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Photosynthetic Activity The Yield And Biomass Of Maize Depending On Mineral Nutrition

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ABSTRACT

The article presents the results of studies of the effect of non-root treatment with micronutrients at different levels of mineral nutrition on photosynthetic activity and yield of maize. Preparations of trace elements stimulated the increase in the photosynthetic surface of the maize plant. In the phase of "panicle formation – cob flowering", the increase in the leaf surface from the use of preparations with trace elements against different backgrounds of mineral nutrition amounted to 9.4...11.3 % (2.4...3.0 thousand m²/ha) in comparison with options without treatment. The largest leaf surface to the harvesting period was preserved by plants with foliar treatment by EcoFus, at different levels of mineral nutrition it exceeded the control variant by 16.4 ... 19.2% or 3.9 ... 5.2 thousand m² / ha. Against the unfertilized background, the preparations with trace elements allowed to increase the amount of photosynthetic potential by 6.9...18.3 %. The greatest potential was formed with foliar processing of maize crops by EcoFus and Gumostim. Against the background of nitrogen-phosphorus fertilizers, the best result was obtained with foliar treatment by EkoFus – 2336 thousand m²/ha×days. Against the background of N120P90K60, the value of photosynthetic potential from foliar treatment with trace elements exceeded the control by 2.1 ... 17.0%. The maximum effect obtained from the use of Siliplant universal and EkoFus. The highest yield was obtained in foliar processing of plants by Cytovit, Humate+7B, and EkoFus – an increase of green mass amounted to 3.9...of 8.8 t/ha, that of dry matter – 0.95...2.7 t/ha in comparison to the control, depending on the level of soil fertility.

Keywords: maize, mineral fertilizers, trace element, leaf area, photosynthesis, yield.

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INTRODUCTION

The cultivation of corn is of great agrotechnical importance, especially its value as a fodder crop. Expansion and introduction of maize crops are dictated by the need to strengthen the fodder base in every way. Corn as a fodder crop is characterised by high yield and excellent forage advantages. However, the violation of elementary methods of cultivation of corn, in particular, the insufficient use of mineral fertilizers, results in low yields of green mass [1-5].

One of the conditions for obtaining high and stable maize yields is the improvement and introduction of a system of fertilizers with the use of trace elements [6-8]. The main elements of mineral nutrition - nitrogen, phosphorus, potassium - regulate the growth of the vegetative mass and determine the magnitude and quality of the crop, activate the growth of the root system. Microelements are required for plants in small quantities, but they have high biological activity, accelerate the passage of developmental phases, stimulate physiological processes, accelerate maturation, improve product quality and yield [9-10]. The yield level is determined by two main indicators - the total leaf area and the intensity of photosynthetic processes per leaf surface unit. At the same time, the increase in plant biomass is more closely correlated with the leaf area than with the intensity of their work [11-12].

The aim of the research was to determine the effect of foliar treatment with preparations with trace elements on the parameters of photosynthetic activity and the yield of maize at various levels of mineral nutrition.

