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EFFECT OF FOLIAR APPLICATIONS OF NANO ZINC AND BORON ON THE GROWTH, YIELD AND QUALITY OF SWEET CORN (ZEA MAYS L.)

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ABSTRACT:
The experiment was conducted at Research farm of IAS, SOADU, Odisha during rabi 2023-24. It was laid out in RBD, consists of eight treatment combinations with replicated thrice in Inceptisols to study the impact of foliar spray of nano zinc and Boron on the growth, yield and quality of sweetcorn (var. Sugar-75). The results revealed that significant difference in plant height and chlorophyll content which was highest in T6 (two foliar spray of nano zinc@0.4% and boron@0.3% with 75% N) at 75 and 90 DAS. Significantly grain yield was varied from 48.07 to 79.22 q ha-1 at different treatment combinations. Highest yield was found in T6 treatment which was 64.8 % over control, 24 % over the conventional ZnSO4 with RDF and 18.1 % over T8. Similarly, the stover and cob yield varied from 68.51 to 109.25 q ha-1 and 85.65 to96.46 q ha-1 respectively. Harvest Index (HI) was found highest in T6 (0.42) and lowest in control (0.31). The protein and carbohydrate were found to be lowest in control and highest in T8 i.e 9.89 and 20.82 % respectively.

KEYWORDS: Sweet corn, zinc, boron, foliar application, yield attributes and quality

INTRODUCTION

Maize (Zea mays L.) is a C4 plant and has high yielding potential and it is also called as “queen of cereals” and “non – tillering plant”. In India, maize covers an area of 9.87 million hectare with the production of 30.16 million tonnes, with an average productivity of 3057 kg/ha (FAOSTAT, 2020). Odisha covers 251.43 lakh hectare with production of 752.57 lakh tonnes with an average productivity of 2993 kg/ha (OAS, 2018), it is cultivated in rainfed area like Gajapati district (Ghosh et al., 2020, Mohapatra et al., 2020).

Besides human food and animal feed, this crop has its significances as a source of large number of industrial products like corn starch, corn oil, baby corn, dairy feed, poultry feed etc. Sweet corn is also called Sugar corn .It accounts for about 25-30% sugar content especially at milk stage which is more in comparison of 2.5% of sugar content in normal corn .Nutritional value per 100 g of sweet corn (seeds) in carbohydrates (19g), sugar (3.2g), dietary fibre (2.7g), fat (1.2g) protein (3.2g), Vitamin A (10 µg), Vitamin B9 (46 µg), Vitamin E (7 mg), iron (0.5 mg), Mg (37 mg), and K (270 mg). As regards to health benefits, cooked sweet corn has significant antioxidant activity which can substantially reduce the chance of heart disease and cancer (USDA nutrient database).

Zn plays a very important role in plant metabolism by influencing the activities of hydrogenase and carbonic anhydrase and stabilization of ribosomal proteins. Maize with its high sensitivity to Zn deficiency in soil, results in disorder called “White bud” (El-Azab,2015) manifested as white parallel bands between the midrib and margin of leaves. To meet crop Zn demands, Zn fertilization seems to be variable option and biofortification is a option to meet human dietary Zn requirement, Increasing seed Zn content by soil and /or foliar Zn spray and with its important involvement in physiological and enzymatic activities of the plant system. It not only participates in the conversion of carbohydrates, protein and chlorophyll production but also stimulates many catalytic functions of the plant (Wasim et al., 2016). Zinc activates the plant enzymes by carbohydrate metabolism, maintaining the integrity of cellular membranes, protein synthesis and regulation of auxin synthesis. It is essential for the synthesis of auxin because Zn helps in tryptophan production, which is a precursor of Indole- 3-acetic acid (IAA). Zinc has a pronounced effect on the important processes of plants like photosynthesis, protection against reactive oxygen species, nitrogen metabolism, carbonic anhydrase activity, chlorophyll synthesis and resistance to biotic and abiotic stresses.

