Fodder Beet (*Beta Vulgaris* var. *crassa* Mansf) Varieties Response to Harvest Dates under North East Conditions of Syria

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Abstract

The field experiment was conducted in AL Raqqa Agricultural Research Center, General Commission for Scientific Agricultural Research (GCSAR), Al Raqqa/Syria, during 2011/2012 season to investigate the response of two fodder beet varieties i.e Vermon, and Jamon, to three harvest dates (10 April, 25 April, and 10 May). Split plot design was used with three replicates. The statistical analysis exhibited no significant effect of harvesting dates (H), and varieties (V), on all the studied traits, but the difference between varieties were significant in terms of sucrose % ($p \leq 0.05$). It was notably that expanding harvest period leads to an introduction in most of studied traits. The results showed that Vermon surpassed Jamon ($p \leq 0.05$), in terms of sucrose% (27.3%). The percentage of variance confirmed that the most effective factor for the all studied traits was the harvest date, followed by the varieties, except for sucrose %, which varieties had the main and significant effect. It could be concluded that harvest date could be prolonged one month after it sown on 10th September, and used Vermon variety to get more sugar content in roots.

Keywords: Fodder beet, Harvest date, Yield and yield components, Syria.

Introduction

The increasing demand for animal proteins of the growing population in Syria is handicapped through the shortage of the carbohydrate components in animal feeds. On the other hand, the horizontal expansion of new reclaimed areas requires the cultivation of crops offering a source for satisfying income to the farmers. Fodder beet can easily fulfill both aims through its high content of carbohydrate which reached about 72% DM (Acar and Mulayim, 2000; Turk, 2010; Kassab, *et al.*, 2012) and production in some new regions ranged between 24 t DM/Ha (Farmfact 1-77, 2013), this crop is considered a source of renewable energy, results from the fact that it provides more energy than cereals and fodder crops (Urban *et al*., 2005; Hnilička *et al*., 2005; Martínez-Pérez *et al*., 2007). It is also reported that the plant is suitable to make silage (Özköse, 2013). Besides the traditional use of fodder beet a new ways of use appear. It is the use in bioenergetics, such as the production of bioethanol (Chochola, 2007; Pulkrábek *et al.*, 2007; Mähnert and Linke, 2009) and biogas (Klocke *et al.*, 2007; Scherer, *et al.*, 2009). At present there is a new application of fodder beet in organic farming, which is among the good fore crop (Kassab *et al*., 2012).

The feeding of low-quality forages, such as crop residues (wheat, barley, straw), and low quality hays, are a common practice in Syria (Kassab *et al.*, 2012; Bagdadi, 2013). The plant is used as a valuable source of fodder for cattle (Özköse, 2013; Al Jbawi *et al.*, 2014). Pembleton and Rawnsley, (2011), stated that fodder beet can take over 200 days to mature.

Many studies demonstrated that yield of fodder beet is determined by genetic dispositions of varieties and the canopy density and weather conditions (Khogali *et al.*, 2011; Kassab, *et al.*, 2012; El Sarage, 2013; Al jbawi *et al.*, 2015). Kassab *et al.*, (2012) tested six fodder beet varieties (Lenka, Hako, Kostelecká Barres, Jamon, Monro, and Starmon). In average of three years the most yielding cultivar was Hako, while Lenka, Kostelecká Barres and Hako were the highest weight of one root.

Al Jbawi *et al.*, (2015), confirmed the significant effect of four fodder beet varieties on root/top ratio, and root yield when sown in autumn (15th October), while the same varieties had a significant effect on root weight/plant, root/top ratio, and root yield when sown in winter (15th January). On the other hand the study clarifies no significant differences between varieties in respect of shoot weight/plant, shoot yield, and number of plant/ha.

This research aims to study the effect of harvesting dates on the production traits of two fodder beet varieties for assessing the optimal harvest time for the best root yield and quality of fodder beet, especially in the north east region of Syria.

