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# Growth analysis rapeseed (*Brassica napus* L.) genotypes in different sowing date under warm and semiarid climate condition in South West of Iran

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## Abstract

In Warm and semiarid climate condition alternative cropping in some cases have a negative effect on yield after summer cropping, because of Rapeseed delay planting. By analyzing the growth process, planting date and effective variables on grain yield, Rapeseed can be managed according to its needs. Therefore a split plot experiment in Randomized Complete Block Design with three replications was conducted. Four planting dates (November 6th and 21st. December 6th and 21st) in main plots and four Genotypes (Hyola401, PP401, RGS003 and Option 500) in subplots were studied. The maximum grain yield was belong of Hyola401 hybrid with 2.61 (ton.ha$^{-1}$) and the minimum grain yield was that of Option 500 variety with 1.51 (ton.ha$^{-1}$). In general first planting date was superior in physiological index comparing with the other planting dates. Also Hyola401 hybrid, due to the fact that it had a higher leaf area index (3.51), total dry matter (1248.91 g.m$^{-2}$), crop growth rate (21 g.m$^{-2}$.day$^{-1}$), net assimilation rate (7 g.m$^{-2}$.day$^{-1}$), relative growth rate (0.064 g.g$^{-1}$.day$^{-1}$) and maximum grain yield, was seen to be the most adaptable genotype.

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## Introduction

Delayed planting, inappropriate weather conditions during the flowering period, fertilization and pod formation can cause a decrease in duration of maturity period, affect the number of pods per plant, affect the number and weight of grains and finally can lead to decrease in grain yield (Mendham and Salisbury, 1995).

According to the results about average yield in dry regions, Hyola308 and Hyola401 hybrids, also Pf 7045.91 and Taporo varieties, respectively with yielding of 2996, 2783, 2231, and 2191 $Kg.ha^{-1}$, was superior over other genotypes and are advised to be planted in dry climate of southwest regions (Rahnama and Bakhshandeh, 2005, Amiri *et al*, 2008).

Growth analysis is a precious method which was first conducted in quantitative growth analysis of plants and their yield by Blackman (1919).

Plant growth analysis is considered to be a standard approach to study of plant growth and productivity (Wilson, 1981).

Growth and yield are functions of a large number of metabolic processes, which are affected by environmental and genetic factors. Studies of growth pattern and its understanding not only tell us how plant accumulates dry matter, but also reveals the events which can make a plant more or less productive singly or in population. In a crop the growth parameters like optimum LAI and CGR at flowering have been identified as the major determinants of yield (Sun *et al*, 1999).

A combination of these growth parameters explain different yields better than any individual growth variable (Ghosh and Singh, 1998). CGR, RGR and NAR directly influenced the economic yield of lentil, Thakur and Patel (1998) reported that dry matter production, LAI, LAD, CGR, NAR and RGR are ultimately reflected in higher grain yield.

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. The ecological advantage of high RGR is very clear. Due to high RGR, a plant will rapidly increase in size and is able to occupy a large space, both below and above ground. A high RGR may also facilitate rapid completion of life cycle of a plant (Ahmadi *et al*, 2014).

The seed yield, total dry matter and harvest index in some genotype of Brassica napus and Brassica juncea has been found to improve with higher rate of N (Kumar *et al*, 2001, Cheema *et al*, 2001).

LAI was recorded more during linear growth stage and during flower stage. During grain filling stage, there was decrease in leaf area and consequently in LAI (Moemeni *et al*, 2013).

Crop growth rate, net assimilation rate and leaf area index in inadaptable or serotinal genotypes (mainly in low-tension conditions), are lower than early maturity genotypes. Due to the fact that the amount of photosynthesis is enhanced by an increase in daily photosynthesis time or by an increase in leaf area duration in grain filling period. Early maturity varieties with high-potentiality have more proper yield, comparing with serotinal varieties (Angadi *et al*, 2003, Christmas, 1996).

Increase in CGR and dry-matter accumulation irrespective to decrease in LAI in the corresponding phase is more likely because of the new actively photosynthesizing tissues of pods which might be responsible for increase in dry weight as well as CGR during these phase (Yasari and Patwardhan, 2006).

This research was conducted to study the physiological characteristics of Rapeseed genotypes in different planting dates and determine most suitable planting date according climate condition.

