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Effects of Management of Agronomical Factors on Sugar Beet Steckling Production and growth index

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ABSTRACT: This experiment was conducted in sugar beet seed research station of Firoozkooh to Evaluation of Effects of management of agronomical factors on Sugar Beet Steckling Production and growth index during in 2012-2013 growing seasons. The experiment design was a split plot factorial with a randomized complete block arrangement and four replications. Treatments consisted of three sowing dates (1 July, 20 July, 13 August) as main plots and four plant densities (10, 20, 30 and 40 plants per square meter) and three levels of nitrogen (25% less than optimum, optimum and 25% higher than optimal) factorial were subplots. Nitrogen treatments based on soil testing in first year included three net nitrogen 197.6, 247, and 296.4 kg N ha^{-1} and 180, 225 and 270 kg N ha^{-1} in second year being split into two stages of early in the growing season and one month after the first stage. A logistic and an expoliner model were used for describing the leaf area variation pattern and the dry matter versus timing in various treatments of sowing dates, plant densities and nitrogen fertilizer. According to the results of these models, leaf area index decreased with delay in planting date. The results of this study showed that, with early sowing and increase the amount of nitrogen fertilizer maximum leaf area index and dry matter accumulation increased. The maximum value W_{max}, in both years was obtained from planting date of July 1 and nitrogen treatments, the amount of 25% higher than the optimum. The treatment, planting date July 1, 10 plants per square meter and 25% higher than the optimum amount of nitrogen had the maximum Stecklings of the appropriate size (100-150 g). The results showed that treatment of plant density and the use of different levels of nitrogen in Steckling production, no significant effect on the quantity and quality of seed. Therefore, to increase the yield of sugar beet seed production earlier planting dates Steckling should be a priority. The results of this study showed the importance of planting date is greater than the other treatments and in case of delay in sowing date, the possibility of improving the production of stecklings with different treatments reduced. In other words, the use of different treatments to improve the quality of the roots, at the time the will be result, that planted at the right time.

Keywords: Sowing date; plant densities; nitrogen; Steckling

INTRODUCTION

Sugar beet is one of the most important industrial plants in Ardebil province. Products derived from this plant have been used. Due to the increased use of chemical fertilizers are used too much product. Therefore, it is important to know the proper use of supplements. To protect farmland and prevent poisoning Soil is important Fertilizer is considered as a limiting factor for obtaining high yield and quality (Ouda, 2002). Yield potential of sugar beet (*Beta vulgaris* L.) depends upon several factors. Intensity of solar radiation intercepted by the canopy, temperatures at critical stages of growth, and distribution of precipitation are the main limiting growth factors (Kenter *et al*., 2006). It is well documented that N is the nutrient limiting the most sugar beet productivity (Hergert, 2010). Sugar beet yield and quality are dramatically influenced by the level of available N. Residual and fertilizer N levels allowing adequate top growth and maximize root growth and extractable sucrose concentration are desired. However, sucrose yield decreases by over-fertilizing sugar beet with more N than needed for maximum sucrose production (Hassanin and Elayas, 2000). An adequate supply of N is essential for optimum yield but excess N may result in an increase in yield of roots with lower sucrose content and juice purity. The application of too little N results in reduced root yield. Contrary, high amount of applied N is the cause of imbalanced partitioning of assimilates among leaves and storage root, and lead to decrease of root sucrose concentration. Its oversupply, increases also concentrations of impurities, such as α-amino-N, K, Na, in turn decreasing storage root quality (Hoffmann, 2005; Malnou *et al*., 2008).

