Research on World Agricultural Economy
http://ojs.nassg.org/index.php/rwae

DCD on Mechanism of Improving Nitrogen Utilization and Application in Production of Slow-Release Fertilizers

Cheng Sun*

Academician Studio of the Rural Education Development Center, World Academy of Productivity Science, Beijing, 102600, China

ARTICLE INFO

Article history
Received: 19 March 2020
Revised: 26 March 2020
Accepted: 24 April 2020
Published Online: 30 April 2020

Keywords:
DCD
Mechanism
Slow-Release fertilizer

ABSTRACT

This paper introduces the composition, properties and uses of DCD, the effect of DCD on various crop, summaries the fertilizer effect test of fertilizer Nano slow release agent, analyzes the economic benefit analysis of fertilizer Nano slow release agent.

1. The Composition, Properties and Uses of DCD

DCD molecular formula is $C_2H_4H_4$, structural formula is $(NH_2)_2CNCN$, molecular weight is 84.08, white crystal, slightly bitter taste, non-volatile, non-moisture absorption. Easily soluble in water, ethanol, acetone, liquid ammonia, ammonia water, etc. Each 100ml of water (25℃) dissolves about 4g, 100ml ethanol dissolves about 1.7g, 100ml acetone dissolves about 0.7g,100ml of liquid ammonia dissolves about 4-8g. Reaction with acid can generate guanidines, and reaction with alkali can generate melamine.

DCD is an ideal nitrification inhibitor. It can effectively inhibit the formation of nitrate ammonia in the soil, inhibit the activity of nitrosating bacteria, and slow down or delay the oxidation of NH_4 to NO_3. NO_3 can be directly absorbed and utilized by crops, but it is easily leached and produces denitrification, forming NO_2, causing environmental pollution. The test results show that the peak of nitrate nitrogen in nitrogen fertilizer without DCD was formed at 32 days, while the peak period of nitrate nitrogen in nitrogen fertilizer with DCD appeared at about 62 days, which was delayed by 30 days.

DCD has an ammonia stabilizing effect. Nitrogen fertilizer mainly has three forms, namely amide nitrogen, ammonium nitrogen and nitrate nitrogen. NH_3 volatilization loss is common in farmland application. Generally, the loss in paddy field accounts for more than 50% of the total nitrogen loss. NH_3 volatilization loss accounts for more than 30% of the total nitrogen loss. This kind of volatilization loss shows different volatilization characteristics and different processes on different nitrogen fertilizer varieties. The volatilization loss of urea and ammonium sulfate occurs after a period of time with the soil. The initial volatilization of urea and ammonium sulfate into the farmland is much lower than that of ammonium bicarbonate. Ammonium bicarbonate is directly decomposed due

**Corresponding Author:*
Cheng Sun,
Academician Studio of the Rural Education Development Center, World Academy of Productivity Science, Beijing, 102600, China;
E-mail: sc@nassg.org

DOI: http://dx.doi.org/10.36956/rwae.v1i1.165

to its active molecules, so the NO_3 concentration is high and the initial volatilization amount is large. DCD has a significant ammonia stabilizing effect. Mix DCD into ammonium bicarbonate in proportion, and perform ammonia volatilization rate comparison experiment with ordinary ammonium bicarbonate at 43 ℃ to determine the volatilization of the two. When the volatilization reaches 1% residual amount It took 10 days for ammonium bicarbonate, 12 days for DCD ammonium bicarbonate, and the time was extended by 1.2 times; the volatilization loss was 3, 4, 5, 6, 7, and 8 days, and the daily reduction of the volatilization loss was 9, respectively. 12, 16, 14, 12, 9 percentage points. This ammonia stabilizing effect of DCD, the results of the indoor simulated cultivation experiment showed that it increased the effective nitrogen storage rate in the soil by 12.5%.

According to practical research results, mixing DCD with urea and carbon into the soil can reduce the loss of ammonia nitrogen by 30%, and the amount of organic matter in the soil has doubled. The organic compound DCD is a nano material that can reduce the pH value of the soil by 0.2-0.4, thereby increasing the adsorption strength of soil colloids and clay particles to ammonia ions.

The practical application of DCD has improved the utilization rate of chemical fertilizers and reduced the amount of chemical fertilizers applied. The amount of organic soil material in the soil has doubled, improved the soil aggregate structure, reduced the soil pH value, and has significant effects on soil ecological restoration effect.

