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Technological Investigations for Improvement of Grapevine Propagation Material Production in Bulgaria. Part II. Testing of Agritechnical Practices in Vine Nursery

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Abstract

The study was carried out at the Institute of Viticulture and Enology, Pleven for improvement the technology for the production of grafted rooted vines. The subject of the study included the agritechnical practices: irrigation and irrigation regime in vine nursery, application of herbicides for weed control and fertilizing with organic fertilizers was the subject of the study. In the comparative tested irrigation practices and irrigation regime in the nursery the results were in favour of the drip irrigation. The action of the herbicides Lumax 538 SC (*375g/l s-metolachlor + 125 g/l terbuthylazine + 337.5 g / l mesotrione*), Stomp 33 EC (*330 g/l pendimethalin*), Goal 2E (*240 g / l oxyfluorfen)* and Dual Gold 960 EC (*960 g/l s-metolachlor*) was studied. The organic fertilizers Humustim, Aagrohumustim, and Biohumus were tested for fertilization optimization. Fertilization with organic fertilizers had a positive effect on the growth processes in terms of the elements of growth and yield of grafted rooted vines.

Key words: vine propagation material, nursery, irrigation regime, herbicides, fertilizing, organic fertilizers

Introduction

The transition from the classical way of vine nursery raising in our country (Neshev and Hadziev, 1970; Mamarov and Neshev, 1977; Mamarov, 1988) to bed-lining technology with open waxed part (Radulov, 1979 Todorov, 2005; Dimitrova, et al. 2007), set a number of issues to be solved by viticultural science related to basic agricultural practices - irrigation and irrigation regime, weed control, fertilization, tillage.

According to Magriso and Lilov, 1965 the proper determining of the methods of irrigation and watering rate ensure the optimal water regime for the growth and development of the vine plants in the nursery. In the open way of growing, unlike the traditional method, it is essential not only to maintain the soil moisture, but also the air humidity in the area of the grafting during the first 45 days after the rooting of the grafted cuttings (Radulov, 1979). Studies on irrigation regime optimization in the nursery were carried out at IVE – Pleven (Tsvetanov and Kumanov, 2011, Tsvetanov et al. 2012).

For weed control in vine nursery a number of active substances (simazine, atrazine, napropamide, fluorochloridone, oxadiazon) had been studied, as the triazine compounds had shown the highest efficiency and selectivity (Chelebiev, 1981; Chelebiev and Katerova, 1988; Nikov et al., 1988; Chelebiev and Encheva, 2002). Over the past decade researches were focused on other, more environmentally friendly substances. Trials for establishing the effect of pendimethalin, s-metolachlor, oxyfluorfen etc. were conducted at IVE - Pleven. The herbicides Goal 2E, Dual Gold 960 EC, Lumax 538 SC and Stomp 33 EC efficiently controlled the annual weeds and did not have an adverse effect on the grafted cuttings of Misket Kaylashki variety (Prodanova-Marinova, 2012). The successful application of these herbicides justified their effect on other varieties to be studied too.

Providing the necessary nutrients by foliar and soil fertilization is another very important factor in growing vines in the nursery (Mihaylova, 1967, Maltabar 1971; Kandeva, 1988, Encheva and Dimitrova, 2007). The application of organic fertilizers not only increases the rate of first-class vines, but contributes to improving the soil physical properties (Pondev and Tsvetkov, 1998).

Objective of the study: improvement the technology of vine propagation material production by testing basic agritechnical practices in vine nursery - irrigation; herbicides testing, fertilization with organic fertilizers.

Material and Methods

The study was carried out in the vine nursery of the Production-Experimental base at the Institute of Viticulture and Enology – Pleven.

Irrigation Methods in Vine Nursery

Comparative testing of irrigation by micro-sprinkling and drip irrigation with micro-sprinkling for cooling waterings was conducted with Misket Kaylashki variety (white, wine variety) grafted to Berlandieri x Riparia SO4 rootstock (Misket Kaylashky/SO4).