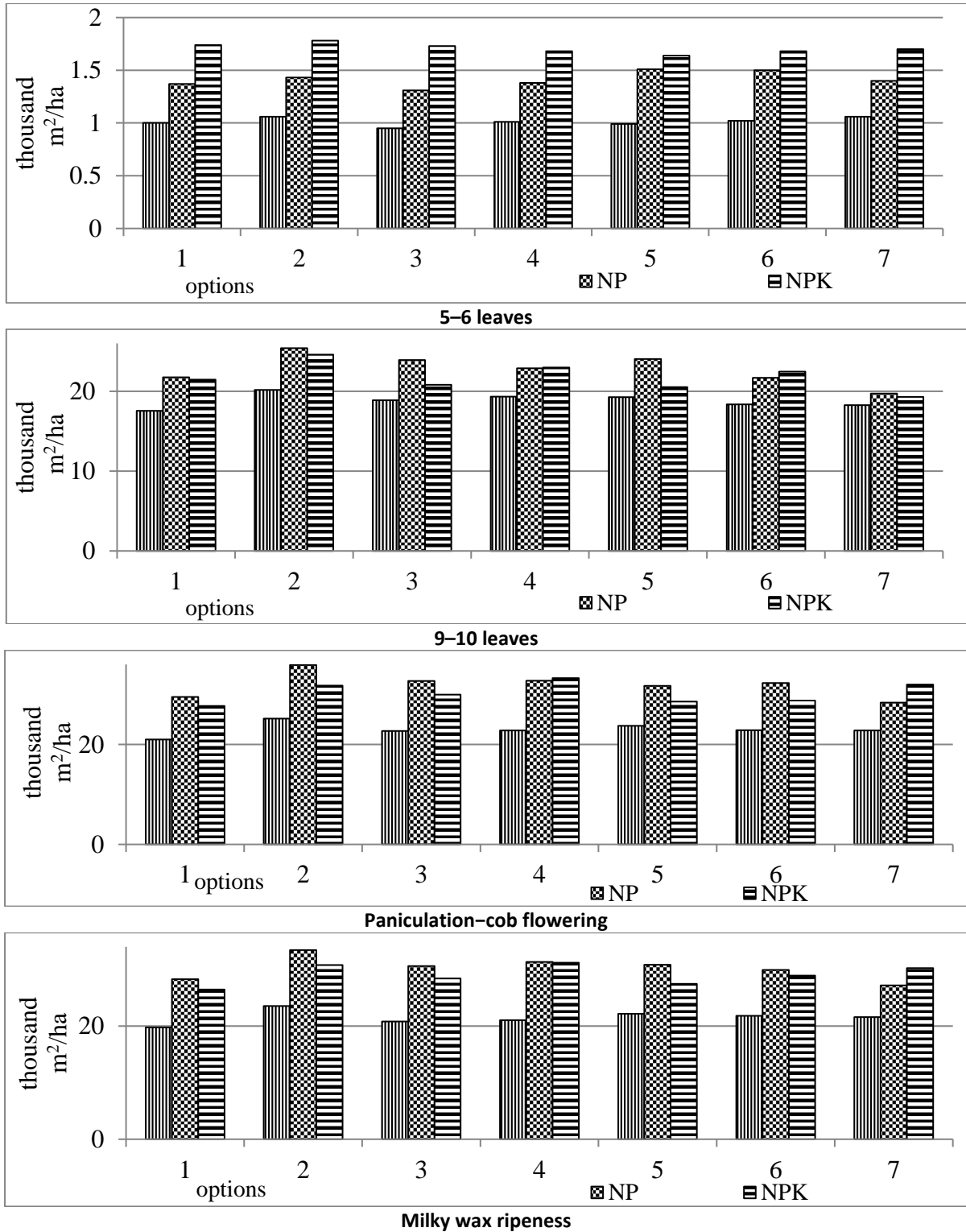
OBJECTS AND METHODS OF RESEARCH

The research was conducted in 2016-2017 on leached medium-thick black soil with an increased content of nitrogen, phosphorus and potassium; the reaction of the soil solution is weakly acidic. The field experiment was carried out in accordance with the standard methods [13-14] in fourfold repetition by the method of split plots according to the scheme: factor A - fertilizer rate (1 - NОPOK0; 2 - N120P90; 3 - N120P90K60); factor B - non-root treatment of plants with preparations with microelements in the phase of 6-7 leaves of maize: 1 - control (treatment with water); 2 - EcoFus (2.5 l / ha); 3 - Green Go (1.5 kg / ha); 4 - Siliplant universal (1,0 l / ha); 5 - Gumostim (0.3 l / ha); 6 - Cytovit (0.5 l / ha); 7 - Humate + 7 (0.5 l / ha). Organomineral fertilizers with trace elements (EcoFus, Gustavim, Gumat + 7) and water-soluble complex fertilizers with trace elements in chelate form (Green Go, Siliplant, Cytovit) were dissolved in water (at a rate of 200 l / ha). The area of the plots of the first order was 196 m², of the second order - 28 m². The object of research was early ripening hybrid of corn ROSS 199 MV (FAO 190). The sowing was carried out with a row spacing of 70 cm. Plant stand (80 thousand / ha) was formed in the phase of full shoots. The predecessor was winter wheat on a clear fallow. Mineral fertilizers (ammonium nitrate, nitroammophos, potassium chloride) were introduced before the first pre-sowing cultivation. The weather conditions of the growing season during the research years varied, but were quite favorable for the growth and development of corn.

