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To cite this article: Mohammed Dayikh Kadhim Al-Karaawi and Hayyawi Wewa Attia Al-Juthery 2022 *IOP Conf. Ser.: Earth Environ. Sci.* **1060** 012035

Effect of NPK, NPK Organic Fertilizers and Spraying Nano-Vanadium and Nano-Selenium on the Growth and Yield of Rice

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Abstract. The research aims to evaluate the response of rice plant to fertilization with NPK , NPK Organic fertilizers and spraying of nano-vanadium and nano-selenium in some growth and yield indicators of rice (Anber 33 cultivar).A field study was conducted in Al-Tali'a district (41 - Al-Hussainiya, south of Hilla city) Babylon province Iraq, for the period from 15/6/2021 to 26/11/2021.The experiment was conducted according to a randomized complete block design (RCBD).The treatments were randomly distributed according to a simple one-way experiment. The experiment was applied by adding NPK fertilizer at two levels (0 and 300 kg ha^{-1}) and NPK Amino Humic Compound fertilizer at two levels (0 and 1000 kg ha^{-1}).While the treatments of spraying with nanomaterials represented by spraying nano-vanadium and nano-selenium at a concentration (100 mg L^{-1}) were two sprays, bringing the number of experimental units to 16 treatments. The results of the statistical analysis of Duncan's test showed that fertilizing with organic acids fertilizer with nanomaterials gave the highest plant height, reaching (120 cm). While the combination (NPK+NPKOrganic+nano-vanadium) showed the highest chlorophyll index, which amounted to (40.80) SPAD.While quadruple combination treatment of (NPK+NPKOrganic +nano-vanadium+nano-selenium) achieved the highest values in biological yield (15.93 $Mg.ha^{-1}$) and grain yield (4.30 $Mg.ha^{-1}$) and harvest index (27.0%) Also, the single (NPK) treatment gave the highest weight of 1000 grains, which weighed (21.37 g).The spraying of nano-selenium and vanadium recorded the highest agronomic efficiency, reaching (1676.7 and 1468.7 kg kg^{-1}) to spray nano-Va and nano-Se respectively , followed by the dual- combination of nano-materials, which amounted to (1202.7) kg kg^{-1}.

Keywords. Rice, NPK, NPK Organic, Nano-vanadium, Nano-selenium.

1. Introduction

Elements N, P, and K are classified as macronutrients due to the large amounts of these nutrients that plants need. It is also classified as the basic building blocks of life required for healthy and optimal growth. Nitrogen plays a central role in providing the amino groups in amino acids, photosynthesis, The construction of purine and pyrimidine bases, and the formation of protein and non-protein compounds such as coenzymes [1,2]. As for potassium, one of its most important roles is its ability to activate enzymes, provide electrical potential during efficient transport, water balance, cell expansion, and plant growth, and enhance plant size, shape, color, and taste [3,4]. Phosphorous, is a component of

