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Effect of Fertilizer Levels on Growth Characters, Dry Matter Yield and Nutrient Quality of Forage Rape in Spring Sowing

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ABSTRACT

To find out the optimum fertilizer level for high yielding variety, Velox, experiment was conducted with 15 compositions of fertilizer levels at the experiment field of forage crop in Sunchon National University from Mar. 2000 to Aug. 2000. The effects of nitrogen fertilizer on plant growth were significant but increasing rate of application in potassium and phosphate fertilizers above 6 kg/a had negligible effects on plant growth. The optimum nitrogen application level of fertilizers turned out to be 16-6-6 kg/10a of N-P_2O_5-K_2O. Content of crude protein was highest and that of crude fiber such as NDF, ADF, cellulose and lignin were lowest at this rate of fertilizer application. Furthermore, IVDMD was high and dry matter yield were highest at the optimum rate

Keywords **:** fertilizer level, forage yield, nutrient quality

INTRODUCTION

According to the results from the experiment of fertilizer application, it was necessary to apply high level of nitrogen fertilizer in order to get high yield of forage rape, and yield was increased more when potassium was combined with nitrogen fertilizer (Sheldrick *et al.*, 1981; Lavrova *et al.*, 1983; Timirgaziu, 1983; Patras and Pinzariu, 1983; Jung et al., 1984; Harangozo and Harangozo, 1985; Han *et al.*, 1985; Songin, 1985; Sinyarskii *et al.*, 1985).

However, high level of nitrogen application increased the content of inorganic nitrogen i.e., NO_3-N forage under conditions of continuous low light intensity and continuous drought. There were several reports about the content of NO_3-N and its toxicity related with N application.

In Korea, varieties of forage rape were introduced recently and hence there were only a few researches on forage rape, and forage rape has been grown only at limited areas. In this experiment was conducted to examine the effects on yield components, yield and

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Table 1. Soil properties of the experimental plot at the beginning of experiment

PH	OM	P_2O_5	Ex	cations	(me/100g)	CEC
H2O 1 : 5	%	mm	Ca	Mg	K	(me/100g)
6.4	4.5	382	5.1	3.9	0.74	11.2

Table 2. The levels of fertilizer application in spring sowing (kg/10a)

Fertilizer \ Level	1	2	3
N	4	8	16
P2O5	3	6	12
K2O	3	6	12

Table 3. Combined application levels of fertilizers on forage rape in spring sowing

No.	N-P_2O_5-K_2O	No.	N-P_2O_5-K_2O	No.	N-P_2O_5-K_2O
11	0 - 0 - 0	21	0 - 0 - 0	31	0 - 0 - 0
12	0 - 2 - 2	22	3 - 0 - 2	32	3 - 2 - 0
13	1 - 2 - 2	23	3 - 1 - 2	33	3 - 2 - 1
14	2 - 2 - 2	24	3 - 2 - 2	34	3 - 2 - 2
15	3 - 2 - 2	25	3 - 3 - 2	35	3 - 2 - 3

nutrient quality of forage rape at the southern area of Korea.

MATERIALS AND METHODS

To find out the optimum fertilizer level for high yielding variety, Velox, experiment was conducted with 15 compositions of fertilizer levels at the experiment field of forage rape in Sunchon National University from Mar. 2000 to Aug. 2000.

The complete randomized block design was used and treatment was randomized in each of the three blocks. The size of each experimental unit was 12.5 m^2 (2.5 m × 5 m). Soil properties of the experimental plot at the beginnig of experiment was the same as this given in the Table 1. The levels of fertilizer application was the same as this given in the Table 2 and combined application levels of fertilizers on forage rape was the same as this given in the Table 3.

Ten plants were randomly sampled from each plot at flowering stage, and plant length, stem diameter and number of main stem leaves were measured. To determine yield, all the plants in 1 m^2 from each plot were harvested by cutting at about 3 cm above soil level. After determining fresh yield, plant materials of about 600 g were sampled and separated into stems and levels and their respective weights were determined. Dry matter weight of samples were measured after drying for 30 min. at 105℃, then for 72 hour at 70℃ in a forced air oven.

The dried samples were ground in a Wiley mill to pass through 18 mesh screen and stored at 18℃ and then subject to chemical analysis. Kjeldahl procedure was used to estimate crude protein (CP) (AOAC, 1970). Contents of fiber such as neutral detergent fiber (NDF), acid detergent fiber (ADF), permanganate lignin (PL) and cellulose were determined by the procedure

described in Goering and Van Soest (1970). The content of hemicellulose was was estimated by the difference between NDF and ADF. The procedure of pepsin-cellulose assay (Goto and Minson, 1977). was used to determine *in vitro* dry matter digestibility (IVDMD) and digestible dry matter yield (DDMY) was calculated by the product of dry matter yield and IVDMD.

