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Study on Seed Germination, Growth and Nutrient Release of Kentucky Bluegrass in Pressed Granulated Grassland

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Abstract: The effects of pelleted pelleting on seed germination, growth and nutrient release of Kentucky bluegrass were investigated. By comparing the seed germination rate, germination potential and seedling growth index of different pelleting, combined with the analysis of nutrient release in soil environment, the synergistic mechanism of pelleting and nutrient release was revealed. The results showed that F1 (80 % bentonite : 10 % organic fertilizer : 10 % sheep manure), F2 (70 % bentonite : 15 % organic fertilizer : 15 % sheep manure), F3 (60 % bentonite : 20 % organic fertilizer : 20 % sheep manure), F4 (50 % bentonite : 25 % organic fertilizer : 25 % sheep manure), F3 treatment can significantly improve seed germination time and growth height, and delay nutrient release rate. This study provides a theoretical basis for optimizing the pelleting process, and has practical significance for achieving precise quantitative seeding and reducing application efficiency.

Keywords: tablet pelletization, seed germination, growth height, nutrient release

1 INTRODUCTION

Qinghai Kentucky bluegrass (Poa pratensis) is a high-quality forage widely planted in the alpine grassland area of Qinghai Province. It has strong stress resistance, abundant leaves, good palatability, developed rhizomes and grazing tolerance[1]. The growth period of Poa pratensis L.in Qinghai is about 140 days. It grows slowly from April to May, the growth peak is from July to August, and stops growing in September[2]. The breeding of Poa pratensis is from the wild species grown in Dari County at an altitude of 4 000 meters after years of cultivation and domestication[3] Under the condition of dry farming in Dawu area with an altitude of 3 800, the average yield of green hay is 6 564 kg / hm2 and the seed yield is 323.7 kg / hm2 in the second to fourth years. In addition, Poa pratensis L.in Qinghai is rich in protein, and the crude protein content in flowering period is 12.68 %, which is 2.04 % higher than that of Poa pratensis L.[4].It is an important ' wild cultivated variety ' in Qinghai Province and has been widely used in ecological restoration projects in Qinghai Province [5]. The suitable sowing time of Kentucky bluegrass in Qinghai is from early April to mid-May in spring or from early September to mid-October in autumn. The sowing methods include uniform sowing or mechanical sowing, and seed treatment and disinfection [6].In order to improve the stress resistance and sowing efficiency of seeds, pelleting treatment is a common practice. In this study, the pelleted pelleted seeds of Poa pratensis L.cv.Qinghai were used as experimental materials, and pot experiments and water-soluble nutrient experiments were carried out to explore the effects of pelleted pelleting on the seedling growth and nutrient release of Poa pratensis L.cv.Qinghai seeds, and to provide technical support for pelleted Poa pratensis L.cv.Qinghai seeds.

2 MATERIALS AND METHODS

2.1 EXPERIMENTAL MATERIALS

The seeds of Kentucky bluegrass were provided by the Institute of Soil and Fertilizer, Academy of Agriculture and Forestry Sciences, Qinghai University.

2.2 METHODS

Pot experiments were set up to determine seed germination and growth, and nutrient release was determined by 25 ° C static water dissolution rate method[7].

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Pot experiment : set up 50 % test soil + 30 % Qinghai Muli mining area slag ; the seed treatments CK, F1, F2, F3 and F4 were sown in two different soil substrates according to random block arrangement. Pot experiments were arranged completely randomly. In a rectangular pot with a length of 30 cm, a width of 20 cm, and a height of 20 cm, 10 pelleted seeds were pelleted in each rectangular pot, with 3 replicates. Taking the day of seed implantation as the first day, the germination rate of seeds was counted. The germination of seeds was based on the emergence of seedlings, and the pelleted seeds were based on the germination of soil. The germination of seeds was observed at the same time every 3 days and the cumulative germination rate was counted. The start-up period of seed germination was calculated by the number of days from culture to the first seed germination [8], and the germination of one seed in three replicates was the germination initiation of this treatment. At the end of germination, the average number of seed germination for 5 consecutive days was less than 1 % of the total number of seeds for testing as the final germination rate [9], and the test was completed after 30 days. At the end, the seedling height was measured, and the percentage of germination rate, germination index, cumulative germination rate, average seedling height, root length and seedling length compared with the control group was calculated [10-12].

