ARTICLE / INVESTIGACIÓN

The impact of the type of bacterial inoculant used and the application method on corn growth and yield (*Zea Mays* L.)

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Abstract: A study included the implementation of a field experiment using a randomized complete Block design at the Agricultural Research Station - College of Agriculture - University of Al-Muthanna, to evaluate the effect of using the immobilization inoculant technique as a biofertilizer compared to applying the bacterial inoculant in the traditional methods by carrying it on zeolite. The results showed the superiority of the immobilization inoculant, regardless of the type of bacterial inoculum on the process of carrying on zeolites in all traits corn growth parameters, as well as the overlap of *T. thiolates* + *B. subtilis* together over the bacterial inoculant for *B. Subtili*s. At the same time, it didn't differ significantly in most of the traits. The study of the dual bacterial inoculant B3M2 superior in plant height, dry weight, bio-yield, grain yield, uptake amount of nitrogen, phosphorus and potassium in the shoots and the concentration of available phosphorus in the soil. Which is recorded at 227.33 Cm, 321.23 g plant-1, 171.44 g, 7.68 t ha-1, 89.21 (kg N ha-1), 21.92 (kg P ha-1), 171.82 (kg K ha-1), 29.6 (mg P ha-1) Sequentially, the same treatment also achieved 99.6% compared to the recommendation of the complete fertilizer in the grain yield.

Key words: Bacterial Inoculant, Growth, Yield, Corn (*Zea Mays* L.)

Introduction

Biofertilizer is one of the modern methods that aim to reduce the excessive use of chemical fertilizers, reduce the sources of environmental pollution, and limit the heavy expense of chemical fertilizers[1] as well; as it is a safe source and its use achieves good economic profits[2,3]. The types of bacteria added as a Biofertilizer, and their uses vary. Some may be phosphorous solvents such as *A.chromobacter* spp., *Bacillus spp*. and *Pseudomonas spp*. On the other side are nitrogen-fixation bacteria such as *Rhizobium spp*. and Azotobacter spp[4].

Biofertilizers, when the application to the soil in the field, faces some problems, including the low number of microorganisms or their lack of competition with the original organisms present in the soil. Therefore, researchers recently sought to try to solve this problem by extending the age of the inoculants and the technique by using the immobilization inoculant, for this purpose through the use of materials of a polymeric nature that can preserve the bacteria inside for as long as possible when applying them to the soil and bacteria's release is slowly[5].

(6) referred that the use of the immobilization inoculant technique for bacteria that dissolve phosphates as a carrier increased the efficiency of inoculation, and the plant's absorption of phosphorous increased by 64%[7] indicated that the use technique with cyanobacteria which fixes atmospheric nitrogen and explained that these inoculant balls behave like capsule as they withstand extreme environmental conditions, and can remain active in the soil for three years, as the results showed an increase in the content of rice leaves of chlorophyll a for treatments containing the immobilization inoculant compared with others, which added in the traditional methods, as many studies dealt with the use of *Thiobacillus thioparus*. The phosphorus present in the soil and added to it in the form of phosphate fertilizers are subjected to adsorption, sedimentation and interaction with calcium, forming many phosphate compounds with different solubility[8]. Therefore, studies focused on studying the application of microorganisms to increase the solubility of phosphorus of soil microorganisms increased the number of dissolved phosphates. Many types of bacteria present in the soil have an influential role in dissolving phosphate minerals. It became the known role of several soil microorganisms in converting insoluble phosphate compounds into available forms for plants. The genus Bacillus is a microorganism that breaks down phosphates from its insoluble compounds in the soil into more available-made forms due to produces from organic acids[9] or its composition, chelating compounds with organic acids resulting from the analysis of the organic matter, and this leads to an increase of available phosphorus in soil[10].

The general view is that there is an absence of any previous study on the importance of using immobilization inoculant technology in calcareous soils in semi-arid and its role in the success of biofertilizers; this study came to achieve this goal through:

Using the Immobilized inoculate technology and comparing its efficiency as an inoculant carrier with the traditional carrying method by using zeolite in field growth and yield of corn. A study of the effect of zeolite and Immobilized inoculum on the viability of B. subtilis and Thiobacillus thiolates in zeolites and in the immobilized inoculate.

