CORN GROWTH RESPONSE WITH
TWO NITROGEN CARRIERS AT
TWO PHOSPHORUS LEVELS

By

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CHAPTER I

INTRODUCTION

Proper use of nitrogenous fertilizers is very important in the maintenance and improvement of crop production. Proper fertilization contributes to improved crop quality as well as production quantity.

One of the problems confronting agricultural workers is an ability to determine the kinds and optimum amounts of nitrogenous fertilizer materials required to achieve the most desirable results.

Cultivated Oklahoma soils are generally deficient in organic matter and the problem of available soil nitrogen is directly related to the amount and activity of soil organic matter. Many sources of nitrogenous fertilizers are available for use in correcting this deficiency for crop production. These materials differ in relative efficiency depending on soil and climatic factors.

The objective of this study was to determine growth response of corn plants to nitrogen from two different carriers on Eufaula fine sand in combination with two phosphorus levels.

CHAPTER II

REVIEW OF LITERATURE

Urea and other types of nitrogenous fertilizer are increasing in importance for crop production in America. When nitrogenous fertilizers are applied in any form to the soil, losses are known to occur and with urea forms this loss may be sizeable (7).

The pH reaction of the soil is a factor in nitrogen absorption. Hoagland (3) presented data in 1919 showing that the absorption of several anions, including NO_3^-, was greater from solutions with acid reactions of pH 5.0 to pH 5.5 than from the neutral pH 6.8.

Mevius and Engel (6) reported an increased rate of absorption of NH_4^+ nitrogen by maize from a culture solution that was neutral or slightly alkaline.

Urea is readily soluble in water, and the dissolved urea is hydrolyzed to ammonium carbonate by soil bacteria and enzymes. The rate of hydrolysis apparently varies a great deal between soils and different environmental conditions. The optimum temperature for urea hydrolysis was reported by Van Slyke and Allen

(10) to be about 55 degrees centigrade. Jones (4) reported the hydrolysis of urea to be more rapid at moderate soil moisture conditions than at field capacity. Wahhab, et al. (11) reported the problem of nitrification and loss of urea to be biochemical in nature. The enzyme urease, secreted by *Micrococcus ureae*, hydrolyzed urea to ammonium carbonate which decomposes to give NH_3, CO_2, and H_2O. NH_3 is then oxidized to nitrites and nitrates by *Nitrosomonas* and *Nitrobacter*. Under all conditions they found less urea was nitrified and more time was needed for its nitrification in sandy than in sandy loam soil. Nitrification was favored at lower concentrations of urea, at moisture levels equivalent to one third of the moisture holding capacity, and at neutral to alkaline pH.

Scarsbrook and Cope (8) found both ammonium nitrate and urea to be satisfactory sources of nitrogen for corn provided the acidity produced by the acid forming sources was neutralized. Their experiments showed no evidence of superiority for either the ammonia or nitrate forms of nitrogen for corn provided other factors, such as soil acidity, were not limiting yields. Loomis, et al. (5) found nitrate carriers to be more suitable than ammonium carriers for late season or emergency applications.

App (1) published an article in Crops and Soils stating that ammonia sources of nitrogen produce a much more intense color in many crops. This is readily seen in corn and all leafy vegetables. With spinach, for example, it was found to be very important to use this form of nitrogen because of the better quality, color, and uniformity of leaves.

Several individuals have noticed some toxic effects of urea on seed germination. According to Brage, et al. (2), transformation processes through which urea proceeds in the soil to the final nitrate form are not entirely clear, but they propose that urea hydrolyzes to carbamate and thence to carbonate. Carbamates are used as weed killers so it might be postulated that carbamate could be the troublesome factor.

CHAPTER III

MATERIALS AND METHODS

Two nitrogen carriers, urea and ammonium nitrate, were applied at five levels and phosphorus at two levels on a Eufaula fine sand. Corn was the experimental plant used.

The experiment consisted of five nitrogen treatments:

N_1	(check) 0 parts per million (ppm)
N_2	100 ppm nitrogen
N_3	200 ppm nitrogen
N_4	300 ppm nitrogen
N_5	400 ppm nitrogen

With these levels of nitrogen, two levels of phosphorus were used, 0 (P_1) and 100 ppm (P_2). The phosphorus was supplied by monocalcium phosphorus, $Ca(H_2PO_4)2.H_20$ with 24.57% P.

