Preliminary study on corn-rapeseed rotation system in Liaoning Province

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Abstract

The preliminary study was carried out on cultivation and ecological benefits of corn-rapeseed rotation by use of split-block experimental design. The results showed that sowing rapeseed after corn prolonged the period of green-plant-cover over the soil, controlled water-soil erosion, protected environment, increased soil organics and improved soil performance as green manure. The corn-rapeseed rotation also promoted the development of stock-raising. Rapeseed is a vegetable growing fast and its cultivation can bring profits. The corn-rapeseed cultivation can improve sustainable development of agriculture.

Key words: Corn-rapeseed rotation; soil fertility; soil and water preservation; environment protection

Introduction

Maize is a primary crop in Liaoning province, China, with a cultivation area of 1.30 million hectares yearly. The planting system is one crop one year in the province and maize is the only crop cultivated in most area year after year. Therefore, the quality of soil declines as well as plant diseases and insect pests increases. The soil remains bare after maize harvest from winter to spring. Liaoning province belongs to monsoonal weather. The strong wind in winter and spring frequently leads to the formation of sand-dust weather (Dong, et, al, 2002). Maize straw from field is mostly used as fuel for cooking and warming resulting in decline of organic matters, nitrogen and phosphorus (Li and Wu, 2005). To solve this problem, rotation of maize-rapeseed is used to increase organic matter content in soil and improve agricultural environment. Temperature, sunlight and rainfall are favorable to rapeseed growth after maize harvest. Three maize varieties with early-maturity, mid-maturity and late-maturity respectively were used to cultivate in rotation with rapeseed in this study. The optimum rotation model of maize-rapeseed was studied preliminarily in potential of sustainable development in agriculture.

Materials and methods

Plant materials: Maize varieties used were "Jingnuo No.5" with early maturity, "Tangkang No.1" with mid-maturity and "Jindan No.10" with late-maturity. The rapeseed variety used in rotation system was "Tianheyou No.18" bred by Crop Introduction and Breeding Center of Anhui province. The soil in trial was umber with 1.1% of organic content and pH 6.5.

Methods: The split-plot design was applied using sowing date of rapeseed as the main treatment: (1) early sowing, (2) medium sowing and (3) late sowing with 3 replicates. The sub-plot treatments were: (1) non-rotation and (2) rotation "Tianheyou No.18" after maize harvest. Each plot was 99.9 m^2. Three maize varieties were sowed in trial field of Bohai university in April 18, 2004 and harvested in July 30, Augest 14 and September 9, respectively. Rapeseed was sowed in July 31, Augest 15 and September 10, respectively. The density of rapeseed was 225,000 plants per hectare. Each plot was divided into three parts and the first part rapeseed was harvested as a calculation of forage yield. The second part rapeseed and the first part rapeseed residue were ploughed and used as green manure to improve soil fertility. The third part was ploughed and used as green manure in next March.

Rapeseed nutrition and soil property analysis: Soil in range of 0~20 cm deep were sampled in five points. The soil moisture and organic matter content were determined. Nutrients in rapeseed plant and the ecologic benefit were also analyzed.

Results

The maize varieties showed differences in yield. The yield of late-mature variety was higher than medium-mature variety. The early-sowing rapeseed had the highest forage yield up to 48.5 t/ha. The forage yield of mid-sowing rapeseed was 37.8 t/ha shown in table1. The forage yield of late-sowing rapeseed was only 12.7 t/ha because of low temperature and short growing season. The ANOVA results showed that the forage yield of early-sowing rapeseed was very significantly higher than the mid-sowing rapeseed. The forage yield of mid-sowing rapeseed was very significantly higher than late-sowing rapeseed. The early-mature and mid-mature varieties were suitable to the maize-rapeseed rotation in Liaoning province. The appropriate sowing date of rapeseed was about in the mid of August in the rotation system.

Crude protein content was higher than crude ash, crude fibre and ether extract in rapeseed forage as in table 2. Nitrogen free extract was the highest nutrient in rapeseed forage. The results in table 3 showed that soil moisture and organic matter were improved. The earlier the rapeseed was sowed after maize harvest, the higher the soil moisture and organic matter were improved. If rapeseed was ploughed as green manure before winter, the soil moisture was increased 10.44%, 7.52% and

5.61%, respectively. The organic matter was increased 0.34%, 0.23 % and 0.13%, respectively.

Table 1 Forage yield of rapeseed

Rotation	Early maize-rapeseed	Medium maize-rapeseed	Late maize-rapeseed
Maize yield (t/ha)	*	6.78	7.65
Sowing date of rapeseed	7/31	8/15	9/10
Harvest date of rapeseed	10/30	10/30	10/30
Forage yield of rapeseed (t/99.9 m^2)	0.485	0.378	0.127
Amount to yield (t/ha)	48.5**	37.8**	12.7

* Early maize was harvested in 25 days after pollination for fresh food.
**significantly at P=0.01 level.

Table 2 Dynamic changes in rapeseed plant nutrients (%)

Date	Crude Protein	Ether Extract	Crude Fibre	Nitrogen free extract	Crude ash
9/15	19.73	3.15	14.64	45.81	15.24
9/30	23.62	3.23	14.10	43.04	14.61
10/15	21.44	2.52	16.93	46.10	13.16
10/30	20.96	2.46	17.55	47.20	12.72

Table 3 Changes in soil moisture and organic matter

Treatment	Date	Soil moisture%	Organic matter %
	7/31	25.53	1.06
	11/10	30.56	1.32
	4/5	18.85	1.29
	7/31	25.53	1.06
	11/10	20.12	0.98
	4/5	8.78	0.92
	8/20	20.46	1.10
	11/10	24.78	1.28
	4/5	16.29	1.22
	8/20	20.46	1.10
	11/10	17.26	1.05
	4/5	8.68	1.01
	9/10	19.37	1.11
	11/10	21.85	1.17
	4/5	12.56	1.13
	9/10	19.37	1.11
	11/10	16.24	1.04
	4/5	8.72	0.96

Discussion

Corn straw is used mostly as life fuel for cooking and warming in Liaoning province recent years. Corn straw is not returned into field which leads to descending of soil fertility (Shao, 1999). Corn straw is burned also resulting in shortage of forage and slowness of stock raising development. Therefore, it is important to increase soil organic matter and improve agricultural environment. Rotation of maize-rapeseed in this study prolonged the period of green plants covering earth, reduced corrosion from wind and water and increased soil moisture. Rapeseed is equivalent to pea in nutrients. Rotation enhanced soil organic matter and soil fertility. This rotation system combined the crop planting and soil maintenance. It could improve sustainable development of agriculture (Fu, et al., 2002).

Stock raising was restricted by over-browsing and degradation of pasture in Liaoning province. Rapeseed grows fast in cool weather. It could be planted after maize harvest. The yield of rapeseed forage is 50~100% higher than sweet clover, pea and Chinese milk vetch with lower cost. The extending of rotation rapeseed is available to development of stock raising in Liaoning region. The rotation of maize-rapeseed can make the best of ground utilization and optimize cultivation structure. It can also improve agricultural environment, increase crop yield and promote sustainable development of agriculture. This reform in cultivation system takes on important effects on economic development of Liaoning province.

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