RESULTS AND DISCUSSION

A great role in creating optimal parameters for sowing is due to the density of standing and fertilization. The role of these important agrotechnical factors in the formation of plant parameters and planting is not the same under different agroecological conditions [15, 17]. For the accumulation of the general harvest, the dimensions of the leaf area, the net productivity of photosynthesis are of great importance. The leaf area is one of the most important indicators characterizing the state of crops. In connection with this, we studied the dynamics of the formation of the leaf area of corn sowing, depending on the studied agrotechnical factors.

It was established that the introduction of mineral fertilizers improves the supply of plants with mineral nutrition and intensifies the growth of the leaf area (Figure 1). The measurements showed that in 2016, on average, maize plants formed a leaf surface of 12.4 ... 18.0 thousand m² / ha against different backgrounds of mineral nutrition during the vegetative period, while the leaf surface area increased with the improvement of root nutrition conditions of plants. The average area of the assimilating surface of plants in 2017 was 16.0 ... 21.6 thousand m² / ha, but the use of a full mineral fertilizer led to a slight decrease in the total leaf surface of the crop.



Picture 1. The effect of fertilizers on the area of the leaf surface of maize crops, average for 2016-2017
Note. Factor B – complex fertilizers: 1 – no fertilizers; 2 – EcoFus; 3 – Green Go; 4 – Siliplant Universal; 5 – Gumostim; 6 – Cytovit; 7 – Humate+7.

During the years of research, the leaf area reached its maximum size in the phase of "panicle – cob flowering". The calculations carried out in 2016 in this phase showed that mineral fertilizers at a dose of N120P90 increased the photosynthetic surface of the leaves by 38.5% or 6.8 thousand m² / ha, and the total mineral fertilizer by 7.7 thousand m² / ha or 44.0%. In 2017, a slightly different trend was noted. Against the background of nitrogen-phosphorus nutrition, the increase was greater, the area of the assimilating surface increased by 42.4% or 10.3 thousand m² / ha in comparison with the level of natural soil fertility, and when

using fertilizers in the norm of N120P90K60, the growth of the leaf surface was less - 5,7 thousand m² / ha or 23,5%. The observations showed that on average during the two years of research in the phase of five leaves of maize, against the background of N120P90, the plants formed a photosynthetic surface area exceeding the level of natural soil fertility by 0.37 thousand m² / ha or 36.5%. With the introduction of full mineral nutrition, the increase was 0.74 thousand m² / ha. It should be noted that differences in the area of the assimilating surface were gradually smoothed out as physiological changes, and in the subsequent phases of corn growth and development, the best results were obtained against a background of nitrogen-phosphorus fertilizers.

Preparations with trace elements stimulated an increase in the photosynthetic surface of maize plants (Figure 1). Even in the phase of 9-10 leaves, differences appeared in the options with trace elements. On average, in 2016 ... 2017 the largest leaf surface was cultivated with EcoFus foliar treatment. In the phase of "panicle formation – cob flowering", an increase in the leaf surface from the use of drugs with trace elements on various backgrounds of mineral nutrition was 9.4 ... 11.3% (2.4 ... 3.0 thousand m² / ha) in comparison with the options without preparations.