The pots used for growing the corn plants contained 400 grams of soil. The hybrid corn variety, Texas 31, was used for the experiment. Ten seeds were planted to each pot and they were thinned to five plants per pot after emergence of the seedlings. The study was conducted under both laboratory and greenhouse conditions using artificial and normal light, respectively. Distilled water was used to keep the soil moist at all times.

The corn plants were harvested when the lower leaves of the plants in the check treatment (0 ppm nitrogen) showed nitrogen deficiency symptoms and began to dry and curl. The corn plants were cut one inch above the soil line to allow for regrowth. A razor blade was used to remove the plants in effort to reduce injury to the stem cells. The plant material was then oven dried and weighed to determine the dry matter from each pot and treatment.

The first harvest in experiment one was made eleven days following planting in the laboratory. The experiment was then moved to the greenhouse and was harvested a second time twenty-six days after replanting. The plants were harvested nineteen days after planting in experiments two and three. The first harvest in experiment two was also conducted in the laboratory. This experiment two also was moved to the greenhouse and the second harvest came twenty-seven days after replanting and in three the second harvest came seventeen days following the first harvest.

Statistical analysis of the data was conducted according to Snedecor (9).

CHAPTER IV

RESULTS AND DISCUSSION

Statistical analysis of the data showed no significant yield difference among the different treatments for the first harvest. This would indicate that there is no real difference in the effect of the nitrogen on corn growth from either of the carriers, urea or ammonium nitrate. There was, however, a significant difference among treatments from the second harvest of experiment two. This difference could have resulted from the extreme variation in temperature which varied from a minimum of 68 F degrees to a maximum of 126 F degrees. The temperature variation for the second harvest in experiment one, and three ranged from a low of 72 F degrees to high of 124 F degrees (Table IV).

Yield results for the various experiments can be observed in Tables I, II, and III for both harvests at all treatment levels. It should be noted that in experiment one and two, the pots were in the laboratory up to the time of the first harvest. The experiments were moved to the greenhouse and replanted for the second harvest. Yields in experiments one and two were greater for the second harvests. Probably as a re sult of increased photosynthetic activity caused by more sunlight.

Experiment three was conducted entirely in the greenhouse without a subsequent yield increase in the second harvest. This may have been the result of sunlight being adequate through the period of growth prior to the first harvest and also because the second harvest was taken from plant regrowth.

In experiment two there was more yield when 100 ppm nitrogen was used for both carriers but the yield was greater when ammonium nitrate was the carrier. The yield of dry matter was decreased at the higher nitrogen levels. Using phosphorus at 100 ppm and no nitrogen produced more yield than check. Phosphorus at 100 ppm increased yields with urea up to 300 ppm N and with ammonium nitrate only at the 100 ppm N level. Higher rates of ammonium nitrate with phosphorus depressed yields.

TABLE I

EXPERIMENT ONE

AVERAGE WEIGHT OF PLANT MATERIAL GIVEN IN GRAMS PER POT OF OVEN DRY MATTER FOR EACH TREATMENT.

Nitrogen and Phosphorus Level	First Harvest (Laboratory)		Second Harvest (Greenhouse)	
	Source of Nitrogen		Source of Nitrogen	
	Urea	Ammonium Nitrate	Urea	Ammonium Nitrate
N_1P_1	0.277	0.277	1.473	1.473
N_2P_1	0.323	0.390	1.670	1.800
N_3P_1	0.363	0.373	2.063	1.890
N_4P_1	0.303	0.373	2.136	1.886
N_1P_2	0.346	0.346	1.640	1.640
N_2P_2	0.386	0.356	1.890	1.763
N_3P_2	0.360	0.363	2.063	2.136
N_4P_2	0.300	0.373	2.006	1.873

TABLE II

EXPERIMENT TWO

AVERAGE WEIGHT OF PLANT MATERIAL GIVEN IN GRAMS PER POT OF OVEN DRY MATTER FOR EACH TREATMENT.