## Material and methods

*Field and Treatment Information's*

This research has been fulfilled during 2005-2006 growing season at split plot experiment based on Randomized Complete Block Designs (CRBD) with three replications, which was conducted at Experimental Field of Khouzestan Agricultural Research and Natural Recourses Organization (Ahvaz station), in south west of Iran with moderate winters and hot summers. Planting on November 6 and 21 as the customary sowing date and planting dates of December 6 and 21 as the delayed planting in the main plots and the subplots were with the four genotypes (Hyola401, Pp401, R.G.S003 and Option500). The texture of the soil in this region was silty clay loam; electricity conductivity of condensed saturation was 3.5 $ds.m^{-1}$ and acidity of the soil was 7.3. The average annual precipitation was 248 mm, long-term daily temperature (in 30 years) was 24-45 degrees centigrade, the average precipitation in agronomic year was 68-136 mm and the average temperature of the agronomic year was 20 degrees centigrade. Each plot consisted of 8 rows with 30 cm distance from each other and each plot was 6 meters long. The average distance between plants was considered to be 3 to 4 cm. using fertilizers in this land was according to information which was gained about the soil. Therefore manure the land using 100 kilogram urea fertilizer per hectare, 100 kilogram triple super phosphate fertilizer and 200 kilogram potassium sulfate per hectare as the basic fertilization, and during the growth period of stem, was 200 kilograms of urea fertilizer per hectare utilized.

*Traits measure*

In order to determine the growth process from January 1st to April 4th, samples were collected for seven times with interval duration of twice a week, and in each sampling, the leaf layer index and total dry weight were estimated in plots. Daily growth degree was calculated by the following formula:

$$\sum GDD = \sum_{j=1}^{n} \left[ (T_{\max} + T_{\min})/2 \right] - T_b$$

**Formula 1**. Growing Degree Days

In this formula $\mathbf{T_{max}}$ is: maximum daily temperature, $\mathbf{T_{min}}$ is: minimum daily temperature, $\mathbf{T_b}$ is: the basic temperature and **n** is: the number of days in a particular period.

The basic temperature in this research was considered +5ºc (Madani *et al*, 2005, Rahnama and Bakhshandeh, 2005). In the final harvest, from each (one- squared meter land) plot, grain yield was calculated. In final harvest area, from each plot (one-squared meter land), grain and biological yields were calculated.

*Statistical analysis*

Data analysis was performed by the SAS (Ver. 8) software and average comparisons were fulfilled according to Duncan multiple rang test at 5 percent probability. All of the charts were drawn by Excel 2003 software.

## Results and discussions

*Grain Yield*

The effect of different planting dates was significant on grain yield (Table 1). Grain yield from the first planting date to the fourth one decreased from 2611.6 $Kg.ha^{-1}$, to 1515.3. The first planting date, benefiting from environmental conditions and extreme photosynthesis, had the maximum yield (Fig. 1). Hyola401 hybrid, by having 2608.5 $Kg.ha^{-1}$ yields, had the maximum yield, and RGS003, Pp401 and Option500 varieties respectively with yield of 1948, 1874 and 1747 $Kg.ha^{-1}$, were categorized in the next stages (Fig. 2).

**Table 1.** Summary results of analysis variance of grain yield trait.

| S.O.V | df | Seed Yield |
|---|---|---|
| Replication | 2 | 36548.1 |
| Planting date | 3 | 377812.7** |
| Error | 6 | 89643.1 |
| Genotype | 3 | 237854.3** |
| Planting date × Genotype | 9 | 331796.9** |
| Error | 24 | 20513.8 |
| CV (%) | - | 7.0 |

ns, * and **: No significant and Significant at 5 and 1% Level of Probability, Respectively.