sugar phosphates, nucleic acids, and phospholipids [5]. It is important due to its role in energy transfer, protein metabolism, plant growth, and health. It is used in the formation of DNA and is essential during cell division and in the development of new tissues [4]. Organic matter was defined by [6] as complex, dark-colored aggregates, arising from the decomposition of plant and animal residues and microorganisms under aerobic and anaerobic conditions in the soil. Whether it is organic fertilizer, in swamps, or in water basins, humic materials are the largest component of organic matter in the soil, reaching (60%), As well as being an essential component of sustainable agricultural practices and terrestrial ecosystems, they are responsible for many of the complex chemical reactions in soil [8] .In addition to pollutants, [7] indicated the addition of humic to soils with a low fertility level, especially alkaline soils. It improved some of its qualities, by adding different levels of humic when cultivation. [9-11] mentioned that humic plays a role in plant nutrition, by increasing the availability of nutrients in the soil and developing the root system, encouraging the absorption of some nutrients, and increasing its enzymatic activity and cell division. This is what was shown by many studies in the effect of organic acids on the solubility of many nutrients by building and forming complex compounds or chelating humic substances for cations, [12,13]. In terms of its effect on nitrogen, [14] mentioned that the addition of organic nitrogen by adding humic and fulvic acid led to an increase in the nitrogen availability in the soil and the efficiency of its absorption from the corn plant. Nano fertilizer is more effective and efficient than traditional fertilizer. Because of its positive effects on the quality of crop nutrition, reducing stress in plants, and reducing additive quantities. The costs are due to the speed of its absorption by the roots due to its large surface area compared to volume and its rapid penetration into cells and plant tissues with the possibility of smart targeting, slow-release, and speed of transport [15].Selenium has excellent bioavailability, high biological activity, and low toxicity in plants [16]. The size of nanoparticles plays an important role in their biological activity, especially in the range from 5-100 nm, Selenium is a free radical in a size-dependent manner [17]. Selenium nanoparticles are a very soluble and stable material [18] indicated that selenium increases the plant's resistance to drought by reducing or reducing oxidative damage, and thus it increases the enzymatic activity of antioxidant enzymes such as Catalase enzyme, Superoxide dismutase, and Glutathione Peroxidase, which work to protect the plant from oxidation stress. Nanotechnology is a promising new field of bioengineering using the unique properties of nanoparticles with diameters less than 100 nm [19]. Vanadium can act as a redox catalyst for electron transfer in photosystems I and II, depending on environmental conditions [20,21]. Another of its functions is its participation as a cofactor in an enzyme. Vanadium-dependent nitrogenase, detected in *Azobacter vinelandii* [22]. bacteria have a role in the transformation of vanadium and increase its availability for plants. *Oryza sativa* L. rice is one of the most important grain crops around the world, and it is mostly grown in tropical regions. It is also grown in more than 114 out of 193 countries in the world [23]. Rice is also one of the most important major food grain crops for more than half of the world's population, where the Asia and Pacific regions produce and consume more than 90% of the total rice production in the world [24]. Locally, the production of rice in Iraq for the summer season 2019 was estimated at 574.70 thousand tons for a cultivated area of 127.85 thousand hectares, an increase of 556.50 thousand tons over the 2018 season, which was estimated at 18.20 thousand tons for a cultivated area of 5.425 thousand hectares (Directorate of Agricultural Statistics, 2020).Rice consumes large quantities of traditional mineral fertilizers during its growth stages due to the immersion method, which exposes the fertilizers to washing, volatilization, and fixation on the surfaces of minerals in the soil as it has a clay texture, so the unbalanced use of nutrients, With a heavy emphasis on supplementing the soil with micronutrients, it may lead to significant deficiencies in other nutrients [25].
research aims :-The study aims to know the effect of NPK and NPK Organic fertilizers on some growth and yield parameters , as well as the effect of spraying nano-materials vanadium and selenium solo or combination with soil addition of NPK and NPK Organic fertilizers on some growth and yield traits of rice.

2. Materials and Methods

2.1. Experiment Location

A field study was conducted in Al-Tali'a district (41 - Al-Hussainiya, south of Hilla city), Babylon province/Iraq, within latitude (N-3560050) and longitude (E-481907), for the period from 6/15/2021 to 11/23/2021, which is the period required for the growth of the rice crop.

2.2. Experience Design

The experiment was conducted according to a Randomized Complete Blocks Design (RCBD), three replicates were located, and each replicate included 16 treatments. The treatments were randomly distributed according to a simple one-way experiment where NPK fertilizer was added at two levels (0 and 300 kg ha^{-1}).Also, NPK Amino Humic Compound fertilizer was added at two levels (0 and 1000 kg ha^{-1}), while the spraying treatments were with nanomaterials represented by spraying nano-vanadium and nano-selenium at a concentration of 100 mg L^{-1} by two sprays, bringing the number of experimental units to 48 experimental units [26].

Table 1. Fertilizers used in the experiment and their components.