By the time of harvest, the area of the leaves naturally decreased due to the drying of the leaves of the lower tier, and the largest assimilating surface was retained by plants with EcoFus foliar treatment: at different levels of mineral nutrition it exceeded the control variant by 16.4 ... 19.2% or 3.9 ... 5.2 thousand m² / ha. Against the background of natural soil fertility, Gumostim, Tsitovit and Humate + 7 promoted a significant increase in the leaf area by 12.3, 10.5 and 9.4%, respectively, in comparison with the untreated variant. The action of Green Go, and Siliplant Universal was approximately equal - the increase was 5.5 and 6.6%. When N120P90 was added, the formation of the leaf surface was most affected by the treatment of Siliplant universal, Gumostim and Green Go, which contributed to the growth of the assimilation apparatus by 10.9, 9.0 and 8.3%, respectively. The greatest effect against the background of N120P90K60 was obtained with foliar treatment with Siliplant universal, Humate + 7 and Tsitovit. The increase was 18.1, 14.4 and 9.4%, respectively, compared to the variant treated with water.

90 ... 95% of the dry mass of plants consist of organic compounds, the source of formation of which is photosynthesis - a process which not only the quantity but also the quality of the crop depends on. An important factor in the formation of high yield is the optimal level of photosynthetic potential (PP). This is provided by the duration of the functioning of the leaves and the total area of the leaf surface [16]. The agrotechnical methods had a different effect on the PP of maize crops. On average, during the two years of research, the improvement of soil fertility allowed to increase the PP of crops using nitrogen-phosphorus fertilizers and full mineral nutrition by 38.7 and 46.0% respectively (Table). Against an unfertilized background, the preparations with trace elements allowed to increase the value of PP by 6.9 ... 18.3%, and the greatest potential was formed with foliar treatment of maize crops with EcoFus and Gumostim. Against the background of nitrogen-phosphorus fertilizers, the best result was obtained with foliar treatment with EcoFus - 2336 thousand m² / ha × day. The formation of the PP under the action of Green Go, Siliplant Universal and Gumostim was approximately equal, the increase was 8.7 ... 9.6% or 170 ... 188 thousand m² / ha × day in comparison with the untreated option. Against the background of N120P90K60, the amount of PP from foliar treatment with drugs with trace elements exceeded the option without the use of trace element preparations by 2.1 ... 17.0%. The maximum effect was obtained from the use of the Siliplant Universal and EcoFus (Table).

The net productivity of photosynthesis (NPP), like the photosynthetic potential of crops and the average leaf area is in closest connection with the yield of maize. As a result of the studies, a significant influence of agrotechnical and agrometeorological factors on the value of NPP of maize crops was revealed. It was revealed that maize crops were most productive in 2016, with a favorable combination of hydrothermal conditions of vegetation. A greater efficiency was noted against the background of nitrogen-phosphorus fertilizer application, where the net productivity of photosynthesis was 11.5 g / m² × day on average. In the variant without fertilizers and improving the conditions of root nutrition due to N120P90K60, the efficiency of photosynthetic activity decreased by 6.5 and 10.1%, respectively.

Table: Photosynthetic activity of maize depending on the methods of agrotechnics, average for 2016-2017

Fertilizer norm	Foliar treatment	PP, thousand m ² /ha · day	NPP, g/m ² ·da.
NOPOKO	Control (water treatment)	1426	8,17
	EcoFus	1687	7,37
	Green Go	1524	7,96
	Siliplant Universal	1541	7,70
	Gumostim	1595	7,98
	Cytovit	1542	9,16
	Humate+7	1536	8,99
N120P90	Control (water treatment)	1957	8,57
	EcoFus	2336	7,19
	Green Go	2145	8,28
	Siliplant Universal	2140	7,29
	Gumostim	2127	8,49
	Cytovit	2074	8,80
	Humate+7	1857	9,49
N120P90K60	Control (water treatment)	1850	8,43
	EcoFus	2144	8,42
	Green Go	1965	9,02
	Siliplant Universal	2164	8,03
	Gumostim	1889	8,80
	Cytovit	1969	9,20
	Humate+7	2033	8,58