2. The Effect of DCD on Various Crops

According to the Shenyang Agricultural Technology Extension Station and the Shenyang Institute of Ecology of the Chinese Academy of Sciences, a systematic field experiment, demonstration and extension of DCD has been carried out in more than ten counties and districts in Shenyang, and a large amount of scientific data has been obtained. The cumulative promotion area of peanuts, soybeans, vegetables and fruit trees has reached more than 2 million mu, which has achieved significant economic benefits and has been recognized by the majority of farm-

Table1. Multi-point test results of slow-release urea applied to corn in 1998

process	Test location	Yield per mu(kg)	To increase production rate (kg/mu)	To increase production rate(%)	Economic benefits (yuan/mu)	Average yield increase (%)
The urea	Xincheng Area	601	0	0	0	0
The urea +DCD	Qingshuitai Town	633	32	5.32	24.8	9.72
The urea	Sunongtun Area	594	0	0	0	
The urea +DCD	Chenxiangtun Town	664	70	11.78	59.0	
The urea	Dongling Area	565	0	0	0	
The urea +DCD	Gaokan Town	608	43	7.61	34.7	
The urea	Dongling Area	485	0	0	0	
The urea +DCD	Wangbin township	540	55	11.34	15.5	
The urea	Donging Area	535	0	0	0	
The urea +DCD	Zhujia Town	593	58	10.84	48.2	
The urea	Kangping County	585	0	0	0	
The urea +DCD	Liangjiazi Farm	622	37	6.32	29.3	
The urea	Yuhong Area	521	0	0	0	
The urea +DCD	Luojiatun Township	604	83	15.93	70.7	
The urea	Yuhong Area	598	0	0	0	
The urea +DCD	Laobian Township	654	56	9.36	56.4	
The urea	Faku Town	765	0	0	0	
The urea +DCD	Yuanzhong Field	841	76	9.93	64.4	
The urea	Xinchengzi Area	556	0	0	0	
The urea+DCD	Huangjia Township	605	49	8.81	40.1	

Table 2. Multi-point test results of slow-release urea in rice in 1998

process	Test location	Yield per mu(kg)	To increase production rate(kg/mu)	To increase production rate(%)	Economic benefits (yuan/mu)	Average yield increase(%)
The urea	Yuhong Area	610	0	0	0	0
The urea +DCD	Yuhongtai Township	653	43	7.05	47.6	9.98
The urea	Faku Country	483	0	0	0	
The urea +DCD	Fengbeibao Township	550	67	13.87	76.4	
The urea	Faku Country	546	0	0	0	
The urea +DCD	Yiniubao Township	592	46	8.42	51.2	
The urea	Xinchengzi Area	579	0	0	0	
The urea +DCD	Shifuo Town	662	83	14.34	95.6	
The urea	Dongling Area	529	0	0	0	
The urea +DCD	Gucheng Township	562	33	6.24	35.6	

 DOI: http://dx.doi.org/10.36956/rwae.v1i1.165

ers. The statistics of the test results are shown in Table 1-5 below.

Table 1 The yield comparison test of basal application or top-dressing of DCD-containing slow-release urea and ordinary urea of corn crops showed that slow-release urea increased the yield by 5.32%-15.93% compared with ordinary urea, and the average yield rate was 9.72%, and the economic benefit per mu increased by 24.8 -70.7 yuan, with an average value of 46.28 yuan per mu.

The rice yield measurement results in Table 2 show that slow-release urea increases the grain yield by 33-83 kg per mu compared with ordinary urea, with an average increase of 54.4 kg; the increase rate is 6.24-14.34%. The average yield increase rate is 9.98%, and the average economic income per mu is 62.28 yuan. Slow-release urea is applied as a one-time base fertilizer when rice seedlings are transplanted, which can eliminate the 4-5 top-dressing process. If weeding with pesticides, it can achieve no cultivating.

The application of slow-release urea for peanuts has a higher yield increase, more than 2 knots per plant, 1g increase in 100-grain weight, the yield increased by 5 percentage points, the yield per acre increased by 64.5 kg, the yield increased by 23.98%, and the economic income per acre increased by 189.5 yuan.

