Assessing light interception and light extinction coefficient on planting dates of different cultivars of wheat in Esfahan region

Ali Soleymani[1*], Mohamad Hesam Shahrajabian[1]
[1]Department of Agronomy and Plant Breeding, Khorasgan Branch, Islamic Azad University, Esfahan, P.O.BOX: 81595-158, Iran.
(e-mail: a_Soleymani@khuisf.ac.ir)

Abstract

Appropriate cultivar and date of sowing are two of the most critical aspects of crop management in semi arid condition with low rainfall like Iran. An experiment was conducted in 2008–2009 in khaton Abad Agricultural Research Station of Islamic university of khorasgan branch, Esfahan, Iran. A split plot layout within randomized completely block design with 3 replications was used. Different planting date levels were in 3 levels including (22th October , 6th November, 2th December) as the main plot and cultivars were in 6 levels including [Kavir and Shiraz (with spring growth habit) , Alvand and Mahdavi (with facultative growth habit) , Gaskoghen and C81 – 14 line (with winter growth habit)] as the subplot. Planting date has significant effect on LAI, total dry matter, NAR, light interception and light extinction coefficient, the number of seed per spike, a thousand seed weight and seed yield. CGR was not affected by planting date, and no trend was found. The influence of cultivar of LAI, total dry matter, NAR, light interception, light extinction coefficient, a thousand seed weight and seed yield was significant. Planting date and cultivar interaction just had significant effect on LAI and light interception. Gaskogen had obtained the highest seed yield and the maximum a thousand seed weight was achieved in C81-14. C81-14 also had obtained the highest LAI, light interception and light extinction coefficient. Plantation on 22th Oct had obtained the maximum LAI, light interception, light extinction coefficient, the number of seed per spike, a thousand seed weight and seed yield.

Keywords: Light interception, light extinction, planting date, cultivar, wheat.

Introduction

Wheat (*Triticum aestivum L.*) is the most commonly planted and used crop in the world (Aydin et al., 2010; Sohrabi et al., 2010; Robiul Islam et al., 2011). Khah (2009) and Barradas and Lopez-Bellido (2009) noted that selection of the planting date is one of the most important management decisions for crop production. When the proper planting date is selected, a cultivar with a suitable growth period can flower and produce seed in a proper time (Yarnia et al., 2010). Awal et al. (2006) reported that the intensity of solar radiation will remain relatively constant and represented a resource that could be used more efficient for crop production. Svirezhev and Steinborn (2001) concluded that a continuous measurement of the components of the radiation balance for different types of vegetation had become an almost standard procedure giving us information about the transformation of incoming solar radiation by vegetation. Falconer and Mackay (1996) reported that to measure environmental interaction and to see interaction variance, different genotypes are reared or grown in a range of environments. Wheat grain yield is the end product of the interaction of a large number of physiological and biochemical process in the plants (Dere and Yildirim, 2006). So the aim of this study is to determine the light interception and light extinction on planting dates of different cultivars of wheat in Esfahan region.

Material and Methods

This experiment was conducted in 2008–2009 in khaton Abad Agricultural Research Station of Islamic university of khorasgan branch, Esfahan, Iran. A split plot layout within randomized completely block design with 3 replications was used. Different planting date levels were in 3 levels including (22th October , 6th November, 2th December) as the main plot and cultivars were in 6 levels including [Kavir and Shiraz (with spring growth habit) , Alvand and Mahdavi (with facultative growth habit) , Gaskoghen and C81 – 14 line (with winter growth habit)] as the subplot. Each plot included 5 meter length and 2 meter width with 10 planting rows. The distance between each row was 20 cm, and the distance between plants on the row was 1.25 cm. All seeds were planted at the depth of 3-4 cm. Plant density for all plots were similar and equal to 400 plants per m^2. The soil preparation consisted of mouldboard ploughing, followed by discing and smoothing with a land leveler. Nitrogen fertilizer as urea (45% pure N) (300 kg urea per ha) was used in different sections for better plant ’s utilization (before irrigation, tillering stage, stem elongation stage). The first irrigation was done immediately after seed plantation. Other irrigations were done on the basis of plant ’s requirement (9 days interval). Rows number 1, 3, 5 and 10 and 0.5 meter (50 cm), primer and edge lines were discarded from sampling. For determining light transmission (T), solar radiation interception (A) and extinction coefficient (K), equation number 1 , 2 and 3 were used respectively. I and I0 mean the solar radiation under plant canopy and solar radiation absorption above of plant canopy.

