Studies on the Effects of Catching Rainwater with Saving Water Technology of Covering Film between Furrows in Eestern Semi-arid Area of Heilongjiang Province

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Abstract: Considering the allocation rainwater effect of covering film between furrows, the article takes data of Gannan County as an example studied the catching rainwater effect of saving water technology with covering film between furrows. The catching rainwater effects relate to the width of covering film and natural rainfall intensity. When the width of covering film is 60-80 cm, natural rainfall intensity is at 5-15 mm, the pant belt beside 15 cm of covering film remained rainwater can be 2.1-3.2 times of rainfall. When less water in the Spring season or the sprinkler irrigated land, the covering film between furrows can catch rainwater efficiently. [The Journal of American Science. 2006;2(1):56-60].

Key words: Semi-arid area; covering film between furrows; effect of catching rainwater

Introduction

The western semi-arid area of Heilongjiang Province is located in north latitude from 45º 58 ´ to 48 º 58 ´ , east longitude from 122º 24 ´ to 128º 19 ´ .Gross area is 10.18×104 km^2, it accounts for 22.4 percent of gross area in the whole province agricultural acreage in the district is 6043×104 acreages, it accounts for 44 percent of agricultural acreage in the whole province agricultural acreage. There is 27 counties and cities in the district. Including Longjiang, Gannan , Tailai county, etc. the district is continental climate, it is more windy and less rain in Spring, it is sweltering and little in Summer , it is cold in Winter. mean annual precipitation is between 380mm and 500mm, and mean annual evaporation is between 1400mm and 1600mm, it is the essential characteristic of drought in spring, bed sowing and sprinkler irrigation as representative of water saving irrigation have been generalizing in large area here in last ten years, they attained better effects of fighting a drought and increasing production. For the sake of improving the general capability of fighting a drought in this area, from 2002, "863 project " of national program —— "integration and demonstration of water saving agriculture integrative system in northeast semi-arid drought resistance irrigation area" come into effect in this area, in virtue of combination of water conservancy measures and mechanization of farming, agriculture measures, people searched after general technologic pattern of fighting a drought and water saving to adapt to local nature condition. Mechanized dry crops semination covering films between furrows was one of the dominating technical measures which were adopted there inro, it has played a important role in improving agriculture integrative capability of fighting a drought, in order to further discuss the effects of catching rainwater of dry crops with saving water technology of covering film between furrows in western semi-arid area of Heilongjiang Province, this paper combined Gannan county data to study. the effects of catching rainwater with saving water technology of covering film between furrow.

1. The analyses of distribution law of rainfall time interval and field moisture deficit amount in growth period.

1.1 The analyses of distribution law of rainfall time interval

The statistical analyses were monthly done by 48 years' s daily rainfall data in the weather station in the Gannan county, from 1955 to 2002, the results were listed in Table 1.

K is a percent which monthly precipitation takes up total precipitation in crop growth period. From tab 1 we can see : ① precipitation distributed asymmetrically in a year, precipitation amount in April, May and June only accounted for 28.2 percent of precipitation in all crops growth period , rainfall centralized in July and August , rainfall in July accounted for 34.7 percent of precipitation in all crops growth period, difference in each month precipitation

was biggish，precipitation in Spring was less. ② The characteristic of precipitation in overyear distribution was that variability coefficient in April and May arrived at 0.78 and 0.91 respectively，but variability coefficient in July and August where precipitation was centralized was less.

Table 1. The rainfall of per month in crop growth period (April-September)

Months	4	5	6	7	8	9	Σ
Precipitation amount mean value P（mm）	16.94	31.27	70.83	146.54	105.15	51.51	421.80
Standard deviation S（mm）	15.36	24.30	39.12	78.77	48.53	31.22	
Variability coefficient C_v	0.91	0.78	0.55	0.54	0.46	0.60	
Proportional coefficient K（%）	4.0	7.4	16.8	34.7	24.9	12.2	100.0

1.2 The analyses of field moisture deficit amount in growth period

The researchful production of water saving and high yield irrigation program of main crop in Heilongjiang Province and isoline map of water demand was quoted，with a view to the effect of non-copious irrigation on crop water demand，that crop water demand of soybean and maize as representative was comfirmed，each month water in crops growth period，compared with precipitation amount in the corresponding period. each month arid degree was analyzed in crops growth period in Gannan county.

According to soil moisture equilibrium theory，without regard to level movement of soil moisture，soil moisture equilibrium equation in the certain soil layer is that

△W= P + I + k—ET。 （1）

combining the characteristic of seedling period of local soybean and maize，and taking into account of the effects of subsoil frozen crust，K of capillary ascending water equals to zero. I equals to zero under no irrigation，soil moisture equilibrium equation in the certain soil layer is that

△W=P — ET。 （2）

△W stands for soil moisture change quantity in time interval in the formula，when △W value is positive number，that shows that soil moisture increase. When △W value is negative number，that shows soil moisture wane；P stands for rainfall in time interval. ET。stands for field transpiration and evaporation in time interval，namely crops water demand.