Experimental variants**:** V1 – irrigation by micro-sprinklers „Water Bird VI Clasic" with flow rate q = 156 L h^{-1} , at 0.2 MPa pressure and radius of operation r = 5.0 m. Square scheme of location was used with distance between the micro-sprinklers a = 1,42r = 7 m, where the irrigated area by one apparatus was Fп = $2r^2$ = 50 m^2, and the intensity rate i=q/Fп = 3,12 mm/h; V2 – drip irrigation in combination with micro-sprinkling for invigorating waterings with micro-sprinkling apparatuses „Water Bird VI Clasic".

In variant V2 the grafted cuttings were watered by drip irrigation system with one lateral per ridge, located between the two rows of cuttings. The laterals had built-in drop-formation units every 15 cm with flow rate of 1.0 L h^{-1}. The volume of the supplied irrigation water was controlled by means of water-meter installed at the beginning of the system. The invigorating waterings were performed twice or three times a day in volume 1 – 2 m^3/dca. Micro-sprinklers „Water Bird VI Clasic" were used for that purpose with flow rate q = 156 L h^{-1}, at 0.2 MPa pressure and radius of operation r = 5.0 m. The micro-sprinklers were located in a square scheme at a distance between them a = 1.42r = 7 m. The irrigated area by one micro-sprinkler was Fп = $2r^2$ = 50 m^2, while the intensity was i=q/Fп = 3.12 mm/h.

The experiment was carried out by the block method in two variants with four replications. Each variant consisted of 400 grafted cuttings - 100 pieces per replication.

The soil moisture dynamics was monitored at an interval from 7-14 days at a depth of 60 cm. Samples were taken in triplicate at intervals of 10 cm and were processed by the conventional weight-thermostatic method.

Herbicides Testing for Weed Control

The action of herbicides Lumax 538 SC *(375 g/l s-metolachlor + 125 g/l terbuthylazine + 337.5 g/l mesotrione),* Stomp 33 EC *(330 g/l pendimethalin)*, Goal 2E *(240 g/l oxyfluorfen)* and Dual Gold 960 EC *(960 g/l s-metolachlor)* on cuttings of Bolgar variety (white, table grapes variety) grafted to Berlandieri x Riparia SO4 rootstock was studied. The nursery was treated immediately after transplanting of the cuttings with different doses of the test herbicides: Lumax 538 SC 4000 ml.ha^{-1} (**V1**); Lumax 538 SC – 6000 ml.ha^{-1} (**V2**); Stomp 33 EC - 6000 ml.ha^{-1} (**V3**); Stomp 33 EC - 8000 ml.ha^{-1} (**V4**); Dual Gold 960 EC - 3000 ml.ha^{-1} (**V5**); Goal 2E - 3000 ml.ha^{-1} (**V6**) and Dual Gold 960 EC – 1500 ml.ha^{-1} + Goal 2E - 2000 ml.ha^{-1} (**V7**). Untreated, manually weeded out control (**K**) was used for comparison.

Sprinkling was performed immediately after the application of the herbicides.

The dynamics of the grafted cuttings germination (%) was monitored and the yield of standard vine propagation material (%) was counted. Data were processed by analysis of variance (Dimova, D., E. Marinkov, 1999).

Study on the Effect of Biohumus Organic Fertilizer

Biohumus organic fertilizer is a product from the processing of manure and other organic waste by the red Californian worms (Eisenia foetida).

The trial was carried out with varieties, selection of IVE-Pleven: Naslada, grafted to Shasla x Berlandieri 41 B rootstock (Naslada/41B) and Misket Kaylashki/SO4. Three variants were studied for Naslada/41B: **V_1 -** not fertilized with Biohumus (control); **V_2 -** fertilized at a dose of 1.5 l/m; **V_3 -** fertilized at a dose of 3.0 l/m; For Misket Kaylashki the variants were two: **V_1 -** not fertilized with Biohumus (control); **V_2 -** fertilized at a dose of 1.5 l/m.

Each variant was set at 10 m length in the row in two replications. The fertilization with the organic fertilizer was performed at the time of transplanting the grafted cuttings by placing the fertilizer at the depth of their basal part.

Results

Irrigation Methods in Vine Nursery

Solving the problem of irrigation in the vine nursery imposed the comparative study of different methods of irrigation – sprinkling, micro-sprinkling, drip irrigation (Dimitrova et al., 2007; Tsvetanov and Kumanov, 2011; Tsvetanov et al., 2012). This paper presents the results of the experiment of micro-sprinkling and drip irrigation, combined with micro-sprinkling for invigorating waterings.