Boron (B) is also an essential micronutrient for plant growth and reproduction. It is important for carbohydrate metabolism and their translocation and also plays an indispensable role in plant cell-wall formation, integrity of plasma membranes, pollen tube growth and increases pollination and seed development. Boron is essential for normal growth and development of all plants (Brown et al., 2002). It plays an important role in the growth and development of new cells in the plant meristems because it is closely associated with cell-division in the growing region of the plant that is near the tip of roots and shoots. It is also needed for the growth of the pollen tube during flower pollination and is therefore important for good seed set and fruit development. Suitable B availability augments meristematic growth, cross links cellulose molecules in cell wall, stimulates enzymes by combining diol comprising groups in cell membrane, movement of sugar into budding parts of plants, pollination and setting of seeds. Tissue of boron-deficient plants often breaks down permanently, causing brown flecks, necrotic spots, cracking and corky areas in fruits and tubers.

Both Zn and B play an important role in the basic plant functions like photosynthesis, protein and chlorophyll synthesis. These nutrients (Zn and B) are also involved in root growth, synthesis of proteins and carbohydrates, increase flower setting and reduce kernel abortion especially. Soil application of Zn and B is highly helpful in improving the maize productivity. However, according to economic point of view, seed treatment and foliar application are better options because these are economical than soil application. Foliar application of micronutrients is 6 to 20 times more useful than the soil application and improves the nutrition.

MATERIALS AND METHODS

A field experiment was conducted at Binjhagiri, Chhatabar, Khordha, Agricultural Research Station, Faculty of Agricultural Sciences, Institute of Agricultural Sciences, SOADU, Odisha during rabi 2023-24 to study the effect of nano zinc and Boron on the growth, yield, nutrient uptake and quality of sweetcorn (var. Sugar-75).

The experiment was laid out in RBD, consist of eight treatment combinations with replicated thrice in Inceptisols. The treatments were: T1-Control, T2-RDF (N:P:K::80:40:40), T3-T2 + Zn @ 5 kg ha-1 from $ZnSO_4$, T4-75% N from urea + Nano Zn foliar spray @ 0.4% (vegetative + tasseling stage), T5-75% N from urea + B foliar spray @ 0.3% (tasseling stage), T6-75% N from urea + nano Zn foliar spray @ 0.4 (vegetative + tasseling stage) and B foliar spray @ 0.3% (tasseling stage), T7-75% N from urea + $ZnSO_4$ @ 0.5% foliar spray(vegetative and tasseling stage), T8-T7 + B foliar spray @ 0.3% (Tasseling stage).

The cultural operations were followed as per the package of practice and treatments were imposed as per the treatments of the experiment. The regular crop protection measures were taken care during the crop growth period. All observations were recorded on five randomly selected plants which were tagged at early stage of the crop within the net plot area for the parameters viz., Crop growth parameters, Yield and yield components, Seed quality parameters.

Statistical analysis

The experimental data collected on growth and yield components, yield and nutrients uptake of plant were subjected to Fisher method of “Analysis of variance” (ANOVA) as outlined by Panse and Sukhatme (1967). Where ever, F-test was significant, for comparison among the treatment means, an appropriate value of critical difference (C.D.) was worked out. If F-test found non-significant, against C.D. values NS (Non-significant) was indicated. All the data were analyzed and the results were presented and discussed at a probability level of five per cent.