Materials and Methods

The research was performed at Al Raqqa, Syria (latitude 35 º 0′ N and Longitude 38 º 55′ E). located on the north east region of Syria during 2011/2012 growing season. The major soil characteristics, based on the method described by Rowell (1996) were found to be as follows; the soil texture was clay silt, PH was 8.0 in soil saturation extract. Climatic data for the research area are given in Table (1). Fodder beet (*Beta vulgaris* var. *crassa* Mansf.) cultivars Vermon and Jamon were introduced from France.

Split plot arrangements of three harvest time (10th April, 20th April, and 10th May), and two varieties were evaluated in a randomized complete block design with three replications. The main plots were allotted to harvesting dates and the sub-plots to the two fodder beet varieties were used.

Seeding rates were 4.6 kg/ha. Individual plot size was 8 x 5m= 40 m^2, consisting of eight ridges of 8m length. Sowing was done by hand on 10th September in 2011/2012. 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. Hand thinning to one plant per hole and re-sowing by the removed seedlings were done simultaneously after 5-6 weeks from planting. Manual hoeing was done, after 5 weeks from planting. Plots were irrigated 8 times through growing period, depending on the temperature, relative humidity and soil moisture conditions.

The soil of the experimental is characterized by low nitrogen content (6.5). The land was disc-ploughed, harrowed twice, leveled and ridged 60 cm apart, and 25 cm the space between holes. There were no problems with pests, diseases or weeds during the course of study.

Plots were harvested on 10 April, 30 April, and 10 May. A sample of five plants of each variety was taken per plot from the inner two ridges randomly hand-pulled to determine: sucrose % which was determined polarimetrically (McGinnis, 1982), Root weight.plant^{-1} (Kg), shoot weight.plan^{-1} (Kg), root/shoot ratio, and three inner rows were harvested on the suggested dates and topped to determine number of plants.ha^{-1} (plant density), biological, root and shoot yield.ha^{-1}.

The temperatures during harvest on April reached 23°C, while on May the temperatures attained 37°C (Table 1).

Table 1: Temperatures and rainfall distribution during 2011/2012 season.

Month	Max. Temperature °C	Min. Temperature °C	Rainfall mm
January	18	-4	17.3
February	23	-4	10.9
March	28	-2	5.5
April	23	13	5.8
May	37	10	1.5
June	41	18	0
July	44	20	0
August	44	21	0
September	39	14	4.3
October	36	2	15.2
November	16.6	2.5	25.8
December	15	-6	24.1

Source: Meteorology Station in Al Raqqa governorate.

Data were analyzed using the standard analysis of variance (ANOVA) technique and means were separated using the comparisons based upon the least significant difference (LSD) using GeneStat Computer Program v.12.

Results and Discussion

Root and shoot weight/plant (g), and root/shoot ratio:

Table (2) illustrates that the effects of harvest date and varieties on root and shoot weight/plant, and root/shoot ratio were non significant ($P \geq 0.05$).

The statistical analysis in Table (3) shows that prolonging harvest period of beet roots in the fields will did not affect the studied traits of the varieties, this result is not in accompany with Al Jbawi *et al.*, (2015) who stated a significant effect between fodder beet varieties for root and shoot weight per plant, and root/shoot ration. While Khogali *et al.*, (2011) who confirmed that fresh weights of root was not significantly affected by cultivars. Kassab *et al.*, (2012) stated a significant effect on root weight for one plant.

Table 2. Analysis of variance (ANOVA) of root and weight/plant (g), and root/shoot ratio.

Trait		Root weight/plant (g)			Shoot weight/plant (g)			Root/shoot ratio		
Source of variance	DF	MS	Variance %	P	MS	Variance %	P	MS	Variance %	P
Replications	2	7591	0.33	-	4641	0.16	-	0.1118	0.46	-
Harvest date (H)	2	28221	1.24	0.381 ns	16929	0.59	0.597 ns	0.7439	3.06	0.156 ns
Error	4	22734	3.13	-	28739	1.59	-	0.2434	0.87	-
Varieties (V)	1	21421	2.95	0.137 ns	170	0.01	0.926 ns	0.2304	0.82	0.400 ns
V*H	2	804	0.11	0.897 ns	4279	0.24	0.796 ns	0.0212	0.08	0.928 ns

DF: Degree of Freedom, MS: Mean Square, SS: Sum of Squares, P: Probability 0.05

Table 3. Response two of fodder beet varieties to harvest date on root and weight/plant (g), and root/shoot ratio.