It is known that for ensuring optimal conditions for development of the grafted cuttings in the vine nursery, the required pre-irrigation moisture ($дт^{пр.\ в/л}$) should be in the range of 19.2 to 21.6% of the absolute dry weight of the soil, while the optimal irrigation rate should ensure soil wetting to the limit soil moisture (LSM) to a depth of 60 cm.

The data presented in Fig. 1 show that soil moisture (% of absolute dry weight of soil) on the average for the soil profile from 0 to 60 cm, provided the necessary conditions for the vine growth processes in the nursery.

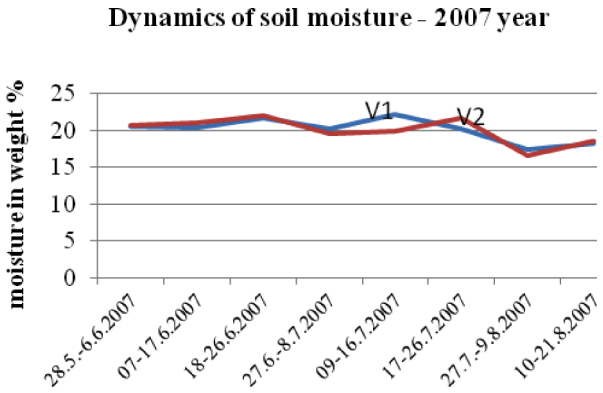

Figure 1. Dynamics of soil moisture in weight %, on the average for the soil layer from 0 to 60 cm.

Fig. 2 presents the results of the shoot germination rate of Misket Kaylashki/SO4 in the nursery. During the first counting on July, 06 the germination rate of the variant with drip irrigation had 83.5% developed shoots exceeding the variant of micro-sprinkling by 25.9%. During the next counting on June, 18 irrigation in the nursery had dropped down to 3.65%. By the end of the follow-up of this indicator the difference in the germination rate between the micro-sprinkling and the drip irrigation was within the range of 6.9% and 9.7% in favour of the drip irrigation.

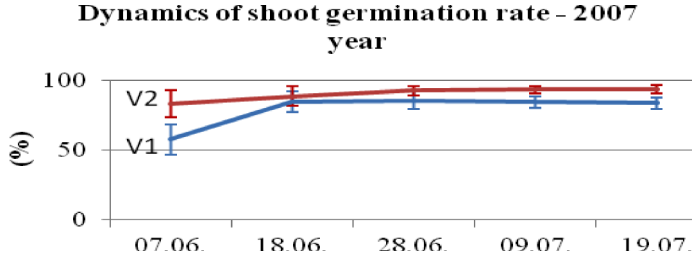

Figure 2. Dynamics of shoot germination rate of Misket Kaylashki/SO4 variety with micro-sprinkling and drip irrigation in the vine nursery

The yield of first-class grafted vines is a summarizing indicator, the result of the interaction between genotype, affinity, technology of propagation, growth media, which defines it as the most important indicator in the production of vine propagation material. The observed tendency in the shoots germination rate in the nursery was similar with the data for the rate of first-class vines (fig.3).

The yield from the drip irrigation variant was by 13.9% higher compared to the micro-sprinkling variant. Most probably the combination of drip irrigation with micro-sprinkling for invigorating waterings provides not only soil wetting, but also better air humidity in the open part of the rooted cuttings and thus better conditions for the processes of differentiation and coalescence of tissues at the site of grafting.

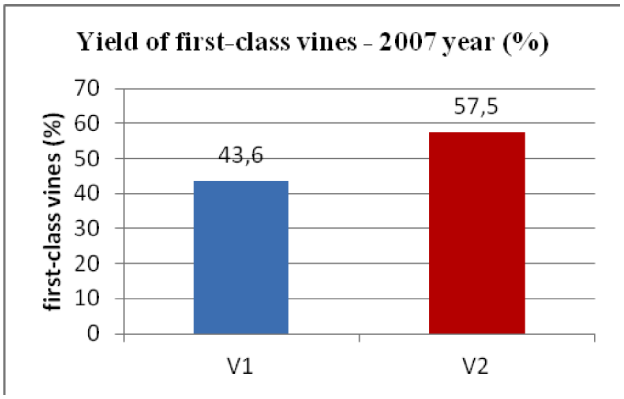

Figure 3. Yield of first-class vines (%) of Misket Kaylashi/SO4 variety obtained during the comparative testing of micro-sprinkling and drip irrigation