$$T = \frac{I}{Io} \times 100 \quad (1)$$

$$A = 100 - T \quad (2)$$

$$\frac{\ln I}{IO} = -K(LAI) \longrightarrow K = -\ln (I/I0) / LAI \quad (3)$$

Data were subjected to analysis of variance (ANOVA) using statistical analysis system, followed by Duncan ’s multiple range test and differences were considered significant at $P<0.05$ by MSTAT-C software.

Results and discussion

Planting date has significant effect on LAI, total dry matter, NAR, light interception and light extinction coefficient, the number of seed per spike, a thousand seed weight and seed yield. CGR was not affected by planting date, and no trend was found. The influence of cultivar of LAI, total dry matter, NAR, light interception, light extinction coefficient, a thousand seed weight and seed yield was significant. Planting date and cultivar interaction just had significant effect on LAI and light interception (Table 1). Soleymani et al. (2011) reported that solar radiation absorption was significantly affected by cultivar.

The highest LAI and total dry matter was obtained in 22th Oct. The differences in LAI between all planting dates treatments were significant. 22th Oct and 2th Dec had no significant difference in total dry matter with each other. The leaves, being the site of photosynthetic activity, appear to have an obvious relationship to the plant 's grain yield ability (Dere and Yildirim, 2006). 2th Dec had obtained the maximum NAR, that had just significant difference with 22th Oct. The maximum and minimum light interception was achieved in 22th Oct and 2th Dec, respectively. The highest light extinction coefficient and the number seed per spike was related to plantation on 22th Oct. Awal et al. (2006) noted that efficient use of solar radiation is one of the major criteria for obtaining a yield advantage through intercropping. A thousand seed weight was significantly decreased from 22th Oct to 2th Dec. Seed yield was significantly differed between planting dates treatments. The highest seed yield was related to 22th Oct, and this treatment had significant difference with two other treatments. The highest LAI and total dry matter was related to C81-14. C81-14 had no significant difference in LAI with Alvand, Mahdavi and Gaskogen. The highest and the lowest NAR was obtained in Kavir and C81-14, respectively. Aydin et al. (2010) concluded that some genotypes are more affected from one environment than another one due to environmental differences. C81-14 had obtained the maximum light interception and light extinction coefficient, and this cultivar had significant differences with all other cultivars. The maximum and minimum number of seed per spike was 31.94 and 27.96, that was related to C81-14 and Shiraz, respectively. C81-14 also obtained the maximum a thousand seed weight. There was no significant difference in a thousand seed weight between Gaskogen and C81-14. The highest seed yield was obtained in Gaskogen. This cultivar had significant differences with all other cultivars, expect of Kavir (Table 2). Planting seeds on suitable date maximize the growth duration and complete seed maturation lead to maximize the growth duration and complete seed maturation lead to maximal yield and reduced the risk of unfavorable environmental conditions (Yarnia et al., 2010). The maximum a thousand seed weight was obtained in 22th Oct and C81-14 interaction. The highest seed yield was related to 22th Oct and Gaskogen interaction (Table 2).

Table 1. Analysis of variance for experimental characteristics.

S.O.V.	d.f.	LAI	Total dry matter	NAR	CGR	Light interception	Light extinction coefficient	The number of seed per spike	A thousand seed weight	Seed yield
Replication	2	0.059*	172655.1**	3.49*	99.0*	3.2	0.10	0.061	0.443	122163.94
Planting date	2	3.857**	361779.5**	2.13*	12.7	55.3*	0.033*	69.933**	83.752**	28834392.56**
Error (a)	4	0.005	9573.8	0.27	9.6	4.4	0.005	0.365	0.100	230277.50
Cultivar	5	0.086**	79999.9**	0.46*	12.6	91.4**	0.099**	27.173**	23.253**	1066966.67**
Planting date × Cultivar	10	0.054**	24676.3	0.07	2.4	12.8**	0.012	0.294	0.393	152628.79
Error (b)	30	0.015	16983.7	0.16	6.1	2.9	0.007	0.387	0.243	163341.36

* and ** Significant at P=0.05 and P=0.01 level, respectively in F-test., NS: Not Significant.