RESULTS AND DISCUSSION

1. Yield components and yield

Mean values of yield components and yield under different fertilizer levels are presented in Table 4.

Plant length, stem diameter, number of branches and leaves increased as fertilizer level by the N-P_2O_5-K_2O=3-2-2 (16-6-6 kg/10a). Dry matter yield was the highest in fertilizer level, N-P_2O_5-K_2O=3-2-2 (16-6-6 kg/10a) with 663 kg/10a, 661 kg/10a, 635 kg/10a on each plots. The fertilizer level, N-P_2O_5-K_2O=3-2-1 (16-6-3Kg/10a) was 617 Kg/10a and ranged from 391 to 590 Kg/10a in other fertilizer levels. There were significant differences in all characters among fertilizer level at the 5% level. According to Harangozo and Harangozo (1985), Jung *et al.* (1984), Timirgaziu (1983) and Sheldrick *et al.* (1981), fertilizer level affected dry matter yield and components. Based on the results obtained so far, plants grow more upwards as fertilizer level is higher by the N-P_2O_5-K_2O=3-2-2 (16-6-6 Kg/10a) in spring culture at southern area of Korea.

Table 4. Mean values of observed characters of forage rape under different application rates of fertilizer in spring sowing

Combined application levels of fertilizers		Plant ength	Stem diametes	No. of branches	No. of leaves		Dry matter yield (kg/10a)		
N -P_2O_5-K_2O		(cm)	(mm)		Main stem	Branch	Total	Stem	Leaf
N	0 - 0 - 0	93.8	21.3	9.3	13.7	55.0	391	254	137
	0 - 0 - 0	98.0	21.6	13.1	16.2	56.8	359	237	122
	1 - 2 - 2	99.7	22.3	14.2	17.3	84.3	393	265	128
	2 - 2 - 2	101.2	23.7	14.5	17.5	85.2	533	307	226
	3 - 2 - 2	108.3	24.8	14.9	18.6	95.7	663	482	181
	L.S.D.(0.05)	2.31	0.70	0.85	0.80	6.87	92.14	29.85	69.25
P_2O_5	0 - 0 - 0	93.8	21.3	9.3	13.7	55.0	391	254	137
	3 - 0 - 2	99.8	22.8	11.2	15.6	76.8	536	334	202
	3 - 1 - 2	105.2	23.7	12.9	16.0	85.4	579	343	236
	3 - 2 - 2	108.1	25.5	13.4	17.2	94.4	631	454	177
	3 - 3 - 2	105.6	24.2	11.7	15.6	82.1	538	340	198
	L.S.D.(0.05)	1.87	1.69	0.01	0.90	8.18	75.21	54.60	47.64
K_2O	0 - 0 - 0	93.8	21.3	9.3	13.7	55.0	391	254	137
	3 - 2 - 0	96.5	21.5	13.1	15.2	79.2	590	372	218
	3 - 2 - 1	99.3	21.8	13.3	16.1	85.1	617	396	221
	3 - 2 - 2	102.1	23.7	13.7	16.7	92.7	635	455	180
	3 - 2 - 3	88.0	22.5	13.0	15.3	79.1	558	364	194
	L.S.D.(0.05)	3.98	1.02	1.17	0.91	12.06	60.16	29.25	43.69

Table 5. Chemical compositions(DM%), in vitro dry mater digestibility and digestible dry matter yield in forage rare under different application rates of fertilizers in spring sowing