Herbicides Testing for Weed Control

The herbicides introduction immediately after transplanting of the grafted cuttings in the nursery created direct contact between the buds and the solution. That resulted in decreasing the germination rate at the end of the first ten-day period after the treatment. The differences in the values of this indicator compared to the control (K – 69.26%) varied depending on the herbicide action and the applied dose (fig. 4). The rate of cuttings treated with Stomp 33 EC – 6000 ml.ha^{-1} (V3), Dual Gold 960 EC – 3000 ml.ha^{-1} (V5) and Lumax 538 SC - 4000 ml.ha^{-1} (V1) was very close to that of the untreated control – 68.98 (V3), 68.88 (V5) and 68.38 (V1). In higher doses Stomp 33 EC and Lumax 538 SC had caused more significant however not mathematically proven reduction in the rate of germinated cuttings. The contact action of Goal 2E had a negative effect on the buds development immediately after the treatment. At the end of the first ten-day period the germination rate in the variants Goal 2E – 3000 ml.ha^{-1} (V6) and the tank mixture Dual Gold 960 EC + Goal 2E (V7) was significantly lower compared to the control – 62.5% for V6 and 61.89% for V7. The differences were significant and well provided (*GD 5% = 3.999, GD 1% =5.550, GD 0.1% = 7.718*).

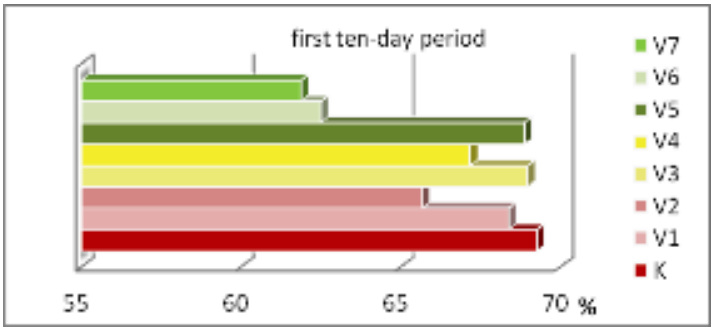

Figure 4. Germination rate of grafted cuttings at the end of the first ten-day period after the treatment of the nursery with herbicides

The dynamics of the germination rate showed that the cuttings were gradually overcoming the herbicidal stress that resulted in significant decrease in the differences between the separate variants as well as between the variants and the control. At the end of the fifth ten-day period, the germination rate of untreated cuttings reached 90.41%, while of treated ones was within the range from 88.53 (V2 - Lumax 538 SC - 6000 ml.ha^{-1}) to 91.01 (V5 – Dual Gold 960 EC – 3000 ml.ha^{-1}) – fig. 5. All differences were not proven (*GD 5% = 2,500, GD 1% =3,470, GD 0.1% = 4,826*) which justified the assumption that even the tested herbicides in the applied doses to slow down to a certain extent the buds germination they did not have a negative impact on the final result of that process.

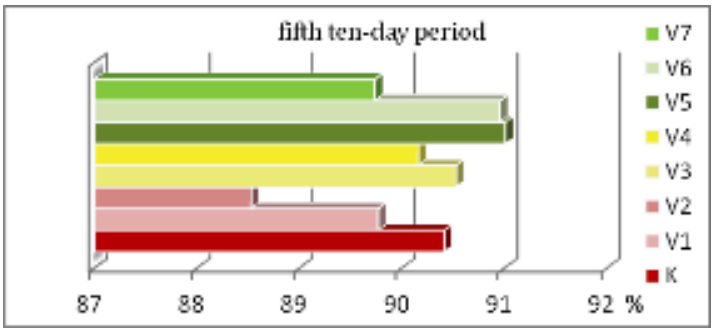

Figure 5. Germination rate of grafted cuttings at the end of the fifth ten-day period after the treatment of the nursery with herbicides