The static water dissolution rate method at 25 ° C : 10.00 g of the test sample was weighed and placed in a 100-mesh nylon mesh bag. After sealing, it was placed in a 250 ML capped plastic bottle, 200 ML of deionized water was added and sealed. Three replicates were set for each slow-release fertilizer and placed in an (25 ± 0.5) ° C incubator. Sampling was performed on days 1,3,5,7,10,14,21,28, and 42, respectively. [13]. During sampling, the plastic bottle was reversed three times to make the liquid concentration in the bottle consistent. The net bag was taken out, the fertilizer extract was shaken well, and 50 ML samples were collected. After the remaining samples in the plastic bottle were discarded, 200 ML deionized water was added again, sealed and placed in an incubator for further culture [14]. The collected samples were immediately determined for nitrogen, phosphorus and potassium content.

2.3 TEST INDICATORS

(1) Germination rate (%) = (number of germinated seeds / total number of seeds) * 100 % ;

(2) Cumulative germination rate (%) = (number of seeds germinated on the day of observation / total number of seeds tested) * 100 %

(3) Germination index (GI) = $\sum \frac{Gt}{Dt}$

(4) Initial nutrient release rate (%) = (fertilizer release amount within 24h /total nutrient component) * 100% ;

(5) 21d cumulative nutrient release rate = 21d cumulative nutrient dissolution / total nutrient content * 100

(6) Cumulative nutrient release rate = nutrient dissolution / total nutrient content * 100

(7) Total nutrient release rate = (N nutrient + P nutrient + K nutrient) / total nutrient component * 100

2.4 DATA PROCESSING

All data were entered and plotted with WPS Office, and SPSS 26 was used for data one-way analysis of variance (P < 0.05), and sorted by TOPSIS method.

3 ANALYSIS OF RESULTS

3.1 EFFECT OF PELLETING ON SEEDS

3.1.1 EFFECT OF PELLETING ON THE START-UP PERIOD OF SEED GERMINATION

It can be seen from Figure 1 that in the pot experiment, the bare seeds of Kentucky bluegrass began to germinate on the 21st day of sowing, and the germination initiation time was 21 days. Compared with the naked seeds of Poa pratensis, the germination time of the pelleted seeds was the same. The germination began on the 21st day of culture, and the germination initiation time was 21 days. In the matrix ratio II, the pelleted seeds did not delay the germination of the seeds.

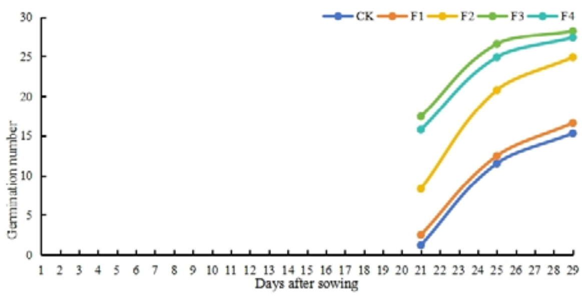

FIG.1 EFFECT OF PELLETING ON THE START-UP PERIOD OF SEED GERMINATION

3.1.2 EFFECT OF TABLETING TREATMENT ON GERMINATION RATE

It can be seen from Fig.2 that among the five treatments, the germination rate of CK (bare seed) was the lowest, and the germination rate of 15 days was 46 %. The germination rate of F3 treatment and F4 treatment was the highest, and the germination rate was 94 %. The germination

rate of F1 was 64 %, the germination rate of F2 was 86 %, the germination rate of F3 was 94.00 %, and the germination rate of F4 was 94 %. The germination rate of CK contrast treatment F1 was reduced by 28.1 %, the germination rate of contrast treatment F2 was reduced by 32.6 %, the germination rate of contrast treatment F3 was reduced by 46.5 %, and the germination rate of contrast treatment F4 was reduced by 51.1 %. Among the five treatments, the 15-day germination rate of F3 treatment and F4 treatment was the highest, which was 100 % higher than CK, 46.9 % higher than F1, and 9.3 % higher than F2. The order of germination rate was F3, F4 > F2 > F1 > CK.

