

Study and demonstration on the cultivating techniques of rape mulching

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Abstract

The cultivating techniques of rape were studied with different mulching methods in the cold and cool area with high altitude in the middle of Gansu province. The results showed that cultivation with film mulching had good function of enhancing temperature and conserving water. It could also speed up the development process of rape and increase the number of pods on the branch. There was significant difference in the developing condition and yield between different treatments. The yield of bunch planting on film was 42.94% higher than that of furrow planting without mulching, and the yield of furrow planting beside film was 34.04% higher than that of furrow planting without mulching. Based on the experiment and the demonstration of two years' mulching cultivation, it indicated that bunch planting on film was inconvenient for the mechanized operation, it cost labors and time, and the relative benefit of it was lower than that of furrow planting beside film. However, furrow planting beside film was convenient for mechanized planting, its operation was also simple and the benefit of it was higher. Furrow planting beside film could be widely promoted.

Key words: Rape, Mulching, Cultivation

The cold and cool area with high altitude in the middle of Gansu province is the appropriate area for planting spring rape in Gansu province, it is also one of the major areas in Gansu province where spring rape is produced. The planting area there is about 38,000 hm² every year, which takes up 44% of the rape area in Gansu province. In the planting area with the altitude of 1800–2400m, because of the influence of short no-frost period, insufficient effective accumulated temperature, drought, disease, pests and so on, the yield of rape is low and unstable. To solve the problem, the cultivating techniques of rape mulching were studied to provide scientific foundation for the high and stable rape yield in the cold and cool area with high altitude in the middle of Gansu province.

1. Materials and methods

1.1 General conditions of experiment area

The experiment was carried out in 2002 in Yangwa Village, Zhaizigou Town, Jishishan County in the cold and cool area with high altitude in the middle of Gansu province, where the altitude is 2260m, the average yearly temperature is 5°C, the accumulated temperature ($\geq 0^{\circ}\text{C}$) is 2811.8°C, the yearly rainfall is 400–650mm and the no-frost period is 118–130 days. And it was demonstrated and promoted in 2003.

1.2 Research materials

The No.1 Huaxie spring rape was adopted in the experiment, which was bred cooperatively by academician Fu Yandong of Huazhong Agricultural University and Sweden SWAB, and which was promoted with large area in Gansu province. The breadth of the film is 1200mm with bunch planting on film or 400 mm with furrow planting beside film, and the thickness of the film is 0.008mm (the film was produced by the Plastic Factory of Tianshui City in Gansu province).

1.3 Research methods

The experiment was arranged randomly and repeated 3 times. The area of the plot was 20m². There were three planting methods: bunch planting on film, furrow planting beside film and the control experiment (furrow planting without mulching, CK). The seeds were sown on 24th, March. 300,000 seedlings were reserved per hm², and the field management was the same as that of the normal farmland. After seeding, the seeding situation and the growth stages were observed and record. The soil layer temperature for the depth of 5cm, 10cm, 15cm and 20cm was measured at 8:00, 14:00 and 20:00 every day. The soil water content was tested by the method of oven dry weight. After maturing, the rape was harvested singly by the plots, and then after threshing, the yield was record. Finally, the samples were taken to identify economic properties.

2. Results and analysis

2.1 Influence of different mulching methods on the yield of rape

From table 1 we could see that the yields of rape with bunch planting on film and furrow planting beside film were all higher than that with furrow planting without mulching, which showed that whichever mulching methods had a good effect of increasing yield. The yield of bunch planting on film was 3695kg/ hm², 1110kg higher than that of furrow planting without mulching (CK), the yield increased rate was 42.94%; The yield of furrow planting beside film was 3465kg/ hm², 880kg higher

than that of CK, and the yield increased rate was 34.04%. Compared with CK, these two mulching methods increased the yield significantly. And the yield increased with bunch planting on film was more than that with furrow planting beside film. The yield of bunch planting on film reached a significant level.

Table 1 Yield of rape under different mulching methods

Treatment	Plot yield (kg)			Σx	\bar{x}	Yield (kg/ hm ²)	±%	
	I	II	III					
Bunch planting on film	7.36	7.48	7.33	22.17	7.39	a A	3695	42.94
Furrow planting beside film	6.95	6.82	7.02	20.79	6.93	b B	3465	34.04
CK	5.18	5.12	5.21	15.51	5.17	c C	2585	

Note: the capital letter and the lowercase letter in the table mean the significant level at 0.01 and 0.05 respectively.

