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THE EFFECT OF PLANT SPACING ON SOME QUALITY TRAITS OF FODDER BEET (*BETAVULGARIS VAR.CRASSA*) VARIETIES

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Abstract

A field experiment was conducted in the (2011/12) season to study the effect plant spacing on yields and its components of four fodder beet cultivars. The experiment was a randomized complete block design (RCBD) in split plots arrangement with three replicates, plant spacing (25X60, 20X60 and 25X50 cm) were assigned to the main plots and fodder beet cultivars (Jamon, Splendids, Starmon and Vermon) were allotted to the sub plots. Spacing had a significant effect on all the quality traits except protein content of shoot. Spacing and varieties exhibited highly significant ($p<0.01$) differences in all of the studied characteristics. Varieties affected dry matter content of root, and protein content of shoot and root significantly (p<o.o5). Dry matter content of shoot, Ash content of shoot and root, and organic content of shoot and root were not significantly affected by varieties. Vermon sown at 25 cm apart and 60 cm between rows significantly ($p<0.05$) attained the highest quality traits.

Key words: Plant spacing, Varieties, Fodder beet, Quality traits

Introduction

Fodder beet (*Beta vulgaris var.Crassa)*, a member of the *chenopodiaceae* family, is also known as mangel (Martin, 1976). The fodder beet is a native of Mediterranean area and was grown as a root crop in Germany and Italy as early as the Sixteenth Century. The crop was introduced into the United States in colonial days (Kipps, 1970). It is World-wide in temperate zones up to 55^{o} N (www.biolaie.uni-hambura.de, 2006). It is considered a valuable source of fodder for cattle (Niazi *et al*., 2000)

The production of forage crops is very important for livestock production in Syria, which contributes largely to the national income. Animal production in Syria depends mainly on natural range which is affected by rain fluctuations and low quality grasses. This necessitates the introduction of irrigated forage crops in the irrigated schemes and in farms around cities like Damascus.

There are many constrains facing forage production in Syria, like lack of information of forage cultivars and technological packages. Suggested solutions for these problems are application of technological packages, integration of animal production with forage production and introduction of new forage species of high yield (Khair, 1999) especially during periods of forage shortage like late winter and early summer.

Fodder beet offers a higher yield potential than any other arable fodder crop (Anonymous, 2006) and when grown under suitable conditions can produce almost 20 t/ha^{-1} dry matter yield (DAF, 1998) and also yields more than 80 t/ha and this makes it popular in many countries like New Zealand, Germany, America, Australia, Syria and Egypt (Shalaby, *et al*., 1989). It contains 10-15% dry matter and may yield 20 t/ha of dry matter in one harvest as compared to 13-15 t/ha from four cuts of grass (Kiely *et al.,* 1991).

The above and below growth parts (leaves and roots) are used to feed the animals but, the main fodder is tuberous roots (Ibrahim, 2005). Therefore the optimum population which produces maximum leaves and roots yield must be carefully determined.

Fodder beet is a good forage especially during the critical period of forage shortage such as early summer season in Syria. The objectives of this study are to study the effectof spacing on yield and yield components of fodder beet to provide information on cultural practices concerning this important crop under Syrian conditions.

Khogali *et al*., (2011) studied the effect of plant spacing (15, 20 and 25 cm between holes) of three fodder beet cultivars (Voroshenger, Anisa and Polyproductiva) on yields and yield components, they reported that Spacing had no significant effects on root fresh weight, shoot fresh weight, and shoot dry weight, also Polyproductiva cultivar sown at 25 cm apart significantly attained the greatest root dry weight.

Materials and Methods

A field experiment was conducted for one autumn season of October (2011-2012), in Al Raqqa Agricultural Research Center, General Commission for Scientific Agricultural Research

(GCSAR), Damascus North East (latitude 35 º 0′ N and Longitude 38 º 55′ E). The soil of the experimental site is clay silty, characterized by low nitrogen content (6.5) and Ph of 8.01. Two factors experiment were conducted in a randomized complete block design (RCBD) in a split plots arrangement and three replications. The main plots were allotted to spacing and the sub-plots to the four fodder beet varieteis were used: Jamon, Splendids, Starmon, and Vermon (all French cultivars). The land was disc- ploughed, harrowed twice, leveled and ridged 60 and 50 cm apart. The size of the plot was 8X5 m, consisting of eight ridges of 8 m length. The seeds were sown manually on the shoulder of the ridge at a rate of 4.6 kg/ha (three seeds per hole) on October 15th.