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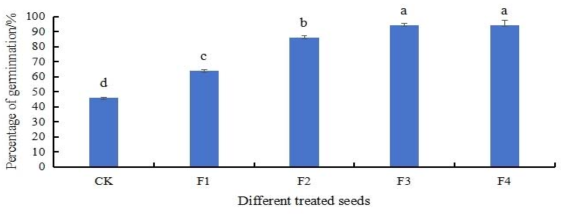

FIG.2 EFFECT OF TABLETING TREATMENT ON GERMINATION RATE

3.1.3 *EFFECT OF TABLETING TREATMENT ON CUMULATIVE GERMINATION RATE*

It can be seen from Fig.3 that the initial germination rate of CK was 4 %, the initial germination rate of F1 was 8 %, the initial germination rate of F2 was 58 %, the initial germination rate of F3 was 58 %, and the initial germination rate of F4 was 53 %. The initial germination rate of F2 and F3 was the highest, which was 14.5 times that of CK. The germination period of CK was 29 days, and the germination rate was 67 %. Among the four treatments, the germination period of treatment F2 was the longest, reaching the maximum germination amount on the 21 st day, and the germination rate was 97 %. The germination period of F3 and F4 was the shortest, and the maximum germination amount was reached on the 17 th day, and the germination rate was 97 %. The germination rate of F2 was 86 %, the germination rate of F3 and F4 was 97 %, and the germination rate was the highest. The results showed that the germination of the seeds treated with tableting was not affected, and the cumulative germination rate was always higher than that of the bare seeds. Among them, the effects of F3 and F4 were the best, the germination time was short, and the germination rate was the highest. According to the actual germination rate, the order was : F2, F3 > F4 > F1 > CK, and the order from small to large according to the germination time was : F2 < F3, F4 < F1 < CK.

