

Hairy vetch and rye as cover crops to reduce soil erosion from sloped land in highland agriculture

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Abstract

Effect of cover crop on reducing soil loss from a highland experimental farm during the cropping period from 2005 to 2008 was examined. The amount of soil loss was 1.6 tons/ha from the bare plot, while that from the plots with cover crops, rye or hairy vetch, were 0.4 and 0.7 MT/ha/yr. Biomass of rye and hairy vetch before incorporation were 27.5 and 31.4 MT/ha/yr, respectively, while that of the non-cover crop control plot was 12.6 MT/ha/yr. It implied that 4.9 kg to 9.9 MT/ha of dry matter could be supplied as covering organic material for main crops in growing season. When these cover crops were used as green manure by inversion into the soil or covering after cutting, the Chinese cabbage of the hairy vetch plot had yields that were over 2 times higher, from 35.9 to 45.2 MT/ha, than the control plot with yields from 16.0 to 20.0 MT/ha, and the yields of rye ranged from 17.7 to 22.4 MT/ha. In the case of radish, the yields from the hairy vetch plot and the rye plot were from 10.2 to 11.5 MT/ha, and 57.7 to 69.3 MT/ha, compared with the yield of control plot which ranged from 43.5 to 45.1 MT/ha. In conclusion, cultivation of cover crops such as rye and hairy vetch in fallow period was a very effective method to reduce soil loss and increase soil fertility.

Key Words

Cover crop, green manure, hairy vetch, rye, highland agriculture.

Introduction

In highland agriculture in Gangwon Province in Korea, about 70% of the farm lands are located on over 7% slope, where the erosion potential is high. Growing season of crops such as Chinese cabbage, radish and potato in this area is 60 to 120 days a year, and the rest of the time the soil was left bare condition susceptible to soil erosion. Cho (1999) pointed out that effective soil depth of highland in this province was range 10 to 60 cm which is quite shallow for most crops, and lefts bare during non-cropping period. Severe erosion occurs with poor soil coverage during fallow periods. Cover crops can provide protection during such periods left bare. Baver *et al.* (1972) and Wischmeier and smith (1978) reported that maintaining of reasonable cropping system reduced erosion by wind, snow melting and rainfall. Plant residues reduce the impact of raindrops that otherwise would detach soil particles and make them prone to erosion (Lafren *et al.* 1979). Surface runoff is slowed by the cover, allowing improved moisture infiltration. And the root system helps stabilize the soil by infiltrating the profile and holding it in place. Cover crops can add organic matter to the soil which improves soil tilth and productivity. Michell and Teel (1977) and Ebelhar *et al.* (1984) who reported that cultivation of hairy vetch as cover crop and green manure could reduce use of chemical fertilizers. The objectives of the study were to find out the effect of cover crop on reduction of soil loss, and increasing organic matter and crop productivities in highland area.

Methods

A field experiment was conducted from 2005-08 on a farm with the 10% slope located in Hoenggye-Ri, Daegwallyeong-Myun, Pyeongchang-Gun, Gangwon-Do, at a 750 m elevation. Cover crops, hairy vetch and rye were seeded in early September, and the main crops, Chinese cabbages and radishes were seeded or planted at the end of June of the following year. The experimental design was a randomized split-plot with 3 replicates, with cover crop species of bare, rye (*Secale cereal* L.), hairy vetch (*Vicia villosa* Roth) as the main plots. The sub treatments included application methods of residues to the soil by incorporating soil and surface covering after cut. Rye and hairy vetch were seeded 200 kg and 50 kg/ha. Covering rate was checked once a month and fresh, and dry matter amounts were measured from 1 m² of every plot before incorporation. The plots with 3 X 10 m² were set for all plots and total runoff and eroded materials were collected with the 400 L collection tanks. Collected eroded materials were sampled after each rain event. Incorporation of cover crop residues was conducted at 15 and 5 days before seeding or planting of main crops, respectively. Surface covering was conducted at 10 days before seeding or planting. No additional

fertilizers were used on the plots. Yields of radish and Chinese cabbage were measured at harvest time. The plants were dried and analyzed for inorganic components (T-N, P₂O₅, K₂O etc.). Cultural methods for growing radish and Chinese cabbage and analytic methods for soil and plant elements followed Standard RDA methods. And statistical analyses were conducted using analysis of variance (ANOVA) procedures of Windows SAS Version 9.0 (SAS Institute, Cary, NC).

Results

The total amount of soil loss from the hairy vetch and rye cover crop plots during fallow period were 7 and 4 MT/ha, compared with bare plot of 16 MT/ha (Figure 1 and Table 1). The results indicated that 56 to 75 percents of soil loss could be reduced by cover crops. In the following year, dry matter of hairy vetch and rye plots were 4.94 and 9.90 MT/ha, compared with 2.29 MT/ha of the bare control plot. There were 216% and 432% increasing effect of organic matter in hairy vetch and rye respectively, compared with the bare control plot. The organic matter supply was higher in the rye plot. The hairy vetch, as a legume has high nutrient contents in itself, could supply 210 kg N, 44 kg P₂O₅ and 114 kg K₂O/ha to the following main crop as calculated from the inorganic contents of Table 1.

