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Preparation and Study of an Environmentally Friendly Wheat Seed Coating Agent

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Abstract

This wheat seed coating agent has been made with natural polymer as the primary material, mixed with trace fertilizer and biological bacteriostatic agent, as the auxiliary material through scientific method. Over the whole trial, the best formula and optimum conditions of this new wheat seed coating agent was determined. The results of field test show that this novel seed coating agent increased yield by about 8%, while the cost was descended by about 28%, compared with the conventionally virulent wheat seed coating agent. It is safe, non-toxic and causes no pollution. The application of this novel seed coating agent can achieve remarkable economic and environmental benefits.

Keywords: Environmentally friendly; Wheat seed coating agent; Natural polymer; Increase wheat yield

Introduction

Our country started to promote prevention and control technology for a long time. Seeds are coated before sowing to protect the seeds from damage of underground pests, for their normal growth and development. The research started in the end of the 70s and seed coating technology entered the field experiment and demonstration stage at 80s, later it was widely used in agriculture in 90s. Development of seed coating technology includes three stages: A) Research stage B) Stage of development C) Application stage.

Wheat seed coating agent was not dissolved in soil, it could release the fertilizer slowly, kill the underground pest and enhance seed germination rate. But, the effective components of these traditional seeds coating agent such as carbonfuran, thiram, Methomyl, and so on, are poisonous, and include a lot of harmful contaminants which will cause serious pollution and harm to our environment [1-8].

Seedling period is an important stage of plant growth. Therefore, it is necessary to prepare a novel environmental friendly seed coating agent to increase wheat yield [9-14]. A new high efficiency environmental protection wheat seeds coating agent has been made, which has more efficiency for environmental protection. This coating agent was developed by using natural polymer materials, supplemented trace elements and biological antibacterial agent. The preponderant characteristic of this novel wheat seed coating agent are environmental friendly, compared with traditional wheat seed coating agent, which can make the wheat yield increased by more than 8%, while the cost fell by 28%, or so. In a word, the novel wheat seeds coating agent has the obvious economic and environmental benefits.

Materials and Methods

The major instruments used in this study were high-pressure steam sterilizer (Model YXQ-SG46-48SA, Shanghai Boyi Industry Co. Ltd., Shanghai, P.R. China), electronic balance (Model FA2004, Shanghai Yuefeng Instrument Appearance Ltd. Shanghai, P.R. China), biological microscope (Model BX41-12HO2, OLYMPUS Corp., Japan), warm up hygrometer (Model STH950,SUMMIT, USA), electron constant speed mixer (Model GS28B,Shanghai Anting Electronic Instruments Plant, Shanghai, P.R. China), constant temperature and humidity incubator (Model MJ-01.150L, Hubei Huang Shi Hengfeng Medical Instrument Co. Ltd. Hubei, P.R. China), Petri-dishes (90 cm in diameter, Shanghai Yuejin Medical Treatment Instrument Plant, Shanghai, P.R. China), beaker, filter paper and polyethylene bag, etc.

Traditional wheat seed coating agents were yufeng 18 (which were obtained from Zhongzhou Agricultural Seed Company in Henan, P.R. China), polysaccharide (PO, made in lab), biological bacteriostatic agent (BT, made in lab), *Rhizoctonia cerealis* (agriculture science and technology academy test site in Henan), deionized water for laboratory, violet natural pigment (German Food Additives, Ltd.,Shantou, Guangdong, China), sand, agar medium (WeiDa chemical Co., Ltd. in Guangzhou), cane sugar (Nan Ning cane sugar crop in Guangxi), potatos (Hong'an,HuBei),Wheat seeds (Yufeng, wheat seeds company ,Henan, China).