2.2 Influence of different mulching methods on the soil temperature

It could be seen from table 2 that both bunch planting on film and furrow planting beside film could increase soil temperature. And in the last ten days of April and first ten days of May, the soil temperature was increased most significantly. In these two periods, at the soil layer of 5cm, the average soil temperature of bunch planting on film was 3.1°C and 2.2°C higher than that of CK, and the average soil temperature of furrow planting beside film was 2.4°C and 1.7°C higher than that of CK; at the soil layer of 10cm, the average soil temperature of bunch planting on film was 2.5°C and 2.0°C higher than that of CK, and the average soil temperature of furrow planting beside film was 2.1°C and 1.5°C higher than that of CK; at the soil layer of 15cm, the average soil temperature of bunch planting on film was 1.9°C and 2.6°C higher than that of CK, and the average soil temperature of furrow planting beside film was 1.3°C and 1.4°C higher than that of CK; at the soil layer of 20cm, the average soil temperature of bunch planting on film was 1.4 °C and 1.9°C higher than that of CK, and the average soil temperature of furrow planting beside film was 1.0°C and 1.3°C higher than that of CK. According to the experiment data, with the growth of rape, severe shadow made the effect of enhancing temperature gradually reduced. From the data tested in July, soil temperatures of mulching and furrow planting without mulching were approximately the same, mulching almost had no effect of increasing temperature. Therefore, the effect of increasing temperature with mulching was mainly between the stages of seeding and bolting.

Table 2 Soil temperature under different mulching methods

Date	Mulching methods	Soil temperature of different layers(°C)			
		5cm	10cm	15cm	20cm
4.16-4.30	Bunch planting on film	11.3	10.3	9.5	9.1
	Furrow planting beside film	10.6	9.9	8.9	8.7
	CK	8.2	7.8	7.6	7.7
5.1-5.15	Bunch planting on film	11.8	11.2	10.8	10.4
	Furrow planting beside film	11.3	10.7	9.6	9.8
	CK	9.6	9.2	8.2	8.5
5.16-5.31	Bunch planting on film	12.9	11.9	11.8	10.6
	Furrow planting beside film	12.6	11.7	11.2	10.7
	CK	10.8	10.6	9.8	10.1
6.1-6.15	Bunch planting on film	19.5	18.6	19.4	18.5
	Furrow planting beside film	18.6	17.3	17.9	17.2
	CK	17.9	17.7	18.1	18.0
6.16-6.30	Bunch planting on film	21.8	20.5	20.4	19.2
	Furrow planting beside film	21.6	20.6	18.2	18.4
	CK	20.9	20.6	19.2	18.1
7.1-7.15	Bunch planting on film	22.0	21.8	22.0	20.4
	Furrow planting beside film	21.9	20.8	21.6	20.1
	CK	21.6	21.2	21.9	20.8
7.16-7.30	Bunch planting on film	22.9	22.7	21.2	20.1
	Furrow planting beside film	22.8	21.5	21.8	20.3
	CK	22.3	21.7	20.8	19.8

2.3 Influence of different mulching methods on soil water content

Soil water content was tested in different growth stages of rape, the results were shown in table 3. The soil water contents of bunch planting on film and furrow planting beside film were both higher than that of CK, especially at the layer of 0~20cm the soil water content changed most significantly. According to the data tested on April 30th, May 30th and June 30th, at the layer of 10~20cm, the soil water content of bunch planting on film was 2.41%, 1.36% and 2.16% higher than that of CK respectively, and the soil water content of furrow planting beside film was 1.46%, 0.7% and 1.3% higher than that of CK respectively. It was indicated that mulching could inhibit the noneffective evaporation effectively, and increase the soil water content.

Table 3 Soil water content under different mulching methods

Sampling date	Treatment	Soil water content (% of different layers (cm))					
		0–10	10–20	20–40	40–60	60–80	80–100
April 30th	Bunch planting on film	11.04	13.67	14.02	14.23	13.75	12.55
	Furrow planting beside film	11.18	12.72	13.78	14.78	12.36	13.01
	CK	10.33	11.26	13.78	14.04	12.69	11.78
May 30th	Bunch planting on film	15.25	16.72	15.26	14.42	14.25	13.88
	Furrow planting beside film	15.29	16.06	14.68	14.62	14.68	13.74
	CK	14.62	15.36	14.06	14.15	13.36	13.24
June 30th	Bunch planting on film	15.86	16.38	15.56	16.02	15.47	14.56
	Furrow planting beside film	16.63	15.52	15.78	14.85	15.26	13.48
	CK	15.37	14.22	14.88	15.02	14.70	13.13

2.4 Influence of different mulching methods on the growth stages of rape

According to the experiment results in table 4, compared with CK, seeding of bunch planting on film was four days ahead of that of CK, budding, bolting and initial anthesis were all six days ahead of that of CK, the maturing advanced eight days, and the whole growth stage shortened four days; seeding of furrow planting beside film was one day ahead of that of CK, budding, bolting and initial anthesis were all two or three days ahead of that of CK, the maturing advanced three days, and the whole growth stage shortened two days. This was mainly because mulching cultivation could speed up the growth process of rape significantly and strive Calories resources for the growth of rape in the area with high altitude. Therefore, it provided temperature and heat for the extension of branches, the increasing of pods and the forming of grains. As a result, it increased the number of branches, the number of pods and the weight of grains, and meanwhile reduced the possibility of reducing yield caused by late frost in the area with high altitude.