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Materials and methods

Preparing inoculant

In immobilized inoculant preparation, take 3 g of sodium alginate, dissolve it in 100 ml of distilled water, and shake it for 30 minutes to obtain a homogeneous solution. Forty-seven grams of Potato-starch was added to sodium alginate to get a matrix solution, and then shake the mixture for 30 minutes for homogeneity. Take 30 ml of the culture and discard it by centrifugal at 8720 rpm for 10 minutes. The pellet or precipitate was taken as a solution in 3 ml of 1% peptone and then mixed with 30 ml of the mixture solution (matrix solution). A 50 ml syringe was used to drop the matrix solution onto a sterile calcium chloride solution (15 g. 1 liter). Leave it for 30 minutes for inoculant balls to form. The wet balls were collected and kept at 4 ° C until use.

How to prepare the regular inoculant (zeolite carrier)

Prepare the zeolite solution at a concentration of 20%, that is, 100 g of zeolite to 500 ml of distilled water in a 1-liter conical flask with three replications, as the rotor was sterilized with a buffer at 121 °C and a pressure of 15 pounds inch-1 then cooled the inoculum and increased 1 ml of the prepared inoculum from the bacterium *T. thioparos* to the first beaker and 1 ml of the inoculum prepared for *B. subtilis* to the second beaker and 1 ml of each of *T. thioparus* and *B. subtilis*, 100 ml of gum arabic was added at a concentration of 10% to all the flasks, and the flasks were incubated for 72 hours. Then corn seeds were added to the inoculant and spread the seeds on cardboard and away from sunlight for half an hour before planting.

Field experiment

A factorial field experiment was carried out at the second agricultural research and experiments station located on the Euphrates River of the Faculty of Agriculture at Al-Muthanna University with two factors, including the first-factor bio-fertilizers. With four levels, the following symbols were taken: B = without application of the bacterial inoculum, B1 = application the *T. thioparus* bacterial inoculant, B2 = application of the bacterial inoculant *B. subtilis*, B3 = application the *T. thioptilis* + *B. subtilis* inoculant, The second factor includes the method of carrying the bacterial inoculant, in which two levels are used. M0 = application of the inoculant carrying on the conventional method, M1 = the carrying of the immobilized inoculant. The land was plowed orthogonally, and the process of leveling and smoothing was performed on it, and then the land was divided into experimental units so that the area of each experimental unit was 6 m-2 (3m x 2m) and the units were divided into lines of the distance between one line and another (70 cm) and the distance between one side and another (25) Then the seeds of maize, class 5018, spring variety, were sown at a rate of (2 seeds hole-1). Soil moisture was maintained for the experimental units when the humidity was lower than 80% of the field capacity after estimating the humidity based on the gravimetric method.

Measurements of Botanical and Statistical Analysis

Plant height, dry weight of shoots, grain yield, nitrogen, phosphorous and potassium uptake in the vegetative part.

The (Genstat) program was used under the operating system (Windows XP) to conduct statistical analyzes. In implementing the field experiment, the design of complete random blocks (RCBD) was used to study the main effects and overlaps between the transactions. The averages were compared by using the lowest significant difference test (LSD Test) at a probability level. 0.05.

Results

Plant height (cm)

The results of Table 1 indicate a significant effect of the type of bacterial inoculum and the method of carrying it on plant height, as treatment B1 surpassed the highest height of 208.11 cm, with an increase of 13.58% in comparison to the control treatment. The reason for this increase may be due to the work of the added microorganisms with different mechanisms, including the dissolution of some nutrients from their insoluble compounds in the soil, as well as the secretion of some organic acids and some hormones and growth regulators that affect cell division and stimulate plant growth. These secretions support plant growth, including increasing plant height. Inoculating maize seeds with biological inoculum increased plant height, and the best results were achieved when using the two inoculums together.

Biofertilizer Type	Carrying Type		Mean B
	M0	M1	
B0	182.77	183.67	**183.22**
B1	202.00	216.22	**208.11**
B2	195.11	212.00	**203.55**
B3	200.3	213.89	**207.09**
Mean	195.04	206.44	
LSD	B	M	BM
	3.35	**3.17**	**5.35**

Table 1. Effect of the type of biofertilizer and its method of carrying it on plant height (cm).