Nitrogen and Phosphorus Level	First Harvest (Laboratory) Source of Nitrogen		Second Harvest (Greenhouse) Source of Nitrogen	
	Urea	Ammonium Nitrate	Urea	Ammonium Nitrate
N_1P_1	0.413	0.413	1.926	1.926
N_2P_1	0.443	0.506	1.910	1.613
N_3P_1	0.406	0.406	1.773	1.813
N_4P_1	0.366	0.380	1.916	1.740
N_5P_1	0.246	0.370	2.040	1.726
N_1P_2	0.533	0.533	1.700	1.700
N_2P_2	0.466	0.546	1.873	2.026
N_3P_2	0.446	0.446	1.906	1.976
N_4P_2	0.436	0.440	1.823	1.900
N_5P_2	0.206	0.373	1.883	1.880

TABLE III

EXPERIMENT THREE

AVERAGE WEIGHT OF PLANT MATERIAL GIVEN IN GRAMS PER POT OF OVEN DRY MATTER FOR EACH TREATMENT.

Nitrogen and Phosphorus Level	First Harvest (Laboratory) Source of Nitrogen		Second Harvest (Greenhouse) Source of Nitrogen	
	Urea	Ammonium Nitrate	Urea	Ammonium Nitrate
N_1P_1	0.813	0.813	0.910	0.910
N_2P_1	1.026	1.263	0.943	1.000
N_3P_1	1.170	1.046	1.083	0.916
N_4P_1	1.026	1.096	1.030	1.003
N_5P_1	0.986	0.933	1.083	0.913
N_1P_2	1.063	1.063	1.136	1.136
N_2P_2	1.190	1.143	1.193	1.166
N_3P_2	1.193	1.123	1.210	1.370
N_4P_2	1.266	0.853	1.186	1.283
N_5P_2	1.130	0.613	1.230	1.203

TABLE IV

TEMPERATURES IN F DEGREES OF BOTH HARVESTS OF THREE EXPERIMENTS.

	Min.	Max.	Min. Ave.	Max. Ave.	Extrem Variation	Average Variation
Experiment one.						
Ist. harvest	78	92	83.1	90	14	6.9
2nd. harvest	72	124	83.6	101.8	52	18.2
Experiment two.						
Ist. harvest	80	98	87.1	90.8	18	3.7
2nd. harvest	68	126	75.7	111.4	58	35.7
Experiment three.						
Ist. harvest	62	112	70.3	105.5	50	35.2
2nd. harvest	72	124	76.5	116.2	52	39.7

Note. The experiments were conducted during May 26 until July 19, 1966.

CHAPTER V

SUMMARY AND CONCLUSIONS

Corn seedlings were grown in small pots filled with 400 grams soil of the Eufaula sand series in both the laboratory under artificial light and in the greenhouse under natural sunlight. The pots were treated with nitrogen using two carriers, urea and ammonium nitrate at five levels and in combination with phosphorus at two levels.

In the first harvest ammonium nitrate produced more plant growth than did urea. There was a further increase in yield by the addition of 100 ppm of phosphorus to the pots.

Yields were greater in the greenhouse than in the laboratory. This was probably due to increased photosynthetic activity produced by the increased intensity of light.

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APPENDIX

TABLE V

TOTAL DRY PLANT MATERIAL OF EXPERIMENT ONE. WEIGHT IN GRAMS FOR BOTH HARVESTS FROM EUFAULA FINE SAND.

Carriers	Nitrogen levels					
	0 ppm	100 ppm	200 ppm	300 ppm		$\overline{X}$
Urea	5.25	5.98	7.28	7.32	25.83	6.4575
Ammonium nitr.	5.25	6.57	6.79	6.78	25.39	6.3475
Urea + P	5.96	6.83	7.27	6.92	26.98	6.7450
Amm. nitr. + P	5.96	6.36	7.50	6.74	26.56	6.6400
	22.42	25.74	28.84	27.76	104.76	
$\overline{X}$	5.605	6.435	7.210	6.940		6.5475

TABLE VI

TOTAL DRY PLANT MATERIAL OF EXPERIMENT TWO.
WEIGHT IN GRAMS FOR BOTH HARVESTS
FROM EUFAULA FINE SAND.