The herbicides Stomp 33 EC, Lumax 538 SC and Goal 2E had both soil and leaf action which caused short-lasting but well expressed signs of phytotoxicity. Stomp 33 EC provoked the appearance of yellow-greenish spots of irregular shape on the leaves of the grafted cuttings and in some cases even rolling up of the leaf blade edges. Whitening along the leaf blade edges (peripheral chlorosis) was observed in cuttings treated with Lumax 538 SC due to the mesotrione action. Fallen drops of solution on the already developed leaves during treatment with Goal 2E or a mixture of Dual Gold 960 EC and Goal 2E led to the tissue decay in the affected area, browning and necrosis. The phytotoxic effect of the herbicides was overcome rather fast – between the thirtieth and the sixtieth day post treatment. The grafted cuttings developed normally and at the end of the vegetation the yield of standard vine propagation material did not differ significantly from the yield of the control (46.23%) – fig. 6. The highest rate of grafted rooted vines on the average for the period of the study was obtained with Stomp EC – 8000 ml.ha^{-1} (V4) – 51.69 % and Dual Gold 960 EC – 3000 ml.ha^{-1} (V5) – 49.04%. The grafted cuttings of Bolgar variety were the most susceptible to Goal 2E, applied at a dose of treatment 3000 ml.ha^{-1} and respectively the yield from this variant was the lowest (44.47%). In the combination of Dual Gold 960 EC and

Goal 2E, where Goal 2E was applied in a dose of 2000 ml.ha^{-1} that problem was overcome and the rate of grafted rooted vines exceeded both the rate of V6 variant and the control. The analysis of variance revealed very good covering of the difference only between V4 and V6, however neither of the treated variants showed proven differences compared to the control (*GD 5% = 13,211, GD 1% =18,336, GD 0.1% = 25,499*). Therefore the tested herbicides are applicable in the vine nursery as the most significant effect could be expected by Stomp 33 EC and Dual Gold 960 EC.

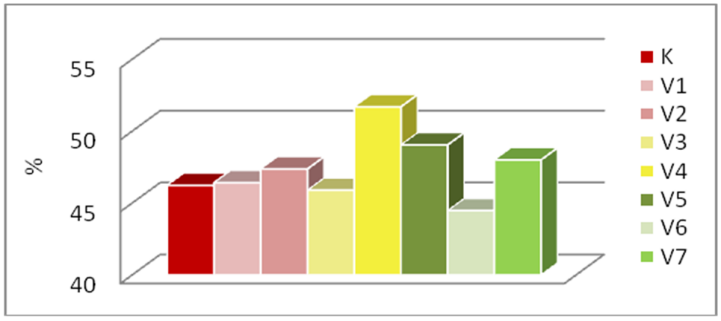

Figure 6. Yield of grafted rooted vines on the average for the period of the study

Study on the Effect of Biohumus Organic Fertilizer

It is known that the total biomass of the grafted rooted vines after being removed from the nursery is the result of the growth processes intensity during the vegetation period.

For Naslada variety the green mass of mature annual growth per vine in the variant with fertilizing V_2 (1.5 l/m), on the average for the three years of the trial, surpassed the control by 10.3 g (fig. 7). In variant V_3, the results confirmed the effect of the organic fertilizer application. The green mass of the mature annual growth was 31.3 g at a dose 3 l/m (V_3) – the increase compared to the control was 9.2 g. More pronounced was the positive effect of testing the bio fertilizer Biohumus in Misket Kaylashki variety for both experimental years. The green mass of mature annual growth in the variants with fertilizing V_2 was 35.5 g - more than twice higher compared to the control – 16.6 g (V_1). The results of the experiment showed that the organic fertilizer had a positive impact - more vigorous vine growth had been induced, expressed by green mass of the mature annual growth in both rates of fertilization.

