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Influence of Foliar Application of Different zinc Sources on yield Contributing Characters and Quality of Potato (*Solonum tuberosum* cv. Kufri Jyoti)

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ABSTRACT: A field experiment was conducted during 2015-16 and 2016-17 on potato (*Solonum tuberosum* cv. Kufri Jyoti) at the experimental farm of Department of Soil Science, CSKHPKV, Palampur with twelve treatments consisting of three sources of Zn ($ZnSO_4$, Zn-EDTA and Zn metalosate) at different concentrations in a randomized block design to evaluate the efficacy of Zn metalosate (a new noble product) in comparision to the standard ones ($ZnSO_4$ and Zn EDTA). The application of Zn did not have any significant effect on the yield attributing characters but significantly influenced quality parameters of potato. However, all the yield contributing characters showed statistically alike behaviour irrespective of zinc sources for both the years. The influence of different sources and methods of Zn application on yield contributing characters was non significant. But the tuber quality was significantly enhanced with foliar feeding through Zn metalosate. Since consumers are more concerned with quality of produce, therefore foliar application of Zn metalosate may be an option for harvesting good quality potato. Better quality tubers were obtained with NPK+FYM and foliar feeding with Zn metalosate at recommended rate. Mean TSS (^{0}brix) and starch content (%) content was recorded 6.88 and 12.1, respectively for treatment receiving NPK+ foliar application of Zn through Zn metalosate at recommended rate and was statistically superior among all Zn sources tested. Since, the noble product was evaluated for its performance and as the haulm does not possess any economic value, it is to be popularized among farming community.

Keywords: *Solonum tuberosum* cv. Kufri Jyoti, randomized block design, Zn metalosate, Zn-EDTA.

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INTRODUCTION

Potato (*Solonum tuberosum*) is the most important nutrition rich tuber crop after rice, wheat and maize. Besides, being a rich source of carbohydrates predominantly starch it also has high protein value and is one of the most commonly consumed vegetable across the world. India being largest producer of potato among South and West Asian countries Kadian (2007) has shown spectacular growth in area, production and productivity in last five decades. High requirement for macronutrients, especially N, P and K have been reported by many researchers. Muhammad *et al*., (1989); Shah-ud-din *et al*., (1997); Westermann (2005)

Micronutrients although required in less quantity also plays equally important role as macronutrients. High yielding varieties are mining the soil off its nutrients especially the micronutrients due to their inadequate application through fertilizers as it was earlier considered that most of the soils can supply these amounts.

Zn has emerged as most deficient micronutrient globally and in India also Naik and Das (2008). Since, potato is heavy feeder of nutrients including micronutrients, the already Zn deficient soils are likely to exhibit major impact on crop productivity. The poor productivity of potato in India has been attributed to many factors and imbalanced use of fertilizers being at the top.

Balanced plant nutrition is emerging as most important issue for increasing crop yield and quality. Foliar application plays an important role as it compensates deficiency of nutrients and their application at lower rates, thereby reducing nutrient fixation and toxicity due to excessive accumulation Romheld and El-Fouly (1999); Malakouti and Tehrani (1999).

It is well established fact that Zn plays an important role as metal component of various enzymes and is required in various biochemical reactions for chlorophyll formation.

Applied Zn has been found to increase the average weight of tuber and converting them from small to medium size and medium to large size Trehan and Sharma (1999). High zinc concentration was found with soil application of Zn through $ZnSO_4$ (Yerokum and Chirwa 2014). For soil and foliar application $ZnSO_4$ is the most common Zn source used, however, foliar application is recommended for immediate results. There are two options to tackle the imbalancing, viz, soil and foliar feeding through the standard sources or introducing new ones. A USA patented liquid fertilizer exclusively designed for foliar spray which is an amino acid chelate a recent introduction in India for correcting Zn deficiency was evaluated for its efficacy against the standard ones for enhancing yield contributing characters and tuber quality.