Table 4 Influence of different mulching methods on the growth stages of rape

Treatment	Sowing (D/M)	Seeding (D/M)	Budding (D/M)	Bolting (D/M)	Anthesis(D/M)			Maturing (D/M)	Growth period (D)
					Initial	Full	Terminal		
Bunch planting on film	24/3	20/4	29/5	3/6	12/6	18/6	4/7	10/8	113
Furrow planting beside film	24/3	23/4	3/6	7/6	15/6	23/6	7/7	15/8	115
CK	24/3	24/4	5/6	9/6	18/6	26/6	9/7	18/8	117

2.5 Influence of different mulching methods on economic characters of rape

According to the data in table 5, the economic characters of rape with bunch planting on film and furrow planting beside film were all better than that with CK. Especially the economic characters of rape with bunch planting on film was the best, compared with CK, the plant height and the length of main inflorescence were 21cm and 9cm longer respectively, the number of branches, the number of pods per plant and the number of seeds per pod increased 0.8, 11 and 3 respectively, and the weight of 1000 grains and the yield per plant increased 0.3g and 3.02g respectively; Under furrow planting beside film, compared with CK, the plant height and the length of main inflorescence were 20cm and 8cm longer respectively, the number of branches, the number of pods per plant and the number of seeds per pod increased 0.6, 9 and 2 respectively, and the weight of 1000 grains and the yield per plant increased 0.2g and 2.05g respectively. Therefore, by improving the soil ecological environment, increasing soil temperature, keeping soil water content and improving the condition of soil nutrition, mulching improved the economic characters of rape and provided foundation for high yield.

Table 5 Economic characters of rape under different mulching methods

Treatment	Planting height (cm)	No. of branches (first)	No. of branches (second)	Length of main inflorescence (cm)	No. of pods per inflorescence	No. of pods per plant	No. of seeds per pod	TKW (g)	Yield per plant (g)
Bunch planting on film	139	4.7	6.7	63	54	163	21	3.2	10.95
Furrow planting beside film	138	4.6	6.6	62	51	161	20	3.1	9.98
CK	118	4.2	6.4	54	46	152	18	2.9	7.93

2.6 Correlation analysis on yield components and yield

The correlation analysis on yield components and yield was conducted to explore the reason for the yield difference in different treatments. The results were shown in table 6. Yield of rape was positively correlated to the number of pods per plant, the number of seeds per pod and the weight of 1000 grains, and it was negatively correlated to the number of plants per unit of area to a certain degree. It had significant correlation with the number of seeds per pod; the correlation coefficient was 0.97742; it had greatly significantly correlation with the weight of 1000 grains, the correlation coefficient was 0.99998; it had no significant correlation with the number of pods per plant and the number of plants per unit of area. The correlation analysis

showed that the yield of rape was mainly influenced by the number of pods per plant and the number of seeds per pod. By improving the environmental factors of light, temperature, water and air, providing good condition for the growth of rape, bunch planting on film and furrow planting beside film increased the number of pods per plant and the number of seeds per pod significantly. Both of them provide foundation for the high yield.

Table 6 Correlation analysis on the yield components

	No. of pods per plant	No. of seeds per pod	Weight of 1000 grains	No. of plants per unit	Plot yield
No. of pods per plant	1	0.88589	0.76427	-0.9683	0.76785
No. of seeds per pod		1	0.97622	-0.97368	0.97742*
Weight of 1000 grains			1	-0.90113	0.99998**
No. of plants per unit				1	-0.90353
Plot yield					1

3 Conclusion and discussion

3.1 Bunch planting on film and furrow planting beside film could significantly increase the yield of rape. Compared with CK, yield of rape under these two mulching methods reached a significantly level, the yields of them were 42.94% and 34.04% higher than that of CK, and the yield of bunch planting on film was higher, and then came the yield of furrow planting beside film.

3.2 Mulching had the significant function of increasing temperature and conserving water, and the function of bunch planting on film was better than that of furrow planting beside film. The effect of increasing temperature was obvious at the stages of seeding and bolting, which was good for the seeding of rape in the area with high altitude and which created condition for early maturing and high yield and provided the possibility of avoid damage of late frost in the area with high altitude in the middle of Gansu province. The effect of conserving water ran through the whole growth process of rape. And mulching could enhance field capacity, which was beneficial for the growth of subsequent crops.

3.3 The effect of increasing yield with bunch planting on film was better than that with furrow planting beside film. But the operation of bunch planting on film was complex, and it cost labors and time, so its promotion was restricted and it was appropriate to be promoted in the area with high altitude in the middle of Gansu province where the no-frost period was short and the labors were sufficient. The operation of furrow planting beside film was simple, and it had obvious effect of increasing yield, meanwhile, its relative benefit was higher than that of bunch planting on film, so it should be promoted with large area.