Kirkuk University Journal for Agricultural Sciences
ISSN:2958-6585
https://kujas.uokirkuk.edu.iq

RESEARCH ARTICLE
https://doi.org. 10.58928/ku24.15226

The response of the rubber plant *Ficus Nitida* L. to the addition of NPK and spraying with cytokinin.

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Received: 12/04/2024 Revised: 03/5/2024 Accepted: 13/5/2024 Published: 01/06/2024

ABSTRACT

The research was conducted in a greenhouse at the Department of Horticulture and Garden Engineering, College of Agriculture, University of Anbar, Ramadi City, to study the impact of NPK supplementation and CPPU cytokinin spraying on Ficus nitida L.'s vegetative and root growth properties. The study encompassed two primary factors. The first factor comprises the NPK chemical fertilizer in four distinct concentrations: F0 (no addition), F1 (1g urea, 3g DAB, 2g potassium sulfate), F2 (2g urea, 6g DAB, 4g potassium sulfate), and F3 (3g urea, 9g DAB, 4g potassium sulfate). The second factor involves the cytokine CPPU at three concentrations: C0 (no addition), C1 (3 mg/ liters), and C2 (6 mg/ liter). The study was structured using a randomized complete block design (RCBD) comprising three blocks, with three pots allocated per experimental unit. Each block consisted of 36 coefficients, resulting in a total of 108 experimental units across all blocks. Leaf area, the number of leaves per plant, The increase in the number of branches, the percentage of nitrogen, phosphorus, and potassium in the leaves, the percentage of carbohydrates, And the surface area of the roots 30.837cm2, 185.083 leaf plant-1, 40.500 Plant Branch-1, 2.66%, 0.291%, 1.585%, 6.005%,43.041 cm-1

***Keywords*:** foliar spray, Ficus nitida , Chemical Fertilizers, Cytokinin, CPPU.

INTRODUCTION

Ficus plant (*Ficus nitida* L.), a member of the Moraceae family, is characterized by its evergreen nature, dense branching pattern, and a maximum height reaching 30 meters, with a minimum height not less than 3 meters. This species, commonly known as the Folige Potted Plant, is cultivated in public and residential gardens for ornamental purposes and internal coordination (EI-Khatib and Samir, 2020; Ahmed et al., 2020). The native countries of Ficus nitida L. include South Australia, India, and Malaysia. Due to the dense vegetative growth and small leaf area of the plant, it is suitable for use in various landscaping and aesthetic applications, such as plant fences or as individual plant models or in plant groups, the plant tolerates mowing operations as one of the processes of environmental stress and also tolerates heat to some extent, but the plant does not tolerate frost (Ahmed et al, 2020).

Sakar (2023) confirmed that treating shrub rose hybrid L with CPPU at a concentration of 0, 30, and 60 mg L-1 increased aesthetic and coordination value and plant growth. Treatment with CPPU at a concentration of 60 mg L-1 also controlled flowering time, flowering age, dry and wet weight, the number of leaves, and the content of anthocyanins in the petals.

Saeed et al. showed in (2022) on the Arthur Bell rose plant that treatment with Thidiiazuron at a concentration of 4 mg L^{-1} led to a significant increase in the plant height of 45.72 CM, the average leaf area of 1519.33 cm2, the average dry weight of leaves 9.48 G, the proportion of carbohydrates in leaves 20.05% and the proportion of carotenoids in leaves 27.79 mg per 100 g^{-1} soft weight.

Al-Khafaji and Mohammed (2016) found that treating Freesia hybrida plants by spraying with cytokinin at concentrations of 0, 10, and 20 mg L^{-1}, the treatment sprayed with cytokinin at a concentration of 20 mg L^{-1} recorded the highest significant increase in flower size, number of flowers, early flowering, floral longevity of harvested flowers, and diameter of the floral peduncle.

Al-Zebari and others (2023) clarified in a study conducted on the Damascus rose plant (Mill) that treating the plant with NPK fertilizer at concentrations of 5 and 10 grams in the autumn and spring seasons, the researcher confirmed obtaining the best results at a concentration of 10 grams and a significant increase in the characteristics of branch number for the autumn season, the average number of leaves, and leaf area for both autumn and spring seasons. There was also an increase in the number of flowers on the plant in the spring season, an increase in chlorophyll content in the leaves, plant height, and plant spread.