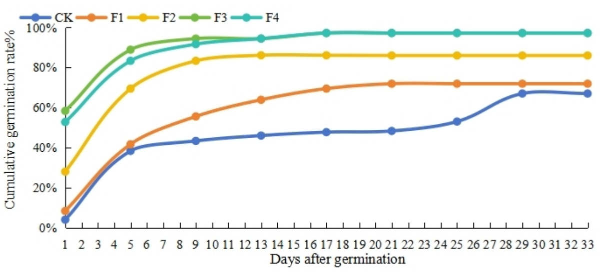

FIG. 3 CUMULATIVE GERMINATION RATE OF TABLETTING TREATMENT

3.1.4 *EFFECTS OF TABLETING TREATMENT ON GROWTH HEIGHT, AVERAGE SEEDLING HEIGHT, GERMINATION INDEX AND ROOT LENGTH*

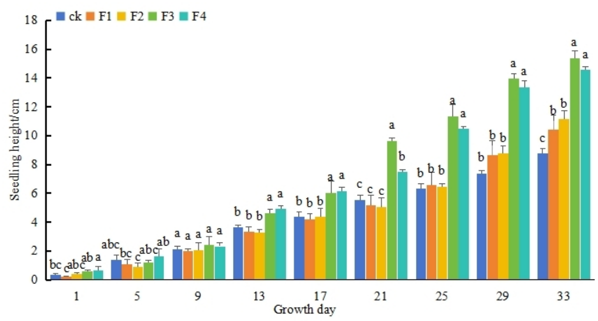

FIG.4 EFFECT OF TABLETING TREATMENT ON GROWTH HEIGHT

(1)It can be seen from Fig.4 that on the first day of germination, the growth height of treatment F4 was the highest, and the growth height of treatment F1 was the lowest. Treatment F4, F1 showed significant difference . On the 9th day, the growth height of CK, F1, F2, F3 and F4 was similar, and there was no significant difference among the treatments ($P > 0.05$). On the 17 th day, the growth height of treatment F4 was the highest, the growth height of treatment F1 was the lowest, and the difference between treatment F3 and CK was significant ($P > 0.05$). The growth height of treatment CK, F1 and F2 was similar, and there was no significant difference ($P > 0.05$). On the 33 rd day, the growth height of treatment F3 was the highest, and the growth height of CK was the lowest. There was a significant difference between treatment F3 and CK (PF4 > F2 > F1 > CK).

(2) The germination index, average seedling height, root length and seedling length of seeds treated by tableting were improved. The germination index of CK was 7.80 ± 1.91d, the germination index of F1 was 4.36 ± 0.67c, the germination index of F2 was 9.38 ± 4.21b, the germination index of F3 was 12.74 ± 4.0a, and the germination index of F4 was 9.66 ± 4.9ab. The order of 50-day average seedling height was F3 > F4 > F1 > F2 > CK, and the order of root length was F3 > F4 > F2 > F1 > CK. The pressing treatment enhanced the vitality of the seed itself, so that the germination index, seedling height and other indicators showed an upward trend. The results of TOPSIS evaluation showed that the final ranking results of pelleted seeds and bare seeds (CK) were F3 > F2 > F4 > F1 > CK.

TABLE 1 GERMINATION INDEX, AVERAGE SEEDLING HEIGHT, SEEDLING HEIGHT AND ROOT LENGTH OF PELLETED SEEDS

	15d	30d	50d

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treat ment	germin ation index	average height of seedling	mean root length	average height of seedling
CK	0±0b	8.75±0.18c	12.40±1.19b	17.33±1.22c
F1	3.96 ± 0.59b	10.40±1.8b	12.02±1.70b	23.53±1.22ab
F2	8.72 ± 4.04a	11.14±0.61b	12.51±1.34b	22.31±0.53b
F3	11.98 ± 3.96a	15.40±0.47a	21.00±0.60a	24.56±0.45a
F4	11.21 ± 1.11a	14.54±0.11a	12.91±0.61b	23.46±1.16ab

TABLE 2 ENTROPY WEIGHT TOPSIS RANKING

treatment	Positive ideal solution distance D +	Negative ideal solution distance D-	Relative proximity C	Ranking results
CK	1.887	0.25	0.117	5
F1	1.639	0.433	0.209	4
F2	0.612	1.541	0.716	2
F3	0.5	1.803	0.783	1
F4	0.791	1.275	0.617	3

3.2 NUTRIENT RELEASE RATE

3.2.1 INITIAL NUTRIENT RELEASE RATE

The nutrient release rate of each treatment was low at 24 h. The total nitrogen F1 treatment had the highest release rate at 24 h, and the release rate was 0.64 %. The treatment F3 had the lowest release rate, and the release rate was 0.61 %. The initial nutrient release rate of total nitrogen was F4 > F1 > F2 > F3. The initial nutrient release rate of total phosphorus showed an overall growth trend. The total phosphorus nutrient release rate of F1 treatment was the lowest, which was 0.08 %, and the release rate of F4 treatment was the highest, which was 1.10 %. The initial nutrient release of total phosphorus was F4 > F3 > F2 > F1. The highest total potassium nutrient release rate of F3 treatment was 0.67 %, and the lowest was 0.35 % in F1 treatment. Compared with F1 treatment, the initial nutrient release rate of F3 treatment increased by 91.43 % compared with F1 treatment. The initial nutrient release rate of total potassium was F3 > F4 > F2 > F1. The overall nutrient release rate of F4 treatment was the highest.

