Eurasian Journal of Biology and Ecology, Vol. 2:(2017),7-13.
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The Effect of Different Row Spacing on the Yield and Quality of Forage Rape (*Brassica napus* L. ssp. *oleifera* Metzg)

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Received 25 March 2017; Accepted 18 July 2017

ABSTRACT

This study was conducted to determine the yield and quality of forage rape on different row spacing during 2014-2015 growing season. The research was established as a randomized complete block design with four replications and four row spacing (20 cm, 30 cm, 40 cm and 50 cm). In the study plant height, green herbage yield, dry herbage yield, crude protein ratio, crude protein yield, acid detergent fiber (ADF), neutral detergent fiber (NDF), digestible dry matter (DDM), dry matter intake (DMI), relative feed value (RFV), calcium, magnesium, phosphor and potassium characteristics were investigated. In the results of research; plant height, green herbage yield, dry herbage yield, crude protein ratio, crude protein yield, acid detergent fiber (ADF), neutral detergent fiber (NDF), digestible dry matter (DDM), dry matter intake (DMI), relative feed value (RFV), calcium, magnesium, phosphor and potassium values were ranged 122.1-144.4 cm, 2114.6-4267.4 kg da^{-1}, 426.9-805.6 kg da^{-1}, 15.5-18.1%, 76.2-125.6 kg da^{-1}, 40.7-44.1%, 46.4-50.5%, 54.5-57.2%, 2.40-2.59%, 101.8-114.9, 1.23-1.31%, 0.19-0.23%, 0.33-0.35% and 1.83-2.18%, respectively. In terms of these parameters; it was concluded that there was no effect on the quality of row spacing but the 40 cm row spacing would be preferable in terms of green herbage, dry herbage yield and crude protein yields.

Keywords: Forage rape, herbage yield, ADF, NDF, crude protein.

1. Introduction

Brassica species, natural plants of the Mediterranean environment, are used as human food in many different forms, and some species are also important as feed plants. These species include forage rape (*Brassica napus oleifera*), feed turnip (*Brassica rapa* L.), repko (*Brassica pekinensis x Brassica rapa*) and forage cabbages (*Brassica oleracea*) (Acikgoz, 2001).

In many countries (especially in northern European countries) farming is being carried out because of the reasons such as the production of abundant green grass in short time, the loving of animals to eat grass, the high digestibility rate. Rape is juicy and delicious. Feeding value is close to legume herbs. Protein percentage in the leaves can reach 20-25%. But the dry matter rate is a little low. The green herbage yield of the rape ranges from 2 to 6 t/da (Acikgoz, 2001; Soya et al., 2004; Acikgoz, 2013).

This study was carried out in order to determine the ideal range from which the best yield could be obtained from the forage rape, which is important for animal nutrition.

2. Material and Methods

The area study related to this research was carried out at the Bingol University Research and Application Area, about 15 km from Bingol province center, during the growing season of 2014-2015. The research area has a 5-10% gradient and an average altitude of 1150 m from sea level.

Climate data related to the research area was obtained from the Meteorology Directorate of Bingol province. According to this climate data; it is seen that the average temperature of Bingol province for years (1990-2015) is 12.3 ^{o}C, total rainfall is 950.8 mm and mean relative humidity is 56.9%. During the 2014-2015 breeding season in which the study was conducted, near average temperature (13.1 ^{o}C) and relative humidity value (54.2%) were obtained for many years. However, during the 2014-2015 breeding season in which the study was conducted, Bingol province received a precipitation amount below the average of long years (832.6 mm).

Soil specimens were taken from 0-30 cm depth and mixed at ten different points in the area where the study was carried out. The obtained representative sample was analyzed in the Soil-Plant Analysis Laboratory of the Agricultural Faculty of Bingol University. Analysis results; were evaluated on the basis of the limit values determined by Sezen (1995) and Karaman (2012). According to the results obtained after the analysis; The soil structure of the study area was low (43.31%), pH was slightly acidic (6.37), unsalted (0.0066%), organic matter was low (1.26%), low calcareous (0.15%), low potassium (24.45 kg da^{-1}) and the phosphorus ratio was found to be medium (7.91 kg da^{-1}).

The field experiment was established as four replications according to the design of the random blocks in the field where the rotatil was taken after the deep version was made with the plow. The plot area is 4 m long and consists of 6 rows. The seed bed was prepared by adjusting the markers to the range of 20 cm, 30 cm, 40 cm and 50 cm. The seeding process was carried out on 09.10.2014 with 8 g seeds coming by hand and each parcel.

The harvest was made on 08.05.2015 by placing rows of 50 cm edges from the sides, bottom and top of the parcels. 8 kg of nitrogen and 8 kg of phosphorus (P_2O_5) were deposited in the experiment area together with planting, and the compound (20-20-0) fertilizer was calculated for each parcel.

