2 (Boric acid @ 0.2%) and B_1 (Boric acid @ 0.1%). In case of magnesium, Mg_3 (Magnesium sulphat @ 0.6%) noted the maximum yield plant^{-1} of 74.9 kg followed by Mg_2 (Magnesium sulphat @ 0.4%) and Mg_1 (Magnesium sulphat @ 0.2%), whereas the minimum yield plant^{-1} of 46.75 kg was recorded under control.

Table 1: Effect of foliar spray of zinc, boron and magnesium on diameter of fruit, volume of fruit and specific gravity of guava

Treatments	Diameter of fruit (cm)			Volume of fruit (ml)			Specific gravity		
	Ist	IInd	Pooled	Ist	IInd	Pooled	Ist	IInd	Pooled
Control	5.80	5.85	5.83	136.99	140.03	138.51	1.059	1.045	1.052
Rest	6.63	6.84	6.73	185.84	200.16	193.00	1.043	0.998	1.021
F test	SIG	SIG	SIG	SIG	SIG	SIG	SIG	SIG	SIG
Zinc levels									
Zn_1	6.26	6.47	6.37	163.51	176.03	169.77	1.049	0.999	1.024
Zn_2	6.64	6.89	6.77	185.42	200.01	192.72	1.047	0.999	1.023
Zn_3	6.98	7.16	7.07	208.59	224.44	216.52	1.034	**0.995**	1.014
SEm+	0.075	0.092	0.077	4.071	5.695	4.440	0.018	0.005	0.012
CD(0.05)	0.214	0.259	0.150	11.543	16.148	8.702	NS	NS	NS
Boron levels									
B_1	6.43	6.66	6.55	173.28	186.98	180.13	1.049	0.997	1.023
B_2	6.68	6.93	6.81	188.14	202.46	195.30	1.044	0.999	1.021
B_3	6.77	6.92	6.85	196.11	211.05	203.58	1.037	0.998	1.017
SEm+	0.075	0.092	0.077	4.071	5.695	4.440	0.018	0.005	0.012
CD(0.05)	0.214	0.259	0.150	11.543	16.148	8.702	NS	NS	NS
Magnesium levels									
Mg_1	6.35	6.57	6.46	168.49	181.85	175.17	1.050	0.998	1.024
Mg_2	6.55	6.79	6.67	180.60	194.37	187.49	1.045	1.000	1.023
Mg_3	6.98	7.15	7.07	208.43	224.27	216.35	1.034	0.996	1.015
SEm+	0.075	0.092	0.077	4.071	5.695	4.440	0.018	0.005	0.012
CD(0.05)	0.214	0.259	0.150	11.543	16.148	8.702	NS	NS	NS

Table 2: Effect of foliar spray of zinc, boron and magnesium on pulp %, seed % and pulp: seed of guava

Treatments	Pulp %			Seed %			Pulp: seed		
	Ist	IInd	Pooled	Ist	IInd	Pooled	Ist	IInd	Pooled
Control	92.67	91.08	91.87	7.33	8.92	8.13	12.89:1	10.21:1	11.55:1
Rest	95.30	95.57	95.43	4.70	4.43	4.57	21.18:1	22.82:1	22.00:1
F test	SIG	SIG	SIG	SIG	SIG	SIG	SIG	SIG	SIG
Zinc levels									
Zn_1	94.44	94.68	94.56	5.56	5.32	5.44	17.40:1	18.27:1	17.84:1
Zn_2	95.35	95.59	95.47	4.65	4.41	4.53	20.78:1	22.01:1	21.39:1
Zn_3	96.10	96.42	96.26	3.90	3.58	3.74	25.35:1	28.17:1	26.76:1
SEm+	0.145	0.143	0.134	0.145	0.143	0.134	0.612	0.806	0.669
CD(0.05)	0.411	0.404	0.263	0.411	0.404	0.263	1.736	2.286	1.311
Boron levels									
B_1	95.25	95.50	95.38	4.75	4.50	4.62	20.592:1	21.98:1	21.28:1
B_2	95.32	95.56	95.44	4.68	4.44	4.56	21.193:1	22.50:1	21.85:1
B_3	95.33	95.63	95.48	4.67	4.37	4.52	21.742:1	23.97:1	22.86:1
SEm+	0.145	0.143	0.134	0.145	0.143	0.134	0.612	0.806	0.669
CD(0.05)	0.411	0.404	0.263	0.411	0.404	0.263	NS	NS	NS
Magnesium levels									
Mg_1	95.23	95.47	95.35	4.77	4.53	4.65	20.457:1	21.66:1	21.06:1
Mg_2	95.17	95.41	95.29	4.83	4.59	4.71	20.822:1	22.10:1	21.46:1
Mg_3	95.49	95.81	95.65	4.51	4.19	4.35	22.248:1	24.69:1	23.47:1
SEm+	0.145	0.143	0.134	0.145	0.143	0.134	0.612	0.806	0.669
CD(0.05)	0.411	0.404	0.263	0.411	0.404	0.263	NS	NS	NS