RESULTS AND DISCUSSION

Growth Parameters

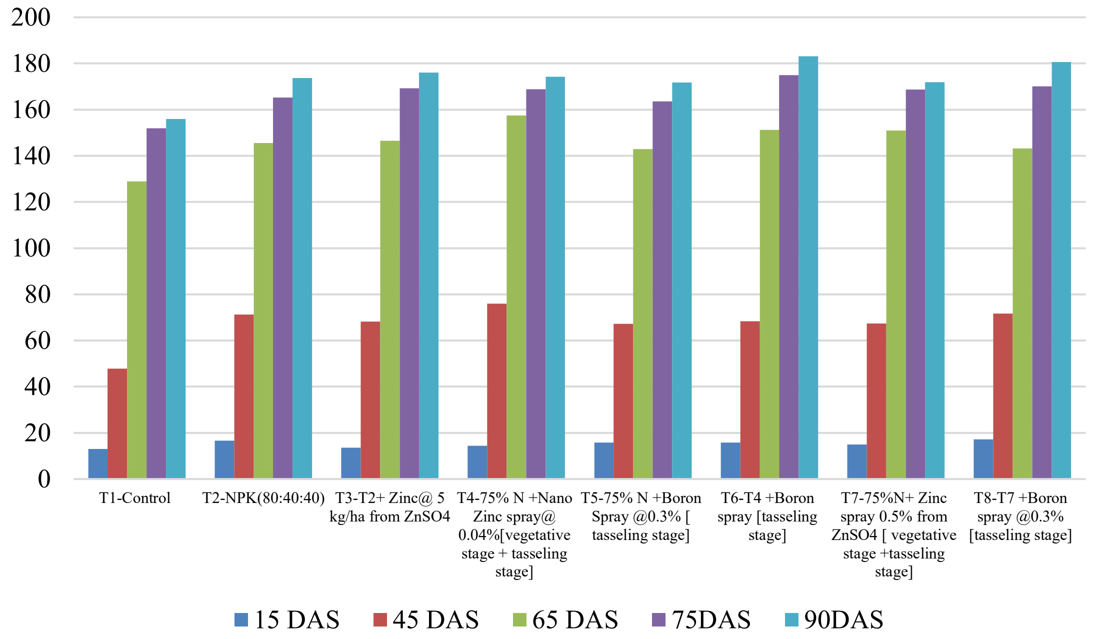
Plant height

Significant difference in plant height (table 1) as well as growth was observed with foliar application of nano zinc and boron with 75% N through urea over absolute control. Maximum height was observed in 75 and 90 days after sowing (DAS) which was significantly increase over the absolute control with the application of nano Zn and B with 75% N through urea. The increase was 15% at 75 DAS and 18 % at 90 DAS over control (Fig. 1). This may be due to adequate supply of zinc and boron which might have accelerated the activity of the enzyme and auxin metabolism in plant that enlarge the cell elongation resulting plant height. This was in the conformity with the work of Rajesh et al. (2021), Sengupta et al. (2023) and Kumar et al. (2024).

Table 1: Mean plant height (cm) at different growth stages of sweet corn as influenced by foliar application of nano zinc and boron

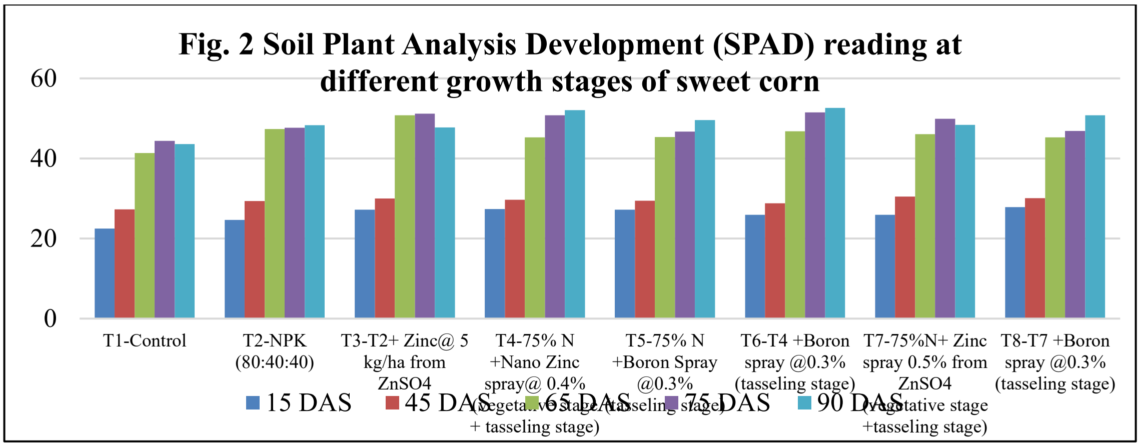
Treatment details	Plant height(cm)				
	DAS				
	15	45	65	75	90
T1- Control	22.48	27.26	41.38	43.38	44.58
T2- NPK (80:40:40)	24.66	29.35	47.37	47.65	48.31
T3- T2+ Zinc @ 5 kg ha-1 from ZnSO4	27.22	30.03	45.75	47.75	51.16
T4- 75% N + Nano Zinc spray @ 0.4% (vegetative stage + tasseling stage)	27.35	29.68	45.26	50.78	52.08
T5- 75% N + Boron Spray @0.3% (tasseling stage)	27.20	29.47	45.39	46.70	49.61
T6- T4 + Boron spray @ 0.3% (tasseling stage)	25.95	28.81	46.82	51.47	52.60
T7- 75% N+ Zinc spray 0.5% from ZnSO4 (vegetative stage + tasseling stage)	25.90	30.45	46.05	48.42	49.92
T8- T7 + Boron spray @ 0.3% (tasseling stage)	27.81	30.10	45.27	46.87	50.77
CD (5%)	3.84	3.23	5.53	3.85	6.85