Ajabzadeh and Hamedi (2022) examined the effect of treating Wiener charme plant at the age of one year on its vegetative and floral growth characteristics when treated with NPK fertilizer at concentrations of 100 and 200 mg L^{-1} of potassium silicate, and three levels of magnesium fertilizer at 0, 7.5, and 15 g L^{-1}. The study confirmed that the concentration of 100 mg L^{-1} recorded significant differences in plant height, flower stem length, an increase in the number and diameter of flowers. Furthermore, the addition of potassium silicate showed significant differences in plant height, leaf phosphorus content, number of flowers, leaf nitrogen content, and floral stem length.

Patil and Jeevitha (2023) explained in a study conducted on the shrub seal plant Althae rose L to find out the effect of nitrogen and phosphate fertilizer on seedlings at a concentration of 0, 120 and 140 kg ha^{-1} and four levels of phosphate fertilizer 0, 120, 140 and 160 kg ha-1 the results confirmed the excess concentration of phosphate fertilizer 160 kg and nitrogen fertilizer 140 kg gave the highest increase in the height of the plant, an increase in flowering, an increase in the weight of dry matter, the number of branches, tender weight, an increase in the content of chlorophyll in the leaves, as for the root qualities, the increase was obvious in the dry and wet weight of the roots.

Materials and methods:

The Experiment location:

The experiment was implemented in the greenhouse of the College of Agriculture at the University of Anbar from 1/10/2023 to 1/4/2024. It aimed to study the effect of NPK addition and foliar spraying with CPPU on improving the vegetative and root growth characteristics of the shiny rubber plant.

Seedling preparation:

The one-year-old seedlings of the shining rubber plant were obtained from a private nursery in the Al-Krayat area (Al-Tasahil nursery) and transported to the experimental site. All seedlings are as homogeneous in size as possible and free of insect and fungal infections. They were transferred on 7/10/2023 in plastic pots with dimensions of 28 cm, and the weight of one pot is 15 kg of sandy soil and peat moss.

Soil Analysis:

Samples were taken from the agricultural environments in which the seedlings involved in the experiment were planted before cultivation, analyzed, and the results are shown in the table below.

Table 1. The Experimental Soil's Chemical and Physical Characteristics Prior to Planting

Attribute	Value	Unit
Ec	1.67	dS m^{-1}
PH	7.34	
Organic Matter O.M	5.42	g kg^{-1} soil
Sand	690	g kg^{-1} soil
Silt	118	g kg^{-1} soil
Clay	192	g kg^{-1} soil
Soil texture	Sandy loam	
Available Nitrogen	112.00	mg kg^{-1}
Available Phosphorus	11.30	mg kg^{-1}
Available Potassium	118.5	mg kg^{-1}
Sulfates	7.42	mol charge kg^{-1}

Field preparation and agricultural service operations:

The greenhouse land to be studied was prepared by cleaning and washing the glass and structure. A preventive program was applied to eliminate fungal and insect pathogens. Then, a group of microelements was added to plants to compensate for the shortage of plants from these elements. Bush growth and weeding were also treated whenever needed. The average of the minimum and maximum temperatures and the humidity percentage from the meteorological network / Ministry of Agriculture / Republic of Iraq was taken (Table 2).

Table 2. Monthly Average of Maximum and Minimum Temperatures During the Study Period

Month	Average temperatures (m^{o})		Relative humidity
	Maximum(m^{o})	Minimum(m^{o})	
October	40.22	26,96	37
November	32.83	20.53	48
December	25.22	15.74	68
January	21.3	13.22	71
February	26.71	16.35	56
March	26.12	19.25	50
April	37.26	25.26	38

* Agricultural meteorological network / Ministry of Agriculture / Republic of Iraq

Experimental design and statistical analysis:

The work was implemented according to the design of the randomized complete block design R.C.B.D. by 3 blocks. Each block contained 12 transactions, and each transaction included three anvils. The total transactions in the experiment became 36 experimental units, and the total number of plants was 108. The data were analyzed using the Genstat program at a probability level of 0.5.