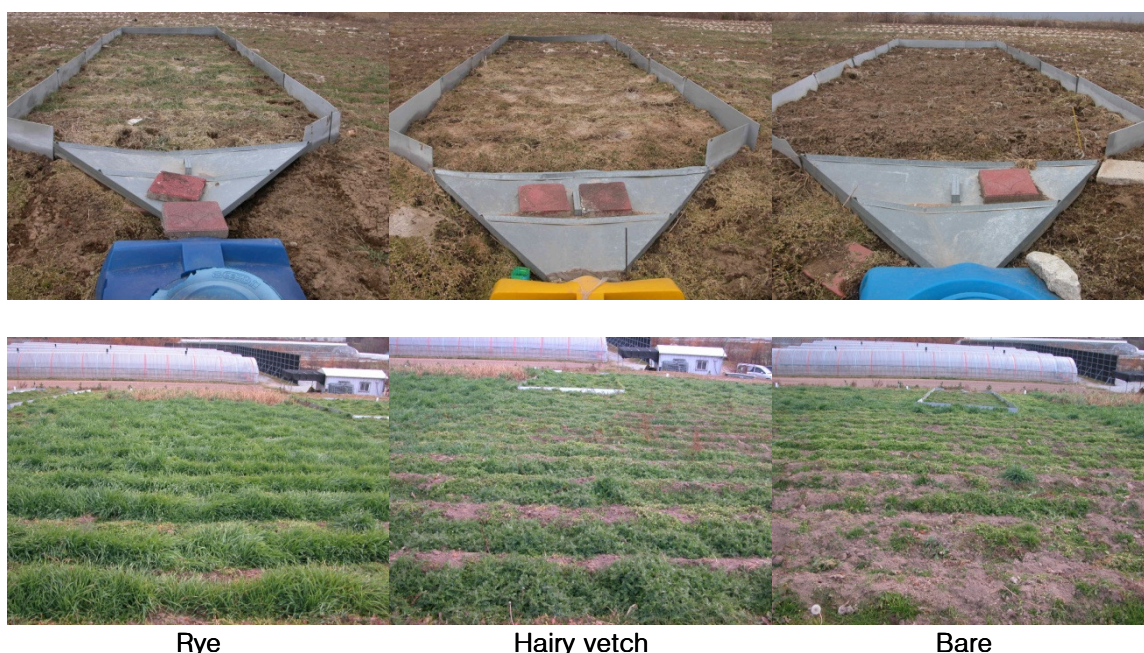


Figure 1. Effect of soil cover of rye and hairy vetch on winter period.

Table 1. Amount of biomass, dry matter, nutrient component, and soil loss from cover crop plots.

Cover crops	Biomass (kg/ha)	Dry matter (kg/ha)	Inorganic component (%)			Soil loss (MT/ha)
			T-N	P ₂ O ₅	K ₂ O	
Hairy vetch	31,420	4,940	4.2	0.9	2.3	7
Rye	27,520	9,900	0.9	0.3	1.1	4
Bare	12,610	2,290	1.8	0.4	1.5	16

The yield of Chinese cabbage and hairy vetch plots was over 2 times higher than the control, ranging from 35.9 to 45.2 MT/ha versus the control plot at 16.0 to 20.0 MT/ha. The yield from the rye plots were 17.7-22.4 MT/ha. In the case of radish, the yield of hairy vetch and rye plots were 102.1-115.1 MT/ha and 57.7-69.3 MT/ha, compared with the bare plot at 43.5-45.1 MT/ha (Table 2).

Conclusion

Cover crop such as hairy vetch or rye resulted in reduction of soil loss from 56 to 75%. Incorporation in the soil of these cover crops showed over 2 to 2.5 times the nutrient supply. Therefore, using hairy vetch and rye during fallow period as cover crop showed large potential to decrease soil loss and increase fertility of soil for highland agriculture. Cover crops in highland can provide environmental benefits that make cover crops suitable for enhancing soil conservation and recovery of soil fertility.

Table 2. Yields and inorganic components of Chinese cabbage and radish in incorporation of cover crops

Cover crops	Incorporation Method (I.M)	Chinese cabbage				Radish			
		Yield (MT/ha)	Inorganic component (%)			Yield (kg 10/a)	Inorganic component (%)		
			T-N	P ₂ O ₅	K ₂ O		T-N	P ₂ O ₅	K ₂ O
Hairy vetch	Inversion	39.5	8.2	3.6	5.8	115.1	13.7	10.6	19.6
	Covering	45.2	7.5	2.9	4.5	102.1	12.9	8.3	17.2
Rye	Inversion	22.5	4.3	2.2	3.4	69.3	7.2	6.5	12.3
	Covering	17.7	4.1	1.8	2.6	57.7	6.7	5.0	10.4
Bare	Inversion	20.0	4.0	2.1	3.1	45.1	5.1	3.9	8.7
	Covering	16.0	3.5	1.6	2.5	43.5	5.4	3.6	7.3
Cover crop (A)		**				**			
I.M. (B)		ns				ns			
A*B		ns				ns			

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