Therefore, the most important purpose of sugar beet growers is to increase nitrogen use efficiency. Any efforts towards fulfillment this objective requires to take into account both N and other nutrients, especially of P and K (Nikolova, 1999; Draycott and Christenson, 2003; Romer *et al*., 2004; Grzebisz *et al*., 2012). Tsialtas and Maslaris (2005) said that the best process for the root and sugar will be when the ratio of leaf surface efficiency compared with nitrogen density is between 3.99 and 3.88. A healthy canopy can be helpful to the above process during the final stages of growth. They also noticed that using 200 kg of nitrogen per hectare results in better sugar beet production. Knowing the chlorophyll of the leaf and indicator of the leaf surface are precise methods to demonstrate the sugar beet nitrogen and the evaluation of the harmful nitrogen in feeding the plant. Kandil *et al* (2004) showed that using nitrogen towards the end of the growing season caused higher chlorophyll density in leaves, but had no noticeable effect on the process of Radiation Use Efficiency in late summer and fall. As a result, using nitrogen at a later time caused the final weight of the body to increase, but had negative effect on the process of sugar quality. So the appropriate amount of fertilizers in sugar beet fields is a critical decision. Although 7-16 g steckling supply is required for the initiation of sugar beet (*Beta vulgaris* L.) reproductive growth and plant emergence (Balan *et al*., 1991), this does not override the considerable effects of steckling weight on the seed yield and growth trend of this crop. Several studies have shown that the growth and seed yield increase as the steckling weight increases (Saini *et al*., 1977; Balan *et al*., 1978; Nicolau, 1978; Podlaski, 1987b). Plant density can be an important factor in quantity and quality of sugar beet production. Leila *et al*.(2005) reported that the best date to plant sugar beet seeds is at the beginning of October in both sides of ridges with 70 cm width and 25 cm distance on the ridges (114,240 plants per hectare). Pospisil *et al* (2000) found that increasing the plant density from 40,000 to 160,000 plants per hectare resulted in leaf surface reduction in each plant. The growth of the sugar beet plants is almost consistent. However, these results are based on 120,000 plants per hectare. Using nitrogen as a fertilizer during the flowering stage resulted in larger surface areas of the leaves. However, the decrease in steckling weight can be compensated by the increase in planting density without any negative effects on the seed qualitative characteristics (Balan and Zagorodnii, 1986). It is shown that the stecklings with the weights of 200 g are appropriate for silage (in transplanting method) and heavier stecklings (600 g) are damaged by freeze (Korzhenko and Tretyak, 1980). Kockelman and Meyer (2005) believed that all techniques in steckling fields goal for an optimal top diameter of 2-4 cm and a weight of 40-80 g and good nursery production should results in 300,000-400,000 plantable stecklings in hectare. The date of sowing and sowing density of basic seed affect the result. The late sowing decrease the average steckling weight and cause the production of small plants which are not developed enough for transplanting. They also say that early sowing dates in France or Italy, end of July to beginning of August, need high seeding densities of about 1.1 million germinating seeds per ha to obtain a good number of even-sized stecklings. With the row of width of 20-25 cm, spacing within the row is 3-5 cm. The fields good preparing allow sowing depths of 1.5-2 cm. Basic seed sowing should be ended by the end of August in order to reach a high recovery of usable stecklings. In late sowing, the planting rate should be reduced by about 10-20% cause the development of single plants with the less competition between the plants. Balan and Zagorodnii (1986) reported that the increase in steckling weight (from 50-300 to 150-800 g) and planting density (from 70 × 70 to 70 × 35 cm) led to an increase in seed yield (1.83 and 2.37 t ha^{-1}, respectively) as well as affected plants growth characteristics such as plant branching and hastened the flowering period by 4-6 days. Podlaski (1987b) by increasing density from 50 × 50 to 30× 30 cm reported a decrease in seed yield from 34.2 to 13.3 g $plant^{-1}$. Also Bordei and Tapus (1981) indicated that the seed yield increased from 0.71 (3 plants m^{-2}) to 0.97 t ha^{-1} (5 plants m^{-2}). Kaw and Mir (1975) studied the effects of variation in planting density via changing row interspaces (30, 45, 60 and 75 cm) and showed that the maximum seed yield (1.60 and 2.52 t ha^{-1}) was obtained in narrower rows (30 and 45 cm, respectively). Agronomical factors such as planting density, steckling weight, harvesting date and method as well as the application of chemical materials affected qualitative characteristics of sugar beet seed-bearing plants through affecting plants ripening uniformity (Bordei and Tapus, 1981). It has been shown that the increase in steckling weight from 150 to 700 g led to an increase in seed yield as well as seed germination rate (Podlaski, 1987a) while Saini *et al*. (1977) found that the increase in steckling weight did not affect the seed maturity and germination rate and thousand-seed weight. Scott and Longden (1973) reported that narrower row (25 cm in comparison to 50 cm) caused an increase in seed yield and germination vigor. But Lachowski and Howwicki (1973) indicated that an increase in planting density did not affect qualitative characteristics such as thousand-seed weight and purity. Crop growth rate (CGR) is slow at early growth stages because the plant cover is incomplete and the plants absorb just a part of the solar radiation. As the plants develop, their growth rate is quickly increased because of the expansion of leaf area and the penetration of less radiation through plant cover to the soil surface. Maximum CGR (the steepest slope in total biomass variations graph) is realized when the plants are tall and dense enough to be able to maximally utilize all environmental parameters (Radford, 1967). The studies on lentil showed that such traits as biological yield, harvest index as well as leaf area index (LAI) and CGR can be used as indices for improving seed yield of lentil (cited in Haghnazari *et al*., 2005).