Fig. 1 Plant height of sweet corn as influenced by foliar application of nano Zn and B



Chlorophyll Content (SPAD)

Significant difference in chlorophyll content of sweet corn was observed at 75 and 90 DAS with 75% N from urea with two foliar spray of nano Zn @ 0.4% and Boron @ 0.3 % over absolute control. Lower SPAD reading was recorded in absolute control. SPAD reading was varied from 43.38 to 51.47 and 44.58 to 52.60 with different treatment combinations with 75 and 90 DAS respectively. The increase was 19% and 18% over control at 75 and 90 DAS respectively, may be due to proper utilization of nutrient by maize crop for their growth (Fig. 2). Overall, SPAD reading (i.e. Chlorophyll content) was increased due to increase of plant growth in the growing period. The measurement with SPAD was an indicative of greenness of the plant which indicate the chlorophyll content of the plant. Increase in chlorophyll content might be due to promotion of absorption and utilization of nutrients as concluded by Farnia and Omidi (2015) and Sengupta et al. (2023).



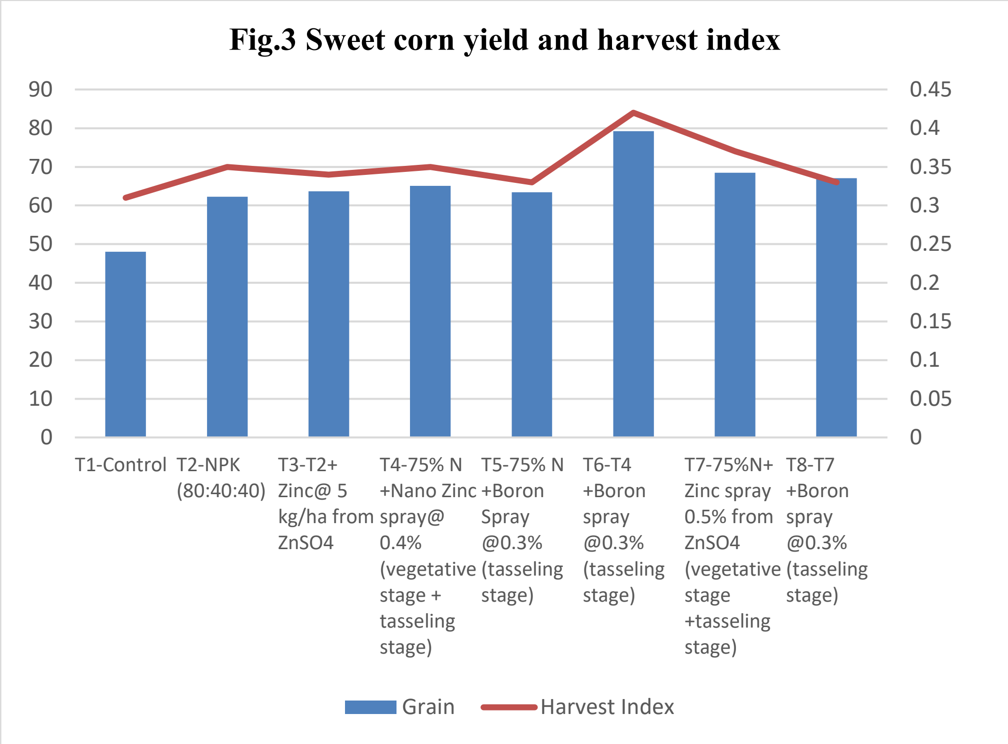
Yield Parameters

Grain yield of sweet corn was found lowest in control (48.07 q ha-1) and highest (79.22q ha-1) in 75% N from urea with spray of nano Zinc @ 0.4% at vegetative and tasseling stage along with Boron spray @ 0.3% at tasseling stage (table 3). The increase in grain yield was 64.8 percent over control, 24.5percent over the conventional ZnSO4 with recommended dose of fertilizer and 18.1% over the treatment T8. Zinc has main role in pollination process, formation of male and female reproductive organ and grain formation (Ziaeyan et al., 2009). The increase in grain yield may be due to the genetic character of the variety as well as improve the nutrient absorption efficiency which boost photosynthesis, nutrient translocation, increasing productivity and grain output (Reddy et al., 2022). The cob yield of sweet corn ranged from 85.65 to 96.46 q ha-1due to various treatments. Lowest cob yield (85.65q ha-1) was found in control and highest cob yield (96.46 q ha-1) was found inT5 treatment. The cob yield increase by12.6% over control. The stoveryield was ranged from 68.51 to 109.25 q ha-1. Lowest stover yield (68.51 q ha-1) was found in control and highest stover yield (109.25) was found 75% N from urea with spray of