

Development of Germination Nonwoven Made from Straw/Cotton Fibers

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Abstract: Agricultural nonwoven fabrics have been widely used for germination matrix, due to their advantages in terms of thermal insulation, air permeability, durability, strength and biodegradability. Nonwoven fabrics made from straw / cotton fibers were applied for wheat germination. Wheat seeds "Wanmai 33" were used to explore the relationship between wheat germination rate and straw / cotton nonwoven structures. Based on the laboratory germination rate of wheat sprouting, the optimal fabric structure was straw mass ratio of 70%, area density 1500g/m², fabric thickness 9 cm. This gave a wheat seeds sprouting ratio of 99%.

Keywords: Germination nonwoven; Wheat Sprouting; Fabric structure.

1. Introduction

nonwoven fabrics are known to be excellent in terms of thermal insulation, air permeability, strength, durability, bio-degradability and environmental friendly. Hence, there are great potential for the applications of germination fabrics in agriculture [1]. The literature regarding agricultural nonwoven covering and breeding clothes are rich, but regarding nonwoven germination fabrics are rather limited. As an agricultural country, there is abundant waste straw in China, which may be regenerated into cellulose fibers.

Straw fibers were mixed with cotton fibers and developed into agricultural nonwovens for wheat sprouting. The influences on the sprouting of wheat seeds in the straw/cotton nonwovens are fairly complicated, such as the material of germination matrix, the breeding environment, the type of seed and so on [3]. In this study, only the influence of fabric structure was investigated in the orthogonal experiment, including the straw mass ratio, area density and fabric thickness. The optimal structural parameters were determined, according to data analysis.

2. Materials and Methods

Waste cotton and straw were obtained from Anhui province. The gelatin was bought from Shanghai Chemistry Reagent Factory. The epoxy resin was from Shanghai Bio-Engineering Co. Ltd. And the osmotic agent was made by Shanghai Chemistry Agent Manufacturer. The nonwoven fabric matrix for wheat germination was made from the mixture of cotton and straw fibers, bonded with gelatin, following the steps described in literature [2].

Germination ratio was chosen as the experimental index, which was measured according to the amount of wheat seeds sprouting on the seventh day, under the

laboratory conditions of temperature 15°C-25°C and humidity 23%-27%.

The experiment was conducted in a laboratory of Anhui Agriculture University. The room conditions were indicated by dry-bulb and wet-bulb thermal meters and controlled to fit the requirement of wheat germination. The seeds were immersed in water for 24 hours before sowing into the nonwoven matrix one by one, in order to accelerate the wheat sprouting.

3. Results and discussion

In the orthogonal experiment, the designed factors were straw fiber mass ratio, area density, and fabric thickness, which affect the wheat sprouting. The optimal parameters were determined by means of orthogonal rejection [3].

From single factor experiments, it was found that straw fiber mass ratio of 60%, area density at 1600g/m², and fabric thickness 9 cm were suitable for wheat sprouting. On the basis of three factors and three levels orthogonal experiment ($L_9(3^3)$), a level of factor form was formulated as Table 1 and the corresponding results were showed in Table 2.

Table 1. Level of factor form.

level	A	areal density/ (g/ m ²)	B	straw rate / %	C	thickness / cm
1		1500		70		8
2		1600		60		10
3		1700		50		9

Table 2. Experiment program and analysis.

Test no.	A	Null columns	B	C	Germination ratio
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1	1	1	1	1	0.89
2	1	2	2	2	0.67
3	1	3	3	3	0.78
4	2	1	2	3	0.67
5	2	2	3	1	0.67
6	2	3	1	2	0.44
7	3	1	3	2	0.56
8	3	2	1	3	0.78
9	3	3	2	1	0.56
mean 1	0.78	0.71	0.70	0.71	
mean 2	0.59	0.71	0.64	0.56	
mean 3	0.63	0.59	0.67	0.74	
range R	0.19	0.12	0.06	0.18	

Dry Straw fiber is hard, but becomes soft after wetted by water. The straw fibers, as the major element of the nonwoven matrix, were entangled with cotton fibers, which form a porous matrix with the properties of thermal and moisture preservation. The matrix is fairly

strong, convenient for move and suitable for wheat breeding [4].

From the orthogonal analysis Table 2, it may be seen that factors affecting seed sprouting were $A > C > B$. Since germination ratio was used as the index, a larger index number means a better germination ratio. Hence, A1C3B1 is the optimal processing conditions, namely straw fiber mass ratio of 70%, area density at 1500g/m², fabric thickness at 9 cm is most suitable for wheat sprouting, with germination ratio of 99%.

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