In a study on heritability and correlation of morpho-physiological traits with yield and yield components of bread wheat, Siahpoosh *et al*. (2003) indicated that out of the studied physiological indices, net assimilation rate (NAR) and leaf area duration (LAD) were effective indices in increasing grain yield. In a three-year study on linseed cultivars, Zajac *et al*. (2005) found a positive relation between dry matter yield and growth indices like CGR and LAD. Also, Mahdavi *et al*. (2006) and Katsura *et al*. (2007) reported that rice grain yield can be increased by selection on the basis of physiological growth indices like LAD, CGR, relative growth rate (RGR) and net assimilation rate.

MATERIAL AND METHODS

This experiment was conducted in sugar beet seed research station of Firoozkooh to Evaluation of Effects of management of agronomical factors on Sugar Beet Steckling Production and growth index during in 2012-2013 growing seasons. The experiment design was a split plot factorial with a randomized complete block arrangement and four replications. Treatments consisted of three sowing dates (1 July, 20 July, 13August) as main plots and four plant densities (10, 20, 30 and 40 plants per square meter) and three levels of nitrogen (25% less than optimum, optimum and 25% higher than optimal) factorial were subplots. Nitrogen treatments based on soil testing in first year included three net nitrogen 197.6, 247, and 296.4 kg N ha^{-1} and 180, 225 and 270 kg N ha^{-1} in second year being split into two stages of early in the growing season and one month after the first stage. Each plot consists of six rows of ten meters and with row spacing of 50 cm. Irrigation was performed after each planting date. First row, fourth and sixth rows as margin, second and third rows for destructive sampling for analysis and plant growth, root and fifth were considered for the final harvest.

The growth pattern typically follows a sigmoid curve, and the growth rate a bell?shaped curve. While the sigmoid pattern can be represented piecewise using an exponential, a linear and a convex equation sequentially (e.g. Lieth *et al*., 1996), a more elegant way is to use a curvilinear equation which gives a gradual transition from one phase to the next. For example, based on principles of light interception and leaf area expansion, Goudriaan and Monteith (1990) derived as single equation. The expolinear equation, for both the

$$w = \frac{c_m}{r_m} \ln\left[\frac{1 + e^{r_m (x - t_o)}}{1 + e^{r_m (x - t_o - w_{\max} / c_m)}} \right]$$

exponential and linear phases of crop growth:

Where is *w* is mass, *t* is time, t_0 is the moment at which the linear phase effectively begins, and c_m and r_m are maximum growth rate in the linear phase and maximum relative growth rate (RGR) in the exponential phase, respectively. Equation (2) gives a symmetrical sigmoid pattern around time to + $w_{\max}$/(2cm). To distinguish it from the truncated equation, eqn (2) is referred to as the symmetrical expolinear function. Alternative, but simpler, functions that can produce two smooth transitions in a single formula are the classical growth functions.

To quantify the degree days, leaf area index was below the growth of the logistics function (Norsworthy, 2004).

$$y = \frac{y_{\max}}{1 + \exp[\frac{-(GDD - b)}{a}]}$$

Where is *y* is leaf area index, GDD: growth degree day, $y_{\max}$: leaf area index maximum, *a* is parameter function, *b* is time to reach 50 percent by the canopy is the leaf area index.

Base temperature, the optimum temperature and the temperature of the ceiling for sugar beet respectively 3, 20 and 35 c_0 was considered.

Data analysis for leaf area and dry matter accumulation with using the software SAS and The model parameters are estimated using iterative optimization with help PROC NLIN it is done. A logistic and an expoliner model were used for describing the leaf area variation pattern and the dry matter versus timing in various treatments of sowing dates, plant densities and nitrogen fertilizer.

