Effects of Se and Co Combined Fertilizer on Production of Alfalfa

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Introduction

Selenium (Se) and cobalt (Co) are important essential trace elements for forage and animal production (Yang *et al*. 1998, Arvy 1993). The supplementation of Se in animal diet significantly increases Se-Glutathione peroxidase (GSH-Px) activities in the liver, testes, spermatozoa and seminal plasma (Abdelrahman *et al*.1998), Selenium is also a key component of a number of functional seleno-proteins. GSH-Px is the best characterized of the family of selenoproteins. In Henan Province, the fine grass and green milk production zones are mainly distributed along the riverbank of the Yellow River where soils are sandy and sterile with lower Se and Co contents (Lu *et al*. 2003). Deficiency of Se and Co in soils affects local forage and animal production level, as well as the qualities and securities of fodder and animal products (Rotruck *et al*. 2003). This experiment was carried out to determine the impacts of the application combined Se and Co on the quality of alfalfa hay.

Materials and methods

A randomized complete block design including 9 treatments with three replications was carried out in September 2006. There were 27 plots and the area of each plot was 3 x 3m. The trial treatments consisted of 9 combination of 3 fertilizer levels of $Na_2SeO_35H_2O$ (Se) and 3 fertilizer levels of $CoSO_47H_2O$ (Co) (S_0C_0, S_0C_1, S_0C_2, S_1C_0, S_1C_1, S_1C_2, S_2C_0, S_2C_1, S_2C_2). The amounts of fertilized Se were 0, 570 and 765 g/ha (S0, S1 and S2), and the amounts of fertilized Co were 0, 762 and 1572 g/ha(C0, C1, C2). Se and Co were used as base fertilizer and plowed into the deep soil layer of perennial alfalfa rangeland (Jie *et al*. 2007, Ma *et al*. 2008).

Alfalfa was sampled at flowering in June, 2010, cut into 3cm sections and sun dried. The sun-dried alfalfa hay samples were taken for analyses of crude protein (CP), crude fiber (CF),ether extract (EE), nitrogen free extract (NFE) , Ash (A) and 8 trace elements. CP and EE of forage hay were determined according to the procedures of AOAC (2000), CF (ADP) of alfalfa hay was analyzed following the method of Goering and van Soest *et al*. (1991), Ash content of alfalfa hay was determined according to Kjeldahl method AOAC (2000) in which the samples were weighed and placed in the muffle furnace at 550°C for 2 hours and the remaining ash weighed. NFE was determined by NFE(%)=100%-CP%-EE%-A%-CF%. A flame photometer and atomic absorption spectrometer was used in the determination of minerals.

Results

The effects of Se and Co on major nutrients of alfalfa hay

Nutrients compositions in alfalfa hay are shown in Table 1. Se and/or Co fertilization had significant effects on major nutrients of alfalfa hay. When application rates of Se and Co were 765 g/ha and 762 g/ha respectively, Se and/or Co fertilization enhanced the contents of crude protein (CP) and ether extract (EE) with little change of crude fiber (CF) and nitrogen-free extract (NFE), and enhanced feed values of alfalfa hay. Other treatments increased the content of CF and decrease the content of EE, and had no significant effect on the of CP and NFE contents.

Table 1. Effects of Se and Co single and combined application on nutrition of alfalfa hay in flowering period. Values with different superscript in the same column are significantly different ($P < 0.05$).

Treatments	CP	EE	A	CF	NFE
S0C0	19.34 a	2.94 b	10.95 a	17.25 b	49.52 a
S1C0	19.17 a	2.88 b	10.28 b	18.56 a	49.11 a
S2C0	19.54 a	2.17 c	10.03 b	19.04 a	49.22 a
S0C1	19.59 a	2.74 b	11.26 a	17.68 b	48.73 a
S0C2	19.28 a	2.87 b	11.28 a	17.55 b	49.02 a
S1C1	19.34 a	2.83 b	11.31 a	18.87 a	47.65 a
S1C2	19.87 a	2.28 c	10.00 b	19.44 a	48.42 a
S2C1	20.10 a	3.65 a	10.11 b	18.02 ab	48.12 a
S2C2	19.23 a	1.87 d	11.39 a	18.46 a	49.05 a

Table 2. Comparison of nutrient contents of trace elements of alfalfa hays among different treatments (mg/kg). Values with different superscript in the same column are significantly different ($P < 0.05$).