Applied to（2）formula，and found water saving and high yield irrigation program of main crop in Heilongjiang Province and isoline map of water demand，with a view to the effects of non-copious irrigation on crop water demand，each month water demand in soybean and maize seedling period，compared with precipitation amount in the corresponding calculated and gained period，wane amount which was in seedling growth period was listed in Table 2.

Table 2. Soil moisture deficit analysis in land of soybean and corn during growth season

Month	4	5	6	Σ
Precipitation uniform value P（mm）	16.94	31.27	70.83	119.04
soybean and maize’s general water demand ET。（mm）	22.2	38.8	112.5	173.5
Soil moisture wane △W（mm）	5.3	7.5	41.7	54.5

Soil moisture wane △W which was shown in Table 2 was counted by mean annual precipitation，thus，which was shown was mean annual moisture wane amount.. Natural rainfall in June was 70.83，water demand in June was 112.5mm，moisture wane amount in June was 41.7mm，June was the month when moisture wane amount was the most，and drought was the most serious，that was fully coincident with factual condition in Gannan area，thus it can be seen that searching after supernal efficiency measures which suited. precipitation in Spring seedling growth season in this area，and increasing natural precipitation utilization factor，it was important significance to improve general fighting a drought capability.

2. The analyses of the technology of covering film between furrows and the effects of catching rainfall

2.1 The ridge form and width of covering film

Dry copy covering film between furrows was that people made use of special covering film sowing machine to sow, space between furrows might adopt equal and unequal space between furrows, such as 85 cm/45 cm, 75 cm/65 cm, 65cm /65cm, in order to improve earth temperature, ground film was covered in wider space between furrows , and reduce soil evaporation and preferably collect natural precipitation. seeds were sowed in bare soil outside film, covering film, there was 2～3cmbetween seeds and margin of film, mulching soil and crushing were completed by coverer and crusher, respectively. The ridge form of covering film approximately was flat ridge, but, in order to improve the quality of covering film, the soil under film should be leveled by special plastic board to wipe off the big clod and root stubble, ridge form should be symmetrical, the middle of ground film which were covered was higher 3～4cm than both sides, so that rain water that flat on the surface of film uniformly flowed to plant belt of film sides, rain water concentratively irrigation to crop root.

2.2 The analyses of catching water of covering film amount and rainfall amount in plant belt

Catching water of covering film amount with different width of covering film might be calculated by next formula:

$$W = X + Y + Z \qquad (3)$$

In the formula

W——unit ridge length amount of catching water of covering film between furrows (m^3);

X——unit ridge length amount of catching water of covering film between the film surface of furrows, it equals the product of catching water depth h in film surface and unit ridge length covering film area A (m^3);

Y——unit ridge length amount of catching water on covering film soil of film sides (m^3), it equals the product of covering film soil bulk V of film sides and field capacity of soil θ_f;

Z——unit ridge length amount of catching water of covering film soil above film surface (m^3), it equals the product of covering film soil area A_0 above film surface and precipitation amount P.

or $$p_a = 1000\ W / a\ L \qquad (4)$$

In the formula

p_a——The depth of catching water of covering film with different width of covering film by conversion (m^3);

a——The depth of covering film (m), it equals that distance between furrows subtracts twofold distance from plant belt center to ground film (it may select 2～3cm);

L——Unit ridge length of covering film between furrows (m).

When rainfall began, rain water that fell on the surface of film collected towards both sides of the film, firstly, contenting water storage of catching water on the surface of the film and covering film soil by the sides of the film, after moisture of covering film soil by the sides of the film was up to field moisture capacity, rain water that fell on the surface of film further stored water up to saturation, succedent precipitation may be collected to irrigate into the soil near plant belt; When rainfall stopped, gravity water in covering film soil by the sides of the film finally infiltrated into the soil of plant belt. If precipitation amount was larger than Catching water of covering film amount between furrows, rain water would exceed precipitation of catching water and that collected into the crop root soil near film, this action corresponded to local irrigation in the crop root soil (like drip irrigation).

Precipitation amount in plant belt might be calculated by next formula:

$$p_b = p + (p - p_a) \cdot a / 2b \qquad (5)$$

In the formula

p_b——Precipitation amount which was received by plant belt (mm);

P——Natural precipitation amount (mm);

b——The width of plant belt (m), there was relationship between its value and soil permeability, irrigation amount, etc. Taking into account of the effects of catching rainwater of covering film, The width which was received by plant belt may be selected 12～20cm;

The meaning of other symbols was the same as the above symbols.