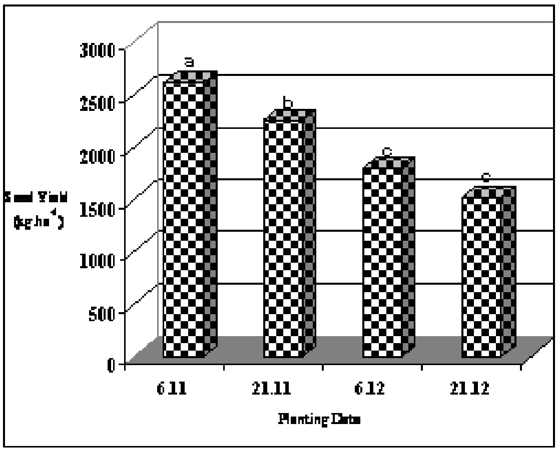


**Fig. 1**. Effect of planting date on Seed Yield.

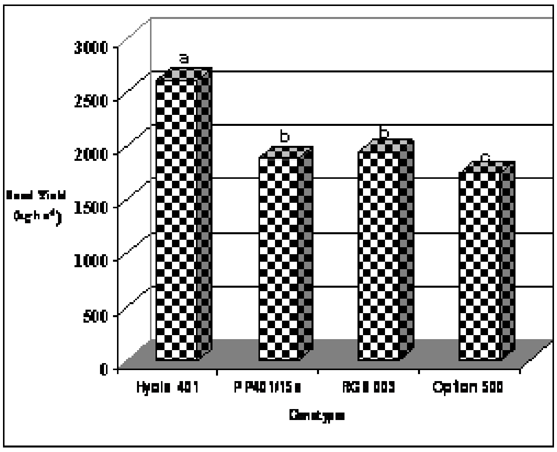


**Fig. 2**. Effect of Genotypes on Seed Yield.

*Total dry matter*

According to Fig. 3, slow growth period in all genotypes continued to the middle of January, and maximum dry weight in the plants was because of the increase in the weight of dry leaves. This occurred as a result of the increase in the number of leaves and the leaf area index. From the middle of January fast growth period began, and total dry weight increased rapidly. Comparing with other genotypes, Hyola401 hybrid had more potentiality to create total dry matter. It was because of its adaptability to environmental conditions and its early maturity. Hence creating a large amount of dry matter during the flowering period can guarantee the increase of grain yield. Hyola401 hybrid (with 1248.91 g.m$^{-2}$) had the maximum, and Option 500 (with 1046 g.m$^{-2}$) had the minimum outputting dry matter and grain yield. In delayed plantings, the plant can not pass the whole vegetable period; therefore it may have a reduction in the number of pods, flower formation, sink's capacity and productive potentiality of the source (Ozer, 2003, Davar *et al*, 2013). The first planting date (with total dry matter of 1271.25 g.m$^{-2}$, had excellence comparing with the other planting dates (Fig. 4). These results had conformity with the findings of other researchers (Gabrielle *et al*, 1998, Johnson *et al*, 1995).

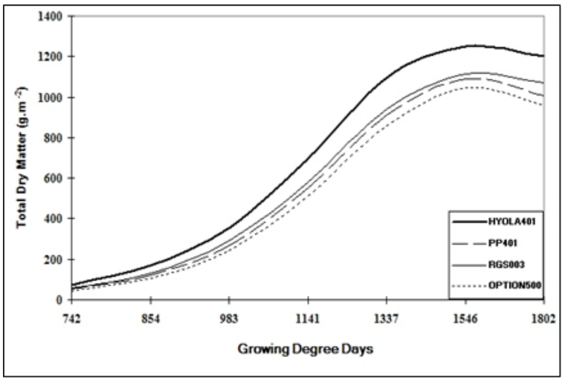


**Fig. 3**. Effect of genotype on total dry matter.

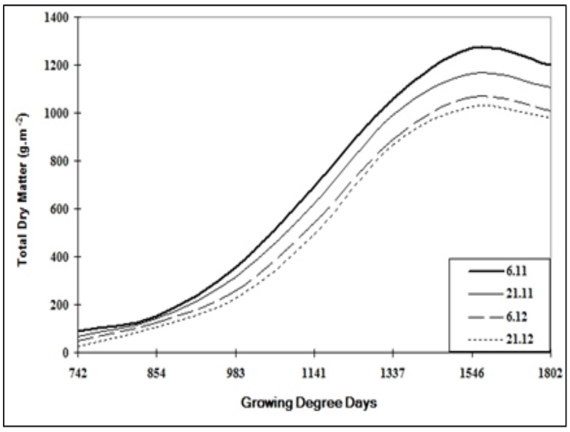

**Fig. 4**. Effect of planting date on total dry matter

Leaf area index.