The crop was irrigated at 7-10 days intervals depending on the temperature, relative humidity and soil moisture conditions. Nitrogen fertilization in the form of urea (46% N) at a rate of 446 kg N/ha was divided equally, the first half was added pre-planting, while the second half after thinning. Triple superphosphate (46% P_2O_5) and (K_2O) were added pre-planting at a rate of 180 and 185 kg/ha, respectively. Two spacing between holes: 20 cm (S1),and 25 cm (S2) were used. Hand thinning to one plant per hole and resowing by the removed seedlings were done simultaneously after 5-6 weeks from planting. Manual weeding was done, after 5 weeks from planting.

At harvest (6 months from sowing), when plants showed signs of maturity which is indicated by leaf yellowing and partial drying of the lower leaves, a sample of one plant of each variety was taken per plot from the inner two ridges randomly hand-pulled to determine: Dry matter content (%), ashes (%), organic matter content (%), and protein content (%) of shoot and root.

Analysis of variance (ANOVA) appropriate for the split plot design was applied (Gomez and Gomez, 1984). The treatment means were compared using Least Significant Difference (LSD) procedures at 5% level using GeneStat Computer Program v.12.

Results and Discussion:

Shoot dry matter content (%):

Table (1) illustrates the effect of spacing and varieties on dry matter content of shoot. This trait was greater under lesser spacing (25X50 cm) (83.24%). Varieties were not significantly different in dry matter content of shoot . However, Vermon and Jamon varieties obtained higher dry matter content of shoot (83.64, 83.20%), respectively. The interaction effect between spacing and varieties on shoot dry matter content (Table 3) showed the superiority of 25X60 and 25X50 cm (S_1 and S_3) for Vermon variety (84.56%). Therefore, the significant highest shoot dry matter content per plant was achieved by sowing at spacing of 25X60 cm (S_1) using the variety Vermon.

Table 1. The effect of plant spacing on shoot and root dry matter contents and ashes (%) of four fodder beet varieties

Plant Spacing (S)	Varieties (V)	Shoot dry matter content (%)	Root dry matter content (%)	Shoot ashes (%)	Root ashes (%)
25X60 (S_1=67)	Jamon	82.18	83.25	4.29	6.77
	Splendids	82.77	81.33	3.92	7.77
	Stramon	82.41	88.38	4.49	7.27
	Vermon	84.56	85.02	3.95	8.43
	Mean	**82.98**	**84.50**	**4.16**	**7.56**
20X60 (S_2=80)	Jamon	83.65	83.43	3.97	8.03
	Splendids	81.61	82.73	4.21	6.94
	Stramon	83.17	87.62	4.41	7.13
	Vermon	84.23	85.73	4.21	8.07
	Mean	**83.17**	**84.88**	**4.20**	**7.54**
25X50 (S_3=83)	Jamon	82.18	83.31	4.01	6.83
	Splendids	82.77	78.84	4.37	7.81
	Stramon	82.41	80.63	4.12	8.15
	Vermon	84.56	84.34	4.41	8.36
	Mean	**83.24**	**81.78**	**4.23**	**7.79**
Mean of varieties over spacing	Jamon	83.20	83.33	4.09	7.21
	Splendids	82.88	80.97	4.17	7.51
	Stramon	82.79	85.54	4.34	7.52
	Vermon	83.64	85.03	4.19	8.29
	Mean	**83.13**	**83.72**	**4.20**	**7.63**
	LSD 0.05	**V=ns S=ns V*S=2.1**	**V=1.4 S=0.8 V*S=1.7**	**V=ns S=ns V*S=0.2**	**V=ns S=ns V*S=1.1**

ns: denote not significant, at 0.05 level of probability.

Root dry matter content (%):

Plants grown at different spacing were significantly different regarding root dry matter content (Table 1). Higher dry matter content of root was significantly recorded for Starmon and Vermon (85.54, 85.03 %), respectively (Table 1). The effect between spacing of root dry matter content showed the superiority of 20X60 and 25X60 cm (S_2 S_1) (84.88, 84.50%), respectively. The interaction between spacing and varieties was significant, therefore, the significant highest root dry matter content was achieved by sowing at spacing of 20X60 cm (S_2) using the variety Starmon (87.62%).

Ashes of shoot (%):

Ashes of shoot was increased when sown at wider spacing of 25X60 cm (4.23%) (Table 1). No significant differences were observed between the varieties regarding shoot ashes (Table 1). Ashes of shoot was significantly affected by interactive effect between spacing and varieties, when Starmon sown at space of 25X60 cm attained the greatest ashes of shoot (4.49%) (Table 1). This may be attributed to the cultivar difference in efficiency of nitrogen utilization. Starmon attained the greatest shoot ashes (4.34%), which increased photosynthesis besides the more nutrients in the wider spacing and hence the greatest shoot ashes.

Ashes of root (%):

Spacing of 25X50 cm (S_3) had higher ash of root (7.79%) than 25X60 cm (S_1) (7.56%) and 20X60 cm (S_2) (7.54%), (Table 1). In closer spacing there was greater number of plants, compared to wider spacing, which resulted in greater yield. Vermon attained the greatest ash content of shoot (8.00%).