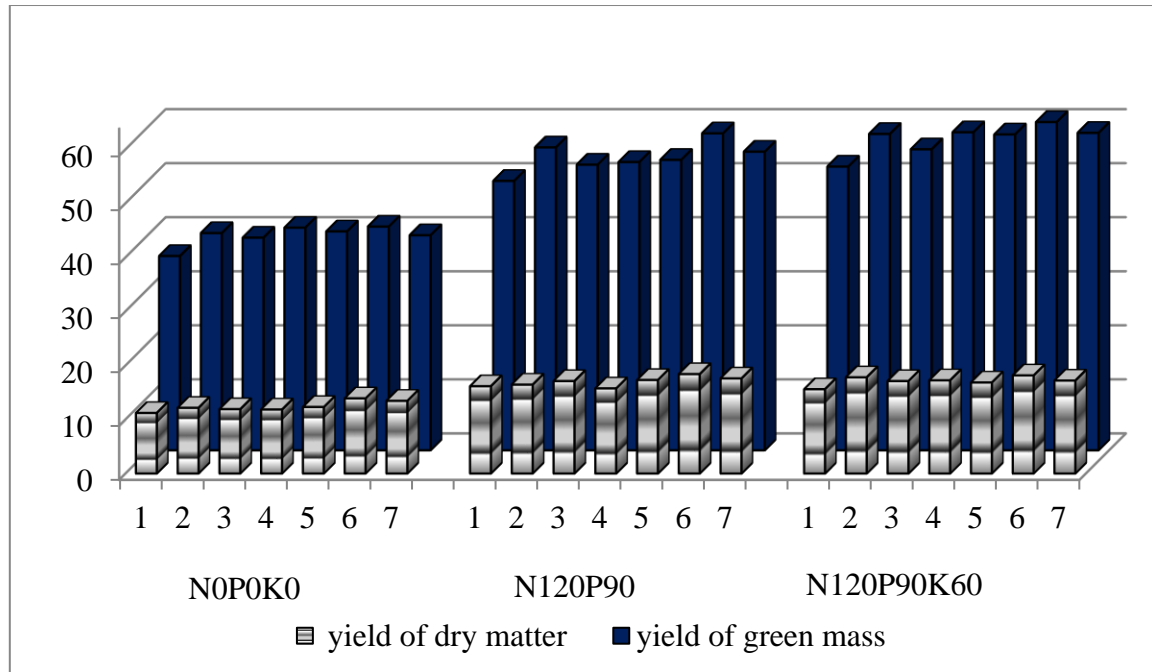
In conditions of 2017, with good moistening and moderately low temperatures in the first half of the vegetation period, the established NPP values were 1.6 ... 2.1 times less in comparison with the previous year. Leaves "worked" more productive with the addition of fertilizers with potassium, NPP exceeded the parameters of options without fertilizers and using nitrogen-phosphorus fertilizers by 0.85 and 0.8 g / m² × day, respectively.

On average in 2016-2017 the maximum accumulation of dry matter in the process of photosynthetic activity against the background of natural fertility was noted during foliar treatment of maize plants with Cytovit and Humate + 7, the increase was 10.2-12.1% in comparison with the option without the preparation. Against the background of the application of nitrogen-phosphorus fertilizers, the application of Humate + 7 was effective, the increase of dry biomass was 10.7%. A positive result was also obtained by treatment with Cytovit. Improving the conditions of mineral nutrition with the addition of potassium fertilizers contributed to an increase in the value of the PPS in the treatment of crops with preparations with microelements, on average, by 5.1 ... 5.9% or 0.42 ... 0.48 g / m² × day compared with the agrophone N120P90 and unfertile options. When applying full mineral fertilizer, the best results were obtained when processing with Cytovit, Green Go and Gumostim, the increase was 9.1, 7.1 and 4.5%, respectively, compared with the variant without drugs treatment.