Experiment Process

Preparation of novel seed coating agent

In 25%, PO is stirred in aqueous solution completely, and different amount of PO will make different solution. The concentration of PO is 6%, 8%, 10%, 12%, 14%, 16% respectively, then 10% of BT, 15% of BJ, 5% of calcium base bentonite and 5% of auxiliary materials are poured into the solution, continue to stir until all kinds of materials dissolved completely. Finally, add 8% of the traces in the liquid, and stir with electronic constant speed mixer.

Laboratory experiments

It includes three aspects: germination potential test, germination rate test and wheat antibacterial rate test (choose Banded sclerotial blight bacteria). First, the wheat seeds are treated with the novel formula and yufeng 18, in the proportion of 1:50. Mix well, put them in room temperature 20 minutes or so, then divided into several groups, each group take 100 seeds, and each treatment is replicated 4 times, experimental data for its average. Petri dishes are put in humidity incubator under the constant temperature (20 ± 1˚C) and humidity

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for 75%. Germination potential and germination rate should be observed every day. The germination potential and germination rate of computation formula is as follows:

$$Germination\ potential(\%) = \frac{Gf}{Gt} \times 100\%$$

$$Germination\ \text{rate}(\%) = \frac{Gs}{Gt} \times 100\%$$

Where Gf is the number of germinated seeds on the 4th day, Gs is the number of germinated seeds on the 7th day, Gt is the total number of seeds.

It includes three aspects in antibacterial rate tests: preparation of medium, banded bacteria vaccination and experimental observation. First, make a medium with potatoes, sugar and raw materials in certain conditions, and then Banded bacteria was vaccinated to the medium, through the growth of the Ban dead bacteria colonies, to judge the inhibitory effect of the different formulations of seed coating agent. Observe the phenomenon after it was cultivated for 72 hours. Remove the petri dishes, and then record the diameter using cross measuring method, repeat 4 times and take the average diameter of the date, the antibacterial rate calculation formula:

$$Fungistic\ \text{rate}(\%) = \frac{Fc - Ft}{Fc} \times 100\%$$

Where Fc is the presence of fungi on the control, Ft is the presence of fungi on the treated Petri dishes.

Through the above three calculation formula, all the germination potential, germination rate and the bacteriostatic rate can be worked out, so choose the best formula. By adjusting some main factors, such as BJ concentration, etc. to improve the germination potential and germination rate as far as possible, finally several good formulas are determined.

The comparative of field trials

The novel formula which get in the laboratory condition and the traditional formula (yufeng 18) are both sowed in wheat testing field in Henan academy in China for year-on-year test. The wheat seeds are coated with the novel formula and yufeng 18 in the proportion of 1:50. Sowing in the field with the kind of Banded contains bacteria. Sowed in October every year and harvested in June next year. The formula is adjusted little by little, according to the result of the experiment.

Results

The preliminary results in the laboratory test

The following are the different wheat seed coating agents prepared for the experiment, which were named F1, F2, F3, F4, F5, F6 respectively, the results included in figure 1.

Adjusting and optimizing this novel wheat seed coating agent

On the basis of F3, F3 formula is optimized by changing the formula of the influence factors such as PO concentration, to find out the best formula in the laboratory.

The effects of PO concentration on the performance of seed coating agent

Keep the F3 formula of the other component and content unchanged, only change the PO concentration, observe the effects of PO concentration on the performance of seed coating agent, results been shown in figure 2.

From the figure 2, we can know: that with the increase of the concentration of the PO, antibacterial rate will increase gradually, but when PO concentration is higher than 10%, antibacterial rate basic remain unchanged. For germination potential and germination rate,when PO concentration from 6% to 10% change, sprout potential and germination rate increase gradually, the concentration of 10% to reach maximum. As PO concentration continued to expand, from 10% to 14%, the germination potential and germination rate reduced. This mainly because: PO has a good function to film [15-18], when the concentration is too low, this property will be effected, the sprout potential, germination rate and antibacterial rate will reduce; Along with the increase of concentration, film performance enhancement, antimicrobial function also increased, so the sprout potential, germination rate and antibacterial rate increased, but when PO concentration is too high, the permeability will reduce, so the sprout potential and germination rate will drop, antibacterial rate was nearly unchanged. Consider these two aspects, 10% of PO is the best concentration.