Trait	Root weight/plant (g)				Shoot weight/plant (g)				root /shoot ratio			
Variety V	Harvest date (H)			Mean	Harvest date (H)			Mean	Harvest date (H)			Mean
	10/4	30/4	10/5		10/4	30/4	10/5		10/4	30/4	10/5	
Vermon	977	1086	1060	**1041**	537	397	462	**465**	2.00	2.81	2.30	**2.37**
Jamon	882	1034	1000	**972**	484	420	511	**472**	1.88	2.46	2.10	**2.15**
Mean	930	1060	1030	**1007**	511	409	487	**469**	1.94	2.64	2.20	**2.26**
$LSD_{0.05}$	**H=241.7, V=98.3, H.V=240.0**				**H=271.7, V=155.1, H.V=285.7**				**H=0.79, V=0.61, H.V=0.93**			
CV%	**8.5**				**20.7**				**20.4**			

Root, shoot and biological yield (ton/ha):

Plants harvested at different harvesting dates shows non significant differences regarding root, shoot, and biological yield (ton/ha) (Tables 4,5). This contravene the work of Al Jbawi *et al.*, (2015), who reported that fodder beet cultivars differed in root and shoot yield significantly. But accompany with Khogali *et al.*, (2011) who stated that green fodder yields were not significantly affected by cultivars.

Table 4. Analysis of variance (ANOVA) of root and shoot, and biological yield (ton/ha).

Trait		Root yield (ton/ha)			Shoot yield (ton/ha)			Biological yield (ton/ha)		
Source of variance	DF	MS	Variance %	P	MS	Variance %	P	MS	Variance %	P
Replications	2	101.57	0.96	-	44.39	0.37	-	276.5	0.62	-
Harvest date (H)	2	213.95	2.02	0.247 ns	36.68	0.31	0.753 ns	217.1	0.48	0.649 ns
Error	4	105.83	1.21	-	120.21	2.30	-	449.3	1.97	-
Varieties (V)	1	38.64	0.44	0.531 ns	2.17	0.04	0.845 ns	22.5	0.10	0.764 ns
V*H	2	41.53	0.47	0.643 ns	21.91	0.42	0.675 ns	120.0	0.53	0.616 ns

DF: Degree of Freedom, MS: Mean Square, SS: Sum of Squares, P: Probability 0.05

Table 5. Response two of fodder beet varieties to harvest date on root and shoot, and biological yield (ton/ha).

Trait	Root weight/plant (g)				Shoot weight/plant (g)				Biological yield (ton/ha)			
Variety V	Harvest date (H)			Mean	Harvest date (H)			Mean	Harvest date (H)			Mean
	10/4	30/4	10/5		10/4	30/4	10/5		10/4	30/4	10/5	
Vermon	44.2	48.8	51.4	48.1	24.5	17.8	22.2	21.5	68.7	66.6	73.6	69.6
Jamon	35.4	50.2	50.0	45.2	20.8	20.4	25.4	22.2	56.2	70.6	75.4	67.4
Mean	39.8	49.5	50.7	46.7	22.7	19.1	23.8	21.9	62.5	68.6	74.5	68.5
$LSD_{0.05}$	H=16.5, V=10.8, H.V=18.11				H=17.6, V=8.3, H.V=17.8				H=34.0, V=17.4, H.V=35.0			
CV%	20.0				20.0				22.1			

Sucrose (%) and plant number (thousand/ha):

Analysis of variance showed a significant effect of varieties in terms of sucrose % ($P \leq 0.05$) (Table 6). Vermon achieved higher sucrose % (6.6%) compared to Jamon (4.8%), the difference between the two varieties in sucrose% was 27.3%, for Vermon sake. When Vermon harvested in (30/4) attained the highest sucrose% (8.1) (Table 7). Number of plants per ha was not significantly affected by harvesting dates and varieties. Al Jbawi *et al.*, (2015) confirmed that number of plant per hectare had non significant effect between fodder beet varieties.