Soybean application of slow-release urea has obvious yield increase benefits. From the performance of the plant, the number of seeds increased by 3-8, the weight of 100-seed increased by 0.7-1.7G, the average yield per mu increased by 34 kg, the yield increase rate was 13.7%, and the economic benefit per mu increased by 67.33 yuan.

The use of slow-release urea in fruit trees has a relatively high yield increase and economic benefits, with an average yield increase rate of 22.29%, increasing economic income by 467 yuan per mu; and slow-release urea can promote early ripening of fruits and increase fruit size due to the effect of DCD.

In summary, the application of DCD on field crops, cash crops, and fruit trees has achieved stable yield and income increase benefits. The yield increase rate on field crops is 5.32%-15.93%, and the annual rate is 9.72%; the application increase rate on oil crops 10.50%-23.98%, with an average of 16.28%; the increase rate of application on fruit trees is 22.2%, all of which have obvious yield increase benefits.

3. Summary of Fertilizer Effect Test of Fertilizer Nano Slow Release Agent

"Century Tianwang" fertilizer nano slow-release agent is composed of natural minerals, nano-organic compound materials, and trace elements. It integrates urease inhibi-

Table 3. Experimental results of slow-release urea for peanut in Liaozhong County in 1998

process	Number of pods(per)	Hundred grain weight(g)	Yield per mu(kg)	Increase production (Kg/mu)	rate of growth(%)	Economic benefit(yuan/mu)
The urea	11.0	18.0	269.0	0	0	0
The urea+DCD	13.0	19.0	333.5	64.5	23.98	189.5

Table 4. Multi-point test results of slow-release urea applied to soybean in 1998

process	Test location	Number of seeds(grain)	Hundred grain weight(g)	Yield per mu(kg)	Increase production (Kg/mu)	rate of growth(%)	Economic benefit(yuan/mu)
The urea	Kaiyuan Town	28.8	18.1	157	0	0	0
The urea +DCD	Agency Farm	31.8	18.8	180	23	14.65	46.3
The urea	Seed Company	43.9	16.9	256	0	0	0
The urea +DCD		48.5	17.8	297	41	16.02	81.8
The urea		52	21.2	362	0	0	0
The urea +DCD		60	22.9	400	38	10.50	73.9
The average					34	13.72	67.33

Table 5. Application of slow-release urea on fruit trees in 1998

process	Test tree species	Yield per mu(kg)	Increase production (Kg/mu)	rate of growth(%)	Economic benefit(yuan/mu)
The urea	Big Sand Apricot Tree	24	0	0	0
The urea +DCD		30	300	25.00	356
The urea	Plum Tree	32	0	0	0
The urea +DCD		39	350	21.88	556
The urea	Hawthorn Tree	20	0	0	0
The urea +DCD		24	240	20.00	428
The average			297	22.29	467

DOI: http://dx.doi.org/10.36956/rwae.v1i1.165

tion, nitrification inhibition, ammonia stabilization, and plant growth regulation. A kind of fertilizer additive with the comprehensive effect of function mechanism. It is also a natural bio-nano composition for soil ecological restoration and agricultural pollution control. Its appearance is a white or dark brown powder, with good stability, not easy to volatilize and not deteriorate. It is mixed and used in a certain proportion with nitrogen fertilizers, which has strong adhesion and good affinity; fertilizer nano slow-release agents can also be added to compound fertilizers, in the formula of compound fertilizer production process, long-acting slow-release compound fertilizer and compound fertilizer are produced. The main functions of fertilizer nano slow-release agents are:

(1) It can be used as a soil conditioner to promote the formation of soil aggregate structure and improve soil physical properties.

(2) It can be used as a plant growth agent. The polyphenol structure in the molecule can be used as oxygen reduction. Therefore, it strengthens the respiration of plants, promotes the absorption of nutrients by plants, promotes root growth, enhances crop resistance, and promotes

Early maturity increases crop yield and improves crop quality.

(3) It can not only improve the utilization of N, P, K but also effectively inhibit the urease activity in the soil and act as a urease inhibitor.

(4) It is also an ideal nitrification inhibitor. It can effectively inhibit the formation of nitrate-nitrogen in the soil, inhibit the activity of nitrosating bacteria, and slow down or delay the rate of oxidation of NH4 to NO3.

(5) Has ammonia stabilizing effect. Mixing slow-release agents with urea and carbon into the soil can reduce the loss of ammonia nitrogen by 30%, while the fixed amount of organic matter in the soil more than doubles.