Carriers	Nitrogen Levels						
	0 ppm	100 ppm	200 ppm	300 ppm	400 ppm		$\bar{X}$
Urea	7.02	7.06	6.54	6.85	6.86	34.33	6.866
Ammonium nitr.	7.02	6.36	6.66	6.36	6.29	32.69	6.538
Urea + P	6.70	7.02	7.06	6.78	6.27	33.83	6.766
Amm. nitr. + P.	6.70	7.72	7.27	7.02	6.76	35.47	7.094
	27.44	28.16	27.53	27.01	26.18	136.32	
$\bar{X}$	6.86	7.04	6.882	6.752	6.545		6.816

TABLE VII

TOTAL DRY PLANT MATERIAL OF EXPERIMENT THREE.
WEIGHT IN GRAMS FOR BOTH HARVESTS
FROM EUFAULA FINE SAND.

Carriers	Nitrogen levels						
	0 ppm	100 ppm	200 ppm	300 ppm	400 ppm		$\bar{X}$
Urea	5.17	5.91	6.76	6.17	6.21	30.22	6.044
Ammonium nitr.	5.17	6.79	5.89	6.30	5.54	29.69	5.938
Urea + P	6.60	7.15	7.21	7.36	7.08	35.40	7.080
Amm. nitr. + P	6.60	6.93	7.48	6.41	5.45	32.87	6.574
	23.54	26.78	27.34	26.24	24.28	128.18	
$\bar{X}$	5.885	6.695	6.835	6.560	6.070		6.409

TABLE VIII

OVEN DRY CORN PLANT MATERIAL WEIGHTS IN GRAMS FROM EUFAULA FINE SAND, FIRST HARVEST OF EXPERIMENT ONE.

Number	Treat-ment	Carrier	Replications I	II	III		$\bar{X}$ 1/
1	N_1P_1	Check	0.24	0.30	0.25	0.83	0.277
2	N_2P_1	Urea	0.31	0.32	0.34	0.97	0.323
3	N_3P_1	Urea	0.42	0.33	0.34	1.09	0.363
4	N_4P_1	Urea	0.32	0.31	0.28	0.91	0.303
5	N_2P_1	Amm. nitr.	0.41	0.39	0.37	1.17	0.390
6	N_3P_1	Amm. nitr.	0.35	0.38	0.39	1.12	0.373
7	N_4P_1	Amm. nitr.	0.36	0.36	0.40	1.12	0.373
8	N_1P_2	P	0.34	0.38	0.32	1.04	0.346
9	N_2P_2	Urea + P	0.37	0.39	0.40	1.16	0.386
10	N_3P_2	Urea + P	0.36	0.37	0.35	1.08	0.360
11	N_4P_2	Urea + P	0.31	0.36	0.23	0.90	0.300
12	N_2P_2	Amm. nitr. + P	0.34	0.37	0.36	1.07	0.356
13	N_3P_2	Amm. nitr. + P	0.33	0.39	0.37	1.09	0.363
14	N_4P_2	Amm. nitr. + P	0.36	0.38	0.38	1.12	0.373
			4.86	5.03	4.78	14.67	0.349

1/ Not significantly different.

P = $Ca(H_2PO_4)2.H_20$, 24.57% P.

Urea = 45% N; Amm. nitr. = NH_4NO_3, 33.5% N.

TABLE IX

OVEN DRY CORN PLANT MATERIAL WEIGHTS IN GRAMS FROM EUFAULA FINE SAND, FIRST HARVEST OF EXPERIMENT TWO.

Number	Treat-ment	Carrier	Replications I	II	III		$\overline{X}$ 1/
1	N_1P_1	Check	0.44	0.36	0.44	1.24	0.413
2	N_2P_1	Urea	0.53	0.40	0.40	1.33	0.443
3	N_3P_1	Urea	0.50	0.42	0.30	1.22	0.406
4	N_4P_1	Urea	0.35	0.35	0.40	1.10	0.366
5	N_5P_1	Urea	0.38	0.20	0.16	0.74	0.246
6	N_2P_1	Amm. nitr.	0.50	0.52	0.50	1.52	0.[illegible]06
7	N_3P_1	Amm. nitr.	0.37	0.40	0.45	1.22	0.406
8	N_4P_1	Amm. nitr.	0.35	0.40	0.39	1.14	0.380
9	N_5P_1	Amm. nitr.	0.32	0.40	0.39	1.11	0.370
10	N_1P_2	P	0.60	0.50	0.50	1.60	0.533
11	N_2P_2	Urea + P	0.50	0.40	0.50	1.40	0.466
12	N_3P_2	Urea + P	0.44	0.48	0.42	1.32	0.446
13	N_4P_2	Urea + P	0.46	0.45	0.40	1.31	0.436
14	N_5P_2	Urea + P	0.27	0.20	o.15	0.62	0.206
15	N_2P_2	Amm. nitr. + P	0.58	0.51	0.55	1.64	0.546
16	N_3P_2	Amm. nitr. + P	0.41	0.48	0.45	1.34	0.446
17	N_4P_2	Amm. nitr. + P	0.47	0.44	0.41	1.32	0.440
18	N_5P_2	Amm. nitr. + P	0.40	0.30	0.42	1.12	0.373
			7.87	7.21	7.23	22.31	0.413