MATERIAL AND METHODS

A field trial for assessing the impact of foliar application of different zinc sources on yield contributing characters, Zn content and quality of potato c.v. Kufri jyoti was laid out during rabi seasons of 2015-16 and 2016-17 at experimental farm of Chaudhary Sarwan Kumar Himachal Pradesh Krishivishva Vidhyalaya, Palampur. The region receives an average rainfall of 2600 mm per annum, and major portion of it is received during monsoons (June to September). Study area had silty clay loam textured soil classified as Typic Hapludalf as per taxonomic system of Soil Classification. The pH of experimental site was 5.25 and organic carbon 9.5 g kg^1 before start of experiment. The available N, P, K and Zn content was 262, 34, 159 kg ha^{-1} and 0.46 mg kg^{-1}, showing low, high, medium and deficient levels, respectively.

The experiment was laid out in randomized block design with 12 treatments replicated thrice, namely, control (only NPK) (T_1), NPK + Soil Zn (T_2), NPK + FYM (T_3), NPK + foliar spray of half of recommended dose of Zn through $ZnSO_4$ (T_4), NPK + foliar spray of recommended dose of Zn through $ZnSO_4$ (T_5), NPK + foliar spray of 1.5 times the recommended dose of Zn through $ZnSO_4$ (T_6), NPK + foliar spray of $1/10^{th}$ of recommended dose of Zn through Zn metalosate (T_7), NPK + foliar spray of $1/4^{th}$ of recommended dose of Zn through Zn metalosate (T_8), NPK + foliar spray of half of recommended dose of Zn through Zn metalosate (T_9), NPK + foliar spray of recommended dose of Zn through Zn metalosate (T_{10}), NPK + foliar spray of 1/4th of recommended dose of Zn through Zn-EDTA (T_{11}), NPK + foliar spray of half of recommended dose of Zn through Zn-EDTA (T_{12}). The sources of N, P and K were urea, single super phosphate and muraite of potash respectively and Zn was applied through three sources ZnSO4, Zn-EDTA and Zn metalosate. In case of soil Zn application Zn was applied through $ZnSO_4$ @ 5.0 kg/ha. Irrigation was applied as and when required. The cultural practices recommended as per package of practice were followed during the growth period of the crop.

For yield contributing characters, plants counted per meter row length were multiplied with a factor of 1.67 for calculating plants per square meter. Number of tubers per plant were calculated by randomly selecting 5 plants after de-haulming and cleaning them with water and were then averaged. Tuber diameter was calculated by taking 5 plants from each plot and after de-haulming were cleaned with water. Digital verniercaliper (Mitutoyo Absolute) was used. Average diameter was recorded in milimeters.

For plant sample analysis, ten representative plants randomly selected were oven dried at 60°C. Dried tubers and haulms were ground separately and passed through 1mm sieve. For quality parameters, total soluble solids (TSS) content in fresh potato tuber samples whereas, starch was determined in dried samples. For the determination of TSS, hand refractrometer was used. A drop of sample juice was placed on prism and percentage was read directly. The analysis of plant sample for starch content, Anthrone reagent method as given by Sadasivam and Manickam (1996) was used.

Data was subjected to analysis of variance (ANOVA) in randomized block design Gomez and Gomez (1984). The treatment differences were compared at 5 per cent level of significance (P=0.05) using Duncan's multiple range test value.

RESULTS AND DISCUSSION

A. Impact of different Zn sources on yield contributing characters

Number of plants per m^2: The treatment receiving NPK + FYM (T_3) recorded the highest number of plants and the comparison of different foliar Zn sources revealed that Zn metalosate at recommended rate (T_{10}) and half of recommended rate (T_9) and $ZnSO_4$ at recommended rate (T_5) were found numerically superior, however, statistically all treatments were alike (Fig. 1).

Number of tubers per plant: Irrespective of sources, levels and methods of Zn application, non-significant differences were formed. However, none of the treatments could match the NPK+FYM treatment (T_3) and significantly higher number of tubers was registered. Numerically more number of tubers per plant was recorded for recommended Zn metalosate treatment while comparing different Zn sources. Omitting Zn application (T_1) showed significantly lower number of tubers (Fig. 2).

Tuber diameter: During both the years (2016-17 and 2017-18) application of recommended NPK+ FYM (T_3) proved its superiority over all other treatments and higher tuber diameter was recorded (Fig. 3). Increasing concentration of all foliar Zn sources recorded larger tuber size. Among foliar sources, Zn metalosate was found superior as significantly large sized tubers were recorded compared to other two ($ZnSO_4$ and Zn-EDTA at similar concentrations).