Table 2. Mean comparison for LAI, total dry matter (g/m^2), NAR (g/m^2/day), CGR (g/m^2/day), light interception and light extinction coefficient.

Treatment	LAI	Total dry matter	NAR	CGR	Light interception	Light extinction coefficient	The number of seed per spike	A thousand seed weight	Seed yield
Planting date (P)									
22th Oct (P1)	7.49a	1524.8b	3.99b	29.91a	97.39a	0.545a	31.98a	40.31a	9273.57a
6th Nov (P2)	6.66c	1796.6a	4.49a	29.96a	95.57ab	0.522ab	29.95b	38.19b	8100.25b
2th Dec (P3)	6.73b	1590.8b	4.66a	31.39a	93.88b	0.462b	28.04c	35.99c	6744.43c
Cultivar (C)									
Kavir (C1)	6.84b	1541.6b	4.58ab	31.35ab	89.94d	0.337c	28.12c	36.27c	7344.78b
Shiraz (C2)	6.84b	1510.7b	4.71a	32.20ab	94.06c	0.466b	27.96c	36.48c	8105.14a
Alvand (C3)	6.95ab	1623.6ab	4.40abc	30.54ab	96.72b	0.547b	30.19b	37.99b	8180.91a
Mahdavi (C4)	7.04a	1711.0a	4.25bc	29.83ab	96.97b	0.522b	29.83b	38.32b	8229.45a
Gaskogen (C5)	7.03a	1706.0a	4.23bc	29.58ab	97.06b	0.532b	31.90a	39.90a	8240.90a
C81-14 (C6)	7.05a	1731.8a	4.12c	29.02b	98.94a	0.655a	31.94a	40.01a	8135.31a
Planting date × Cultivar									
P1C1	7.123b	1256.34g	4.390abcdef	31.303ab	91.073d	0.339ef	30.28cd	38.37cd	8753.99bcd
P1C2	7.263b	1350.14fg	4.277abcdef	31.050ab	98.733ab	0.602abc	30.05d	38.41cd	8929.58abc
P1C3	7.523a	1517.13ef	4.100cdef	30.887ab	98.747ab	0.583abcd	32.00b	40.67b	9457.62ab
P1C4	7.687a	1681.82abcde	3.717ef	28.537ab	98.117ab	0.535abcd	31.30bc	40.14b	9337.91ab
P1C5	7.680a	1685.19abcde	3.670f	28.107b	98.260ab	0.538abcd	34.25a	42.01a	9597.66a
P1C6	7.693a	1658.61abcde	3.843def	29.603ab	99.423a	0.675a	34.01a	42.25a	9564.66a
P2C1	6.693c	1818.44abc	4.513abcd	30.243ab	88.567de	0.325ef	27.91e	36.57e	7234.95e
P2C2	6.597c	1688.47abcde	4.910ab	32.417ab	95.510bc	0.480cde	27.81e	36.18ef	8537.37cd
P2C3	6.597c	1734.75abcde	4.570abcd	30.077ab	97.110abc	0.624abc	30.43cd	37.69d	8099.25d
P2C4	6.710c	1858.22ab	4.343abcdef	29.200ab	96.950abc	0.523abcd	30.10d	38.71c	8388.95ed
P2C5	6.663c	1801.11abcd	4.497abcdef	29.987ab	96.533abc	0.524abcd	31.85b	40.09b	8271.54cd
P2C6	6.700c	1879.14a	4.157bcdef	27.883b	98.780ab	0.657ab	31.63b	39.88b	8069.45d
P3C1	6.720c	1550.02def	4.840abc	32.530ab	90.193de	0.346ef	26.18f	33.87h	6045.41f
P3C2	6.670c	1493.73ef	4.967a	33.143a	87.943e	0.317f	26.03f	34.84g	6848.49e
P3C3	6.743c	1619.06bcde	4.547abcd	30.673ab	94.303c	0.434def	28.15e	35.63fg	6985.87e
P3C4	6.743c	1593.05cde	4.703abc	31.770ab	95.863bc	0.507bcd	28.10e	36.11ef	6961.49e
P3C5	6.757c	1631.84abcde	4.530abcd	30.667ab	96.387abc	0.534abcd	29.60d	37.60d	6853.50e
P3C6	6.753c	1657.63abcde	4.377abcdef	29.593ab	98.620ab	0.634abc	30.18cd	37.90cd	6771.83e

Common letters within each column do not differ significantly.

