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COMPARATIVE WEED INVESTIGATIONS IN WHEAT AND MAIZE CROPS CULTIVATED TRADITIONALLY AND TREATED WITH WEEDICIDES
II. CHANGES IN THE WEED VEGETATION OF MAIZE CROPS

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Abstract

Coenological studies were carried out on several state farms to establish the changes in the weed-vegetation on the socialist reorganization of agriculture, with regard to the more modern large-scale agrotechnology, and also to chemical weedicides (Simazin, Atrazin). The results were compared previous data for the same sites, and the following conclusions were drawn.

During 15 years the weed-cover of the maize crops decreased significantly as a result of the more modern large-scale agrotechnology. The decrease took place in the perennials wintering in the soil (G).

In crops first sprayed with Hungazin PK (Atrazin) a further decrease of almost 50% (compared to the traditionally cultivated crops) occured in the weed-cover; this was due to the annuals (T), the perennials remaining unchanged.

Simazin and Atrazin treatment for several years resulted in very unfavourable changes in maize monocultures. Although the total weed-cover showed little change compared to the traditionally cultivated data, its composition shifted in a negative direction, for the cover of the perennials wintering in the soil (G) increased to about two and a half times that of the control.

Investigations in 1961 showed that a very considerable decrease resulted in the weed vegetations of wheat and maize crops on the effect of large-scale agrotechnology in addition to traditional cultivation, compared to the national weed survey of 1947—1953 (FEKETE, 1963). As already reported in the publication dealing with the first part of the investigations (FEKETE, 1973), the main aim of these researches was to establish the extent of the role of a more developed large-scale agrotechnology in the change of the weed vegetation, and that of the application of various chemical weedicides (2,4-D and aminotriazines), since besides the agrotechnology the state of the weed vegetation is affected considerably by the ever increasing use of the different herbicides. Further justification for these researches was the fact that in connection with Simazin and Atrazin, and the identical Hungazin DT and Hungazin PK, a number of important problems required elucidation.

At the time of the commencement of the investigations (in 1963) it was generally held that with triazine chemicals (independently of the composition of the weed flora) it was possible to rid maize crops completely of weeds (UBRIZSY, 1960; 1962; UBRIZSY et al., 1961; VIRÁG et al., 1960; 1962; SZIGETHY, 1961; 1963). Data were not available with regard to how the weed vegetation of an area changes if aminotriazines (Simazin and Atrazin) are applied on it for a prolonged period, although just this method of treatment had been proposed for maize (VIRÁG et al,. 1962), and in practice certain farms had turned over to this method. Since this problem had not been clarified up to the beginning of the investigations, besides the traditional and the first-year chemically treated maizes, increased attention was devoted to the study of the weed relations of such crops under large-scale farming conditions.

Materials and Methods

Weed coenological surveys were carried out with the BALÁZS (1944) scale from 1963 in traditional maize crops and in others freed from weeds at various times since with Simazin and Atrazin (Hungazin PK). The sites and methods of investigation were reported in detail in the earlier publication dealing with the results for wheat crops (FEKETE, 1973). It is necessary to add only that apart from the state farms mentioned surveys were carried out everywhere in plots on cooperative farms employing traditional cultivation. Since only sparse data are available on the weed conditions of maize crops at the beginning of summer, in contrast with the national weed surveys investigations were performed twice during the growing period, at the beginning of June (survey 1) and in the second half of August (survey 2). Those weed species were listed from the results obtained, which occupied an area greater than 1% in an average compiled according to treatment for the investigated sites (Table 1), and in addition the distribution of the weed cover according to life forms is also reported (Table 2) in the classification of ÚJVÁROSI (1952).

The soil and precipitation conditions were also reported in the earlier publication. In connection with the precipitation, however, it must be pointed out that at the time of the national weed surveys (in 1950) the weather was predominantly extremely arid and in part of the investigated sites (Fehérgyarmat, Mezőnagymihály, Lábod and Kaposvár) in general 200—300 mm less precipitation fell up to the end of the growing period than in 1963. The total precipitations in 1963 corresponded to the 40-year averages for these areas, being somewhat more than the average at Mezőhék. Even in this year, however, conditions were not favourable everywhere for the effects of the Hungazin chemicals to be exerted, for at Lábod in April, for example, only 12 mm of rain fell (13 mm at Kaposvár), and May too was dry.