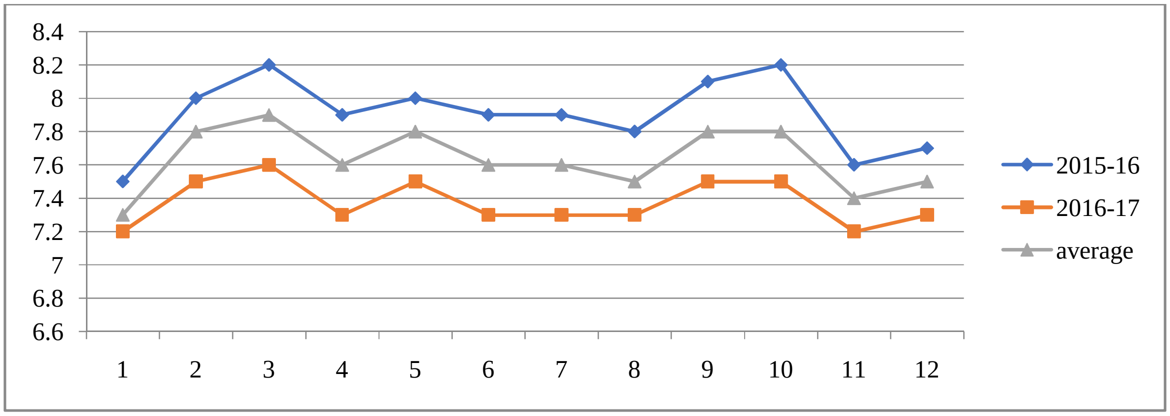

Fig. 1. Effect of different Zn sources on number of plants m^{-2}.

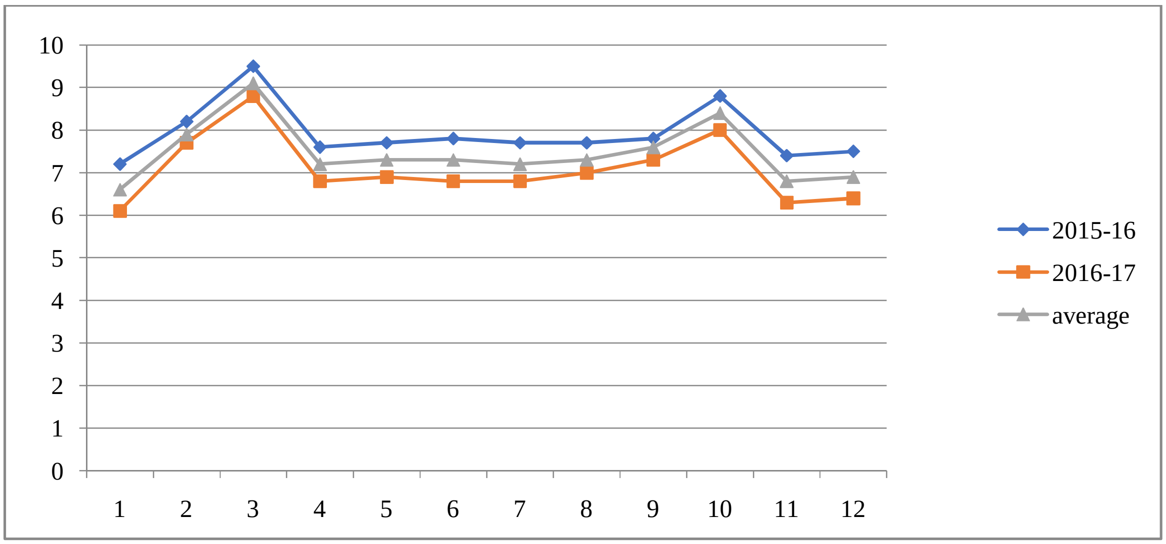

Fig. 2. Effect of different Zn sources on number of tubers per plant.