Fertilizer name	Fertilizer type	Components
NPK mineral compound fertilizer	Granular	N=3 $\pm$3%, P=1.5$\pm$5,K=2$\pm$1 and Zn 1$\pm$0.5
NPK Amino Humic Compound fertilizer	Granular	Organic matter 50%,Humic Acid 20%, Amino Acid 25.5%, Fulvic Acid 15.5% , NPK Customized pH 4.5
Vanaduom oxide	Nano material (powder)	VaO_2 99.5%
Seienuom oxide	Nano material (powder)	SeO 99.5%

2.3. Experiment Field Preparations

The experiment field was assigned and the process of orthogonal tillage, smoothing and leveling was conducted for it. A sample of field soil was taken at a depth of 20 cm from five sites represented by the four sides of the field and the middle to be a representative sample of the field soil, which is characterized as alluvial soil with a Silty Clay Loam texture and its classification. Entisols according to the recent American classification [27].The soil had properties that included electrical conductivity (Ec) = 3.02 ds m-1 (pH) = 7.56, available N = 24.00 mg N kg-1, available P = 2.90 mg P kg-1, available K= 126.00 mg K kg^{-1}, organic matter = 0.72%. The experimental field of 300 m2 was divided into three equal replicate, Each replicate was divided into 16 experimental units, where the area of one plot was (3x1.5=4.5 m^2), in addition to opening the water ways necessary to irrigate the plots (experimental units) and sewers needed to drain the excess water.

2.4. Experiment Field Preparations

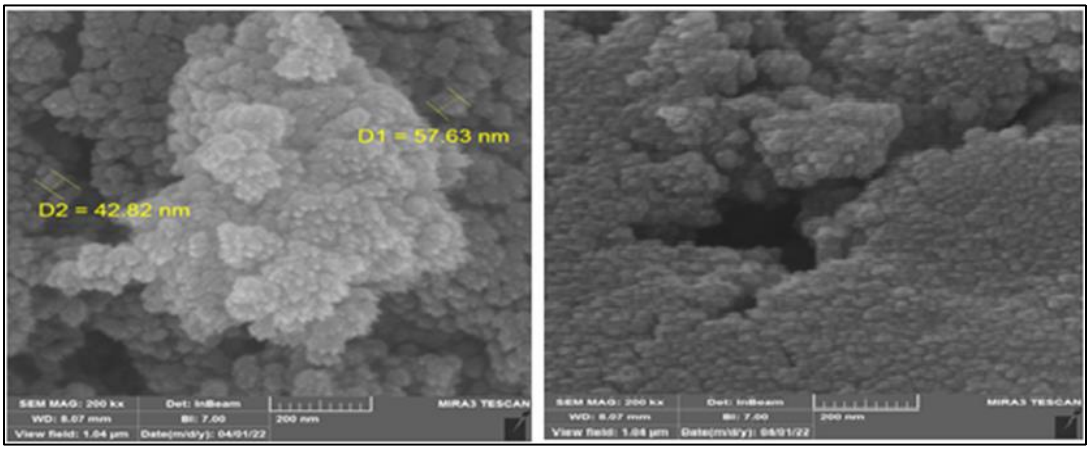
Dry rice seeds (Anber 33) certified by the Rice Research Station in Al-Mishkhab District / Najaf province on 15/6/2021, were sown 120 kg ha^{-1} of seeds by scattering directly on the previously prepared soil and then covering it with soil to prevent erosion with Irrigation water and captured by birds. The soil was irrigated and the irrigation process continued (every 3 days) starting from irrigating germination until the patching stage (1-3/8/2021), after which the irrigation water depth was maintained at about 10 cm to ensure the availability of the appropriate amount of water needed for plant growth up to full maturity stage of plants, Irrigation water was cut off from the field 15 days before harvest, in addition to the continuous weeding of the bush.

Table 2. a description of the fertilizing treatments of soil addition fertilizers, their levels, nanomaterials, their concentrations, and the number of sprays.

No. Tr	Treatments		Dose Kg ha^{-1} Spray one	sprays concentration mg L^{-1} Spray two
T1	Control (spray water only)	0	Water spray	Water spray
T2	Spray nano-Vanadium (Va)	0	100	100
T3	Spray nano- Selenium (Se)	0	100	100
T4	Spray nano Va+Se	0	50+50	50+50
T5	NPK fertilizer (NPK)	300	0	0
T6	NPK fertilizer + Spray nano -Va	300	50	50
T7	NPK fertilizer + Spray nano -Se	300	50	50
T8	NPK fertilizer + Spray nano -Va+ Se	300	50+50	50+50
T9	NPK Amino Humic Compound fertilizer (NPK-Organic)	1000	0	0
T10	NPK-Organic fertilizer + Spray nano Va	1000	50	50
T11	NPK-Organic fertilizer + Spray nano Se	1000	50	50
T12	NPK-Organic fertilizer + Spray nano Va +Se	150+500	50+50	50+50
T13	NPK fertilizer + NPK-O fertilizer	1000	0	0
T14	NPK fertilizer + NPK-O fertilizer +Va	150+500	50	50
T15	NPK fertilizer + NPK-O fertilizer +Se	150+500	50	50
T16	NPK fertilizer + NPK-O fertilizer +Va+Se	150+500	50+50	50+50