1/ Not significantly different.

TABLE X

OVEN DRY CORN PLANT MATERIAL WEIGHTS IN GRAMS FROM EUFAULA FINE SAND, FIRST HARVEST OF EXPERIMENT THREE

Number	Treat-ment	Carrier	Replications I	II	III		$\overline{X}$ 1/
1	N_1P_1	Check	0.86	0.80	0.78	2.44	0.813
2	N_2P_1	Urea	1.28	0.90	0.90	3.08	1.026
3	N_3P_1	Urea	1.18	1.32	1.01	3.51	1.170
4	N_4P_1	Urea	1.22	0.80	1.06	3.08	1.026
5	N_5P_1	Urea	1.04	0.80	1.12	2.96	0.986
6	N_2P_1	Amm. nitr.	1.32	1.22	1.25	3.79	1.263
7	N_3P_1	Amm. nitr.	1.04	1.02	1.08	3.14	1.046
8	N_4P_1	Amm. nitr.	0.93	1.20	1.16	3.29	1.096
9	N_5P_1	Amm. nitr.	1.03	0.77	1.00	2.80	0.933
10	N_1P_2	P	0.97	1.12	1.10	3.19	1.063
11	N_2P_2	Urea + P	1.10	1.23	1.24	3.57	1.190
12	N_3P_2	Urea + P	1.10	1.38	1.10	3.58	1.193
13	N_4P_2	Urea + P	1.30	1.20	1.30	3.80	1.266
14	N_5P_2	Urea + P	1.20	0.98	1.21	3.39	1.130
15	N_2P_2	Amm. nitr. + P	1.16	1.22	1.05	3.43	1.143
16	N_3P_2	Amm. nitr. + P	1.10	1.20	1.07	3.37	1.123
17	N_4P_2	Amm. nitr. + P	0.81	0.90	0.85	2.56	0.853
18	N_5P_2	Amm. nitr. + P	0.72	0.50	0.62	1.84	0.613
			19.36	18.56	18.90	56.82	1.052

1/ Not significantly different.

TABLE XI

OVEN DRY CORN PLANT MATERIAL WEIGHTS IN GRAMS FROM EUFAULA FINE SAND, SECOND HARVEST OF EXPERIMENT ONE

Number	Treat-ment	Carrier	Replications I	II	III		$\overline{X}$ 1/
1	N_1P_1	Check	1.30	1.50	1.62	4.42	1.473
2	N_2P_1	Urea	1.77	1.60	1.64	5.01	1.670
3	N_3P_1	Urea	2.18	1.84	2.17	6.19	2.063
4	N_4P_1	Urea	1.96	2.37	2.08	6.41	2.136
5	N_2P_1	Amm. nitr.	1.87	1.63	1.90	5.40	1.800
6	N_3P_1	Amm. nitr.	1.77	2.10	1.80	5.67	1.890
7	N_4P_1	Amm. nitr.	1.74	2.02	1.90	5.66	1.886
8	N_1P_2	P	1.57	1.84	1.51	4.92	1.640
9	N_2P_2	Urea + P	1.83	1.97	1.87	5.67	1.890
10	N_3P_2	Urea + P	1.98	2.10	2.11	6.19	2.063
11	$N\ P_2$	Urea + P	1.70	2.37	1.95	6.02	2.006
12	N_2P_2	Amm. nitr. + P	1.62	1.72	1.95	5.29	1.763
13	N_3P_2	Amm. nitr. + P	2.21	2.20	2.00	6.41	2.136
14	N_4P_2	Amm. nitr. + P	1.78	1.84	2.00	5.62	1.873
			25.28	27.10	26.50	78.88	1.878

1/ Not significantly different.