Studied Factors:

NPK addition:

The NPK fertilizer was uniformly incorporated into the soil in a single application at four levels. Subsequently, Diammonium phosphate (DAP) was applied at rates of 0, 3, 6, and 9g per 15 kg, while potassium sulfate was applied at rates of 0, 2, 4, and 8 g per 15 kg of anvil weight on October 15, 2023. The urea was added at levels 0, 1, 2, and 3 g per 15 kg of anvil weight after 3 weeks of adding the two levels.

Spraying with a CPPU growth regulator:

Certain plants were treated with a cytokine growth regulator at concentrations of 6, 3, and 0 mg L^{-1} in the early morning through two spray applications. The initial spray was performed a week after the cytokine application, followed by a second spray a month later. The cytokine forchlorfenuron (CPPU) was dissolved in drops of ethanol and distilled water, adjusted to one liter in the presence of a stirrer. The plants were uniformly sprayed using a handheld sprayer until thoroughly moistened.

Studied Characteristics:

The data for the studied characteristics were taken in the autumn and spring period and include:

1- The average of raised in the number of secondary branches (plant Branch-1)

2. The area of the plant nesting (CM)

3. Average diameter of secondary branches (mm)

4. Dry weight of leaves

5. Chlorophyll (Acetone method)

The total chlorophyll content in the plant material after the second spray of treatments was determined by taking 0.2 grams of fresh weight of the plant material and treating it with 20 ml of 80% acetone alcohol solution. The sample was then placed in a dark vial for 50 hours. Subsequently, optical density readings of the sample were taken using a Spectrophotometer at wavelengths of 645 and 663 nanometers. The total chlorophyll content was then estimated according to the equation below (Goodwin, 1976).

Total Chlorophyll (mg 100 g^{-1}) = (20.20) (A645nm) + (8.02) (A663nm)

6. Phosphorus Percentage in Leaves:

The quantity of phosphorus present within the plant was calculated using the Ammonium Molybdate and Vitamin C method, and the results were presented by reading with a Spectrophotometer device at a wavelength of 620 nanometers.

7. Nitrogen Percentage in Leaves:

The amount of nitrogen was calculated using the Kjeldahl method with a Micro-Kjelal device.

8. Potassium Percentage in Leaves:

The potassium percentage was estimated using a Flame Photometer device.

Leaf Area Index (LAI) (m^2 $plant^{-1}$):

The results in Table 4 indicated a significant difference in the Leaf Area Index. Regarding the NPK fertilizer factory, the LAI significantly increased when treated with F2, recording 31.192 m^2 $plant^{-1}$, while the comparative treatment recorded a lower LAI rate of 28.539 m^2 $plant^{-1}$. As for the cytokinin growth regulator CPPU treatments, the spraying treatment at a concentration of 3 mg L^{-1} significantly increased, reaching 30.837 m2 plant-1, while the comparative treatment with cytokinin recorded a lower LAI rate of 28.539 m^2 $plant^{-1}$.

Table 3. The Effect of NPK Chemical Fertilizer and CPU Cytokinin on Leaf Area Index (m^2 $plant^{-1}$) : for Rubber Plant Seedlings.

	C_0	C1	C_2	Average F
F_0	28.173	28.810	28.633	28.539
F_1	28.320	30.510	30.460	29.763
F_2	28.473	33.920	31.183	31.192
F_3	29.190	30.107	29.117	29.471
Average C	28.539	30.837	29.848	
	LSD F		N.S	0.05
	LSD C		N.S	
	LSD F*C		N.S	

Increase rate in the number of leaves (leaf plant^{-1})

Table 5 results indicated a significant difference in the rate of leaf numbers. Regarding the NPK chemical fertilizer factor, there was a significant increase in the leaf number rate when treated with F2, recording 194.333 leaves plant-1. In contrast, the comparison treatment recorded a lower leaf area rate of 156.778 leaves plant^{-1}. As for the CPPU growth regulator treatments, there was a significant increase in the leaf number rate when sprayed at a concentration of 3 mg L^{-1}, reaching 185.083 leaves plant^{-1}. The comparison treatment with cytokinin recorded a lower leaf number rate of 166.750 leaves plant^{-1}. Table 5 indicated a significant superiority in the dual interaction treatment between NPK fertilizer and CPPU in the leaf number rate for plants. Treatment F2C1 gave the best leaf number rate at 206.333 leaves plant^{-1}, while the leaf number rate decreased in treatment F0C0, recording 146.667 leaves plant^{-1}.