RESULTS AND DISCUSSION

A. Leaf area index maximum (LAI$_{max}$)

The trend of the leaf area index of sugar beet Steckling logistic model able to describe the different treatments for both years as well (Table 1).

Thomson and Siddique (1997) Stated that the plant leaf area index changes versus time of a sigmoid reaction follow. According to the model between the different treatments in terms of maximum leaf area index was statistically significant in both years. In the second test the highest and lowest maximum leaf area index planting respectively on 1 July and august 13. Thus, leaf area index decreased with delay in planting. The leaf area index in early growth was low and gradually increased over time and with the development of the plant. The time of maximum leaf area index (b) at different planting dates were significantly different in the two years together at both the time of maximum leaf area index of the plant on 1 July, for the first year 1331.5 and in the second year of this time period1612.1 GDD after planting took place.

Table 1: Parameters logistic model includes a (Parameter function), b (GDD to reach 50 percent by the canopy leaf area index), LAI$_{max}$ (Leaf area index maximum), Root mean square (RMSE), RR (Restate ratio) in describing the trend of LAI Steckling in planting dates in different years in 2012 and 2013.

R^2	RMSE	LAI_{max}	b ± SE	a ± SE	Plant date	year
0.97	0.152	2.31±0.12	1331.5±37.99	145.3±32.8	1 july	2012
0.97	0.091	1.25±0.08	1158.4± 31.57	116.3±25.24	20 july	
0.99	0.035	1.24±0.05	1125.1± 37.27	156.8± 25.15	12 august	
0.97	0.136	2.32±0.12	1612.1± 25.55	110.4± 20.92	1 july	2013
0.97	0.081	1.24±0.08	1331.7± 20.17	85.6± 17.45	20 july	
0.99	0.012	0.32±0.009	986.7± 4.94	35.3± 4.07	12 august	

Table 2: Parameters logistic model includes a (Parameter function), b (GDD to reach 50 percent by the canopy leaf area index), LAImax (Leaf area index maximum), Root mean square (RMSE), RR (Restate ratio) in describing the trend of LAI Steckling in planting dates in different years in 2012 and 2013.

R^2	RMSE	LAI_{max}	b ± SE	a ± SE	Plant density	year
0.95	0.139	1.81±0.11	1409.1±39.22	185.3±26	10	2012
0.96	0.147	2.13±0.12	1427.5± 35.28	183.5±23.36	20	
0.97	0.155	2.54±0.12	1350.9± 31.55	194.8± 21	30	
0.96	0.216	3.11±0.16	1342.2± 32.7	180.4± 22.18	40	
0.93	0.123	1.43±0.12	1572.1± 42.86	165± 27.86	10	2013
0.93	0.123	1.44±0.12	1572.1± 42.86	165± 27.86	20	
0.93	0.212	2.58±0.21	1548.4± 44.36	183± 28.59	30	
0.93	0.278	3.42±0.28	1569.6± 44.45	180± 28.34	40	

Because of the close relationship that the biomass is produced during the growing season, planting date through compliance with seasonal changes in solar radiation and temperature growth process, a special effect on the leaf area (Theurer, 1979). Early sowing date, growth rate leaves slowly increasing and this would be the time it takes to reach the maximum of biomass per unit area increases. Late planting fewer opportunities to cover your plants to take advantage of favorable days to operate and therefore less leaf area index in delayed sowing of the crop to be timely (Watson, 1947). The maximum LAI treatment was 40 plants per square meter in the first and second years respectively 3.11 and 3.42. The lowest index was observed at 10 plants per square meter in the first and second years respectively 1.81 and 1.43 (Table 2). The time of maximum leaf area index (b) at different densities was not significantly different in the two years since the first and second time respectively 1342.2 up to 147.5 and 1566.6 up to 1572.5 GDD after planting was variable. At high densities because the plants produce more leaves per unit area, as well as to be better able to cover the field level and to form a closed canopy, produced more leaf area. Increasing plant density, solar energy use efficiency in corn has increased because of the increase as the leaf surface (Mahlooji and Afiuni, 2004).

The results showed that among the different fertilizer treatments LAImax there was a significant difference in both years. In the years first and second maximum levels LAImax in fertilizer treatment 25% more than was optimal and its amount in first and second years respectively 2.7 and 2.75.