(6) The organic compound in the fertilizer nano slow release agent is a kind of nanomaterial, which can reduce the pH value in the soil, thereby increasing the adsorption strength of soil colloids and clay particles to ammonia ions.

Fertilizer nano slow-release agent is a new high-tech material for soil ecological restoration with DCD and natural humic acid as the main raw materials. The material is a new high-tech material for soil ecological restoration, which integrates urease inhibition, nitrification inhibition, ammonia stabilization, and plant growth stimulators. New type fertilizer slow release agent. Multiple applications of variable nitrogen fertilizers are used as a base application. During the entire growth period of the crop, no topdressing can be used to extend the effective period of nitrogen fertilizer and increase the nitrogen utilization rate. According to the Liaoning Provincial Soil Station in 1997, 8 test points were arranged on corn and rice. The test results can be summarized as follows.

3.1 Materials and Methods

(1) Test materials: Diammonium, urea, ammonium chloride, fertilizer slow release agent

(2) Test soil: Paddy soil, brown soil, meadow soil

(3) Test crop: Corn, rice

(4) Field trial design: Set 4 treatments (the treatment changes or less than 4 treatments are also taken into consideration), each treatment is set to be repeated three times, arranged in random blocks, and the plot area is 20 square meters.

3.2 Experimental Effect of Fertilizer Nano Slow-Release Agent on Corn

(1) Test results in five sites in Liujiahe, Fengcheng city and Xima, Dengta city

I. Conventional fertilization (Diammonium 10 kg/mu + urea 10 kg/mu)

II. Conventional fertilization + slow release agent 0.6 kg/mu

III. Urea 20 kg/mu + slow release agent 1.2 kg/mu

Analysis of Test results

From Table 6 to Table 7, it can be seen that the 2 and 3 places where the slow-release agent is applied. From Table 6 to Table 8, it can be seen that the growth and development of corn is significantly better than that of conventional fertilization in the 2 and 3 treatments of the

Table 6. Investigation Form of Corn Growth Period

Experiment location	Process	Sowing period	Emergence period	Pull seedlings peroid	Tasseling period	Grouting period	Maturity peroid
Feng City	I	4.24	5.9	6.18	7.22	8.10	9.20
Liu Jia He	II	4.24	5.5	6.17	7.21	8.9	9.19
	III	4.24	5.9	6.18	7.22	8.10	9.20
Deng Ta	I	5.15	5.20	6.10	7.20		10.3
Xi Ma	II	5.15	5.20	6.10	7.19		10.2
	III	5.15	5.20	6.10	7.18		10.3

 DOI: http://dx.doi.org/10.36956/rwae.v1i1.165

Table 7. Investigation Form of Corn Growth Characters

Experiment location	Process	Plant height(cm)	Leaf color	Ears per mu (per)	Number of grains per spike (per)	100 grain weight
Feng City	I	291	green	2364	498.0	37.0
Liu Jia He	II	294	Dark green	2464	556.0	38.8
	III	292	Dark green	2398	532.0	37.6
Deng Ta	I	220	Darker green	2623	634.2	32.1
Xi Ma	II	218	Darker green	2634	634.4	33.3
	III	216	Darker green	2628	636.1	34.0

Experiment location	Process	Plant height(cm*cm)	Ear number per/m^2	Empty shot rate%	Ears per mu (per)	Number of grains per spike (per)	100grain weight(g)
Deng Ta	I	55*36.3	5.0	15.5	2824	645.8	32.1
Wang Jia	II	55*37.2	4.8	12.7	2818	622.0	33.3
	III	55*36.6	5.0	15.5	2807	632.1	34.0

Table 8. Corn Production Survey Form

Test Location	I	II			III		
	Yield per mu	Yield per mu	Increase yield per mu	Increase rate	Yield per mu	Increase yield per mu	Increase rate
Fengcheng Liujiahe	382.5	416.9	34.4	9.0	410.2	27.7	7.2
Dengta Xima	534.0	556.4	22.4	4.2	568.4	34.4	6.4
Dengta Wangjia	524.7	545.7	21.0	4.0	546.1	21.4	4.1

slow-release agent. The performance is the best. Compared with other treatments, the maturity period is 1 day earlier, the leaf color is dark green, the empty stem rate is reduced, and the number of ears per mu and 100-grain weight are increased. In terms of output, treatments 2 and 3 increase the output by 21.4-34.4 kg compared with 1 and the increase rate is 4.0%-9.0%.