Table 4. The effect of NPK chemical fertilizer and CPPU cytokinin on the leaf number rate (leaf plant^{-1}) of rubber plants.

	C_0	C1	C_2	Average F
F_0	146.66	164.66	159.00	156.778
F_1	167.33	182.00	176.33	175.222
F_2	180.00	206.33	196.66	194.333
F_3	173.00	187.33	182.66	181.000
Average	166.75	185.08	178.66	
	LSD F		N.S	0.05
	LSD C		N.S	
	LSD F*C		N.S	

Rate of increase in the number of secondary branches (Plant Branch^{-1}):

The results of Table 6 showed a significant difference in the rate of the number of secondary branches. Treatment with chemical fertilizer F2 significantly outperformed the other treatments, recording 41.889 plant branches $^{-1}$, while the control treatment F0 showed the least significant difference in the rate of the number of secondary branches at 31.667 plant branches $^{-1}$. As for the treatment with CPPU spray, the treatment with a concentration of 3 mg L^{-1} significantly outperformed and recorded 40.500 plant branches -1, while the rate of secondary branches decreased in the control treatment C0, recording 34.500 plant branches^{-1}.

The same table indicated significant differences in the interactions between chemical fertilizer and cytokinin treatment F2C1 in the rate of increase in the number of secondary branches. It recorded 47.333 plant branches^{-1}, while the rate of secondary branches decreased in the treatment F0C0, reaching 28.666 plant branches^{-1}.

Table 5. The effect of chemical fertilizer NPK and cytokinin CPPU on the rate of increase in the number of secondary branches (Plant Branch^{-1}) for rubber plant.

	C_0	C1	C_2	Average F
F_0	28.666	33.333	33.000	31.667
F_1	36.000	41.333	39.667	39.000
F_2	37.667	47.333	40.667	41.889
F_3	35.667	40.000	38.333	38.000
Average C	34.500	40.500	37.917	
	LSD F		N.S	0.05
	LSD C		N.S	
	LSD F*C		N.S	

Nitrogen Percentage in the leaves (%):

The findings from Table 3 highlight significant variations among plant treatments with NPK chemical fertilizer. The nitrogen percentage in the leaves significantly increased in the F2 treatment, reaching 2.664%, whereas it decreased in the comparison treatment to 2.396%. Regarding CPPU spraying, the C1 treatment showed a significant increase, reaching 2.666% nitrogen in the leaves, while the control treatment exhibited a decrease to 2.424%. The data from the same table affirmed a substantial enhancement in the combined interference of NPK fertilizer and the cytokine CPPU. Specifically, the nitrogen percentage in the leaves increased significantly with the F2C1 treatment. Reaching 2.860%, while the comparison treatment exhibited a decrease to 2.390

Table 6. NPK and cytokine CPPU Chemical Fertilizer Effect on Nitrogen Percentage in Leaves (%) of Nitida Rubber Plant

	C_0	C_1	C_2	Average F
F_0	2.39	2.417	2.38	2.396
F_1	2.407	2.71	2.583	2.567
F_2	2.437	2.86	2.697	2.664
F_3	2.463	2.677	2.553	2.564
AveragC	2.424	2.666	2.553	
	LSD F		0.032	0.05
	LSD C		0.028	
	LSD F*C		0.055	

Phosphorus Percentage in Leaves (%):

The results of Table 8 indicated the absence of statistically significant differences, both at the level of mono-factors and bilateral interference coefficients in the phosphorus ratio of the leaves.