Table 6. Analysis of variance (ANOVA) of sucrose (%), and plant number (thousand/ha)

Trait		Sucrose (%)			Plant number (thousand/ha)		
Source of variance	DF	MS	Variance %	P	MS	Variance %	P
Replications	2	2.9477	0.86	-	155.51	1.84	-
Harvest date (H)	2	4.0452	1.18	0.396 ns	59.19	0.70	0.549 ns
Error	4	3.4330	6.33	-	84.55	1.79	-
Varieties (V)	1	13.9744	25.77	0.002*	0.03	0.00	0.982 ns
V*H	2	1.9345	3.57	0.095 ns	28.68	0.61	0.576 ns

DF: Degree of Freedom, MS: Mean Square, SS: Sum of Squares, P: Probability 0.05

Table 7. Response two of fodder beet varieties to harvest date on sucrose (%), and plant number (thousand/ha)

Trait	Sucrose (%)				Plant number (thousand/ha)			
Variety V	Harvest date (H)			Mean	Harvest date (H)			Mean
	10/4	30/4	10/5		10/4	30/4	10/5	
Vermon	6.0	8.1	5.6	6.6	45.3	44.9	48.3	46.2
Jamon	4.9	5.1	4.5	4.8	40.5	48.3	50.0	46.3
Mean	5.4	6.6	5.0	5.68	42.9	46.6	49.2	46.2
$LSD_{0.05}$	H=3.0, V=0.8*, H.V=2.9				H=14.7, V=7.9, H.V=15.3			
CV%	13.0				14.9			

Conclusion

Harvest date had non significant (P≥0.05) effect on all of the studied traits; accordingly harvest date could be prolonged one month after it sown on 10th September. Also the difference was non significant (P≥0.05) between the varieties for all of the studied traits except sucrose%, where Vermon variety was superior over Jamon. Hence it is recommended to be planted. All interactions between harvesting date and varieties were not significant for the studied traits.

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استجابة أصناف من الشوندر العلفي (*Beta Vulgaris* var. *crassa* Mansf) لمواعيد القلع تحت تأثير ظروف المنطقة الشمالية الشرقية من سورية

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الملخص:

نفذت التجربة في مركز البحوث العلمية الزراعية في الرقة، الهيئة العامة للبحوث العلمية الزراعية/سورية، خلال الموسم 2012/2011، لدراسة استجابة صنفين وحيدي الجنين من الشوندر العلفي، هما: فيرمون وجامون، تحت تأثير ثلاثة مواعيد للقلع (10 نيسان/أبريل، 25 نيسان/أبريل، و10 أيار/مايو). استخدم تصميم القطع المنشقة بثلاثة مكررات. أوضح التحليل الإحصائي عدم وجود تأثير معنوي لمواعيد القلع (H) والأصناف (V) بالنسبة لجميع الصفات المدروسة، ولوحظ وجود تأثير معنوي للأصناف في نسبة السكر ($P\leq0.05$). بصفة عامة أدى التأخير في موعد القلع إلى ارتفاع في قيم الصفات المدروسة. أظهرت النتائج تفوق الصنف فيرمون على الصنف جامون ($P\leq0.05$) في نسبة السكر بنسبة 27.3%. توضّح نسبة التباين أن عامل موعد القلع هو الأكثر تأثيراً في جميع الصفات المدروسة. نخلص من الدراسة إمكانية إطالة فترة القلع لشهر عند الزراعة في 10 أيلول/سبتمبر، وزراعة الصنف فيرمون للحصول على نسبة أعلى من السكر.

الكلمات المفتاحية: الشوندر العلفي، موعد القلع، الغلة ومكوناتها، سورية.