2.5. Fertilization

Initial Fertilization All soil treatments were fertilized with Tron (20:20:20) NPK fertilizer Tron fertilizer at 300 kg ha^{-1} , Fertilizing with NPK fertilizer at levels (0, 300 kg ha^{-1}), which was added to the soil before the planting date (Table 3), and the added quantities were calculated according to the area of the experimental unit, by fertilizing with NPK Amino Humic Compound fertilizer at levels (0,1000 kg ha^{-1}),Foliar fertilization (spray) with nanomaterials were sprayed with Nano-Vanaduom and Nano-Selinuom at a concentration of 100 mg L^{-1} for one spray and two sprays of each nanomaterial before the flowering stage and 50% flowering between sprays and another 14 days according to the instructions, The mixture was sprayed in the early morning and at (400 liters ha^{-1}) (Table 3). The size of nano-Vanadium and nano-Selenium was also detected by scanning electron microscope FE-SEM in the central laboratory of the Physics Department / University of Tehran to ascertain the size of the particles within the nanoscale (1-100) nanometers.



Nano-Vanaduom Nano-Selienuom

Figure 1. Size of Nano- Vanaduom and Nano-Selienuom FE-SEM scanning electron microscope.

2.6. Harvest

The rice crop was harvested on 26/11/2021 when all plants reached the stage of full maturity and the moisture content of the grains ranged between 18-25% [28].

2.7. Studied Indications Before Harvest

2.7.1. Plant Peight (cm)

Plant height was measured by measuring tape from the soil surface level to the top of the plant peak at 100% flowering for ten plants randomly taken from each experimental unit and the mean was extracted from the sum of plant heights divided by the number of plants [29].

2.7.2. Chlorophyll in Leaves Index (SPAD)

The chlorophyll content of the leaves before the flowering stage of plants was measured by a portable SPAD-502 chlorophyll meter to get a quick estimation of the chlorophyll content of leaves in real time in the field [30]. The leaf readings of ten plants were randomly taken from each experimental unit and the mean was extracted from the product of dividing the total leaf content of the plants by their number.

2.8. Studied Indications after Harvest

2.8.1. Biological Yield (Meg ha^{-1})

The biological yield was estimated from the weight of the plants harvested within the specified square meter of each experimental unit after being air-dried for 10 days and converted to Meg ha^{-1}, which includes the weight of the total dry matter above the soil surface after the sample was air-dried and its weight constant [31].

2.8.2. Grain Yield (Meg ha^{-1})

The grain yield of plants harvested within the specified square meter of each experimental unit was estimated after being air-dried for 10 days, then Threshed and Separated Grain from Straw, The grain yield was recorded in kilograms per square meter and then mathematically converted to $Mg.ha^{-1}$at a moisture content of 14% that was measured by the Multi-grain device of the General Company for Seed Production in Ghammas/Al-Diwaniyah province/Iraq [31].

2.8.3. Harvest Index (%)

The harvest index of the rice yield was estimated by the equation:

$$\text{Harvest Index (\%)}=\frac{grain\ yield}{biological\ yield}\times 100 \quad [31].$$

2.8.4. 1000 Grain Weight (g)

The weight of 1000 grains for each treatment was estimated from 1,000 grains counting using a grain counting device in the Babylon Agriculture Directorate / Al-Muradia Research Station, and then weighed with an electronic scale (measuring from 100 mg kg^{-1}) at a moisture content of 14%, which was measured by a multi-grain device.

2.8.5. Netting Percentage %

(100) g of grain were ground in the laboratory of Al- Hilla rice silo using a Japanese-made laboratory grinder, and the raw rice obtained from the milling process was put into a Japanese-made laboratory stone husk (Satake Husking rice machine) also to obtain the satake milling rice machine.), and the rice purification ratio was calculated according to the following equation: [32].