In connection with the agrotechnological data, it should be mentioned that in the maize crop areas (with the exception of those sprayed at Enying from 1962) the autumn deep ploughing, the spring soil cultivation preceding the sowing, and the sowing itself were performed in good time and with the required quality. In the former-mentioned area, however, the maize treatment involved spring ploughing. The traditionally cultivated maizes, again with the exception of Enying, were subjected to two or three mechanical, and two manual row-hoeings. At Mezőnagymihály and Kaposvár hoeing was carried out over the whole area of the traditional maizes a few days before the first surveys. At that time the crops at Fehérgyarmat, Mezőhék and Enying had been subjected to cultivator treatment only once, about 2—3 weeks before, while those at Lábod had not yet been hoed. In these latter four farms the first hoeing was performed immediately after the first surveys, and the second at the beginning of June. In contrast with the normal practice, at Enying the chemically treated maizes too were hoed the same number of times as the traditional ones there: two mechanical and one manual hoeing was applied, with the difference that up to the time of the first surveys the chemically treated maizes received one hoeing over the whole area, while the traditional ones underwent only one cultivator treatment. It is very important to take this into consideration, therefore, in the evaluation of the June data for the chemically treated maizes.

The amounts of chemicals applied are given in the text.

Results and discussion

1. Effect of large-scale agrotechnology on the development of the weed vegetation in maize crops

a) Weed conditions of traditionally cultivated maize crops at the beginning of summer

The distribution of the weeds found at the beginning of June according to life forms is shown by survey 1 of Table 2 and by Fig. 1. It is clear from these that even then the late-summer annuals (T_4) are present in greatest numbers (10.8%), since they comprise almost half of the total cover. The relatively low value (5%) of the cover for the spring-sprouting early-summer varieties (T_3) compared to the late-summer forms is in effect due to the fact that at the time of the first surveys only at Lábod was the soil of the maize crops untouched. As a result, only here did the spring-sprouting early-summer varieties occur in bulk (22.79%). In contrast, where

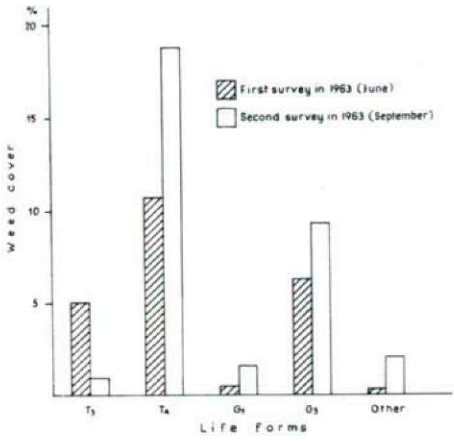

Fig. 1. Comparison according to life forms of the early- and late-summer weed conditions in traditionally cultivated maize crops.

the crops had already received one interrow hoeing, the species belonging to the T_3 group occurred in lesser amounts, and mainly only in the rows. This shows that from the sowing of the maize until the first hoeing the T_3 life-form occupied a much larger area in the investigated sites. The above weed cover at Lábod consisted also entirely of *Raphanus raphanistrum* (21.87%), and at the other sites of *Sinapsis arvensis*, as typical members of the early-summer (second) aspect.

In June the perennials played a much smaller part compared to the annuals in the development of the weed cover, and among them only the root-like couch-grasses (G_3) were significant (6.25%).

b) Late-summer weed conditions of traditionally cultivated maize crops

According to the surveys in 1950, at the end of the growing time in the maize crops of the investigated sites 78 weed species lived, with a cover of 42%. According to the combined data, there were now 97 weed species, with an average weed cover of 32.6%. As can be seen from the data, during the intervening nearly one and a half decades the weed cover of the maize crops decreased by 24% as a result of the more up-to-date large-scale agrotechnology (Table 2, survey 2). The decrease in maize crops, therefore, was not so extensive as that in wheat crops, or as that experienced in both cultures in 1961 (FEKETE, 1963; 1964 manuscript; 1973). On the other hand, the number of species was now increased.