Table 3: Parameters logistic model includes a (Parameter function), b (GDD to reach 50 percent by the canopy leaf area index), LAImax (Leaf area index maximum), Root mean square (RMSE), RR (Restate ratio) in describing the trend of LAI Steckling in planting dates in different years in 2012 and 2013.

R^2	RMSE	LAI_{max}	b ± SE	a ± SE	Nitrogen level	year
0.94	0.169	2.21±0.12	1329.6±31.2	161.8±17	%20 less than optimal	2012
0.96	0.140	2.42±0.12	1360.5±33	174.9±18.21	Optimal	
0.96	0.166	2.70±0.12	1402.7±48.33	201.3±27.14	25% higher than Optimal	
0.92	0.165	2.06±0.16	1552.3± 43.87	178.7± 28.39	less than optimal 20%	2013
0.94	0.180	2.41±0.17	1577.6± 37.72	166± 24.36	Optimal	
0.94	0.212	2.75±0.12	1593.1± 43.61	184± 27.23	higher than Optimal %25	

The lowest index In both years of treatment 20% was less than optimal. It is well documented that N is the nutrient limiting the most sugar beet productivity (Hergert, 2010). Sugar beet yield and quality are dramatically influenced by the level of available N. Residual and fertilizer N levels allowing adequate top growth and maximize root growth and extractable sucrose concentration are desired. However, sucrose yield decreases by over-fertilizing sugar beet with more N than needed for maximum sucrose production (Hassanin and Elayas, 2000). An adequate supply of N is essential for optimum yield but excess N may result in an increase in yield of roots with lower sucrose content and juice purity. The application of too little N results in reduced root yield. Contrary, high amount of applied N is the cause of imbalanced partitioning of assimilates among leaves and storage root, and lead to decrease of root sucrose concentration. Its oversupply, increases also concentrations of impurities, such as ?-amino-N, K, Na, in turn decreasing storage root quality (Hoffmann, 2005; Malnou *et al*., 2008).

REFERENCES

Balan, V.M., V.N. Kirichenko and L.Y. Zhovtonochuk, (1991). Stand density for seed production sugar beet grown without transplanting. *Vestinik Selskogozyaistvennoi Nauki Moskva*, **7**: 97-100.

Balan, V.N. and A.N. Zagorodnii, (1986). Sowing rates in seed production systems without transplanting. *Sakhaaranaya Svekla,* **5**: 40-41.

Balan, V.N., S.K. Shevchuk and V.L. Mudrik, (1978). Seed yield and quality of sugar beet in relation to root size and nutrition area of stecklings. *Visnik Sils Kogosskodars Nauki*, **4**: 14-16.

Bordei, V. and M. Tapus, (1981). Aspect of technology of seed production of monogerm forage beet. *Analele Instit. Corcetari Pentru Cereale Plante Techn. Fundulea*, **47**: 99-103.

Draycott, A. P. and D. R. Christenson, (2003). Nutrients for Sugar Beet Production. Soil-Plant Relationships. CABI Publishing, Wallingford, pp.242.

Grzebisz, W., and J. Diatta, (2012). Constraints and solutions to maintain soil productivity: a case study from central Europe. In: J. Whalen (Ed.), Soil fertility improvement and integrated nutrient management a global perspective. InTech Europe, Rijeka, Croatia, pp. 159-182.

Grzebisz, W., K. Pepliński, W. Szczepaniak, P. Barłóg and K. Cyna, (2012). Impact of nitrogen concentration variability in sugar beet plant organs throughout the growing season on dry matter accumulation patterns. *Journal of Elementology*, **17**: 389-407.

Hassanin, M.A. and S.E.D. Elayas, (2000). Effect of phosphours and nitrogen rates and time of nitrogen application on yield and juice quality of sugar beet. *J. Agric. Sci. mishigan Univ.,* **25**: 7389-7398.

Hergert, G. W., (2010). Sugar Beet Fertilization. *Sugar Tech*, **12**: 256-266.

Hoffmann, C. M., (2005). Changes in N composition of Sugar Beet Varietes in Response to increasing N supply. *Journal of Agronomy and Crop Science,* **191**: 138-145.

Kandil AA, Badawi MA, El-Moursy SA, Abdou UA. (2004). Effect of planting dates, nitrogen levels and biofertilization treatments on 1: Growth attributes of sugar beet. *Scientific journal of king faisal university*. Vol. **5** 1425.