Netting percentage = weight of bleached rice (g) / weight of grains (g) x 100

2.9. Statistical Analysis
The data of the results were statistically analyzed using the Analysis of Variance test within the Analysis ToolPak included in the additional functions of the tabulation program, and the averages of the coefficients were compared when the differences between them were significant using Duncan's least significant difference test at the level of probability ($P \leq 0.05$), as stated in [21].

3. Results

3.1. Plant Height (cm)
It is noticed from the results shown in Table No. (3) that there is a significant variation of the study's coefficients in the character of plant height, with the superiority of the triple combination (NPK-O+Se+Va) compared to its counterparts (120.0 cm) and it did not differ significantly from the quaternary mixture (NPK+NPK-O+Va+Se), (NPK+NPK-O+Va), (NPK+NPK), (Hu-O+Se), and (NPK-O+Se) (NPK+Se) workshops (Se), whose values were (117.7, 117.3, 118.0, 118.7, 118.3 and 119.0) cm compared to the comparison treatment, which amounted to (110.5) cm, while the treatments (NPK, Va+Se and Va) were not recorded. With values (111.2, 112.0 and 113.0) cm, any significant differences with the comparison treatment.

3.2. Chlorophyll Index(SPAD)
Treatments (NPK+Hu-O+Va) excelled their counterparts, where value was (40.80), The (NPK+NPK-O+Se), (NPK+NPK-O), (NPK-O+Se), (NPK-O) and (NPK+Se) and (NPK) and (Se)was excelled with consecutive values of (38.80, 37.07, 38.43, 38033, 37.47, 37.20 and 38.50) SPAD compared to the control treatment of (36.00) SPAD,The bi and single spraying treatments of nanomaterials achieved the excel of spraying nano vanadium on selenium and did not differ from spraying the two of them, as it reached (Va and Va +Se) with values of (40.67 and 39.27) SPAD compared with (Se) which amounted to (38.50) SPAD.

3.3. Biological Yield (Mg.ha^{-1})
We note that the treatment (NPK+NPK-O+Va+Se) with a value of (15.93) Mg.ha-1 was significantly excelled the rest of the treatments, but it did not show a significant difference from the treatments (NPK+Se+Va, NPK+NPK-O+Se and NPK+ NPK-O+Va) with values respectively (15.62, 15.54 and 15.43) Mg.ha^{-1}.A significant difference was also observed between the spraying of the combined nanomaterials (Va+Se) with a value of (13.51) Mg.ha^{-1} for the control treatment with a value of (12.26) Mg.ha^{-1} While the treatments of spraying with nanomaterials (Va and Se) with values of (13.06 and 13.20) Mg.ha^{-1}did not show any significant difference from the control treatment.

3.4. Grain Yield (Meg ha^{-1})
Table (1), we note that the treatments (NPK+Hu+Va+Se) and (NPK+NPK-O+Se) have values (4.30 and 4.15) Mg.ha^{-1} gave the largest significant difference and did not differ significantly from the treatments (NPK+NPK-O+Va and NPK+Se+Va) with values (4.10 and 4.09) Mg.ha^{-1}, but it excelled in all treatments and the control treatment, which amounted to (2.97) Mg.ha^{-1}.The spraying with nanomaterials also increased the level of significance compared to control treatments, and they did not achieve a significant difference between them, as the values of the treatments (Se and Va) were respectively (3.2 and 3.20) Meg ha^{-1}.

3.5. Harvest Index %
Table (4) that the combination (NPK+NPK-O+Va+Se) with a value of (27.0)% was significantly excelled on other treatments, but it did not show a significant difference from the treatments (NPK+NPK-O+Se and NPK+NPK-O+Va, NPK+NPK-O, NPK+Se+Va, NPK-O+Se+Va, NPK-O+Se, and NPK+Se+Va) with values (27.6, 26.6, 26.5, 26.4, 26.3, 26.0 and 25.7) % respectively.The treatments of spraying with nanomaterials did not achieve any significant differences in the due to the harvest index (Va, Se and Va + Se) with values (24.8, 24.5 and 24.5%), as well as the Soil addition (NPK) with a value of (24.8) with the control treatment of value (24.2)%.