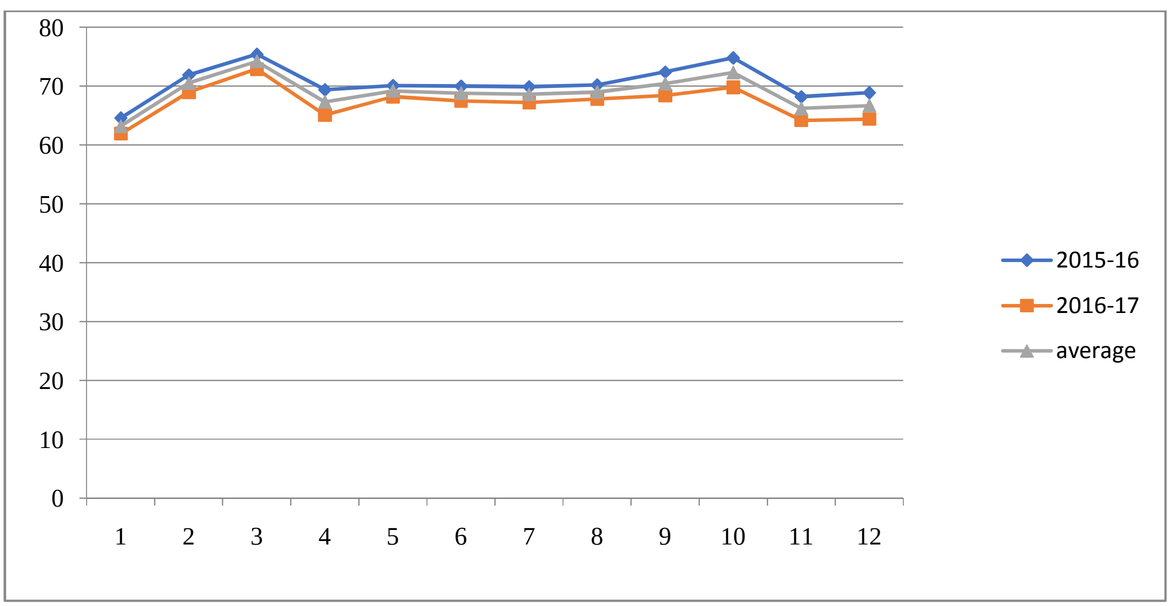

Fig 3. Effect of different Zn sources on diameter (mm) of potato tuber.

Highest value of all the yield contributing characters for treatment receiving NPK+ FYM might be due to the multi dimensional role of FYM. Besides, providing essential nutrients it also improves physical properties like aggregation, porosity, water holding capacity of soil along with improving biological health. And the better performance of Zn metalosate in increasing all yield contributing parameters at its recommended rate may be attributed to the reason that being a Zn chelate, Zn metalosate has better absorption than the other two sources. Zn improves the IAA/ABA and cytokinin/ABA ratio, which induces formation and growth of stolen mainly due to decrease in ABA content with gibberllin content of plant Puzina (2004). The favourable impact of Zn application through different sources has also been reported by Elayaraja and Singaravel 2017). These results were confirmed by the earlier findings of Taya *et al.,* (1994); Bari *et al.*, (2001); Al-Jobori and Al-Hadithy (2014); Taheri *et al.*, (2012) and Mousavi *et al*., (2007).

B. Impact of different Zn sources on quality parameters of potato

Total Soluble Solids (TSS): Different treatments influenced the TSS of potato tuber significantly (Fig. 4). However, irrespective of treatments, again application of NPK + FYM (T_3) recorded maximum mean TSS value (7.08 ^{0}Brix) which was significantly superior over all the other treatments. The comparison of means of different Zn sources, Zn metalosate at recommended rate (T_{10}) was found superior to all other Zn sources for both the years. However treatment T_9 receiving half of recommended dose of Zn metalosate was found statistically at par with T_{10}. In 2015-16, foliar feeding of Zn at recommended rate through Zn metalosate was found superior to soil Zn application. But, in 2016-17 both behaved statistically alike. The mean of two years also showed superiority of recommended Zn application through Zn metalosate over its soil application through $ZnSO_4$.

Treatment T_3 (NPK + FYM) registering significantly higher TSS value could be ascribed to vigorous vegetative growth and deep green colour of the foliage favoring better photosynthetic activity of the plants resulting in greater accumulation carbohydrate in the tuber and more synthesis of TSS owing to FYM application. This was in agreement with the results found by Khar *et al.*, (2007); Song *et al*., (1997). Conversely, Rabari *et al*., (2016) found non-significant impact of use of FYM on TSS content.