Comparison of the results with the data of ÚJVÁROSI for 1950 led to the following findings:

The cover of the spring sprouting early-summer varieties (T_3) increased by a factor of two compared to the value for 1950, while that of the late-summer ones (T_4) (in contrast with the investigations in 1961, when a very considerable decrease was found for all weed groups) remained essentially unchanged (18.58% and 18.76%). The fact that the annuals did not decrease involves two factors. One of these, as already indicated, is that 1963 was much wetter than 1950. The other was that because of the limited nature of the crop-rotation, maize had been grown continually

by the traditional way in some (3) farms in these areas since 1961. In this respect it is known that this favours just the accumulation of the late-summer varieties and the root-like couch-grasses. Although the overall cover of the late-summer varieties is essentially unchanged, the covers of certain species are changed. The two most numerous species of the group, *Ambrosia elatior* and *Echinochloa crus-galli*, for example, were reduced to about half compared to their 1950 values, while at the same time *Chenopodium album* and *Amaranthus retroflexus* multiplied appreciably (Table 1).

In contrast with the late-summer varieties, the annual stemmed couch-grasses (G_1) and root-like couch-grasses (G_3) exhibited a considerable decrease as a result of the large-scale agrotechnology (from 5.8% to 1.5% for G_1 and from 16% to 9.3% for G_3), similarly to the results for the wheat crops in 1961 and this year. The greatest decrease now too was for *Convolvulus arvensis*, belonging to group G_3 (from 10.4% to 5.6%). A similar considerable decrease can be observed for *Cirsium arvense*, but in contrast there is an increase for *Rubus caesius* (Table 1).

2. Effect of the application of Atrazin (Hungazin PK) on the development of the weed vegetation in maize crops

a) Weed conditions of maizes sprayed for the first year

On the Enying State Farm 5 kg Hungazin PK and 1.1 kg Dikonirt was applied per kh, and on the other farms 6 kg/kh Hungazin PK (Atrazin) to the maize crops, in the majority of cases on pre-emergents. Application was in all cases performed by aeroplane.

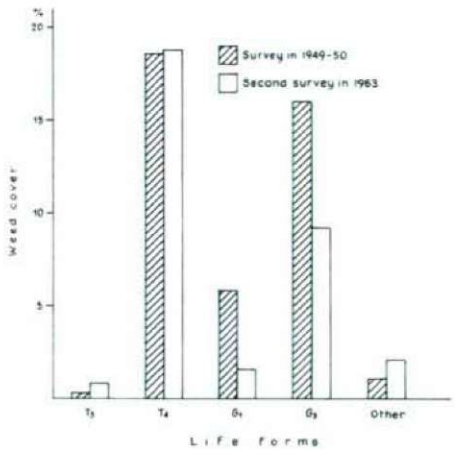

Fig. 2. Effect of large-scale agrotechnology on the cover of the weed groups in maize crops (overall data).

In maizes sprayed for the first time the combined data indicate that Hungazin PK decreased the cover of weeds by about 50% during the complete growing time (Table 2, surveys 1 and 2, and Figs. 3 and 4). In this difference of about 50% in the weed cover of maizes treated with Hungazin, however, it must be remembered that at Enying all of the chemically treated maizes were hoed. At the beginning of

the growing time the difference arising from the hoeing in the average weed cover of these areas (taking into account that the average of several investigation sites is involved) may have been about 0.5—1 %, while at the end of the growing time this difference practically disappeared, since mainly dicotyledonous annuals and geophyte species exhibiting very little or no sensitivity at all to the chemical were weeded out from the crops of the farm, and these soon came up again after the hoeing (see the subsequent paper, and Table 2 and Figs. 3 and 4 there).

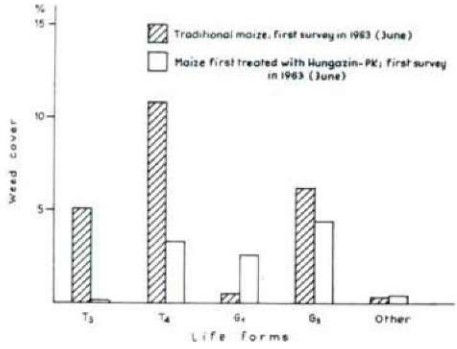

Fig. 3. Effect of Hungazin PK on the weed conditions of maize crops in the first half of the growing period: first-year treatments.