(2) Test results in Zhen'an district, Dandong city:

Test treatment: I Conventional fertilization (Diammonium 10 kg/mu + urea 10 kg/mu) II Conventional fertilization (Diammonium 10 kg/mu + urea 20 kg/mu) III Conventional fertilization 1+Slow release agent 0.6 kg/mu IV Conventional fertilization 2+ slow release agent 1.2 kg/mu

Table 9. Corn growth period, growth traits and yield survey table

process	Sowing period	Emergence period	Feast	Tasseling period	Grouting period	Maturity	Growth Period
I	5.3	5.14	6.27	7.23	8.8	15	9
II	5.3	5.14	6.27	7.23	8.8	15	9
III	5.3	5.14	6.27	7.23	8.8	15	9
IV	5.3	5.14	6.27	7.23	8.8	15	9

Treatment/ fertility traits	Plant height/ CM	Leaf color	Ear rows	The number of grains	100grain weight	—
I	208	green	16	570	27.4	—
II	212	green	16	600	28.5	—
III	217	Dark green	16	620	29.9	—
IV	215	Dark green	16	600	29.3	—

Processing item	Plot yield /123	Average	Yield per mu/ Kg	Yield increase per mu	Increased production rate	project
I	12.76	13.65	12.95	13.12	364.08	—
II	13.74	14.22	15.13	14.36	398.49	34.11
III	16.86	14.6	15.28	15.58	432.62	68.54
IV	15.56	14.6	14.18	14.78	410.15	46.07

It is obvious from the test results in Table 9 that all the treatments using sustained-release agents:

Obviously there is no difference in growth period, but growth traits and yield are dominant, especially treatment III. Compared with conventional fertilization I, the plant height increases by 9 cm, the leaf color is dark green, the number of grains per ear increases by 50 grains, and the 100-grain weight increases by 2.5g. The output increased by 68.5 kg, an increase of 18.8%. From the perspective of the increase in yield, Treatment III (10 kg/mu of diammonium + 10 kg/mu of urea + 0.6 kg/mu of sustained-release agent) is better than IV (10 kg/mu of diammonium + 20 kg/mu of urea + sustained-release agent 1.2 Kg/mu), indicating that too much nitrogen fertilizer should not be applied to the slow-release agent. It has obvious fertilizer

DOI: http://dx.doi.org/10.36956/rwae.v1i1.165

saving effect. A small amount of slow-release agent can play an ideal synergistic effect.

3.3 Application Effect of Fertilizer Nano Slow-Release Agent on Rice

(1)Test results in Kaiyuan test site

Test treatment: I Conventional fertilization□Diammonium 10 kg/mu + ammonium chloride 25 kg/mu□ II Conventional fertilization I+ sustained release agent 1.0 kg/mu III Diammonium 10 kg/mu + urea 15 kg/mu IV Diammonium 10 kg/mu + urea 15 kg/mu + sustained release agent 0.9 kg/mu The test results and analysis are shown in Table 10.

It can be seen from Table 10 that the application of slow-release agents does not affect the growth period of rice, but obviously promotes the growth and development of rice. Compared with the control, the color of the two leaves is darkened, and the number of effective tillers,

Table 10. Rice growth period, growth traits and yield survey table

Treatment \ Childbearing Period	Sowing period	Planting period	Rejuvenation period	Tillering stage	Jointing period	Heading date	Maturity
Ⅰ	4.9	5.25	5.31	6.8	7.11	8.9	10.2
Ⅱ	4.9	5.25	5.31	6.8	7.11	8.9	10.2
Ⅲ	4.9	5.25	5.31	6.8	7.11	8.9	10.2
Ⅳ	4.9	5.25	5.31	6.8	7.11	8.9	10.2
Treatment \ Childbearing Period	Plant height	Leaf color	Dispensing rate	Ears per mu	Number of grains per spike	Number of loam	Thousand grains
Ⅰ	100.1	green	85.5	274680.4	68.1	21.4	25.1
Ⅱ	100.2	yellow	86.0	278680.6	68.9	24.5	25.6
Ⅲ	100.5	green	85.1	273347.0	68.3	21.6	25.0
Ⅳ	100.9	green	85.6	277347.2	68.0	23.2	25.9
		yellow					
		green					
Treatment/ Project		Plot yield/123		Average/ kg	Yield per mu/kg	Yield increase per mu/kg	Increased production rate/%
Ⅰ	14.5	14.8	13.2	14.1	470.0	—	—
Ⅱ	14.8	15.0	14.2	14.7	490.0	20.0	4.3
Ⅲ	14.1	14.3	13.7	14.0	466.7	—	—
Ⅳ	14.1	15.2	14.9	14.8	493.4	20.7	4.7