The plant size was measured in the field conditions and the amount of herbage obtained from each plot was converted into decare and green herbage yield was calculated. 500 g of green herb samples were taken from each plot and dried at 70 °C for 48 hours. After that, dry herbage yield was calculated over dry weight obtained (Anonymous, 2016).

Analyzes of crude protein, ADF, NDF, P, K, Ca and Mg quality values were carried out at Dicle University Science and Technology Application and Research Center Laboratory by NIRS (Near Infrared Spectroscopy - Foss Model 6500).

Crude protein yields were determined by multiplying the dry herbage yield with the crude protein ratio. The digestible dry matter (DDM = 088.9 - (0.779 x ADF)), dry matter intake (DMI = 120 / NDF) and relative feed values (RFV = (DDM x DMI) / 1.29) were calculated with ADF and NDF (Morrison, 2003).

Findings obtained from the study were analyzed by variance analysis according to the four replicate randomized blocks trial design with the help of JUMP statistical package program. The statistically significant factor averages according to the variance analysis results were compared with the LSD test (Kalayci, 2005).

3.Results and Discussion

Plant Height, Green Herbage Yield and Dry Herbage Yield

The plant height, green herbage yield and dry herbage yield averages observed in different row spacing of forage rape are given in Table 1. Different row spacing of forage rape are statistically significant at a level of 5% in terms of plant height and of the 1% in terms of green herbage and dry herbage yields.

Table 1. *Plant height, green herbage yield and dry herbage yield in forage rape*

Row Spacing	Plant Height (cm)	Green Herbage Yield (kg da^{-1})	Dry Herbage Yield (kg da^{-1})
20 cm	122.1 b*	2114.6 c**	426.9 c**
30 cm	138.6 a	2895.1 bc	578.3 b
40 cm	144.4 a	4267.4 a	805.6 a
50 cm	136.2 a	3485.4 ab	737.2 a
Mean	135.3	3190.6	637.0

*) significant at level %5, **) significant at level %1, $CV_{(height)}$=%5.58, $CV_{(green\ herbage)}$=%15.39, $CV_{(dry\ herbage)}$=%13.81

The highest plant height has been obtained from 40 cm row spacing by 144.4 cm, 30 cm row spacing by 138.6 cm and 50 cm row spacing by 136.2 cm. The lowest plant height has been obtained from 20 cm row spacing by 122.1 cm. The average plant height of the forage rape cultivated in different row spacing was obtained as 135.3 cm.

The highest green herbage yield has been obtained from 40 cm row spacing by 4267.4 kg da^{-1} and it was followed 50 cm row spacing by 3485.4 kg da^{-1}. The lowest green herbage

yield has been obtained from 20 cm row spacing by 2114.6 kg da^{-1}. The green herbage yield average of the forage rape has been defined as 3190.6 kg da^{-1}.

The highest dry herbage yield has been obtained from 40 cm row spacing by 805.6 kg da^{-1} and 50 cm row spacing by 737.2 kg da^{-1}. The lowest dry herbage yield has been obtained from 20 cm row spacing by 426.9 kg da^{-1}. The dry herbage yield average of the forage rape has been defined as 637.0 kg da^{-1}.

It was reported that the plant height 60 cm, green herbage yield 2122 kg da^{-1}, dry herbage yield 252 kg da^{-1} by Aygun (2001); plant height 32-73 cm, green herbage yield 2282-8609 kg da^{-1}, dry herbage yield 553-1153 kg da^{-1} by Altinok and Karakaya (2003); dry matter yield 122.8-418.6 kg da^{-1} by Keogh et al. (2011) and dry matter yield 250-774 kg da^{-1} by Guillard and Allinson (1988) were obtained. The reason for the differences between our findings and these studies could be associated with the varieties used or the soil and climate conditions of the study area.

Crude Protein Ratio and Crude Protein Yield

The crude protein ratio and crude protein yield averages observed in different row spacing of forage rape are given in Table 2. Different row spacing of forage rape are statistically significant at a level of 5% in terms of crude protein yield.

Table 2. *Crude protein ratio and crude protein yield in forage rape*

Row Spacing	Crude Protein Ratio (%)	Crude Protein Yield (kg da^{-1})
20 cm	17.8	76.2 b*
30 cm	18.1	104.8 ab
40 cm	15.5	125.6 a
50 cm	15.8	119.3 a
Mean	16.8	106.5

*) significant at level %5, $CV_{(Protein)}$=%10.06, $CV_{(Protein\ yield)}$=%17.96

The row spacing in forage rape is statistically insignificant in terms of crude protein contents. The crude protein ratio of the forage rape ranged from 15.5 to 18.1%. The crude protein ratio average of the forage rape has been defined as 16.8%.

The highest protein yield has been obtained from 40 cm row spacing by 125.6 kg da^{-1}, 50 cm row spacing by 119.3 kg da^{-1} and it was respectively followed 30 cm row spacing (104.8 kg da^{-1}) statistically in the same group.