Rapeseed in its initial growth period had the lowest number of leaves, while it had the maximum number of leaves in its flowering period (Fig. 5 and 6). After that, the leaf area index eventually decreased, to the extent that in the time of harvest it reached zero. Hyola401 hybrid, (with amount of 3.51) contained the maximum leaf area index (Fig. 5). The maximum leaf area index was conducted for all genotypes during their flowering period. It was because in this period, sufficient photosynthesis materials can have positive effects on the number of pods and grain yield. In serotinal genotypes, the leaf area index (because of meeting uncomfortable environmental conditions), is considered to be a preventive element for yielding. Therefore; Option500 variety, owning the minimum leaf area index, devoted minimum grain yield to itself. Yet Hyola401 hybrid, not only had the maximum leaf area index, but also because of having more leaf area duration, had the maximum dry matter. 45 days delay in planting, caused 2.83 decreases in leaf area (Fig. 6). The other researchers have mentioned the same results (Gabrielle *et al*, 1998, Kazerani and Ahmadi, 2004).

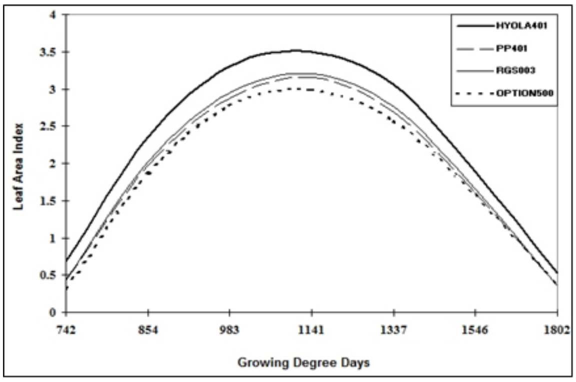


**Fig. 5**. Effect of genotype on leaf area index.

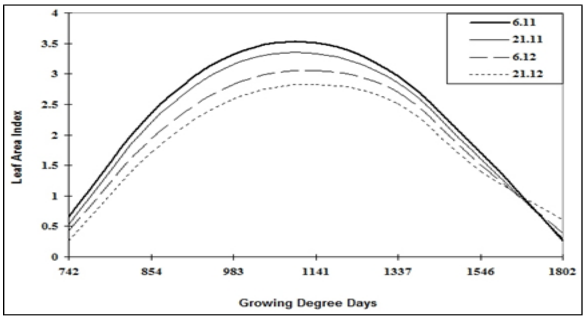


**Fig. 6**. Effect of planting date on leaf area index.

*Relative Growth Rate*

In Rapeseed genotypes, by the passage of time relative growth rate decreases, and at the end of the season it reaches zero (Fig. 7). At the beginning of the growth period, all of the cells are involved in photosynthesis function and assimilates production. But by the passage of time, the lower leaves (because of being old) are not able to make appropriate photosynthesis; therefore the proportion of assimilates to total dry weight would decrease. This process occurs because old leaves are involved in measuring dry weight, but they have no function in assimilates production (Solymanzadeh *et al*, 2007, Gan *et al*, 2004). Fig. 7 indicates the similarities between different genotypes according to their relative growth rate changes. Hyola401 hybrid had the maximum and Option500 variety had the minimum amount of this index. Delay in planting had an influence on this index, and in plantings which were conducted after the middle of November, Relative growth rate in delayed plantings was lower than the first planting date. At the beginning of the growth period, in all varieties, this index was in maximum amount, but as the plant grew older this amount decreased. This happened as a result of the increase in structural texture and decrease in production efficiency.