Table 3. Effect of NPK, NPK-Organic fertilizers and spray of nano-vanadium and nano-selenium on plant height, chlorophyll index, biological yield and grain yield.

Treatments number	Treatments Symbol	Traits							
		plant height (cm)		chlorophyll index SPAD		biological yield mega $g.ha^{-1}$		Grain yield mega $g.ha^{-1}$	
1	Con	110.5	f	36.00	f	12.26	f	2.97	j
2	Va	113.0	ef	40.67	ab	13.06	ef	3.20	i
3	Se	119.0	ab	38.50	cde	13.20	ef	3.23	i
4	Va+Se	112.2	ef	39.27	abcd	13.51	de	3.35	hi
5	NPK	111.2	f	37.20	ef	13.91	cde	3.45	gh
6	NPK+Va	114.5	cde	39.60	abc	13.67	de	3.50	fgh
7	NPK+Se	118.3	ab	37.47	def	14.12	cde	3.72	cde
8	NPK+Va+Se	116.7	bc	39.63	abc	15.62	ab	4.09	ab
9	NPK-O	116.5	bcd	38.33	cde	13.67	de	3.50	efgh
10	NPK-O+Va	114.0	de	39.57	abc	13.78	cde	3.60	defg
11	NPK-O+Se	118.7	ab	38.43	cde	14.06	cde	3.70	cdef
12	NPK-O+Va+Se	120.0	a	39.27	abcd	14.77	bc	3.90	bc
13	NPK+NPK-O	118.0	ab	37.07	ef	14.35	cd	3.80	cd
14	NPK+NPK-O+Va	117.3	ab	40.80	a	15.43	ab	4.10	ab
15	NPK+NPK-O+Se	114.7	cde	38.80	bcde	15.54	ab	4.15	a
16	NPK+NPK-O+Va+Se	117.7	ab	39.60	abc	15.93	a	4.30	a

3.6. The weight of 1000 grains (g)

Table (4) that the largest significant difference for the weight of 1000 grains was recorded in the treatment (NPK) which amounted to (21.37) g with a significant percentage of the other treatments. While the rest of the treatments recorded significant differences from the control treatment with a value of (19.20) g, while the treatments (NPK-O+Se and NPK-O+Se+Va) with values of (19.67 and 19.40) g did not record a significant difference with the control treatment.

3.7. Field Efficiency (kg kg^{-1})

From the results in Table (4), the two treatments of spraying with nanomaterials (Se and Va) amounted (1373.7 and 1468.9) kg kg^{-1} respectively recording the highest significant difference value. They were followed by the treatment of spraying the nanomaterials combination (Va+Se) with a significant amount of (1202.7) kg kg^{-1} is significantly excelled on all other treatments.

3.8. Netting Percentage %

Through the results shown in Table (4), we note that the lowest netting percentage was when the treatment (NPK + NPK-O), which amounted to (28.73)% While we notice the lowest netting percentage when the treatment (NPK + NPK-O) amounted to (28.73)%, with a significant decrease without the control treatment.

Table 4. Effect of NPK, NPK-Organic fertilizers and nano-vanadium and nanno-selenium sprays on harvest index, weight of 1000 grains, agronomic efficiency and netting percentage.

Treatments number	Treatments Symbol	traits							
		Harvest Index (%)		The 1000 grain weight (gm)		field efficiency kg kg-1		Netting percentage %	
1	Con	24.2	e	19.20	h	0.0	c	32.20	fg
2	Va	24.5	de	19.87	efg	1468.7	a	32.27	fg
3	Se	24.5	de	20.63	b	1676.7	a	33.40	ef
4	Va+Se	24.8	cde	20.27	bcdef	1202.7	b	33.03	efg
5	NPK	24.8	cde	21.37	a	1.6	c	35.97	c
6	NPK+Va	25.6	bcd	20.33	bcde	1.8	c	32.07	fg
7	NPK+Se	25.7	bc	19.97	defg	2.5	c	42.63	a
8	NPK+Va+Se	26.2	ab	20.10	bcdef	3.8	c	33.63	ef
9	NPK-O	25.6	bcd	20.50	bcd	0.5	c	32.00	fg
10	NPK-O+Va	26.0	ab	20.00	cdef	0.6	c	35.40	cd
11	NPK-O+Se	26.3	ab	19.67	fgh	0.7	c	39.80	b
12	NPK-O+Va+Se	69.70	ab	0.86	c	20.00	bcd	26.00	d
13	NPK+NPK-O	69.10	abcd	0.52	c	20.30	bc	24.87	ef
14	NPK+NPK-O+Va	67.50	ef	0.57	c	20.00	cd	24.40	f
15	NPK+NPK-O+Se	68.60	bcde	0.73	c	19.70	de	27.67	bc
16	NPK+NPK-O+Va+Se	68.50	bcde	1.04	c	20.90	a	29.69	a