Shoot organic matter content (%):

Organic matter content of shoot was increased when fodder beet was sown at denser spacing (20X60 and 25X50 cm) (95.79%) compared to wider one (25X60 cm) (95.84%) (Table 2). The variety of Jamon, Splendids, Starmon and Vermon were comparable in organic matter content of shoot (Table 2). The interaction between spacing and varieties was significant, therefore, the significant highest dry matter was achieved by sowing at spacing of 25X60 cm (S_1) using the variety Splendids (96.08%).

Table 2. The effect of plant spacing on shoot and root organic matter and protein contents (%) of four fodder beet varieties.

Plant Spacing (S)	varieties (V)	Shoot organic matter content (%)	Root organic matter content (%)	Shoot protein content (%)	Root protein content (%)
25X60 (S_1=67)	Jamon	95.71	93.23	13.84	6.71
	Splendids	96.08	92.23	13.63	6.62
	Stramon	95.51	92.73	14.23	6.86
	Vermon	96.05	91.57	14.99	6.69
	Mean	**95.84**	**92.44**	**15.03**	**6.72**
20X60 (S_2=80)	Jamon	96.03	91.97	14.22	6.87
	Splendids	95.79	93.06	13.83	7.02
	Stramon	95.59	92.87	14.02	7.06
	Vermon	95.79	91.93	14.69	7.39
	Mean	**95.79**	**92.46**	**14.19**	**7.09**
25X50 (S_3=83)	Jamon	95.99	93.17	14.59	8.43
	Splendids	95.63	92.19	14.81	8.76
	Stramon	95.88	91.85	15.04	8.45
	Vermon	95.67	91.64	15.65	9.93
	Mean	**95.79**	**92.21**	**14.17**	**8.89**
Mean of varieties over spacing	Jamon	95.91	92.79	14.22	7.34
	Splendids	95.84	92.49	14.09	7.47
	Stramon	95.66	92.48	14.43	7.46
	Vermon	95.84	91.71	15.11	8.00
	Mean	**95.81**	**92.37**	**14.46**	**7.57**
	LSD 0.05	**V=ns D=ns V*D=0.5**	**V=ns D=ns V*D=0.4**	**V=0.5 D=0.3 V*D=ns**	**V=0.8 D=0.5 V*D=0.6**

ns: denote not significant, at 0.05 level of probability.

Root organic matter content (%):

Plants grown at different spacing were comparable regarding organic matter content of root (Table 2). Higher organic matter content of root was recorded for Jamon (92.79%) (Table 2). Interaction between spacing and varieties was significant, therefore, the significant highest root organic matter content was achieved by sowing at spacing of 25X60 cm (S_1) using the variety Jamon (93.23%).

Shoot protein content (%):

Protein content of shoot was increased when sown at wider spacing of 25X60 cm (15.03%) (Table 2). A significant differences were observed between the varieties regarding protein content of shoot (Table 2), Vermon surpassed the other varieties in protein content (15.11%). Protein content of shoot was significantly affected by interactive effect between spacing and varieties, when Vermon sown at space of 25X50 cm attained the greatest protein content of shoot (15.65%) (Table 2).

Root protein content (%):

Plants grown at different spacing were significantly different regarding root protein content (Table 4). Higher protein content of root was significantly recorded for Vermon (8.29%) (Table 2). The effect between spacing of root protein content (Table 2) showed the superiority of 25X50 cm (S_3) (8.89%). The interaction between spacing and varieties was not significant, therefore, the highest root protein content was achieved by sowing at spacing of 25X50 cm (S_3) using the variety Vermon (9.93%).

Conclusion

* There was a trend for yield components to increase at wider plant spacing of 25X60 cm. However, the highest ($p<0.05$) quality traits were obtained under wider spacing of 25X60 cm. So, it is recommended to plant fodder beet at 25 cm apart and 60 cm between rows.

* Vermon variety was superior over Jamon, Splendids, and Starmon in root dry matter content, and shoot and protein content. But, there was no significant difference between the four tested varieties in dry matter content of shoot, Ashes of shoot and root, and organic content of shoot and root. Hence for the four varieties are recommended to be planted.

* The high quality characteristics shown by all varieties tested may be attributed to the favorable growing conditions for the crop and are indication of the adaptability of fodder beet at the experimental site.

* Most interactions between spacing and varieties were significant for the studied quality traits.

* The present results are, indicative of the potential success of fodder beet as a winter fodder crop in Syria in Al Raqqa Governorate. Since climatic and agronomic factors can influence the performance and success of beet culture, hence, further trials are required to identify optimum agronomic practices especially sowing time, harvesting date, soil type, land preparation, fertilization and spacing in the other sites in Syria.

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