Table 7. The impact of chemical fertilizer NPK and cytokinin CPPU on the percentage of phosphorus in the leaves (%) of the rubber plant Nitida

	C_0	C1	C_2	Average F
F_0	0.173	0.220	0.187	0.193
F_1	0.197	0.283	0.230	0.237
F_2	0.203	0.390	0.310	0.301
F_3	0.227	0.270	0.223	0.240
Average	0.200	0.291	0.238	
	LSD F		N.S	0.05
	LSD C		N.S	
	LSD F*C		N.S	

Percentage of Potassium in Leaves (%):

The results of Table 10 indicated that there were significant differences between the plant treatments with chemical fertilizer NPK, the percentage of potassium in the leaves increased at the F2 treatment and amounted to 1.648 % , while it decreased at the comparison treatment and amounted to 1.179% , Regarding the transactions of spraying with CPPU, the potassium content in the leaves increased significantly when treated with a growth regulator at an intensity of 3 mg/L-1C1, reaching 1.585%. In contrast, with the control treatment, the potassium level in the leaves dropped and eventually reached 1.194%. The results of the same table confirmed a significant increase in the interaction between NPK chemical fertilizers and CPPU cytokinins. The F2C1 treatment significantly exceeded potassium percentage in the leaves, reaching 1.923%, while the potassium percentage in the leaves under the comparison treatment decreased to 1.163%.

Table 8. The impact of chemical fertilizer NPK and cytokinin CPPU on the percentage of potassium in the leaves (%) of the rubber plant Nitida

	C_0	C_1	C_2	Average F
F_0	1.163	1.200	1.173	1.179
F_1	1.187	1.793	1.653	1.544
F_2	1.203	1.923	1.817	1.648
F_3	1.223	1.423	1.350	1.332
Average	1.194	1.585	1.498	
C				
	LSD F		0.015	0.05
	LSD C		0.013	
	LSD F*C		0.025	

Carbohydrate Percentage in Leaves (%):

The results of Table 17 indicated no significant differences, whether at the level of individual factors or in the pairwise interactions between study factors, in terms of the carbohydrate percentage in the leaves.

Table 9. The Effect of NPK Chemical Fertilizer and CPPU Cytokinin on the Carbohydrate Percentage in Leaves (%) of Rubber Plant.

	C_0	C_1	C_2	Average F
F_0	5.690	5.823	5.803	5.772
F_1	6.760	5.747	5.660	6.056
F_2	5.710	6.520	5.690	5.973
F_3	5.823	5.930	5.863	5.872
Average C	5.996	6.005	5.754	

LSD F	N.S		0.05
LSD C	N.S		
LSD F*C	N.S		

Surface Area of Roots (cm2):

The results of Table 20 confirmed the presence of significant differences between plant treatments with NPK chemical fertilizer. The surface area of roots increased significantly in treatment F2, reaching 48.400 cm2, while it decreased in the control treatment to 32.177 cm2. As for treatments with CPPU spray, the surface area of roots increased significantly in the treatment with growth regulator at a concentration of 3 mg L-1 C1, reaching 43.041 cm2, while the leaf area decreased in the control treatment to 34.771 cm2. The same table results confirmed a significant increase in the interaction between NPK chemical fertilizer and CPPU cytokinins. Treatment F2C1 significantly outperformed in the surface area of roots, reaching 55.223 cm2, while the control treatment had a lower surface area of roots at 31.187 cm2. Table 20: The Effect of NPK Chemical Fertilizer and CPPU Cytokinins on the Surface Area of Roots (cm2) for Rubber Plant.

Table 10: The Effect of NPK Chemical Fertilizer and CPPU Cytokinins on the Surface Area of Roots (cm2) for Rubber Plant.

	C_0	C_1	C_2	Average F
F_0	31.187	33.013	32.330	32.177
F_1	33.863	47.390	41.123	40.792
F_2	38.833	55.223	51.143	48.400
F_3	35.200	36.537	34.560	35.432
Average C	34.771	43.041	39.789	
	LSD F		1.418	0.05
	LSD C		1.228	
	LSD F*C		2.457	

Discussion:

The results of the results tables confirmed that the chemical fertilization of the Hevea rubber plant had a significant effect on the vegetative and root growth characteristics, as well as some chemical properties. The third treatment, F2, which is a mixture of the following fertilizers: 2 grams of urea, 6 grams of DAP, and 4 grams of potassium sulfate, recorded the best results for the studied characteristics, including plant height, leaf area, nitrogen, phosphorus, and potassium content in the leaves, chlorophyll content in the leaves, root surface area, and root length. The increase in vegetative, root, and chemical growth characteristics is attributed to the fact that chemical fertilization with nitrogen plays a major role in the plant's life by participating in the formation of RNA and DNA acids, as well as the enzymatic co-factors NAD and NADP, and also participates in the photosynthetic process (El-Badawy and Sultan, 2020). It is also known that nitrogen is a fast-moving element inside the plant, transferring from old leaves to new leaves, promoting vegetative growth. Due to the added nitrogen, the plant becomes tall with large, broad, and vibrant green leaves. Phosphorus participates in cell division and branch elongation, leading to an increase in the number of leaves on the plant. Phosphorus also plays an important role in the formation of cell membranes in conjunction with fats and the vacuolar membrane, as well as in the synthesis of enzymatic co-factors for NADP and NADPH, nucleic acids RNA and DNA, and contributes to the oxidation and reduction process, as well as the photosynthetic and respiratory processes. Phosphorus can be found in the tips of branches and roots, and is important for plant growth and cell division processes. As for potassium plays an active role in the osmotic regulation process through the opening and closing of stomata, protein and enzyme synthesis, and nutrient transport.

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استجابة نبات المطاط *Ficus Nitida* L. لاضافة الـ NPKوالرش بالسايتوكانين

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لخلاصة

نفذت هذه التجربة في احد البيوت الزجاجية التابعة لكلية الزراعة /جامعة الانبار ،لدراسة تأثير إضافة ال *NPK*والرش بالسايتوكانين *CPPU*في النمو الخضري والجذري لنبات المطاط البراق *Ficus nitida L* ، تضمنت التجربة عاملين ،العامل الأول هو السماد الكيميائي *NPK* بأربع تراكيز وهي *F0*بدون إضافة ،والتركيز الثاني *F1* مزيج من الأسمدة 1غم من اليوريا +3 غم داب +2 غم كبريتات البوتاسيوم ، التركيز الثالث*F2 2* غم يوريا +6 غم داب +4 كبريتات البوتاسيوم ،التركيز الرابع *F3* مزيج من الأسمدة 3غم يوريا +9 غم داب +8 غم كبريتات البوتاسيوم اما العامل الثاني وهو السايتوكانين *CPPU*بثلاث تراكيز التركيز الأول *C0* بدون إضافة ،والتركيز الثاني *C1* بلغ 3ملغم لتر−1 ،والتركيز الثالث *C2* وكان 6ملغم لتر−1 ،صممت التجربة باستخدام تصميم القطاعات العشوائية الكاملة *(RCBD)* بثلاث قطاعات وثلاث اصص للوحدة التجريبية الواحدة وبلغ كل قطاع 36 معاملة وبعدد 108 وحدة تجريبية لكافة القطاعات وتلخصت النتائج بما يلي:

عند تركيز *F2* ،اذ تفوقت في صفات النمو الخضري والجذري والكيميائي والمتمثلة في بعض الصفات ، اذ سجلت *F2* اعلى قيمة في معدل ارتفاع النبات والمساحة الورقية وعدد الأوراق وعدد الافرع الثانوية وقطر الساق الرئيسي وسمك الورقة والوزن الرطب للأوراق ونسبة النتروجين والفسفور والبوتاسيوم في الأوراق ونسبة الكلوروفيل في الأوراق ومساحة افتراش النبات والمساحة السطحية للجذور ومعدل طول الجذور ومعدل عدد الجذور الرئيسية وقطر الافرع الثانوية 19.889 سم و 31.192 سم و194.333 ورقة نبات−1 و41.889 فرع نبات−1 و17.111 ملم و0.967 ملم و5.304 غم و2.664 % و0.301 % 1.648 % و1.386 ملغم و0.547 سم و48.400 سم و12.369 سم و21.393 سم و6.441 ملم على التوالي.

الكلمات المفتاحية : الرش الورقي، اللبخ النيتيدا، الأسمدة الكيماوية، السيتوكينين، *CPPU*.