The lowest protein yield has been obtained from 20 cm row spacing by 76.2 kg da^{-1}. The protein yield average of the forage rape has been defined as 106.5 kg da^{-1}.

It was reported that the crude protein ratio 10-28%, crude protein yield 21.2-317.8 kg da^{-1} by Altinok and Karakaya (2003); crude protein ratio 20.45% (in the flowering stage) by Canbolat (2013), crude protein ratio 16.82% by Canbolat et al. (2013) and crude protein ratio 20.1-24.4% (in plant stem) by Keogh et al. (2011) were obtained.

Acid Detergent Fiber and Neutral Detergent Fiber Ratios

The ADF and NDF ratios of the forage rape and the values of DDM, DMI and RFV calculated from these ratios are given in Table 3. As seen in Table 3; there is no statistically significant difference in the row spacing in terms of ADF, NDF, DDM, DMI and RFV. The ADF ratios of the forage rape ranged from 40.7% to 44.1%, with an average of 42.2% and NDF ratio ranging from 46.4% to 50.5%, with an average of 47.9%. The ratio of DDM varied from 54.5% to 57.2%, with an average of 56.0% and DMI ratio ranging from 2.40 to 2.59%, with an average of 2.52% and RFV ranging from 101.8 to 114.9, with an average of 109.8.

Table 3. *ADF, NDF, DDM, DMI and RFV ratios for forage rape*

Row Spacing	ADF (%)	NDF (%)	SKM (%)	KMT (%)	NYD
20 cm	42.7	48.0	55.7	2.51	108.3
30 cm	41.3	46.4	56.8	2.59	114.1
40 cm	44.1	50.5	54.5	2.40	101.8
50 cm	40.7	46.7	57.2	2.58	114.9
Mean	42.2	47.9	56.0	2.52	109.8

$CV_{(ADF)}$=%7.96, $CV_{(NDF)}$=%7.24, $CV_{(SKM)}$=%4.34, $CV_{(KMT)}$=%7.34, $CV_{(NYD)}$=%11.69

In similar studies performed in the forage rape; 37.56% ADF, 55.12% NDF, 67.42% DDM, 2.68% DMI and 140.05 RFV were determined by Canbolat (2013) during the flowering period; 37.79% ADF, 45.65% NDF were determined by Canbolat et al. (2013) and 12.2-21.8% ADF and 18.0-32.0% NDF were determined by Guillard and Allison (1988).

Calcium, Magnesium, Phosphorus and Potassium Ratios

The Ca, Mg, P and K ratios of the forage rape cultivated in different row spacing are given in Table 4. There was no statistically significant difference in the range of Ca, Mg, P and K in different row spacing.

Table 4. *Ca, Mg, P and K ratios for forage rape*

Row Spacing	Ca (%)	Mg (%)	P (%)	K (%)
20 cm	1.31	0.23	0.35	1.96
30 cm	1.29	0.22	0.35	2.18
40 cm	1.23	0.19	0.33	1.83
50 cm	1.28	0.22	0.33	1.86
Mean	1.28	0.21	0.34	1.96

$CV_{(Ca)}$=%4.27, $CV_{(Mg)}$=%9.30, $CV_{(P)}$=%5.55, $CV_{(K)}$=%15.05

The Ca ratios of the forage rape ranged from 1.23% to 1.31%, with an average of 1.28%, Mg ratio of 0.19% to 0.23% and an average of 0.21%. P ratio varied from 0.33% to 0.35%, with an average of 0.34% and K ratio of 1.83% to 2.18%, with an average of 1.96%.

Khajali and Slominski (2012) found that the Ca, Mg, P and K contents were 0.67%, 0.56%, 1.02% and 1.17% for the canola flour, respectively.

4.Conclusions

It has been determined that the different row spacing is important on the plant height of the forage rape, and the effect on green herbage yield and dry herbage yield is very important. However, it has been determined that there is no effect on the parameters of crude protein, ADF and NDF, which are the leading quality criteria in feed plants of different row spacing applied in forage rape. In the same way, it was seen that there was no effect on the ratios of the nutrients such as Ca, Mg, P and K in different row spacing.

Good results were obtained in 50 cm row spacing. However, as can be understood from the yield of green herbage the 40 cm row spacing is peak point. Yield starts to fall by 50 cm row spacing. If the row spacing increases, the yield will decrease further.

Therefore, in order to obtain higher green herbage yield, dry herbage yield and crude protein yields in the unit area, it was concluded that sowing at 40 cm row spacing of the forage rape is more suitable.

Acknowledgment

This article was presented at the "International Conference on Agriculture, Forest, Food Sciences and Technologies" conference held in Cappadocia/Nevşehir on May 15-17, 2017 and published in abstract.

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