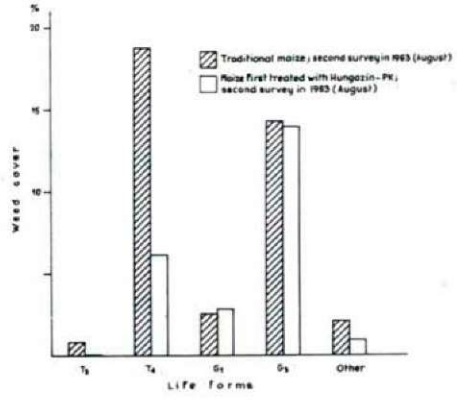

Fig. 4. Effect of Hungazin PK on the weed conditions of maize crops at the end of the growing period: first-year treatments.

It emerges from the data of Table 2 that the Hungazin PK suppressed the spring-sprouting early-summer varieties completely, and the late-summer ones to about one-third during the whole growing time. Of the late-summer varieties, comparatively much *Echninochloa crus-galli* and panic grass *(Setaria)* remained. (This must unconditionally be noted, for this further maintains the contamination of the soils with weed seeds, which may cause a very serious problem in the year of the post-effect. At the same time, the danger remains that as a consequence of selection types of these species more resistant to Hungazin may develop.)

Table 1. More important weed species and % covers in maize crops, based on overall data for examination sites with different treatments

Treatment		Tradi-tional	Traditional		1 yr. Hungazin		2 yr. Hungazin		3 yr. Aminotriazine	
Yeer of survey		1950	1963		1963		1963		1963	
			Surv. I.	Surv. II.	Surv. I.	Surv. II.	Surv. I.	Surv. II.	Surv. I.	Surv. II.
G_1	*Equisetum arvense*	1.58	0.01	1.02			0.64	1.15	3.62	5.47
G_1	*Aristolochia clematitis*	1.00		0.21		0.12				
G_2	*Rubus caesius*	0.72	0.42	1.98	1.47	1.78	1.03	2.74	3.75	6.95
G_3	*Convolvulus arvensis*	10.04	3.89	5.66	1.92	5.21	3.24	9.21	4.35	10.20
T_3	*Sinapis arvensis*	0,13	2.18	0.36	0.07	0.01	0.03	0.01		
T_3	*Raphanus raphanistrum*		2.74	0.18	0.09					
T_4	*Ambrosia elatior*	2.39	1.42	0.91	0.01	0.27	0.05	0.25	0.48	0.94
G_3	*Cirsium arvense*	3.06	1.20	1.08	0.85	1.40	0.53	1.39	0.66	1.13
T_4	*Chenopodium album*	1.83	1.19	3.07	0.25	0.15	0.02	0.01		
T_4	*Amaranthus retroflexus*	0.80	0.62	2.41	0.28	0.31		0.06		
G_1	*Agropyron repens*	0.68	0.11	0.04	2.56	1.70	0.70		0.92	1.00
T_4	*Echinochloa crus-galli*	6.02	3.11	3.09	1.46	3.35	0.21	3.18	1.33	6.50
T_4	*Setaria glauca*	1.55	0.44	1.95	0.20	0.87	0.34	1.21	0.25	1.12
T_4	*Setaria viridis*	1.46	0.52	1.59	0.18	0.71		0.71	0.01	0.09

The weedicide had more difficulty in eliminating the perennials, for the total cover of the varieties wintering in the soil ($G = G_1$, G_2 and G_3) in the first-year treatments agreed with those cultivated by hoeing, or was somewhat larger, throughout the entire growing period. Although as regards the perennials the multiplication of *Convolvulus arvensis* was observed in places, overall its cover did not exceed the value found for the traditionally cultivated crops (Table 1).

b) Development of the weed vegetation in the event of the application of Simazin, Atrazin (Hungazin PK) for several years

Several-year treatments were no encountered at every investigated site. Maize plots sprayed for two years were surveyed at Enying and on the Rózsamajori and Tátomi sub-units of the Kaposvár State Farm. Plots systematically chemically treated for three years were found on the Nagybaráti and Nagykorpádi sub-units of the Lábod State Farm and again at Enying.