The determination to the best formula

It can be seen from figure 3 that when the proportion is 1:50, germination rate and sprout potential is the best, and when the proportion is too high or too low, germination potential and germination rate are reduced. If the concentration too high, it will hinder the absorption of nutrients, or it will lead to not a good film, which can lead to sprout potential and germination rate drop, therefore, the best medicine is 1:50.

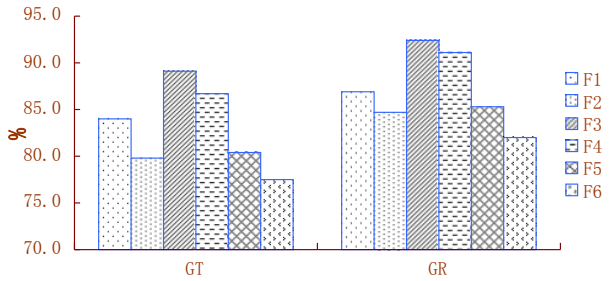

Figure 1 of the experimental data show that the F3 and F4 of the coating of wheat germination potential, germination rate were 89.1%, 92.4% and 86.7%, 91.1%, respectively. F3 and F4 germination potential and germination rate are relatively higher than the other groups, but in the experiment observed; wheat root is robust, wheat seeding growing strong, and wheat seeding highly uniform after the seeds were coated with the F3, so F3 is the basic formula as the next step experiment, where GT is germination potential and GR is germination rate.

Figure 1: The comparison of different Wheat seeds coating agent about germination potential and germinate rate.

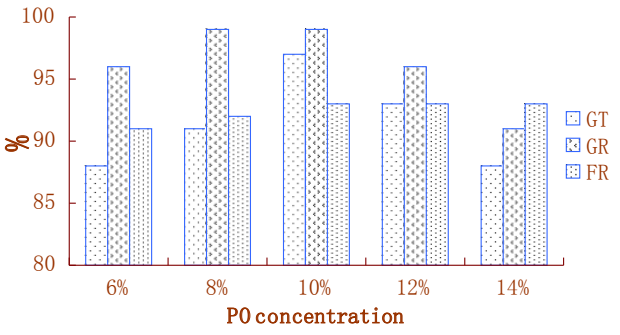

Figure 2: The effects of PO concentration on the performance of seed coating agent.

Comparison of the powder PO with flake PO

When the main influence conditions have set, according to the best formula, were configured out including powder of PO and flake of PO (other conditions are the same), to compare sprout potential and germination rate (Figure 4).

It can be seen from figure 4, germination potential, germination rate and fungi static rate of powder PO are slightly higher than the flake PO, but not obvious. Powder PO is easier to dissolve, which can make its film-former better. So, powder PO is better.

The comparison optimized with traditional in laboratory

It can be seen from the table 1 that the germination potential and germination rate of F3-F are increased by 12% and 13%, respectively, compared with CK ,increased by 5% and 8%, respectively, compared with the traditional (Yufeng). Costs dropped by about 22%, and it can be seen from the measurement of average height on tenth day, average seedlings were 1.9 cm higher than blank group, 0.8 cm higher than traditional, its antibacterial rates also increased 7%.

The comparative results of field trials

The optimized, blank group and traditional (yufeng) are all sowed in the field, then the same field management must be carried out, and its comparison results are as shown in table 2.

It can be seen from the table 2 that the F3-F germination rate is 13% higher than the bank group, 5% higher than the traditional. Thousand Kernel Weight has also improved about 4.8% and 2.9%, respectively, the production is also increased by about 16%, compared with the blank group, and increased by 6% compared with the traditional,. In a word, it is non-toxic, no pollution and environment friendly, which has a good application value.