Table 11. Rice growth period, growth traits and yield survey table

Treatment\ Growth Period	Sowing period	Planting period	Rejuvenation period	Tillering stage	Jointing period	Heading date	The mature stage
Ⅰ	4.8	5.25	5.31	6.5	6.18	8.3	9.24
Ⅱ	4.8	5.25	5.31	6.5	6.18	8.5	9.24
Ⅲ	4.8	5.25	5.31	6.5	6.18	8.6	9.24
Ⅳ	4.8	5.25	5.31	6.5	6.18	8.7	9.24
Treatment/ fertility traits	Plant height	Leaf color	Tillering stage(%)	Ears per mu(per)	Spike grain number	Pi grain number	Thousand grains
Ⅰ	102	Light green	28.9	106.3	79.5	25.2	25.4
Ⅱ	101	green	28.5	108.5	81.8	24.6	25.3
Ⅲ	97	Dark green	29.2	110.2	84.4	23.4	26.0
Ⅳ	100	Dark green	28.8	109.8	84.1	23.4	25.8
Treatment/ Project		Plot yield/123		Average/ kg	Yield per mu/kg	Yield increase per mu/kg	Increased production rate/%
Ⅰ	15.6	16.0	15.8	15.8	526.9	0	0
Ⅱ	16.5	16.6	16.8	16.6	553.6	26.7	5.1
Ⅲ	17.0	17.1	16.8	17.0	565.8	38.9	7.4
Ⅳ	16.8	17.6	16.9	16.9	563.6	36.7	7.0

 DOI: http://dx.doi.org/10.36956/rwae.v1i1.165

ears per mu, grains per ear, Thousand-grain weights all increased. In terms of the increase in output, the increase rates were 4.3% and 5.7%, respectively.

(2) Test results in Haicheng test site

Test treatment: Ⅰ Conventional fertilization（Diammonium 10 kg/mu + ammonium chloride 25 kg/mu）Ⅱ Conventional fertilization I+ sustained release agent 1.0 kg/mu Ⅲ Ammonium Chloride 40 kg/mu + slow release agent 1.6 kg/mu Ⅳ Diammonium 10 kg/mu + urea 15 kg/mu + sustained release agent 0.9 kg/mu

See Table 11 for test results and analysis

From the test results in Table 11, it can be seen that the slow-release agent has no effect on the growth period of rice, but it has an effect on the growth and yield of rice. The treatment with the slow-release agent has dark green leaf color, number of grains per ear, number of grains, Thousand-grain weights were increased compared to the control, the empty rate also decreased, the yield rate increased by 5.1%, 7.4% and 7.0%, and the average yield rate was 6.5%.

(3) Test results in two sites in Dashiqiao, Yingkou

Test Treatment

Ⅰ Conventional fertilization（Diammonium 10 kg/mu + ammonium chloride 15 kg/mu）

Ⅱ Conventional fertilization I+ sustained release agent 1.0 kg/mu

See Table 12 for test results and analysis

It can be seen from Table 12 that the application of slow-release agents has no effect on the growth period of rice; however, it has a greater impact on the growth characteristics. Compared with the control, the stem thickness, ear number per mu, grain number per ear, and 1000-grain weight all increase, An increase of 5.6%-10.6%, a thousand-grain weight increase of 0.1-0.5 grams, an increase of 79.8-113.5 kg per mu, an increase rate of 12.7%-19.6%, an average of 16.15%.

3.4 Conclusion

(1) Simultaneous application of nitrogen fertilizer in corn base, combined with slow-release agent, can increase the utilization rate of nitrogen fertilizer. Extend the effective period of nitrogen fertilizer. One-time basal application of nitrogen fertilizer without topdressing can achieve no defertilization during the whole growth period of corn, and the leaf color will be darkened to improve the fertility of corn the number of ears per mu, the number of ears per ear, and the weight of 100 kernels all increased.