The results showed an effect of the method of carrying the bacterial inoculant on plant height, as it indicates the superiority of the immobilization inoculant method over carrying with zeolites, as it recorded a height value of 206.445 cm. perhaps this is due to the efficiency of the immobilization inoculant in increasing the availability of nutrients such as phosphorous, nitrogen and micronutrients. The results of Table 1 showed the effect of the dual interaction between the type of bacterial inoculant and the method of carrying (B×M) that the treatment of the inoculant (B1M1) was significantly superior to the remaining dual interactions, reaching 216.22 cm. This may be attributed to the efficiency of the immobilization inoculant on the one hand and the other hand, the effectiveness of *T. thioparus* in increasing.

The dry weight of shoots (g plant^{-1})

The results of Table 2 show a significant effect of the type of bacterial inoculum and the method of carrying it, as the results indicate an effect of the type of bacterial inoculum on the dry weight of the vegetative group, as the treatment of the double inoculant for B3 was superior, as it recorded the highest weight of 285.82 g of plant^{-1}, with an increase of 29.23% of the comparison Which recorded 256.59 g of plant^{-1} may be due to the effect of the inoculant for *T. thioparus* + *B. Subtilis*. It gave an increase in the availability of phosphorus from unavailable sources in the soil due to its release of phosphate-dissolving bacteria throughout the growing season as well as the secretion of some organic acids, some hormones and growth regulators affecting cell division and stimulating plant growth and these secretions support plant growth, including increasing its dry weight.

The results of the table indicated the effect of the inoculant carrying method on the dry weight of the plant, as it showed the superiority of the fixed inoculant method (M1) over the zeolite carrier (M0), which recorded 283.13 g. Increasing nutrient availability by secreting enzymes and growth regulators and encouraging plant growth through building a dense root system.

The results of the table showed a significant effect of the interaction between the type of bacterial inoculum and the method of carrying, as it indicated the superiority of the interaction treatment (B3M1) in the dry weight of the plant, as it recorded 293.48 g. Protocooperation, as the bacteria in the soil need one or more vitamins or growth elements in their growth, so many other soil organisms secrete these substances in order for other bacteria to benefit from them, which encourages their growth and increase in their numbers, which positively affects their effectiveness and this was confirmed by Wu *et al.*[14] In addition to the efficiency of the immobilization inoculant in an environment suitable for bacteria against the extreme environmental conditions of drought and high temperatures.

Grain yield in mg ha^{-1}

The results of Table 3 show a significant effect of the type of bacterial inoculum and the method of carrying the inoculum. The results indicate a product of the kind of bacterial inoculum on the grain yield. The double inoculum treatment B3 excelled, as it recorded the highest weight of 6.963 kg ha^{-1} with an increase of 9.43% relative to the comparison treatment, that It recorded 6.3625 kg ha^{-1}. The reason for this increase may be due to the work of microorganisms added with different mechanisms and mechanisms, including the dissolution of some nutrients from their insoluble compounds in the soil, as well as the secretion of some organic acids, some hormones and growth regulators that affect cell division and stimulate plant growth and support these secretions Plant growth, including increasing grain yield

The results of the table indicated the effect of the method of carrying the inoculum on the dry weight of the plant, as it showed the superiority of the method of restricting the bacterial inoculum (M1) on the carrying with zeolite (M0), as it recorded 7.186 kg.ha^{-1}.

The results of the table showed the effect of the dual interaction of the type of bacterial inoculum and the method of carrying, as it indicated the superiority of the interaction B1 M1 between the single inoculum of *T. thioparus* and the method of inoculum fixed in the dry weight of the plant on the rest of the treatments, as it recorded 7.188 kg ha^{-1}. This may be attributed to the positive interaction between the two genera of bacteria. A protocooperation arose between them, as the bacteria in the soil need one or more vitamins or growth elements for their growth, so many other microscopic soil organisms secrete these substances for the bacteria to benefit from them, which encourages their growth and increase in their numbers, which positively affects the effectiveness of bacteria and this is what Confirmed by Schoebitz[6]. In addition to the efficiency of the inoculum installed in a suitable environment for bacteria against the extreme environmental conditions of drought and high temperatures.

Biofertilizer Type	Carrying Type		Mean B
	M0	M1	
B0	250.13	263.06	**256.59**
B1	277.16	285.84	**281.50**
B2	267.07	290.16	**278.61**
B3	278.17	293.48	**285.82**
Mean	268.13	283.13	
LSD	B	M	BM
	5.57	4.77	7.54

Table 2. Effect of the type of biofertilizer and its method of carrying it on The dry weight of the shoots (g plant^{-1}).