Combined application levels of fertilizers		CP	NDF	ADF	Cellulose	Hemi cellulose	Lignin	IVDMD(%)		DDMY (kg/10a)		
	N-P_2O_5-K_2O							Stem	Leaf	Total	Stem	Leaf
N	0 - 0 - 0	16.64	41.94	37.36	31.32	4.65	4.35	71.75	80.65	283.8	177.9	105.9
	0 - 2 - 2	16.54	42.47	37.09	31.49	4.61	4.25	71.07	80.87	271.0	169.3	101.7
	1 - 2 - 2	17.79	41.83	36.91	31.21	4.64	4.20	71.25	80.83	291.4	180.7	110.5
	2 - 2 - 2	18.69	40.49	35.87	30.75	4.24	3.81	74.41	81.71	395.7	218.7	177.0
	3 - 2 - 2	22.61	41.41	36.71	30.78	4.37	3.54	74.30	85.38	491.3	337.5	153.8
	L.S.D.(0.05)	0.45	0.485	0.25	0.327	0.7	0.087	0.75	1.03	4.02	3.31	2.56
P_2O_5	0 - 0 - 0	16.64	41.94	37.36	31.32	4.65	4.35	71.75	80.65	283.8	177.9	105.9
	3 - 0 - 2	22.34	39.41	34.46	29.34	3.79	3.34	73.28	85.43	41.28	239.9	172.9
	3 - 1 - 2	22.54	38.32	35.73	28.75	3.41	3.27	73.34	85.54	458.3	252.7	205.6
	3 - 2 - 2	22.63	41.26	31.65	29.37	4.46	3.41	74.10	85.38	452.0	302.7	149.3
	3 - 3 - 2	22.71	39.25	33.78	29.05	4.27	3.32	73.98	84.87	420.1	247.3	172.8
	L.S.D.(0.05)	0.36	0.72	0.65	0.4	0.65	0.13	0.35	0.57	0.95	1.75	1.32
K_2O	0 - 0 - 0	16.64	41.94	37.36	31.32	4.65	4.35	71.75	80.65	283.8	177.9	105.9
	3 - 2 - 0	22.29	39.78	33.98	35.52	3.95	3.35	73.67	80.42	456.4	278.3	178.1
	3 - 2 - 1	22.38	40.36	33.18	36.09	4.08	3.42	74.35	84.53	476.1	302.7	173.4
	3 - 2 - 2	22.45	40.41	32.66	36.78	4.48	3.51	74.32	85.37	499.2	347.6	151.6
	3 - 2 - 3	22.57	40.54	32.39	36.04	4.40	3.43	74.21	84.21	435.6	267.3	168.3
	L.S.D.(0.05)	0.48	0.72	0.53	0.34	0.89	0.06	0.69	0.95	3.44	4.47	2.46

2. Nutrient quality and digestible dry matter yield.

The means of content of crude protein, contents of fiber such as NDF, ADF, hemicellulose and lignin, IVDMD and DDMY are presented in Table 5. As shown in Table 5, mean content of crude protein ranged from 16.64 to 22.71 percent. The results were in agreement with the reports (Groppel *et al.*, 1982; Gupta *et al.*, 1974) and calculated nutrient content for 19 different types of winter grazing and found that rape and winter cereals were highest in crude protein. Gupta *et al.* (1974) reported that content of crude protein ranged from 12 to 23 percent when it was measured for nine brassica species. There were statistically significant differences in crude protein among fertilizer levels and the fertilizer level, N-P_2O_5-K_2O=3-2-2 (16-6-6 Kg/10a) was the highest in content of crude protein with 22.61, 22.63 and 22.45 percent.

Mean contents of NDF, ADF, cellulose hemicellulose and lignin for fertilizer level, N-P_2O_5-K_2O=3-2-2 (16-6-6 Kg/10a) were 22.45~22.61, 41.26~41.41, 32.66~36.71, 29.37~36.78, 4.37~4.48 and 3.41~3.54 percent respectively (Table 5). There were significant differences among fertilizer levels. The fertilizer level of N-P_2O_5-K_2O=3-2-2 (16-6-6 Kg/10a) was the lowest in content of fiber. The results were fairly in agreement with those of Berendonk (1982a, 1982b, 1983a, 1983b) reported that the content of crude fiber in rape varied within 2 percent under variations of growing environment and with variety. Groppel *et al.*

(1982) found that rape was the lowest in crude fiber when nutrient content was calculated for 19 different types of winter grazing.

IVDMD of fertilizer level, N-P_2O_5-K_2O=3-2-2 (16-6-6 Kg/10a) was 74.30, 74.10 and 74.32 percent for the stem and 85.38, 85.38 and 85.37 percent for the leaf (Table 5), and the differences were significant at the 5% level. Fertilizer level, N-P_2O_5-K_2O=3-2-2 (16-6-6 Kg/10a) which was high in crude protein and low in NDF, ADF, cellulose, hemicellulose and lignin shows higher IVDMD.

According to the above results, rape, especially forage rape, shows higher IVDMD compared with other forage crops and it is consistent with other reports (Jung *et al.*, 1984, 1986; Gupta *et al.*, 1974; Sheldrick *et al*, 1981).

Fertilizer level, N-P_2O_5-K_2O=3-2-2 (16-6-6 Kg/10a) which was high in digestible dry matter yield (DDMY). According to the report by Harper and Compton (1980), the principal value of brassica crops was in providing forage with dry matter yield from 4 to 8 MT/ha for autumn grazing *in situ* at a time of year when production from grassland was declining. In addition, they provided an acceptable feed of high nutritive value at relatively low cost. Judging from the reports and the results so far obtained, forage rape (fertilizer level, N-P_2O_5-K_2O=3-2-2 (16-6-6 kg/10a) provides high digestible dry matter yield with high nutritive value, so that it can be recommended as a catch fodder crop. Fertilizer level, N-P_2O_5-K_2O=3-2-2 (16-6-6 kg/10a) is considered to be a suitable fertilizer level of spring seeding culture at the southern area of Korea.

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