Table 3: Effect of foliar spray of zinc, boron and magnesium on no. of fruits, fruit weight and yield of guava

Treatments	Fruits plant^{-1}			Individual fruit weight (g)			Yield plant^{-1} (kg)		
	Ist	IInd	Pooled	Ist	IInd	Pooled	Ist	IInd	Pooled
Control	447.81	469.15	458.48	144.99	146.64	145.82	46.93	46.56	46.75
Rest	600.91	644.49	622.70	193.09	199.40	196.24	68.59	71.67	70.13
F test	SIG	SIG	SIG	SIG	SIG	SIG	SIG	SIG	SIG
Zinc levels									
Zn_1	542.53	582.64	562.59	170.28	175.39	172.83	63.58	66.47	65.03
Zn_2	602.84	644.08	623.46	193.86	199.68	196.77	68.69	71.95	70.32
Zn_3	657.35	706.75	682.05	215.13	223.13	219.13	73.49	76.59	75.04
SEm+	12.12	14.49	12.02	4.68	5.36	4.51	1.20	1.22	1.09
CD(0.05)	34.38	41.09	23.55	13.27	15.19	8.84	3.40	3.46	2.13
Boron levels									
B_1	568.80	610.71	589.75	180.48	185.90	183.19	66.19	69.27	67.73
B_2	608.62	650.43	629.53	196.14	202.03	199.09	69.26	72.15	70.71
B_3	625.31	672.33	648.82	202.64	210.27	206.45	70.3	73.58	71.94
SEm+	12.12	14.49	12.02	4.68	5.36	4.51	1.20	1.22	1.09
CD(0.05)	34.38	41.09	23.55	13.27	15.19	8.84	3.40	3.46	2.13
Magnesium levels									
Mg_1	556.47	597.72	577.09	175.70	180.97	178.33	65.27	68.28	66.77
Mg_2	589.37	629.57	609.47	188.60	194.26	191.43	67.13	70.28	68.71
Mg_3	656.88	706.18	681.53	214.97	222.96	218.97	73.36	76.45	74.9
SEm+	12.12	14.49	12.02	4.68	5.36	4.51	1.20	1.22	1.09
CD(0.05)	34.38	41.09	23.55	13.27	15.19	8.84	3.40	3.46	2.13

4. Discussion

The increase in fruit yield due to the increased growth and yield parameters may be due to the increased auxin production. Zinc acts as catalyst in the oxidation and reduction processes and is also great importance in the sugar metabolism which might have improved the physical characters of guava fruit and thus increased the yield per tree. Heavier fruits under zinc treatment might be due to the high level of auxin in the various parts of the fruit maintained by zinc application. The role of Zn in production of auxins is well known. The increase in the fruit weight by zinc spray was due to the significant increase in the fruit width and length because of zinc is reported to regulate the semi permeability of cell walls thus mobilizing more water into the fruits. The increase in the yield under the effect of zinc sprays might be due to the fact that zinc is universally claimed to be an essential micro nutrient and it is considered indispensable for the growth of all organism (Arora & Singh 1970b) [1].

Rapid increase in fruit size (length and diameter) under boric acid application could be attributed to its involvement in the cell division, cell elongation and higher moisture content of the fruits (Rajput and Chand, 1976) [10]. Boron is also known to be associated positively with the early stages of fruit development (Heinicke, 1942) [4]. A notable characteristic of boron has been found to affect the photosynthesis of plants (Lal and Patil, 1948) [5]. Movchan and Soboroikova (1972) reported that boron enhances nitrogen uptake and thus facilitates the process of photosynthesis, which ultimately led to the accumulation of carbohydrate and helped in increasing the fruit size and weight (Tiwari and Lal, 2014) [13]. Active salt absorption, maintenance of water relation, cellular differentiation and photosynthesis, all has been suggested as a

functions of boron. Being a non metal, it may only influence the functions rather than taking any active part in the system, resulting in increased fruit size in terms of length and diameter of fruits and the yield of plant (Nijjar, 1990) [9].
Mg brought betterment in both growth and yield attributes may be due to stimulatory effect of mg on plant metabolism (Devlin, 1966). They might have been augmented due to higher synthesis of nucleic acids, magnesium also participates in enzymatic activities involved in various functions. The increase in the yield parameters and yield in Mg treated plants may be on account of maximum availability of plant metabolism. Similar yield improvements with mg application were observed by Kuznetsov and Koridze (1977) in Satsuma, Mann *et al.* (1985) [6] in sweet oranges and Bangali *et al.* (1993) in guava.

5. Conclusions

It is quite clear on the basis of results obtained in present investigation. It is concluded that foliar spray of zinc, boron and magnesium had significantly improved the various yield attributing parameters of guava. From the different concentration Zn_3, B_3 and Mg_3 were found superior to other concentrations of zinc, boron and magnesium for all the parameters that was studied as compared to control. So it may be recommended at farmer's level for increasing the quality and yield of guava with the help of zinc, boron and magnesium along with the recommended dose of NPK.

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