Biofertilizer Type	Carrying Type		Mean B
	M0	M1	
B0	6.372	6.353	**6.362**
B1	6.663	7.188	**6.925**
B2	6.576	7.071	**6.823**
B3	6.74	7.186	**6.963**
Mean	**6.59**	**6.95**	
LSD	B	M	BM
	0.282	**0.251**	**0.412**

Table 3. Effect of the type of biofertilizer and its method of carrying it on Grain yield in (mg ha^{-1}).

Nitrogen uptake (kg ha^{-1})

The results of Table 4 show a significant effect of the type of bacterial inoculum and the method of its carrying. The results indicate that there is an effect of the type of bacterial inoculum on the amount of nitrogen uptake, as the treatment of the dual inoculum of B3 bacteria was superior, as it recorded the highest percentage of 120.15 kg ha^{-1} with an increase of 23.91% relative to the comparison treatment, which recorded 96.96 kg ha^{-1}. This is due to the effect of the inoculum effect of the double bacterium *T. thioparus* + *B. Subtilis*, which gave an increase in the availability of nitrogen and phosphorous from unavailable sources in the soil as a result of its release by the bacteria throughout the growing season, the reason for this may be due to the efficiency of the inoculum in increasing the availability of nutrients such as nitrogen, phosphorous and micro-nutrients and their secretion to growth regulators such as indole acetic acid (IAA) and gibberellic acid (GAA). The availability of nutrients through their secretion of enzymes and growth regulators and the encouragement of plant growth by building a dense root system. The best results were achieved when using the two inoculums together.

The results of the table indicated the effect of the method of carrying the inoculum on the amount of nitrogen uptake by the plant, as it showed the superiority of the method of restricting the bacterial inoculum (M1) (the fixed inoculum) over carrying with zeolite (M0), which recorded 114.96 kg. ha^{-1}, which may be due to the effectiveness of the method of fixing the inoculum in Increasing the effectiveness of the inoculum added to the soil.

The results of the table showed the effect of the dual interaction of the type of bacterial inoculum and the method of carrying on the uptake nitrogen, as it indicated the superiority of the interaction of B3 M1 between the single *T. thioparus* inoculum and the method of the fixed inoculum on the rest of the treatments, which recorded 124.73 kg N ha^{-1}.

Phosphorous uptake (kg ha^{-1})

The results of Table 5 show a significant effect of the type of bacterial inoculum and the method of its carrying. The results indicate an effect of the type of bacterial inoculum on the uptake of phosphorous. The treatment of the dual inoculum of B3 bacteria was superior, as it recorded the highest value of 29.57 kg ha^{-1} with an increase of 30% relative to the comparison treatment that It was recorded 22.63 kg ha^{-1} due to the effect of the inoculum against the double bacterium *T. thioparus* + *B. Subtilis*, and the effect of the inoculum against the bacterium *T. thioparus* in increasing the availability of phosphorus from unavailable sources in the soil as a result of its release of phosphate-dissolving bacteria throughout the growing season.

The results of the table indicated the effect of the method of carrying the inoculum on the uptake phosphorous, as it showed the superiority of the method of immobilization

Biofertilizer Type	Carrying Type		Mean B
	M0	M1	
B0	94.36	99.57	**96.96**
B1	111.04	118.26	**114.65**
B2	105.32	117.31	**111.31**
B3	115.58	124.73	**120.15**
Mean	106.57	114.96	
LSD	B	M	BM
	6.1	**5.8**	**6.6**

Table 4. Effect of the type of biofertilizer and its method of carrying it on Nitrogen uptake (kg ha^{-1}).