Information on the amounts of weedicide applied to the sites investigated is given below:

At Enying the doses applied to the plots treated since 1961 were 5 kg Atrazin in 1961, 1.1 kg Dikonirt in 1962, and again 5 kg Hungazin PK in 1963. Those treated since 1962 received 5 kg Hungazin + 1.1 kg Dikonirt in 1962, and 2.5 kg Hungazin and 1.1 kg Dikonirt in 1963.

On the Lábod State Farm 4.5 and 5 kg Simazin were applied as a basic treatment on 1961 on the Nagybaráti and Nagykorpádi sub-units, respectively, and annually since then 3 kg Hungazin PK.

In the Tátomi sub-unit of the Kaposvár State Farm in 1962 a 4.5 kg Simazin basic treatment was applied, with a 5 kg similar treatment at Rózsamajor; in 1963 a uniform overtreatment of 5 kg Hungazin PK was used at both sites.

The given doses in all cases refer to an area of one cadastral acre (0.57 hectares).

Table 2. Number and % cover of weed species belonging to the individual life forms, as overall averages for the examination sites according to treatments, as found in the surveys for 1950 and 1963

Treatments	Tradnl.		Traditional				1 yr. Hungazin				2 yr. Hungazin				3 yr. Aminotrazine			
Surveys year	1950		1963 I		1963 II		1963 I		1963 II		1963 I		1963 II		1963 I		1963 II	
Species no. (1) % Cover (2)	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
Life forms:																		
Annuals																		
T_1	3	0.18	5	0.04	7	0.57			1	0.01			2	0.02	5	0.02	4	0.02
T_2	5	0.21	10	0.05	7	0.35	3	0.03	1	0.01	2	0.01	2	0.02	4	0.02	4	0.02
T_3	5	0.37	6	5.06	8	0.86	3	0.16	1	0 .01	3	0.03	2	0.02	4	0.02	3	0.02
T_4	30	18.58	34	10.81	46	18.76	16	3.32	17	6.16	16	0.79	23	5.82	15	2.22	19	9.86
Total T	43	19.34	55	15.96	68	20.54	22	3.51	20	6.19	21	0.83	29	5.88	28	2.28	30	9.92
Biennials:	1	0.01																
Perennials:																		
H_3	6	0.25	5	0.24	5	0.27	2	0.03	2	0.16	2	0.02	5	0.35	3	0.05	3	0.38
H_5					5	0.86											1	0.01
Total H	10	0.58	5	0.24	10	1.13	2	0.03	2	0.16	2	0.02	5	0.35	3	0.05	4	0.39
G_1	11	5.85	5	0.49	8	1.57	3	2.57	3	1.83	4	1.52	4	1.73	4	5.65	4	7.51
G_2	2	0.15	1	0.02	1	0.06	1	0.36	1	0.74	1	0.11	1	0.33	1	0.35	1	0.31
G_3	11	16.07	7	6.25	10	9.29	6	4.40	6	8.94	6	4.96	7	13.59	6	9.84	6	19.06
Total G.	24	22.07	14	6.76	19	10.92	10	7.33	10	11.51	11	6.59	12	15.65	11	15.84	11	26.88
Overall totals	78	41.99	74	22.96	97	32.59	34	10.87	32	17.86	34	7.44	46	21.88	42	18.17	45	37.19

I: early June survey
II: August survey

1: species no.
2: % cover

T_1 = early-spring hardy annuals
T_2 = autumn-sprouting early-summer annuals
T_3 = spring-sprouting early-summer annuals
T_4 = late-summer annuals

H_3 = tap-rooted
H_5 = oblique-rooted
G_1 = couch-grasses
G_2 = tuberous
G_3 = rhizome-like roots

If the weed cover of maize crops treated with Hungazin over several years is compared with that for the traditionally cultivated crops, one finds somewhat surprisingly that, with the exception of one case, there is no appreciable difference as regards the overall weed cover. This clearly means that even after chemical treatment for 2—3 years maize plots remain weedy; for example, at the end of the growing period in crops sprayed for 3 years (from 1961) the weed cover was higher (37.16%, Table 2, survey 2) than in the hoed crops (32.59%). However, although there are no essential differences in the overall weed covers, very considerable differences can be observed in the distributions of the weed cover according to life-forms, as can be seen from the data of Table 2 and from Figures 5 and 6.