Treatments	Fe	Mn	Cu	Zn	Mo	B	Se	Co
S0C0	398.25 c	29.65 d	13.18 d	40.48 d	2.48 e	3.63 c	1.59 e	2.25 d
S1C0	443.52 b	30.35 d	14.42 c	44.91 c	6.05 c	4.07 bc	7.93 c	2.30 d
S2C0	587.54 ab	38.60 b	14.32 c	53.78 b	6.49 c	4.86 a	14.56 b	2.36 d
S0C1	461.32 b	34.68 c	13.91cd	42.62 cd	3.81 d	3.72 c	2.87 d	4.21 c
S0C2	416.28 bc	35.41 c	13.22 d	41.28 cd	2.73 e	3.81 c	2.68 d	4.44 c
S1C1	605.12 a	40.95 ab	18.10 a	79.50 a	8.84 a	5.07 a	9.22 c	4.30 c
S1C2	590.04 a	42.00 a	17.05 ab	73.01 a	7.29 b	4.99 a	8.30 c	4.95 b
S2C1	635.00 a	39.81 b	14.95 c	55.50 b	6.19 c	4.16 b	19.04 a	5.10 b
S2C2	620.05 a	39.40 b	16.15 b	55.57 b	6.01 c	4.17 b	16.15 b	5.50 a

The effects of Se and Co fertilization on the contents of Se, Co, Mo, Cu, B, Fe, Mn and Zn in alfalfa hay

From the results presented in Table 2, it can be seen that Se and Co applied fertilizers could enhance the contents of Se, Co in alfalfa forage (hay), especially Se contents. Also, it can be seen that Se and Co applied fertilizers could enhance the contents of Mo, Cu, B, Fe, Mn and Zn significantly (P<0.05). When the application rates of Se and Co were 765 g/ha and 762 g/ha, respectively, the contents of the trace minerals were increased. The contents and accumulation of 6 trace elements can reach optimal levels.

Discussion

Our experiment suggests that the combination between Se (765 g/ha) and Co (762 g/ha) can be used to improve quality of alfalfa. Firstly, Se and Co fertilization, applied either singularly or combined, had optimal effects on alfalfa hay which could enhance crude protein (CP) and ether extract (EE), and keep stable crude fiber (CF) and nitrogen-free extract (NFE) and enhanced feed values of alfalfa hay. Secondly, Se and Co combined fertilizers could raise Se and Co contents . Because of soil conditions, there is about 80% arable land in China with bad Se deficiency, which affects the development of agricultural and animal production, especially animal product quality (Zhang *et al.* 2000). The traditional method for solving Se deficiency in animal feeds was to supply inorganic selenium chemicals (Zhang 2000), but this method was tedious and expensive, and might be dangerous due to significant wastage of chemicals to the environment. Alfalfa has strong capacities not only for absorption of selenium from soil fertilizers, but also for transfer from inorganic selenium to organic selenium, which is safer for animal production. Selenium application combined with cobalt could strengthen these abilities and overcome Se and Co deficiency in animal hay and feeds significantly Thirdly, Se and Cobalt applied fertilizers could enhance the contents of Se, Co, Mo, Cu, B, Fe, Mn and Zn significantly (P<0.05) up to optimal levels.

Conclusions

This paper analyzed benefits and critical techniques of Se and Co basal fertilizer applied in alfalfa forage production, which not only could enhance contents of trace elements in forage effectively, but also raise alfalfa nutrition significantly. The results have great theoretical meaning and practical value for safe and high efficient production of alfalfa in central China.

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