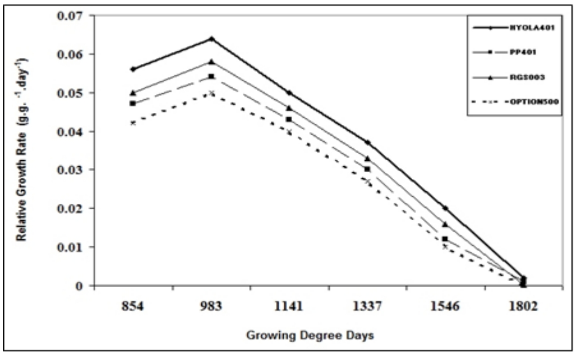


**Fig. 7**. Effect of genotype on relative growth rate.

*Crop growth rate*

This trait is an index dealing with production potentiality of plant and it is utilized in order to determine yield among different varieties and to operate agronomic activities (Diepenbrock, 2000, Gulzar *et al*, 2006). Crop growth rate was observed to be low in the initial growing process, yet it was increased by the passage of time, so much so that during the flowering period of plant, it reaches the maximum amount simultaneously with leaf area index (Fig. 8). The maximum and minimum crop growth rates were respectively those of Hyola401 hybrid (21 $g.m^{-2}.day^{-1}$) and Option500 (17.08 $g.m^{-2}.days^{-1}$). They also contained the maximum and minimum total dry matter (Fig. 8). Delayed plantings (because of insufficient vegetation cover, low amount of sunlight absorption and heat during end of the season) own a slow growth rate. The first planting date (with 22.34 $g.m^{-2}.day^{-1}$), had the maximum relative growth rate, and the fourth planting date (with 16.5 $g.m^{-2}.day^{-1}$), had the minimum relative growth rate (Fig. 9).

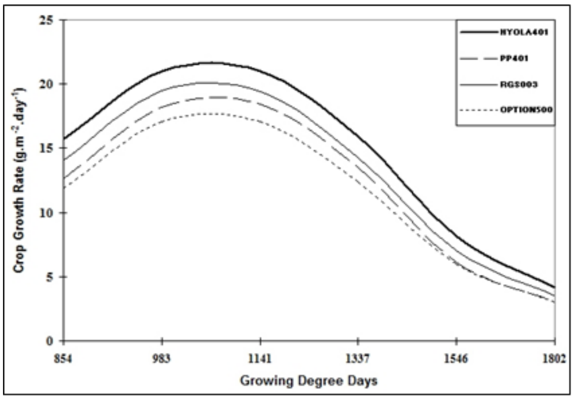


**Fig. 8**. Effect of genotype on crop growth rate.

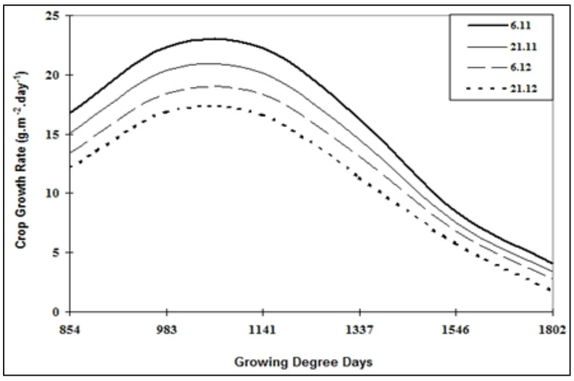


**Fig. 9**. Effect of planting date on crop growth rate.

*Net assimilation rate*

The purpose of measuring this parameter is to determine the amount of dry matter, produced by the leaves. As plant's growth carries on, (due to the fact that leaves cast shadow on each other and older leaves have lower photosynthesis efficiency, net assimilation rate decreases (Solymanzadeh *et al*, 2007, Din *et al*, 2011). By having delayed planting, observed an extreme decrease in net assimilation rate during November cultivation. Hyola401 hybrid (7 $g.m^{-2}.day^{-1}$), from this aspect, had excellence to other varieties, while Option 500 variety (5.6 $g.m^{-2}.day^{-1}$), had the pure absorption rate (Fig. 10).

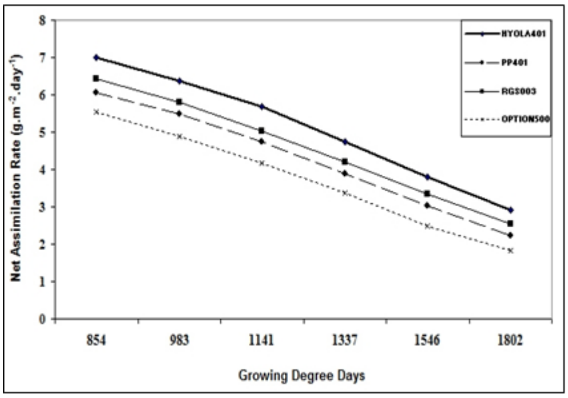


**Fig. 10**. Effect of genotype net assimilation rate.

**Conclusion**

Hyola401 hybrid due to its physiological characteristics such as total dry matter, leaf area index, relative growth rate, net assimilation rate and crop growth rate optimum usage of environmental conditions, has excellence over other varieties.

According to the findings of this research, in order to achieve maximum yield, planting Hyola401 hybrid in the middle of November in warm and semi arid climates of Iran is suggested.

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