The situation is clearly the same in connection with the annuals as in the first-year treatments, but here appreciably more *Echninochloa crus-galli* remained.

Surprisingly, the perennials wintering in the soil (G) reacted differently to the several-year treatment. Comparison of the survey data reveals that the geophytes (G_1 and G_3) occupied a substantially larger area in the maizes systematically sprayed with aminotriazine than in theose cultivated traditionally. This multiplication can be observed in the crops treated for 2 years (Table 2), but much more so in the regions treated with Hungazin for 3 years, in which the late-summer survey showed the G life-form (G_1 and G_3 together) to have an average cover of 26.88%; this is more than two and a half times the value found in the hoed maizes (10.92%) (Table 2).

In these regions the multiplication of *Equisetum arvense* brought about a 4—5 times greater amount of the couch-grasses (G_1) compared to the traditional values (Table 1). From the group of the root-like couch-grasses (G_3) *Rubus caesius* and *Convolvulus arvensis* showed up in large amounts. Hungazin PK clearly caused no, or only slight damage in these three weeds. This is understandable, since in the majority of cases these species root extremely deeply, and as a result have difficulty in absorbing the root herbicides which act in the upper layer of the soil. Further, an appropriate weedicide effect could not have developed, for in 1963 at Lábod, and at Kaposvár too, the spring was abnormally dry.

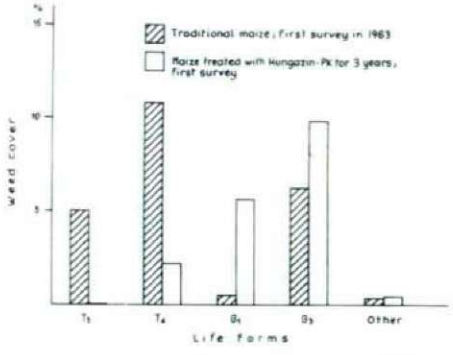

Fig. 5. Effect of 3-year aminotriazine treatment on the distribution of the early-summer weed vegetation in maize plots according to life forms.

Accordingly, although the examination data showed the soils to contain much weedicide, the Hungazin destroyed only the annuals, and of these mainly the very sensitive dicotyledonous ones. Following the destruction of the majority of the

annuals, the conditions temporarily became much more favourable for the deeply-rooted perennials, and to a certain extent for some monocotyledonous late-summer weeds (T_4), including *Echniochloa* and *Setaria* consequently, they gradually took the place of the weed species sensitive to the chemical. In this way the situation arose that in the maizes treated systematically with aminotriazine for several, and particularly 3 years, not only did the overall weed cover not decrease, but it actually increased compared to the state for the traditionally cultivated maizes. Analysis of the weed

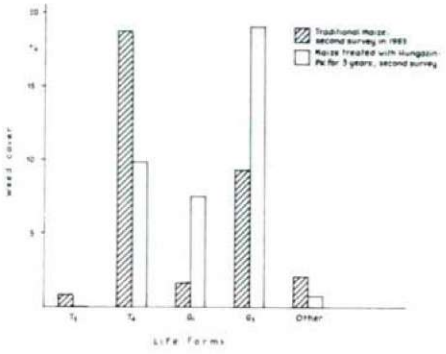

Fig. 6. Effect of 3-year aminotriazine treatment on the distribution of the late-summer weed vegetation in maize plots according to life forms.

cover according to life forms showed that in maizes repeatedly (for 3 years) sprayed with aminotriazine more than two-thirds of the total weed cover (26.88% out of 37.16%) consisted of the most harmful, and most difficult to remove, perennial couch-grasses (G_1) and root-like couch-grasses (G_3); at the same time, the situation is just the reverse in the case of hoeing (cf. Table 2).

As emerged above, therefore, the results of the investigations do not confirm the earlier conceptions of VIRÁG et al. (1962) in connection with this mode of treatment. On the contrary, as a consequence of the one-sided use of Atrazin for a prolonged period the species resistant to this chemical multiply, and the picture which develops on these areas is much less favourable than in the traditionally cultivated plots. Practically simultaneously with the preparation of this manuscript, VIRÁG (1964) also established the multiplication of *Rubus* and *Convolvulus* for such an application of the aminotriazines.

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