As FYM is becoming scarce with every passing day and in such events, foliar feeding can be an option to supply the desired nutrients. Foliar feeding of Zn metalosate was superior among other sources, which could be due the reason that being an amino acid chelate, it leads to better and more Zn absorption by the plant and Zn has an important role in photosynthesis and enzymes responsible for plant metabolism, the increased TSS could be attributed to Zn metalosate application. Singh *et al*., (2002) also advocated that micronutrient had positive effect on fruit quality and TSS. The results were also in agreement with the findings of Mishra *et al*., (2003); Moustafa *et al.*, (1986).

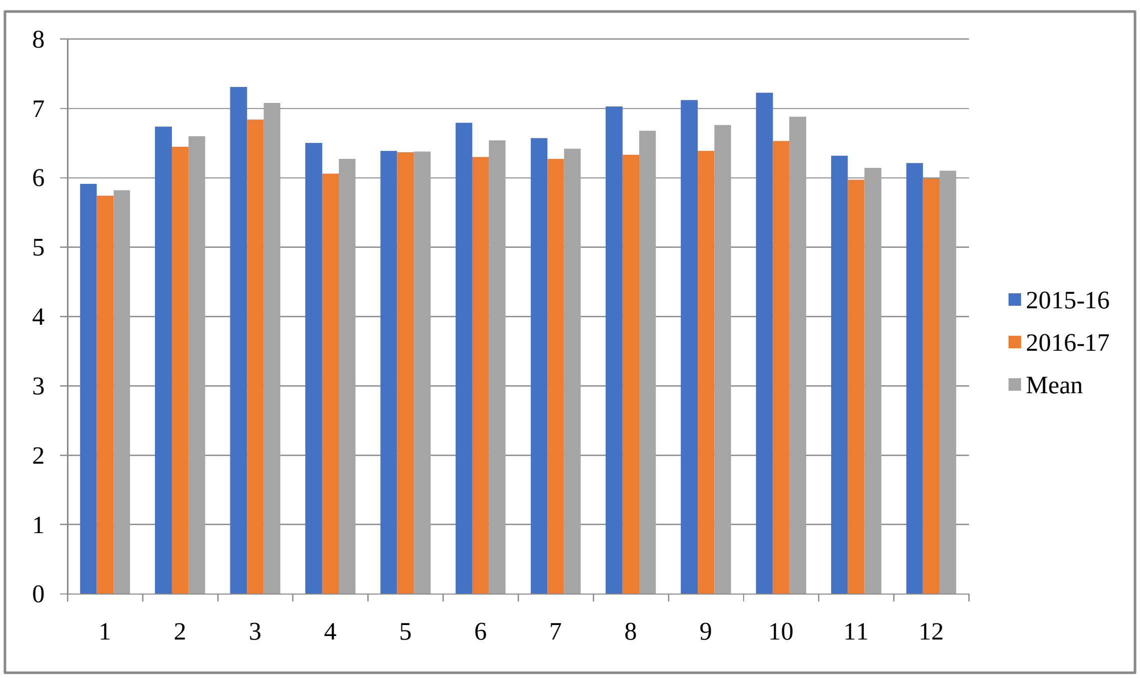

Fig. 4. Effect of different Zn sources on TSS (^{0}brix) of potato.

Starch content (%): The advantage of conjoint use of NPK and FYM can be seen as significantly higher starch content (Fig. 5) was recorded and it was significantly superior to all the other treatments irrespective of the sources and methods.

While comparing different foliar Zn sources used, the mean value of starch content for two years showed significant differences among different sources. Significantly higher value of starch content was recorded for treatment receiving NPK along with recommended dose of Zn through Zn metalosate (T_{10}). Irrespective of concentrations and sources of Zn used Zn metalosate was found better. However, Zn metalosate at half of the recommended dose along with NPK (T_9) behaved statistically alike with that of treatment T_{10}.