4. Discussion

Through these results, the addition of NPK Amino Humic Compound fertilizer gave the highest rate of rising because adding NPK-Organic to the soil has a role as a fertilizing soil enhancer and has direct effects through its various biochemical interactions in increasing the permeability of the cell membrane,Chelation of elements and nutrients increase their readiness, as well as acidification of the medium, which leads to an increase in the availability of elements, especially phosphorous [33,34,35],Which includes improving the processes of photosynthesis, respiration, and the effectiveness of plant hormones like active, as well as in the overlapping addition treatments between ground addition and spraying with nanomaterials. This is due to the very high surface area of the nanomaterials, which leads to an increase in biochemical reactions and peroxidase enzymes. The catalase leads to increased cell divisions as well as the nano-elements reduce or inhibit the formation of reactive oxygen species (ROS), which reduces oxidative damage, delays senescence, and promotes vegetative growth [36].The direct absorption of humic acid has a hormonal effect that affects the cell protoplasm and cell wall, which leads to the rapid division and growth of cells, and then increases the height of the plant between [37].The addition of spray nutrients (Nano-Vanadium and Nano-Selenium) plays an important role in plant growth, photosynthesis-related metabolic processes, chlorophyll formation, and the efficacy of enzymes involved in primary and secondary metabolism. It also significantly increased the content of chlorophyll, when using two different sources of vanadium, to increase chlorophyll in addition to the dry and wet vegetative yield [38]. it may be attributed to the role of nanoparticles in increasing the area of reactions and enzymatic activities and their rates, thus producing sufficient raw materials for the continuation of cell division and encouraging the absorption of nutrients from the leaves compared to the ground application in the soil [39]. and the increase in the surface area of the leaves and their numbers, which is reflected positively on the increase in the evidence of chlorophyll in the leaves [40,44,45].It also seems that spraying nanomaterials plays a role in increasing the efficiency of carbonization and resulting in an increase in the leaf area, thus increasing the biological yield [40,41]. and the importance of enhancing the ground additives with nano-combinations, which have a role in improving the ability of plants to absorb and grow. The highest grain yield was also achieved when the combined quartet of NPK ground additives, organic acid fertilizer and nanomaterials spraying, where NPK fertilizer plays an important role in changing the growth and division of cells. The increase in cell division and increase in growth led to an increase in the biological yield and carbon metabolism, which was reflected in the yield as indicated [40,42]. The addition of combinations of composts reinforced with materials or nanomaterials led to obtaining the highest grain yield, which is what the research results showed. As for the highest biological production, it is the characteristic of the optimal management of fertilization and the common additives between the ground additions and spraying, which is reflected in the increase in yield and the harvest index, and this was confirmed by [40,43]. that the field efficiency depends on the amount of additives and their effect This is the new trend in the use of nanotechnology instead of the traditional methods of using fertilizers and fertilizer formulations

Conclusions

It turns out that the most important finding of our current study is the recording of the highest averages of the studied traits in the rice plant by the effect of adding ground and nano fertilization at the highest level represented by NPK fertilizer, organic acid fertilizer and spraying with nano vanadium and nano selenium,This indicates the intertwined role of fertilizers in providing integrated nutrition for the plant, which in turn achieved the highest characteristics for the growth and yield of Amber 33 rice, Therefore, these combinations can help reduce the amount of fertilizer applied to crops and reduce fertilizer waste and thus environmental pollution due to wrong agricultural practices. However, there is a need for a detailed physiological and molecular understanding of the effect of these fertilizers, especially the nano-fertilizers, on rice and that the highest field efficiency was achieved when spraying the nano-materials individually and This is due to the small amount of added.

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