(2) Compared with the control, the application of slow-release agent in rice has a darker leaf color, an increase in the number of effective tillers and the number of ears per ear, the number of grains per mu per ear increased by 0.7-19, and the thousand-grain weight increased by 0.1-0.9 grams. Fat phenomenon.

(3) Apply a small amount of slow-release agent (usually

Table 12 Rice growth period, growth traits and yield survey table

Test Location			Planting period	Rejuvenation period	Tillering stage	Jointing period	Heading date	Maturity
Dashiqiao Water Source	I	4.16	5.26	5.30	6.2	7.1	8.4	10.3
	II	4.16	5.26	5.30	6.2	7.1	8.4	10.9
Dashiqiao Water Source	I	4.14	6.2	6.6	6.9	7.2	8.7	10.9
	II	4．14	6.2	6.6	6.9	7.2	8.7	10.9

Test Location	Process	Plant height	Thick stem	Ears per mu	Spike	Number of loam(per)	Thousand grains(%)	
Dashiqiao Water Source	I	100.7	2.10	351611	1228	11,1	13.2	
	II	99.7	2.25	409451	135.8	11.3	23.7	
Dashiqiao Water Source	I	100.1	2.30	369515	110.4	10.1	20.2	
	II	101.5	2,86	437885	116.6	11.5	20.3	

Treatment/Project		Plot yield/123		Yield per mu/kg	Yield increase per mu/kg	Increased production rate/%		
Dashiqiao Water Source	I	21.2	18.5	16.4	18.9	630.3	_	_
	II	21.7	21.2	409451	135.8	11.3	79.8	127
Dashiqiao Water Source	I	15.0	17.7	18.1	17.3	577.0	_	_
	II	20.2	22.4	19.4	20.7	690.5	113.5	19.6

DOI: http://dx.doi.org/10.36956/rwae.v1i1.165

Table 13. Comparison table of application of slow-release nitrogen fertilizer to increase yield and income of several field crops

Crop varieties	Slow release nitrogen fertilizer		Ordinary nitrogen fertilizer			Increase production and income	
	Fertilizer amount kg/mu	Yield Kg/mu	Fertilizer amount Kg/mu	Yield Kg/mu	Increase production Kg/mu	Increased production rate %	Value added per mu
	Urea + slow release agent				Urea		
Corn	20	686.4	20	604.1	82.3	13.6	57.6
Rice	25	731.8	25	666.8	65.0	9.8	65.0
Wheat	10	249.5	10	227.0	22.5	9.9	27.0
Soybeans	7	253.9	7	222.3	31.6	14.2	63.0
Peanut	7	667.0	7	583.0	129.0	23.9	193.5
Beet	25	3293.8	25	2792.6	501.2	17.9	160.4

0.6 kg/mu) to corn under normal fertilization conditions, and a good yield increase effect can be obtained, with an increase rate of 4.1%-18.8%.

(4) Under the conditions of normal application of nitrogen fertilizer, the application of slow-release agents will increase the yield of rice. The yield per mu can be increased by 20-113 kg, and the yield increase rate is 4.3%-19.6%.

(5) Due to the severe drought and typhoon in Liaoning in 1997, the test was affected to a certain extent. However, it can be seen from the test results that the application of slow-release agents can enhance the stress resistance of crops.

4. Economic Benefit Analysis of Fertilizer Nano Slow Release Agent

In the process of experimental demonstration and popularization and application in the past few years, the cumulative application area of various field crops has reached more than 3 million mu, and fertilizer slow-release agents have shown significant social and economic benefits.

(References in this chapter: Zhang Zhiming, Feng Yuanqi and other materials on DCD's mechanism and application effects)

References

[1] Feng Yuanqi. Mechanism of long-acting nitrogen fertilizer and its application in slow-release compound fertilizer[J]. Chemical Fertilizer Design, 2003(05):56-58.

[2] Zhong Yi. Nitrogen release characteristics of bag-controlled slow-release fertilizer and its application effect in Leizhulin [D]. Hangzhou: Zhejiang Agriculture and Forestry University, 2018.

[3] Changhai Zhang, Guiping Zhang, Zhiguo Chen. Research on nitrogen fertilizer operation technology of Super rice[J].Agricultural Science and Technology,2014(6):100-103.

 DOI: http://dx.doi.org/10.36956/rwae.v1i1.165