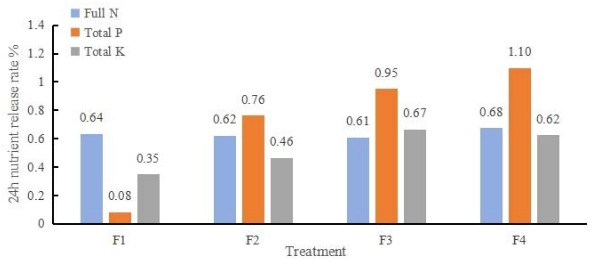

FIG.5 INITIAL NUTRIENT RELEASE RATE OF DIFFERENT TREATMENTS

3.2.2 21 D CUMULATIVE NUTRIENT RELEASE RATE

The highest cumulative nutrient release rate of total nitrogen, total phosphorus and total potassium in the first 21 days was F4 treatment, the highest total nitrogen nutrient release rate was 1.1 %, the lowest was 0.68 %, and the nutrient release rate of the 21 days increased by 61.76 % compared with the first day.

The highest cumulative nutrient release rate of total phosphorus was F4 treatment, with the highest nutrient release rate of 1.29 % and the lowest of 1.10 %. The nutrient release rate of 21 d increased by 17.27 % compared with that of 1 d.

The highest total potassium nutrient release rate was F4 treatment, and the release rate was 0.96 %. Compared with F4 treatment, the initial growth rate was 54.84 %, and the nutrient release rate was F4 > F3 > F2 > F1 from high to low.

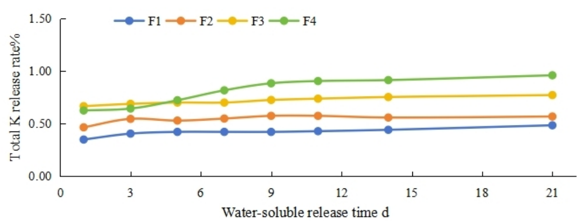

FIG.6 TOTAL NITROGEN CUMULATIVE NUTRIENT RELEASE RATE IN THE FIRST 21 DAYS

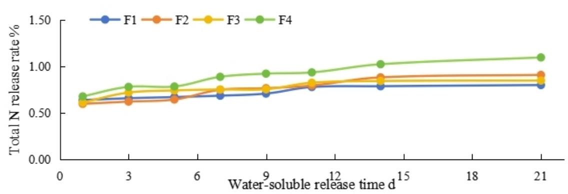

FIG.7 TOTAL PHOSPHORUS CUMULATIVE NUTRIENT RELEASE RATE IN THE FIRST 21 DAYS

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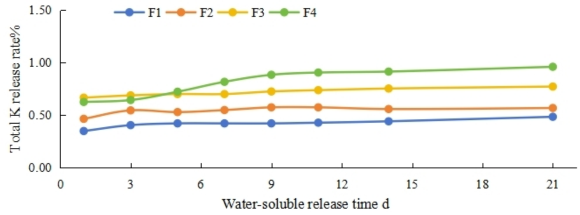

FIG.8 TOTAL POTASSIUM CUMULATIVE NUTRIENT RELEASE RATE IN THE FIRST 21 DAYS

3.2.3 *TOTAL NUTRIENT RELEASE RATE*

The highest total nitrogen release rate in the culture stage was F4 treatment, 9.28 %, and the lowest was F1 treatment, 7.30 %. The nutrient release of F4 treatment increased by 27.12 % compared with F1 treatment. The highest total phosphorus nutrient release rate was F4 treatment, and the lowest was F1 treatment. The nutrient release of F4 treatment increased by 239.11 % compared with F1. The highest nutrient release rate of total potassium was F4 treatment, the lowest was F1 treatment, and F4 treatment increased by 174.80 % compared with F1 treatment. The total nutrient release rate is the sum of the nutrient release amount of each treatment divided by the total nutrient component of each treatment. The total nutrient release amount of F1 treatment is 4.99 %, and the highest nutrient release amount of F4 treatment is 13.00 %, which is 160.52 % higher than that of F1 treatment. The total nutrient release rate from high to low is F4 > F3 > F2 > F1.