Zn @ 0.5% from ZnSO4 at vegetative and tasseling stage along with Boron spray @ 0.3% at tasseling stage which was statistically at par with T6. The increase was 59% over control. The biological yield was ranged from 154.16 to 200.25 q ha-1. Similar findings were reported by Varshney et al. (2018), Talan et al. (2018) and Sengupta et al. (2023).Zn and B are involved in many physiological processes of plants, including chlorophyll formation, stomatal regulation and starch utilization which improve seed output, Boron is essential for many physiological process and plant development, nutrition is also important for boosting crop yield and quality (Alimuddin et al., 2020).

Highest HI (0.42) was found in the treatment of T6and lowest in control (0.31) with respect to yield (Fig. 3). Improvement of HI may be due to photosynthates to grain filling rather than accumulation in stover. HI indicate the efficiency of plant to assimilate photosynthate to the economic parts, higher the HI more will be deposit of assimilate in plant Maize (Epstein, 1956). The increase in grain yield might be due to the favourable influence of Zn and B in increasing the plant growth. However, increase in stover yield was attributed due to enhanced morphological characters. The yield variability is a key to crop improvement and its productivity (Matias et al., 2016). The results are in agreement with the findings of Pal et al. (2018), Bhuiya et al. (2020), Sammi et al. (2022) and Sengupta et al. (2023).

Table 3: Mean yield (q ha-1) of grain, stover, cob, biological and harvest index of sweet corn as influenced by foliar application of nano Zn and B

Treatment details	Yield (q ha-1)				Harvest index
	Grain	Stover	Cob	Biological	
T1- Control	48.07	68.51	85.65	154.16	0.31
T2- NPK (80:40:40)	62.27	85.93	92.41	178.34	0.35
T3- T2+ Zinc @ 5 kg ha-1 from ZnSO4	63.64	94.42	93.52	187.94	0.34
T4- 75% N + Nano Zinc spray @ 0.4% (vegetative stage + tasseling stage)	65.11	101.52	86.43	187.94	0.35
T5- 75% N + Boron Spray @0.3% (tasseling stage)	63.44	96.85	96.46	193.31	0.33
T6- T4 + Boron spray @ 0.3% (tasseling stage)	79.22	102.46	87.79	190.25	0.42
T7- 75% N+ Zinc spray 0.5% from ZnSO4 (vegetative stage + tasseling stage)	68.44	92.74	93.67	186.41	0.37
T8- T7 + Boron spray @ 0.3% (tasseling stage)	67.05	109.25	91.0	200.25	0.33
CD (5%)	13.12	11.80	17.77	-	-