TABLE XII

OVEN DRY CORN PLANT MATERIAL WEIGHTS IN GRAMS FROM EUFAULA FINE SAND, SECOND HARVEST OF EXPERIMENT TWO.

Number	Treat-ment	Carrier	Replications I	II	III		$\bar{X}$ 1/
1	N_1P_1	Check	1.60	1.97	2.21	5.78	1.926
2	N_2P_1	Urea	2.15	1.80	1.78	5.73	1.910
3	N_3P_1	Urea	1.56	1.86	1.90	5.32	1.773
4	N_4P_1	Urea	1.81	2.17	1.77	5.75	1.916
5	N_5P_1	Urea	1.68	2.18	2.26	6.12	2.040
6	N_2P_1	Amm. nitr.	1.53	1.51	1.80	4.84	1.613
7	N_3P_1	Amm. nitr.	1.60	2.21	1.63	5.44	1.813
8	N_4P_1	Amm. nitr.	1.80	2.05	1.37	5.22	1.740
9	N_5P_1	Amm. nitr.	1.70	1.81	1.67	5.18	1.726
10	N_1P_2	P	1.90	1.32	1.88	5.10	1.700
11	N_2P_2	Urea + P	1.85	2.10	1.67	5.62	1.873
12	N_3P_2	Urea + P	1.75	2.07	1.90	5.72	1.906
13	N_4P_2	Urea + P	1.62	2.02	1.83	5.47	1.823
14	N_5P_2	Urea + P	1.80	2.00	1.85	5.65	1.883
15	N_2P_2	Amm. nitr. + P	1.98	2.14	1.96	6.08	2.026
16	N_3P_2	Amm. nitr. + P	1.62	2.28	2.03	5.93	1.976
17	N_4P_2	Amm. nitr. + P	1.70	1.84	2.16	5.70	1.900
18	N_5P_2	Amm. nitr. + P	2.00	1.50	2.14	5.64	1.880
			31.65	34.84	33.81	100.29	1.857

1/ Significantly different at 1% level.

TABLE XIII

OVEN DRY CORN PLANT MATERIAL WEIGHTS IN GRAMS FROM EUFAULA FINE SAND, SECOND HARVEST OF EXPERIMENT THREE.

Number	Treat-ment	Carrier	Replications I	II	III		$\overline{X}$ 1/
1	N_1P_1	Check	0.85	0.88	1.00	2.73	0.910
2	N_2P_1	Urea	1.00	0.93	0.90	2.83	0.943
3	N_3P_1	Urea	1.00	1.20	1.05	3.25	1.083
4	N_4P_1	Urea	1.07	1.02	1.00	3.09	1.030
5	N_5P_1	Urea	1.00	1.10	1.15	3.25	1.083
6	N_2P_1	Amm. nitr.	1.08	1.00	0.92	3.00	1.000
7	N_3P_1	Amm. nitr.	0.80	1.04	0.91	2.75	0.916
8	N_4P_1	Amm. nitr.	0.97	1.04	1.00	3.01	1.003
9	N_5P_1	Amm. nitr.	0.98	0.90	0.86	2.74	0.913
10	N_1P_2	P	1.10	1.16	1.15	3.41	1.136
11	N_2P_2	Urea + P	1.00	1.30	1.28	3.58	1.193
12	N_3P_2	Urea + P	1.03	1.40	1.20	3.63	1.210
13	N_4P_2	Urea + P	1.28	1.15	1.13	3.56	1.186
14	N_5P_2	Urea + P	1.16	1.13	1.40	3.69	1.230
15	N_2P_2	Amm. nitr. + P	1.04	1.15	1.31	3.50	1.166
16	N_3P_2	Amm. nitr. + P	1.10	1.23	1.78	4.11	1.370
17	N_4P_2	Amm. nitr. + P	1.18	1.40	1.27	3.85	1.283
18	N_5P_2	Amm. nitr. + P	1.20	1.11	1.30	3.61	1.203
			18.84	20.14	20.61	59.59	1.103

1/ Not significantly different.

VITA

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