During the practice of covering film between furrows in western semi-arid area of Heilongjiang Province, by investigation, survey and calculation, double-side covering film soil of each 1000 extended meter between furrows was $2.5m^3$, according to the calculation of thirty percent (percent that moisture accounts for soil bulk) of field moisture capacity of loam and clay, so that the precipitation of catching rainfall when water volume of $2.5m^3$ covering film soil was up to moisture-holding capacity, the precipitation of catching rainfall was 0.75 m^3; In order to prevent that ground film was blown by wind, a shovel of soil was covered in the middle of film every $2.5m^3$, the covering film soil of each 1000 extended meter was 400 shovels, the area of covering film was $0.1m^3$ according to covering film soil of each shovel, so the area of covering film soil above film was $40m^3$, under the

circumstance that the precipitation was not very large, the corresponding precipitation of catching rainfall was the product of the area of covering film soil and precipitation; taking into account of the effects of catching rainwater of ground film itself, the precipitation of catching rainfall above film may be calculated by 1mm, received rainwater in plant belt with deferent width of covering film, deferent natural precipitation in Table 3.

Table 3. received rainwater in plant belt with deferent width of covering film, deferent natural precipitation

a（cm）	80	70	60
P=5mm	12.5	11.5	10.4
P=10mm	30.3	27.5	24.8
P=15mm	48.3	43.5	39.2

The width of covering film between furrows in table 3 was calculated by outboard film seeding, the width of plant belt was selected 15 cm. From Table 3 we can see that under the circumstance of 60～80 cm, when natural precipitation was 5～15 cm, the precipitation received practically of 15 cm width of plant belt was 2.1～3.2 fold of quondam precipitation, it is very obvious to the effects of catching rainwater .

3. The effects of catching rainwater with saving water technology of covering film between furrows in western semi-arid area of Heilongjiang Province

taking an example of Gannan county, if the technology of covering film between furrows was adopted, according to the calculation of mean annual precipitation during growth period from April to June, when the width of covering film between furrows was 60 cm, the precipitation received practically in 5mm natural precipitation plant belt was 10.4 mm, the precipitation received practically in 10mm natural precipitation plant belt was 24.8 mm, the precipitation received practically in15 mm natural precipitation plant belt was 39.2mm, the precipitation received in plant belt corresponded 2.1～2.6 fold of natural precipitation. If the technology of covering film between furrows was adopted from the late April to the early May, the mean value of the precipitation received practically in corresponding plant belt in May and June precipitation was not under 84 mm （May）and 148 mm （June）, from mean annual precipitation we can see that covering film between furrows in May and June made plant belt excessively receive precipitation 129mm, it is very important to prevent drought during growth period.

According to foregoing analyses, from mean annual precipitation we can see that water deficit of soybean and maize in May was 7.5 mm, water deficit in June was 41.7mm, water deficit in two months was 49.2 mm, which was out and away less than the 129 mm precipitation received excessively of covering film between furrows. But, because of annual precipitation randomicity, it was no practically significant to the effects of catching rainwater of covering film between furrows in the month in Spring when precipitation was more, if precipitation in Spring was less, then it was finite to the effects of catching rainwater of covering film between furrows. Only when rainfall was little in Spring but not especially little in some year or there was sprinkler condition in some plots, the effects of catching rainwater with saving water technology of covering film between furrows were commendably brought into play.

4. Conclusions

(1) The statistical analyses were done by 48 years' s daily rainfall data in the Gannan county, from 1955 to 2002, findings were shown that there was a question of drought in each month of growth period, the probability of happening gentle drought in June came up to 89.6 percent, June was the month when field moisture wane was most, drought was the most serious.

Therefore, utilization factor of natural precipitation in growth period was enhanced, that was important significance to improve general capability of fighting a drought in agriculture.

(2) The technology of covering film between furrows had better effects of catching rainwater, the effects of catching rainwater has a very relationship with the width of covering film and natural precipitation, under the circumstance of 60～80 cm, when natural precipitation was 5～15 cm, the precipitation received practically of 15 cm width of plant belt was 2.1～3.2 fold of quondam precipitation.

(3) From mean annual precipitation we can see that covering film between furrows in May and June made plant belt excessively receive precipitation 129mm, it is very important to prevent drought during growth period. But, because of annual precipitation randomicity, it was no practically significant to the effects of catching rainwater of covering film between furrows in the month in Spring when precipitation was more, if precipitation in Spring was less, then it was finite to the effects of catching rainwater of covering film between furrows. Only when rainfall was little in

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