Kenter, Ch., C. M. Hoffmann and B. Märländer, (2006). Effects of weather variables on sugar beet yield development (*Beta vulgaris* L.). *European Journal of Agronomy,* **24**: 62-69.

Korzhenko, N.P. and T.V. Tretyak, (1980). Resistance of the stecklings to low temperature. *Sakharnaya Svekla,* **9**: 38-39.

Mahlooji, M. and D Afiuni. (2004). Study of growth analysis and grain yield in barley (*Hordeum vulgare* L.) gnotypes. *Pajouhesh Sazandegi J.* **63**: 37-42.

Malnou, C. S., K. W. Jaggard and D. L. Sparkes, (2006). A canopy approach to nitrogen fertilizer recommendations fort the sugar beet crop. *European Journal of Agronomy*, **25**: 254-263.

Malnou, C., K. Jaggard and D. Sparkes, (2008). Nitrogen fertilizer and the efficiency of the sugar beet crop in late summer. *European Journal of Agronomy*, **28**: 47-56.

Nicolau, A., (1978). Studies on the planting density of different sized steckling of sugar beet. *Cercetari Agron. Moldavia*, **2**: 65-68.

Nikolova, M., (1999). Nutritional problems of sugar beet production in Bulgaria. In: I. Buzas and A.E. Johnston (Editors), Balanced plant nutrition in sugar beet cropping systems for high yield and quality, *Proceedings of the regional Workshop of Beta Research Institute, IMPHOS*, IPI, Budapest, Hungary, pp. 68-76.

Norsworthy, J.K. (2004). Soybean canopy formation effects on pitted morningglory (*Ipomoea lacunosa),* and sicklepod (*Senna obtusifolia*) emergence. *Weed Sci.* **52**: 954-960.

Ouda, M.M.S., (2002). Effect of nitrogen and sulphur fertilizers levels on sugar beet in newly cultivated sandy soil. *Zagazig J. Agric. Res.*, **29**: 33-50.

Podlaski, S., (1987). Effect of some biological features of seed-bearing sugar beet plant on seed yield and quality. II. Effect of the rate of growth and development of seed-bearing sugar beet plant on seed yield and quality. *Roczniki Nauk Rolniczych Produkcja Roslinna*, **106**: 35-44.

Podlaski, S., (1987). The residual effect of growing conditions for sugar beet on the yield and quality of seed. *Biuletyn Instytutu Hodowli Aklimtyzacji. Roslin*, **162**: 179-186.

Radford P.J., (1967). Growth Analysis formulas; their use and abuse. *Crop Sci.,* **7**: 171-175.

Romer, W., N. Claassen, B. Steingrobe and B. Märländer, (2004). Reaktion der Zuckerrübe (*Beta vulgaris* var. altissima) auf die Kaliumdüngung - ein 20-jähriger Feldversuch. *Journal of Plant Nutrition and Soil Science*, **167**: 726-735.

Saini, S.S., K.B. Rastogi and P.P. Sharma, (1977). Effect of steckling size on seed yield of sugar beet. *Indian Sugar Crops J.,* **4**: 69-70.

Scott, R.K. and P.C. Longden, (1973). The production of high quality seeds. Seed ecology. *Proceedings of the 19th Easter School in Agricultural Science*, August 1, 1973, University of Nottingham, pp: 81-98.

Siahpoosh, M.R., Y. Imam and A. Saeedi, (2003). Genotypic variations, heritability, genotypic and phenotypic correlation coefficients of grain yield, its components and some morpho-physiological characters in bread wheat (*Triticum aestivum* L.). *Iranian Journal of Agronomical Sciences,* **5**(2): 86-101. (In Persian)

Theurer JC (1979). Growth patterns in sugarbeet production. *Journal of the American Society of Sugarbeet Technologists* **20**(4): 342–367.

Tsialtas JT, Maslaris N. (2005). Effect of N Fertilization Rate on Sugar Yield and Non-Sugar Impurities of Sugar Beets (*Beta vulgaris* L.) Grown Under Mediterranean conditions. *J. Agronomy & Crop Science* **191**: 330-339.

Watson DJ. (1947). Comparitive physiological studies the growth of field crop variation in net assimilation rate and leaf years. *Ann Bot.* 1947; **11**: 41-76.