The enhancement in starch content might be attributed to activation of enzymes like aldolase and carbonic anhydrase by Zn which helps in translocation of starch from leaves to tubers. Zn metalosate being an amino acid chelate helps in its better absorption through foliar spray. Puzina (2004) suggested that Zn improves diameter of isodiametic cell of perimedullary tuber zone which are characterized by the most intense starch accumulation. Similar results were repoted by Awad *et al*., (2010); Swaminathan and Verma (1979); Ahmed *et al.*, (2011); Panitnok *et al*., (2013); Mousavi *et al*., (2007); Mohamadi (2000) reported that application of Zn along with Mn as foliar application caused increased efficiency and quality of potato crop.

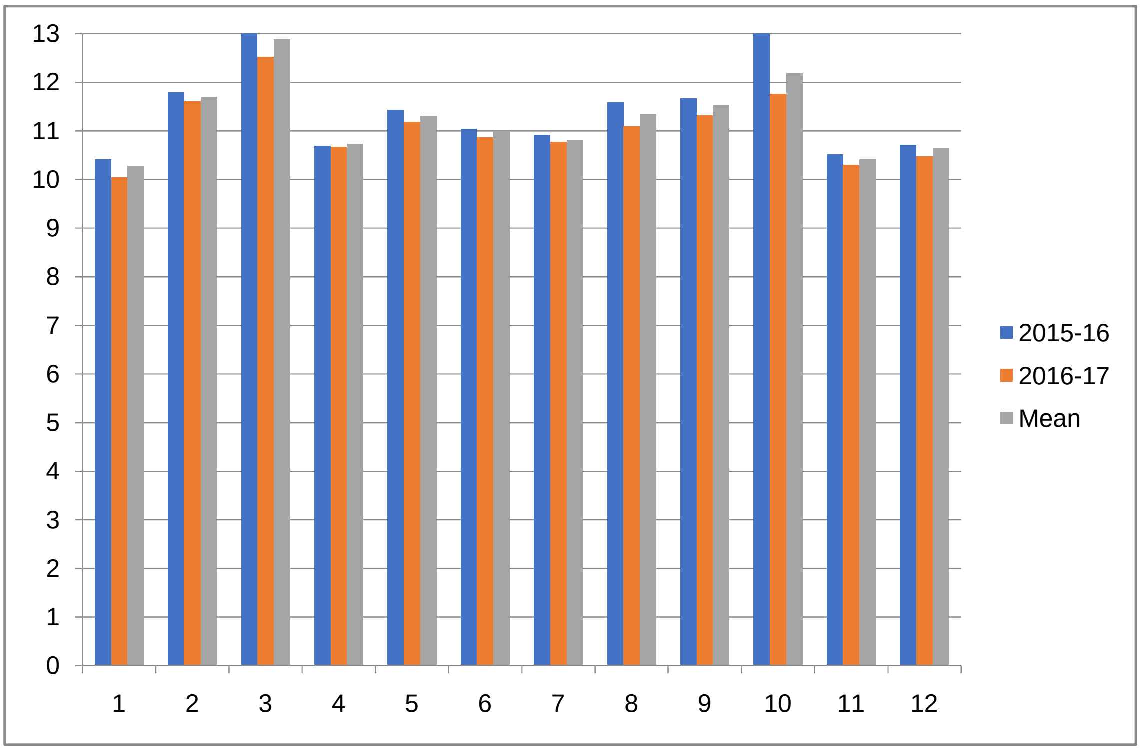

Fig. 5. Effect of different Zn sources on starch content (%) of potato.

CONCLUSION

– Although conjoint use of recommended NPK and FYM proved superior to soil and foliar application of Zn through different sources and graded levels but in the event resource crunch of FYM, soil and foliar feeding of targeted nutrients are available options.

– Different foliar supplements behaved differently. However the newly introduced Zn metalosate at recommended rate improved the quality parameters of potato and can be substituted to standard ones in producing the quality food stuff which is, of course, the demand of consumers also.

– Since the preliminary work was done at one location in order to popularize, it is to be evaluated under different agro ecological zones.

FUTURE SCOPE

Considering the emerging Zn deficiencies in soils and crops across the states, require comprehensive investigation of soil and plant analysis. However for immediate correction of Zn deficiency, foliar feeding through different economic sources need evaluation. Since the initial evaluation of Zn metalosate have shown encouraging results in terms of yield advantage and use efficiency but should be tested in different agro climatic regions and crops. As the product is yet to be included in FCO, once done it is expected to find favour with the stakeholders.

Conflict of interest. Nil.

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