Studies have shown that the yield of green mass varies considerably depending on the moisture availability, the weather conditions of the growing season of corn and the studied technological methods.

The record of the harvest showed that in conditions of high humidity against a background of moderate temperatures in the first half of the vegetation period in 2017, the yield of green mass was higher in comparison with the indicators of 2016. However, the lack of active temperatures during vegetation adversely affected the accumulation of less dry matter by plants. The greatest yield of dry biomass from a unit of planting area was obtained under conditions of a more favorable combination of temperature and humidity conditions in 2016 due to a higher dry matter content in the phytomass and a sufficiently high yield.

According to the obtained experimental data, on average for 2016-2017, with an improvement in the conditions of root nutrition, the yield of the vegetative mass increased by 13.9 ... 16.6 t / ha or 38.7 ... 46.0%. The increase from the use of complex preparations with trace elements varied from 3.0 to 8.8 t / ha, while the best results were obtained against the background of N120P90K90 (Fig. 2). It is possible to note the advantage of processing with Cytovit, which contributed to the growth of the yield of green mass by 5.5 ... 8.8 t / ha, depending on the background of the mineral nutrition in comparison with the options without treatment.



Picture 2. The effect of fertilizers on the yield of maize crops, average for 2016-2017

Note. Factor B – complex fertilizers: 1 – no fertilizers; 2 – EcoFus; 3 – Green Go; 4 – Siliplant Universal; 5 – Gumostim; 6 – Cytovit; 7 – Humate+7.

On average, over the years of research under the influence of mineral fertilizers, the yield of dry maize biomass increased by 39.3 ... 44.2%, the best results were obtained with the application of N120P90 (Figure 2). Treatment with complex preparations was more effective when using full mineral fertilizer. Against the background of natural soil fertility and N120P90, options with foliar treatment with Cytovit and Humate + 7 were isolated, an increase of 2.7 and 2.3 t / ha, 2.3 and 1.5 t / ha, respectively, was obtained. With the introduction of full mineral nutrition, the treatment of corn plants by Cytovite and EcoFus made it possible to get additional 2.6 and 2.2 t / ha of dry biomass.

CONCLUSIONS

- Preparations with trace elements stimulated the increase in the photosynthetic surface of maize plants.
- In the phase of "paniculation – cob flowering" the increase in the leaf surface from the use of preparations with trace elements against various backgrounds of mineral nutrition was 9.4 ... 11.3% (2.4 ... 3.0 thousand m² / ha) in comparison with variants without treatment.
- By harvesting the largest leaf surface was preserved by plants with foliar treatment by EcoFus. At different levels of mineral nutrition it exceeded the control variant by 16.4 ... 19.2% or 3.9 ... 5.2 thousand m² / ha.
- Without the use of mineral fertilizers, preparations with trace elements made it possible to increase the amount of seeding photosynthetic potential (PP) by 6.9 ... 18.3%, and the largest total leaf surface for vegetation was formed with foliar treatment of corn sowings by EcoFus and Gumostim.
- Against the background of nitrogen-phosphorus fertilizers, the best result was obtained with foliar treatment by EcoFus - 2336 thousand m² / ha day.

- Against the background of N120P90K60, the value of PP from foliar treatment with preparations with trace elements exceeded the control by 2.1 ... 17.0%. The maximum effect was obtained from the use of Siliplant Universal and EcoFocus.
- The highest yield was obtained by foliar treatment of plants with Cytovit, Humate + 7 and EcoFus - the increase of green mass depending on the level of soil fertility was 3.9 ... 8.8 t / ha, of dry matter - 0.95 ... 2.7 t / ha compared to options without preparations with trace elements.

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