Conclusion

Appropriate planting date management for each cultivar in a region is considered to be the most important manageable factor in plant production, that does not promote excessive crop growth that delays maturity (Ali et al., 2009; Barradas and Lopez-Bellido, 2009). Gaskogen had obtained the highest seed yield and the maximum a thousand seed weight was achieved in C81-14. C81-14 also had obtained the highest LAI, light interception and light extinction coefficient. Plantation on 22th Oct had obtained the maximum LAI, light interception, light extinction coefficient, the number of seed per spike, a thousand seed weight and seed yield.

References

1- Ali, H., Afzl, M. N., Ahmad, S., and Muhammad, D. 2009. Effect of cultivars and sowing dates on yield and quality of *Gossypium hirsutum L*. crop. Journal of Food, Agriculture and Environment. 7(3&4): 244-247.

2- Aydin, N., Mut, Z., and Ozcan, H. 2010. Estimating of broad-sense heritability for grain yield and some agronomic and quality traits of bread wheat (*Triticum aestivum L*.). Journal of Food, Agriculture and Environment. 8(2): 419-421.
3- Awal. M. A., Koshi, H., and Ikeda, T. 2006. Radiation interception and use by maize/peanut intercrop canopy. Agriculture and Forest Meteorology. 139: 74-83.
4- Barradas, G., and Lopez-Bellido, R. J. 2009. Genotype and planting date effects on cotton growth and production under south Portugal conditions, II. Monitoring. Journal of Food, Agriculture and Environment. 7(2): 313-321.
5- Dere, S., and Yildirim, M. B. 2006. Inheritance of grain yield per plant, flag leaf width, and length in an 8 x 8 diallel crops population of bread wheat (*T. aestivum L*.). Turkish Journal of Agriculture and Forestry. 30: 339-345.
6- Falconer, D. S., and Mackay, T. F. C. 1996. Quantitative Genetics, 4th edn. Longman Group Ltd., 321 p.
7- Hassanpanah, D., Hosienzadeh, A. A., and Allahyari, N. 2009. Evaluation of planting date effects on yield and yield components of Savalan and Agria cultivars in Ardabil region. Journal of Food, Agriculture and Environment. 7(3&4): 525-528.
8- Khah, E. M. 2009. Effect of sowing date and cultivar on leaf yield and seed production of coriander (*Coriandrum sativum L*.). Journal of Food, Agriculture and Environment. 7(2): 332-334.
9- Robiul Islam, M., Hu, Y., Fei, C., Qian, X., Eneji, A. E., and Xue, X. 2011. Application of superabsorbent polymer: A new approach for wheat (*Triticum aestivum L*.) production in drought-affected areas of northern China. Journal of Food, Agriculture and Environment. 9(1): 304-309.
10- Sohrabi, M., Heidari, G., Mohammadi, S., and Yazdanseta, S. 2010. Evaluation of quantitative and qualitative characteristics of yield in dryland wheat cultivars under supplemental irrigation conditions. Journal of Food, Agriculture and Environment. 8(2): 400-403.
11- Soleymani, A., Shahrajabian, M. H., and Naranjani, L. 2011. The responses of qualitative characteristics and solar radiation absorption of berseem clover cultivars to various nitrogen fertilizers levels. Journal of Food, Agriculture and Environment. 9(2): 319-321.
12- Svirezhev, Y. M., and Steinborn, W. H. 2011. Exergy of solar radiation: information approach. Ecological Modelling. 145: 101-110.
13- Yarnia, M., Khorshidi Benam, M. B., and Farajzadeh Memari Tabrizi, E. 2010. Sowing dates and density evaluation of amaranth (cv. Koniz) as a new crop. Journal of Food, Agriculture and Environment. 8(2): 445-448.