Biofertilizer Type	Carrying Type		Mean B
	M0	M1	
B0	21.79	23.47	**22.63**
B1	27.19	29.28	**28.23**
B2	25.96	29.24	**27.6**
B3	28.19	30.96	**729.5**
Mean	25.78	**28.23**	
LSD	B	M	BM
	1.41	**0.82**	**1.62**

Table 5. Effect of the type of biofertilizer and its method of carrying it on Phosphorous uptake (kg ha^{-1}).

of the bacterial inoculum (M1) (the fixed inoculum) to carrying with zeolite (M0), as it recorded 28.23 kg. Biofertilization with Azotobacter bacteria led to the ability of the bacterial inoculum to increase the availability of major elements such as phosphorous, nitrogen and microelements in the soil, which is positively reflected on the amount uptake in the plant and thus to transport carbohydrates from the areas of their manufacture to their assembly in the grains, as mentioned[17] that the importance of These elements come from its important role in improving the products of photosynthesis and the speed of transporting the products to storage sites such as fruits, grains and tubers, as it speeds up the process of converting those products into starch, proteins and oils, and this was confirmed by (Member, 2004). The reason for this may be due to the efficiency of the inoculum in increasing the availability of nutrients such as nitrogen, phosphorous and micro-nutrients and their secretion to growth regulators such as indole acetic acid (IAA) and gibberellic acid (GAA), and this was confirmed by (14). Availability of nutrients through their secretion of enzymes and growth regulators and encouragement of plant growth by extensive a dense root system

The results of the table showed the effect of the dual interaction of the type of bacterial inoculum and the method of carrying on the uptake phosphorous, as it indicated the superiority of the interaction B3 M1 between the single inoculum of *T. thioparus* and the method of the inoculum fixed in the uptake phosphorus on the rest of the treatments, which recorded 30.96 kg ha^{-1}. The reason for this may be attributed to the positive interaction between genus Bacteria as a protocooperation arose between them as the bacteria in the soil need one or more vitamins or growth factors in their growth, so many other microscopic soil organisms secrete these substances in order for the bacteria to benefit from them, which encourages their growth and increase in their numbers, which positively affects the effectiveness of bacteria This was confirmed by (18) in addition to the efficiency of the inoculum installed in a suitable environment for bacteria against the extreme environmental conditions of drought and high temperatures.

Potassium uptake (kg ha^{-1})

The results of Table 6 show a significant effect of the type of bacterial inoculum and the method of its carrying. The results indicate that there is an effect of the type of bacterial inoculum on the uptake of potassium, as the treatment of the dual inoculum of B3 bacteria was superior, as it recorded the highest value of 76.00 kg ha^{-1} with an increase of 21.91% relative to the comparison treatment It was recorded 62.34 kg ha^{-1} due to the effect of the inoculum effect of the double bacterium *T. thioparus* + *B. Subtilis*, which gave an increase in the availability of phosphorus from unavailable sources in the soil as a result of releasing phosphate-dissolving bacteria throughout the growing sea-

Biofertilizer Type	Carrying Type		Mean B
	M0	M1	
B0	60.71	63.98	**62.34**
B1	71.88	75.25	**73.56**
B2	68.72	75.17	**71.94**
B3	72.93	79.07	**76.00**
Mean	68.56	73.36	
LSD	B	M	BM
	2.2	**1.1**	**3.9**

Table 6. Effect of the type of biofertilizer and its method of carrying it on Potassium uptake (kg ha^{-1}).

son. The reason for this increase may be due to the action of microorganisms added with different mechanisms and mechanisms, including the dissolution of some nutrients from their insoluble compounds in the soil, in addition to the secretion of some organic acids and some hormones and growth regulators that affect cell division and stimulate plant growth. These secretions support plant growth, including increasing its dry weight. This was confirmed by Rahmani (2018) and Al-Obaidi (2013) that inoculation of maize seeds with Azospirillum SPP or Pseudomonas fluoescence led to an increase in chlorophyll concentration, leaf surface area, vegetative dry weight and water content, and the best results were achieved when using both inoculums together.

The results of the table referred to the effect of the method of carrying the inoculum on the uptake of potassium, as it showed the superiority of the method of restricting the bacterial inoculum M1 on the carrying with zeolite (M0), as it recorded 73.36 kg. ha^{-1}. The ability of the bacterial inoculum to increase the availability of major elements such as phosphorous, nitrogen and microelements in the soil, which is positively reflected on the amount uptake in the plant and thus to transport carbohydrates from the areas of their manufacture to their assembly in the grains, as mentioned (Mengel and Kirkby, 1987) that the importance of these elements comes from its important role In improving the products of photosynthesis and the speed of transporting the products to storage sites such as fruits, grains and tubers, as it speeds up the process of converting those products into starch, proteins and oils, and this was confirmed by18. The reason for this may be due to the efficiency of the inoculum in increasing the availability of nutrients such as nitrogen, phosphorous and micro-nutrients and their secretion to growth regulators such as indole acetic acid (IAA) and gibberellic acid (GAA), and this was confirmed by (6). Availability of nutrients through their secretion of enzymes and growth regulators and encouragement of plant growth by building a dense root system.

