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THE PRODUCTIVITY OF FOUR FODDER BEET CULTIVARS (*BETA VULGARIS* VAR. *CRASSA*) AFFECTED BY AUTUMN AND WINTER SOWING

Entessar.Al-Jbawi[1*], Mohamad Bagdadi[2] and Yousef. Nemr[3]
[1] General Commission for Scientific Agricultural Research (GCSAR), Sugar beet Research Department, Crops Research Administration, Al Halbouni, Damascus, Syria
[2] GCSAR Animal Wealth Research Administration, Al Halbouni, Damascus, Syria
[3] Faculty of Agriculture, Crops Department, Damascus University, Damascus, Syria
[*]Corresponding author: dr.entessara@gmail.com

Abstract

There is renewed interest in fodder beet (*Beta vulgaris* L.) production in Syria. However, recommended agronomic practices for maximizing productivity are limited. A field experiment was conducted in season 2011-2012 to study the effect of autumn and winter sowing 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, sowing dates were assigned to the main plots and fodder beet cultivars (Jamon, Splendids, Starmon and Vermon) were allotted to the sub plots. The results of T-Test exhibited the superiority of autumn date as compared with winter date, but in a small percentage. Sowing dates and varieties exhibited highly significant ($p \leq 0.05$) differences in most of the studied characteristics (shoot weight.plant-1, root/shoot ratio, root and shoot yield ($t.ha^{-1}$). Varieties affected all of the production traits significantly ($p \leq 0.05$). Vermon surpassed the other cultivars in terms of the production studied traits. The conclusion is to sow fodder beet in autumn time in Al Raqqa, Syria, to attain the highest yield and yield components traits. Also The study recommends further trials identify optimum agronomic practices especially harvesting date, soil type, land preparation, fertilization and spacing in the other sites in Syria
Key words: Sowing date, fodder beet, production traits.

Introduction

There is renewed interest in fodder beet (*Beta vulgaris* L.) production in Syria, especially a strong interest toward use of fodder beet for autumn and winter feeding of dairy herds (Al-Jbawi, 2014). Fodder beet (*Beta vulgaris* var.*Crassa)*, is a member of the *Chenopodiaceae* family, and 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). In Tasmania fodder beet is sown in mid to late spring when soil temperatures are greater than 5^{o}C and after the last frosts. Waiting till a soil temperatures are greater than 10^{o}C before sowing will ensure a more even germination and improve seedling vigor. As the crop can take over 200 days to mature later sown crops will not have enough time to fully develop before winter which will limit yield (Pembleton and Rawnsley, 2011).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. Recent research suggests high dry matter (DM) yields of 19–35 t DM/ha (Chakwizira et al., 2012; Matthew et al. 2011) are attainable in New Zealand. These DM yields are higher than the 10–15 t DM/ha for the traditional winter crops, e.g., kale and swedes (Chakwizira et al., 2011; Gowers et al., 2006; Wilson et al., 2006).

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; El-Sarag, 2013). Therefore the optimum population which produces maximum leaves and roots yield must be carefully determined.

Fodder beet is 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 effect of sowing dates on yield and yield components of fodder beet to provide information on cultural practices concerning this important crop under Syrian conditions, specifically the on the north of Syria (Al Raqqa).

Khogali et al., (2011) studied the effect of three fodder beet cultivars (Voroshenger, Anisa and Polyproductiva) on yields and yield components, they reported that cultivars affected shoot fresh weight significantly ($p<0.01$) in the first season and highly significantly ($p<0.01$) in the second.And fresh weights of root, green fodder yields were not significantly affected by cultivars. El Sarag (2013) illustrated that Rotta cultivar surpassed Voroshenger one in all yield attributes at harvesting time in combined analysis.

This research aims to study the effect of sowing dates on the production traits of four fodder beet in Al Raqqa governorate, Syria.

Materials and Methods

A field experiment was conducted for on autumn and winter seasons of October and January (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 sowing dates and the sub-plots to the four fodder beet varieties were used: Jamon, Splendids, Starmon, and Vermon (all French cultivars). The land was disc- ploughed, harrowed twice, leveled and ridged 60 cm apart, and 25 cm the space between holes. The size of the plot was 8X5 m, consisting of eight ridges of 8m 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 October15^{th} and January 15^{th}.

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. 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 five plants of each variety was taken per plot from the inner two ridges randomly hand-pulled to determine:

Root weight.plant^{-1} (Kg), shoot weight.plan^{-1} (Kg), root/shoot ratio, and three inner rows were harvested to determine number of plants.ha^{-1} (plant density), and root and shoot yield.ha^{-1}.

The temperatures during harvest at autumn reached 37°C, while at winter the temperatures ranged between 41°C to 44°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.

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

Root weight.plant^{-1}(Kg):

Table (2) illustrates the effect of sowing date and varieties on root weight.plant^{-1}. This trait was greater under autumn sowing (15th Oct.) (1.616 Kg) as compared with winter sowing (15th Jan.) (1.526 Kg) ($P>0.05$).Varieties were significantly ($P\leq0.05$) different in root weight.plant^{-1}.Vermon variety obtained the highest root weight.Plant^{-1}in the autumn and winter sowing (1.831, and 1.839 Kg), followed by Starmon variety (1.752, 1.566 Kg), respectively.