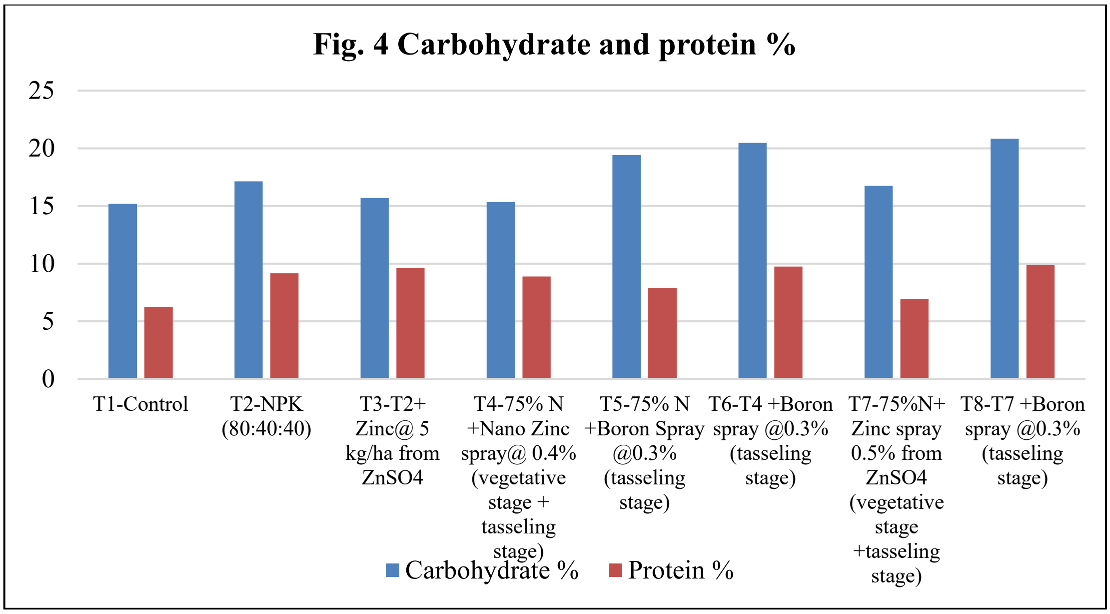
Carbohydrate and Protein Content in sweetcorn grain

The effect of nano Zn and nano B on the carbohydrate and protein content in grain are presented in table 4 and Fig.4. It was found that carbohydrate content of grain varied from 15.18 to 20.82% in different treatment combinations. Lowest carbohydrate content was found in control and highest carbohydrate was found in T8 treatment, which was statistically at par with T6 (i.e.75% N from urea +nano Zn spray twice@ 0.4% at vegetative and tasseling stage + B spray @ 0.3% at tasseling stage). The increase of carbohydrate was 37% in T8 and 35% in T6 over control.

Similarly, protein content varied from 6.21 to 9.89% in different treatment combinations. Lowest protein content was found in control whereas highest in T8 treatment which was statistically at par with T6 (i.e.75% N from urea and nano Zn spray twice @ 0.4% at vegetative and tasseling stage along with B spray @ 0.3% at tasseling stage). Nano Zn spray improve the root CEC which enhance nutrient absorption by root specially nitrogen, which is responsible for higher protein content in sweet corn grain further Zn is essential for production of plant growth promoting compound such as Indole-3-Acetic Acid as well as carbohydrate and protein metabolism (Satdev et al., 2020). Similar findings were reported by Oktem, A. (2007), Wasim et al. (2016), Jolliet al. (2020), Samal (2023) and Shreedevi et al. (2023). From above findings, it can be concluded that application of 75% N from urea and twice nano Zn spray @ 0.4% at vegetative and tasseling stage with once B spray @ 0.3% at tasseling stage are most useful to enhance the quality of grain of sweetcorn which is consumed by human beings as a nutritional point of view.

Table 4: Carbohydrate and protein (%) in sweetcorn grain

Treatment details	Carbohydrate (%)	Protein (%)
T1- Control	15.18	6.21
T2- NPK (80:40:40)	17.13	9.16
T3- T2+ Zinc @ 5 kg ha-1 from ZnSO4	15.70	9.60
T4- 75% N + Nano Zinc spray @ 0.4% (vegetative stage + tasseling stage)	15.32	8.90
T5- 75% N + Boron Spray @0.3% (tasseling stage)	19.40	7.88
T6- T4 + Boron spray @ 0.3% (tasseling stage)	20.46	9.74
T7- 75% N+ Zinc spray 0.5% from ZnSO4 (vegetative stage + tasseling stage)	16.73	6.94
T8- T7 + Boron spray @ 0.3% (tasseling stage)	20.82	9.89
CD (5%)	4.83	2.65



CONCLUSION

It was concluded that application of 75% N from urea + nano Zn spray twice @ 0.4% at vegetative and tasseling stage along with B spray @ 0.3% at tasseling stage helps in increasing height, chlorophyll content and grain yield of sweet corn as well as quality of the grain which is consumed by human beings and most essential for human health.

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