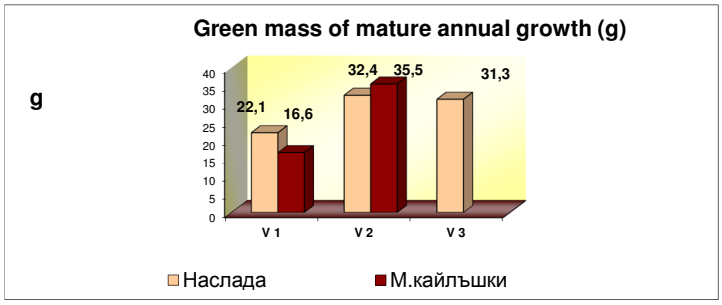

Figure 7. Green mass of mature annual growth per vine with organic fertilizing with Biohumus of Naslada and Misket Kaylashki varieties in vine nursery

Regarding the yield of grafted rooted vines the effect of the organic fertilizer Biohumus on this indicator is clearly shown in fig. 8. Data for Naslada variety were similar to those obtained for green mass of mature annual growth per vine. In the control (V_1) it was obtained 31% first-class vine propagation material; at fertilization dose of 1.5 l/m (V_2) - 40%, followed by variant V_3 - 38%. Fertilization with Biohumus had a positive impact on the

yield of grafted rooted vines of Misket Kaylashki variety. The data were also in correlation with the green mass of the mature annual growth, however expressed as a ratio, it was in a much lesser degree. In the variant of fertilization V_2 (1.5 l/m), 49% first-class grafted rooted vines were obtained. Compared to the control, with 43% vines, the rate of increase was 6%.

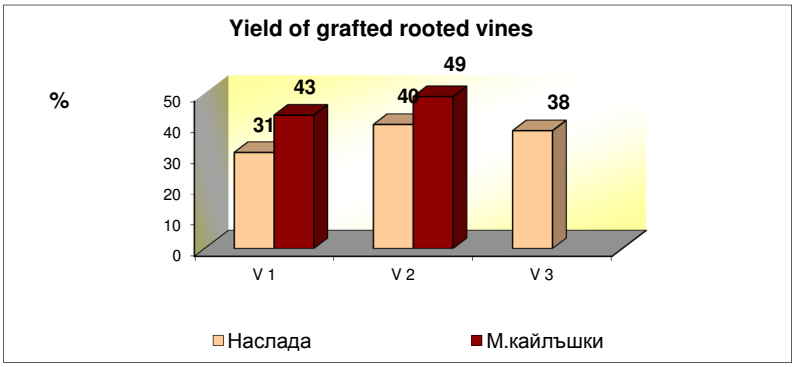

Figure 8. Yield of grafted rooted vines with organic fertilizing with Biohumus of Naslada and Misket Kaylashki varieties in vine nursery

The results of the study with the biological fertilizer Biohumus showed that it had a greater effect on the vine growth in the nursery expressed in green mass of mature annual growth, compared to its effect on the rate of first-class vine propagation material. Probably organic fertilization facilitated vines nutrition in the nursery and especially vines with less potential to reach the required length of the mature shoot for first-class vine propagation material. At the same time, the significantly greater biomass of mature annual growth in the variants with fertilization, ensured better biological potential of the vines, which was essential for catching, production and longevity in the future vineyards established with them.

Conclusion

In the comparative study of micro-sprinkling and drip irrigation, combined with micro-sprinkling, the yield of first-class vines was by 13.9% higher in the variant of drip irrigation in combination with micro-sprinkling, justifying this variant to be preferred for supplying the vines with water, and the micro-sprinkling to be used to regulate the microclimate in the nursery.

The herbicide Dual Gold 960 EC at a dose of 3000 $ml.ha^{-1}$ did not have a negative impact on the germination rate of the grafted cuttings, did not cause a phytotoxic response and resulted in obtaining the highest yield of grafted rooted vines.

However the well expressed signs of phytotoxicity provoked by the application of Stomp 33 EC and Lumax 538 SC it was not found a decrease in the yield of vine propagation material after treatment with them. Introduced at doses of 8000 $ml.ha^{-1}$ for Stomp 33 EC and 4000 and 6000 $ml.ha^{-1}$ for Lumax 538 SC they could be used efficiently for the annual weeds control in the vine nursery.

The grafted cuttings of Bolgar variety showed significant susceptibility to Goal 2E which in some cases could lead to significant decrease in the rate of grafted rooted vines, obtained from them.

The experimental results showed that the organic fertilizer in the applied doses had a stimulating effect on the growth processes in the vine nursery of Naslada and Misket Kaylashki varieties expressed in the green mass of the mature annual growth of the grafted rooted vines. The effect on the yield was not so high compared to the green mass of the mature annual growth – the increase of first-class vine propagation material was by 7 to 9% for Naslada variety and 6% for Misket Kaylashki variety.

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