TABLE 3 TOTAL NUTRIENT RELEASE RATE

Treatment	N	P	K	Total nutrient release rate
F1	7.30 %	3.58%	4.92%	4.99%
F2	7.77 %	9.15%	7.85%	7.92%
F3	7.77 %	10.51 %	10.69 %	10.43%
F4	9.28 %	12.14 %	13.52 %	13.00%

3.2.4 *WATER ABSORPTION*

The water absorption of each treatment in different periods showed a slow upward trend, and the water absorption of each treatment in different periods was significantly different ($P < 0.05$), and the most water absorption was F4 treatment.

TABLE 4 WATER ABSORPTION OF EACH TREATMENT IN DIFFERENT PERIODS

Treatment	1d	3d	5d	7d	9d
F1	9.72±0.16b	9.82±0.13c	9.9±0.09d	10.14±0.12d	10.71±0.08d
F2	8.8±0.15c	9.66±0.06c	10.13±0.12c	10.7±0.05c	11.07±0.07c
F3	10.19±0.05a	10.83±0.04b	10.89±0.1b	11.18±0.08b	11.71±0.1b
F4	10.12±0.03a	11.27±0.19a	11.53±0.05a	11.76±0.13a	12.05±0.11a

Continued Table

Treatment	11d	14d	21d	28d	42d
F1	10.81±0.02d	10.85±0.02d	11.91±0.03c	12.07±0.03d	12.25±0.07b
F2	11.56±0.09c	11.73±0.04c	11.82±0.07c	12.79±0.18c	12.85±0.57b
F3	12±0.08b	12.36±0.06b	12.77±0.12b	14.96±0.18b	15.47±0.49a
F4	12.68±0.17a	13.15±0.14a	13.94±0.06a	14.29±0.25a	15.33±0.19a

The values in the table are mean ± standard deviation, and different lowercase letters in the same column indicate significant difference ($P < 0.05$).

4 DISCUSSIONS

4.1 *EFFECTS OF PELLETED KENTUCKY BLUEGRASS ON SEED GERMINATION AND GROWTH*

The tableting treatment significantly increased the germination rate and enhanced the vigor of the seeds. At the same time, the seeds absorbed water through the micro-soil environment. Thanks to the growth conditions created by this environment, the germination rate of the seeds was improved, which had a positive impact on the germination rate and growth.

4.2 *EFFECTS OF PELLETED KENTUCKY BLUEGRASS ON NUTRIENT RELEASE*

During the whole release process, the initial nutrient release is very important, affecting the rooting and germination of seeds. In the early stage of crop growth, the demand for nutrients in seedlings is more urgent [15]. The initial release of nutrients in pelleting can provide necessary nutrients for seedlings in time, such as nitrogen (N), phosphorus (P), potassium (K), etc., and promote the root development, leaf growth and photosynthesis of seedlings. If sufficient nutrients are not released at an early stage, seedlings may suffer from leaf yellowing, slow growth, stunting, or even death due to nutrient deficiency. Therefore, the initial nutrient release is essential to ensure the normal growth of crops in the early stage. In the nutrient release rate, the release rate of total nitrogen F4 treatment was the highest, the release rate was 13.00 %, which was higher than that of treatment F1, F2, F3, and the release rate of treatment F1 was the lowest, the release rate was 4.99 %. The order from high to low was F4 > F3 > F2 > F1, and the optimal nutrient release rate was F4 treatment.

This study showed that the germination ability of Kentucky bluegrass seeds was not affected and the quality of seedlings was improved after pelleting treatment. The optimal pelleting formula was F3 treatment (60 % bentonite : 20 % organic fertilizer : 20 % sheep manure).

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