The results of the table showed the effect of the dual interaction of the type of bacterial inoculum and the method of carrying on the uptake of potassium, as it referred to the superiority of the interaction B3 M1 between the single inoculum of *T. thioparus* and the method of the inoculum fixed in uptake phosphorous on the rest of the treatments, which recorded 79.07 kg ha^{-1}. Bacteria as a protocooperation arose between them, as the bacteria in the soil need one or more vitamins or growth elements in their growth, so many other microscopic soil organisms secrete these substances in order for the bacteria to benefit from them, which encourages their growth and increase in their numbers, which positively affects the effectiveness of bacteria.

Discussion

The results showed an effect of the method of carrying the bacterial inoculant on plant height; this is due to the efficiency of the immobilization inoculant in increasing the availability of nutrients such as phosphorous, nitrogen and micronutrients and their excretion of growth regulators such as indole acetic acid (IAA) and gibberellic acid (GAA) this is what (7) confirmed, to the possibility of using the immobilization inoculant technology in soils poor in nutrients, as he used this technique with bacteria that fix atmospheric nitrogen and explained that the inoculant balls behave like spores as they endure extreme environmental conditions to remain active in the soil for three years. The availability of the necessary nutrients for growth and the secretion of bacteria to organic acids reduce the acidity of the soil as the immobilization inoculant increases the bacterial density per unit volume of soil as a result of providing bacteria during the growing season[11]. The above results was confirmed by (12) that inoculation of yellow corn seeds with Azospirillum SPP or Pseudomonas fluorescence led to an increase in chlorophyll concentration, leaf surface area and dry vegetative weight, and the best results were achieved when Use both inoculants together. These results are also consistent with what (8) indicated that many types of microorganisms that inhabit the rhizosphere have the ability to encourage plant growth when added to seeds and roots in addition the leaves, through the secretion of many stimulants for growth[13]. (7) emphasized the possibility of using the immobilization inoculant technology in soils poor in nutrients when he used this technique with cyanobacteria that fix atmospheric nitrogen and explained that these inoculant balls behave like capsule to withstand extreme environmental conditions and can remain active in the soil for up to three years. The results of the table indicated the effect of the method of carrying the inoculum on the dry weight of the plant, the reason for this is due to the efficiency of the proven inoculum in releasing bacteria to the soil continuously and for a longer period, and therefore Increasing the availability of nutrients through their secretion of enzymes and growth regulators and encouraging plant growth through building a dense root system[15]. Moreover, (7) pointed out to the possibility of using the proven inoculum technique in soils poor in nutrients when he used this technology with cyanobacteria that fix atmospheric nitrogen. It can remain active in the soil for three years, as it speeds up the process of converting these products into starch, proteins and oils. However (16) indicated that the inoculum immobilization by *T. thioparus* has increased the amount of phosphorus uptake in the wheat plant as a result of increasing the availability of phosphorus due to the phosphatase enzyme secreted by the bacteria, which dissolves the deposited phosphate and forms a dense radical group, which is positively reflected in the availability of phosphorus from non-available sources. ready-made in the soil as a result of its release of phosphate-dissolving bacteria throughout the growing season. (7) was confirmed in addition to the efficiency of the inoculum installed in a suitable environment for bacteria against the extreme environmental conditions of drought and high temperatures[19,20].

Conclusions

The study of the dual bacterial inoculant B3M2 superior in plant height, dry weight, bio-yield, grain yield, uptake amount of nitrogen, phosphorus and potassium in the shoots and the concentration of available phosphorus in the soil. which is recorded 227.33 Cm, 321.23 g $plant^{-1}$, 171.44 g, 7.68 t ha^{-1}, 89.21 (kg N ha^{-1}), 21.92 (kg P ha^{-1}), 171.82 (kg K ha^{-1}), 29.6 (mg P ha^{-1}) Sequentially, the same treatment also achieved 99.6% compared to the recommendation of the full fertilizer in the grain yield.

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