Table 2: The effect of sowing date on root and shoot weigh.plant^{-1} (Kg), and root/shoot ratio of four fodder beet varieties

Sowing date (D)	Varieties (V)	Root weight.plant^{-1} (Kg)	Shoot weight.plant^{-1} (Kg)	Root/shoot ratio
Autumn (15th Oct) (D_1)	Jamon	1.363	0.540	0.25
	Splendids	1.519	0.507	0.31
	Stramon	1.752	0.467	0.29
	Vermon	1.831	0.553	0.34
Mean		**1.616**	**0.517**	**0.30**
LSD (V) 0.05		**ns**	**ns**	**0.08**
Winter (15th Jan) (D_2)	Jamon	1.272	0.497	0.26
	Splendids	1.425	0.467	0.32
	Stramon	1.566	0.413	0.33
	Vermon	1.839	0.510	0.35
Mean		**1.526**	**0.471**	**0.32**
LSD (V) 0.05		**0.34**	**ns**	**0.07**
Mean of varieties over Sowing dates	Jamon	1.318	0.518	0.26
	Splendids	1.472	0.487	0.32
	Stramon	1.659	0.440	0.31
	Vermon	1.835	0.531	0.35
Mean		**1.571**	**0.494**	**0.31**
LSD (V) 0.05		**0.39**	**0.04**	**0.08**
LSD (V*D) 0.05		**ns**	**ns**	**Ns**
T-Test (D) 0.05		**ns**	**1.84**	**0.01**

ns: not significant, at 0.05 level of probability.

Shoot weight.plant^{-1} (Kg):

Plants grown at different sowing dates significantly different regarding shoot weight.plant^{-1} (Table 1). Higher shoot weight.plan^{-1} was significantly ($p \leq 0.05$) recorded for autumn sowing (0.517 Kg), as compared with winter sowing (0.471 Kg) (Table 1). The effect between varieties of shoot weight.plant^{-1}showed the superiority of Vermon (0.531 Kg). This agrees with the work of Khogali (2011), who reported that fodder beet cultivars differed in foliage fresh weight significantly. The highest shoot weight.plant^{-1} was achieved by sowing in autumn using the variety Vermon (0.553 Kg).

Root/shoot ratio:

Root/shoot ratio was increased when sown at winter (0.32) (Table 2). This refers to the loosing and senescence of eldest leaves (El Sarag, 2013). Significant differences were

observed between the varieties regarding root/shoot ratio (Table 2). Root/shoot ratio was not significantly affected by interactive effect between sowing dates and varieties, when Vermon sown at winter attained the greatest root/shoot ratio (0.35) (Table 2). Vermon attained the greatest root/shoot ratio (0.35).

Number of plants (thousand plant. ha^{-1}):

The results exhibits no significant difference in number of plants between sowing dates ($P \geq 0.05$) (Table 3), the optimum plant number is 70.000 plant.ha-1 (DLF, 2013). The varieties Jamon, Splendids, and Vermon were comparable in number of plants (Table 3). The interaction between sowing dates and varieties was not significant, therefore, the highest number of plants was achieved by sowing at autumn using the variety Splendids (51.70 thousand plant.ha^{-1})

Table 3: The effect of sowing date on number of plants (thousand plant ha^{-1}) and root and shoot yield (t.ha^{-1}) of four fodder beet varieties

Sowing date (D)	varieties (V)	Number of plants (thousand plan.ha^{-1})	Root yield (t.ha^{-1})	Shoot yield (t.ha^{-1})
Autumn (15th Oct) (D_1)	Jamon	50.00	60.90	27.00
	Splendids	51.70	69.80	25.30
	Stramon	40.80	60.60	23.30
	Vermon	51.50	84.60	27.70
Mean		**48.50**	**68.98**	**25.89**
LSD (V) 0.05		**ns**	**19.11**	**Ns**
Winter (15th Jan) (D_2)	Jamon	50.50	57.70	24.80
	Splendids	51.67	66.00	23.30
	Stramon	43.17	66.80	20.70
	Vermon	49.17	81.00	25.50
Mean		**48.63**	**66.38**	**23.58**
LSD (V) 0.05		**ns**	**16.28**	**Ns**
Mean of varieties over Sowing dates	Jamon	50.25	59.30	20.25
	Splendids	51.69	67.90	23.85
	Stramon	40.99	60.70	23.50
	Vermon	51.34	82.80	27.05
Mean		**48.56**	**67.68**	**23.66**
LSD (V) 0.05		**ns**	**12.69**	**3.71**
LSD (V*D) 0.05		**ns**	**ns**	**Ns**
T-Test (D) 0.05		**ns**	**0.85**	**1.38**

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

Root yield ($t.ha^{-1}$):

Plants grown at different sowing dates were significantly ($P \leq 0.05$) differed regarding root yield (Table 3), this may refer to the difference in the temperatures during the growing season (Table 1). It is well known that fodder beet when grown under suitable conditions, can produce almost 20 t. ha^{-1} dry matter yield (DAF, 1998) compared with 13±15 t DM/ha^{-1} from four harvests of grass. Higher root yield was recorded for Vermon (82.80 $t.ha^{-1}$) (Table 2). Interaction between sowing dates and varieties was not significant, but the highest root yield was achieved by sowing in autumn using the variety Vermon (84.60 $t.ha^{-1}$).

Shoot yield ($t.ha^{-1}$):

Table (3) showed an increment in shoot yield when sown in autumn (25.89 $t.ha^{-1}$) as compared with winter (23.58 $t.ha^{-1}$) ($P \geq 0.05$). Significant differences were observed between the varieties regarding shoot yield (Table 3). Shoot yield was not significantly affected by interactive effect between sowing dates and varieties, but when Vermon sown at autumn attained the greatest shoot yield (27.70) (Table 3). Vermon attained the greatest shoot yield (27.05 $t.ha^{-1}$).

Conclusion

The highest ($p \leq 0.05$) production traits were obtained under autumn. So, it is recommended to plant fodder beet in autumn. In terms of varieties, Vermon variety was superior over Jamon, Splendids, and Starmon in all the studied traits. Hence it is recommended to be planted. Most interactions between sowing date and varieties were not significant for the studied production traits.

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