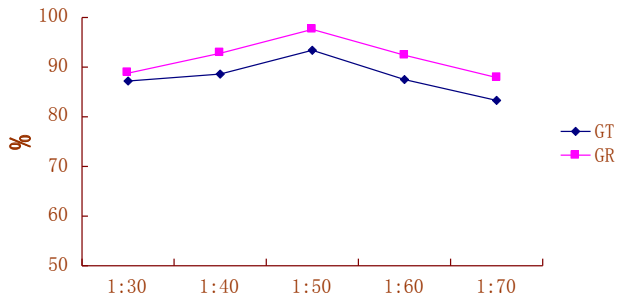

Figure 3: The effects of different amount of seeds coating agent on germination and potential germinate rate.

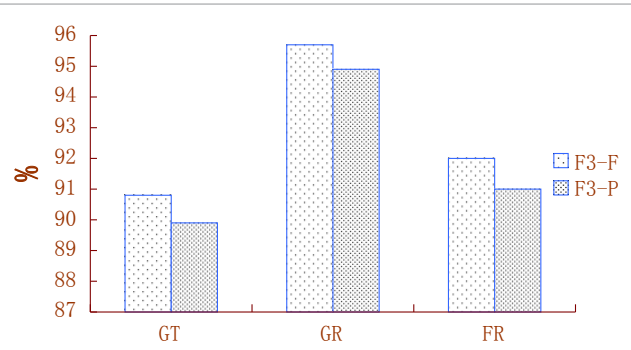

Figure 4: The effects of powdery PO and platy PO on the performance of seed coating agent.

Main index	F3-F	samples CK	yufeng no.18
Cost /yuan/kg	7.0	0	9.0
Germination potential (%)	86	77	82
Germination percentage (%)	98	87	91
Fungistatic rate (%)	96	0	90
Average height on tenth day /cm	8.7	6.8	7.9

Table 1: The results of the experiments in the lab.

Main index	F3-F	samples CK	yufengno.18
Germination percentage (%)	86	86	92
Thousand kernel weight/g	43.8	43.8	44.6
yield/kg/mu	586	586	641
Pollution state	no	no	serious

Table 2: The results of experiments in the field.

Discussion

The PO polysaccharide is the key to this novel wheat seed coating agent. PO has many good physical and chemical properties and physiological activity function [19,20]. There are many special functional groups on the molecular chain; it has a good Physiological adaptability. Therefore, it has the unique plant and animal tissues and organs physiological adaptive, and safety. In addition, PO is a natural plant growth regulator which can promote the root growth and adjust the wheat growth, increasing the resistance of the wheat, improving wheat production. During the seed germination growth period, PO can enhance seed germination rate and improve the content of amylase in the endosperm; obviously, it also can improve the chlorophyll content, so it has an important role in the germination of seeds and seeds growth.

Antibacterial function is good. PO itself has the antimicrobial properties. Most pathogens are anions, the sugar in PO will interfere with the metabolism of the bacteria through adsorption of the anion, and the bacteria can't grow normally. In addition, it also has the ability of forming a dense protective film on the surface layer of seeds. The film increases the brightness of the coated seeds, and it can prevent bacteria from the absorption of nutrients.

PO is a good film-former. It is a polymer extracted from chitin derivatives; one of its characteristics is a good film function. After the wheat seeds are coated, it will form a layer of symmetrical film on the surface of the seeds, which can bear seeds in suitable conditions.

Conclusion

This wheat seed coating agent has been made with natural polymer as the primary material, which has good film and bacteriostatic properties. Seeds are treated with it, and the results of field trials show that its effect on increase yield and bacteriostasis are higher than the traditional, and there is no pollution to the environment. It reaches the best result when pH adjustment is to 6 and PO concentration reaches 10%. This can enhance seed germination rate above 5%, improve the wheat yield 8%, and the cost decreased as 28%. It is a kind of environmentally friendly seed coating agent, which is well worth be introduced in agriculture.

Acknowledgements

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