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DETERMINATION OF THE EFFECTS OF GENOTYPE AND SOWING TIME ON PLANT GROWTH AND DEVELOPMENT IN CAMELINA [(*Camelina sativa* L. (Crantz)]

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Abstract
Appropriate sowing time and effects on agricultural and technological properties of sowing time is one of the most important issues. Therefore, this research has been carried out to determine plant growth and development pattern which effects on changes in agricultural characteristics which are important for growing and adaptation of genotype and sowing time in camelina. Research was carried out according to split-split plot design with three replications that four different sowing times (1 May 2017, 11 May 2017, 21 May 2017 and 31 May 2017) using two camelina genotypes (Ames-26665 and PI-304269).
As a result, it was determined that the longest plant length for Ames-26665 genotype was reached at the 1st sowing time, while the highest plant height at PI-304269 genotype was reached at the 4th sowing time. The maximum amount of total dry matter: Ames-26665 genotype was obtained at the first sowing time whereas PI-304269 genotype was obtained at the third sowing time. In addition, the maximal relative growth rate was obtained at the 1st sowing time in Ames-26665 genotype and 3rd sowing time in PI-304269 genotype.

Key words: *camelina, total dry matter, relative growth rate, sowing time.*

INTRODUCTION

Camelina (*Camelina sativa* L. Crantz), a member of the *Brassicaceae* family, has been attracting researchers and industry in recent years due to its adaptability, reasonable seed yield and good oil quality for many biological based applications. Camelina seed oil content ranges from about 35 to 45% and is suitable for biodiesel production (Fröhlich, Rice, 2005). It has recently been used as an excellent raw material for renewable aviation fuels (Shonnard et al., 2010). Another important characteristic of camelina plant is the low cost of agricultural input (Gesch, 2014).

Camelina plant is an alternative plant that can be planted in summer or winter. The most important factors determining the sowing time, which have different effects on plant growth and development, are the climate conditions of the region and the biology of the plant to be grown. Seed oil content and composition of fatty acids are affected by the plant variety and growth conditions of the plant. When sowing time is determined according to climate factors, the maximum expected yield can be obtained. For this reason, this research has been carried out in order to determine the effect of sowing time on the growth and development of camelina plant in Samsun ecological conditions and to determine the most suitable planting time.

MATERIALS AND METHODS

This research was carried out in Samsun Province, Alaçam District, Geyikkoşan location in the summer of 2017. The altitude of the experimental area is 4 meters. The soil characteristics of the experimental area are the following: clay, lime, salt-free, pH is slightly alkaline, soil organic structure is medium, phosphorus is medium and potassium is high.

When the climate is evaluated as the average of the growth season of the experimental area and the multiannual average, the data are the followig: the amount of rainfall is 708 mm in the growing season of 2016-2017, which is higher than the multiannual average (581 mm). The average temperature range is 15.5°C during the growing season of 2016-2017, which is higher than the multiannual average (14.5°C). The average relative humidity is 65.15% in the 2016-2017 growing season and is lower than the multiannual average (72.1%).

Two camelina genotypes (Ames-26665 and PI-304269) were used as plant material in the study. Field experiment was arranged in a split-split plot design with three replicates. Seed of the camelina cultivars were drilled at a rate of 600 plants per square meter 4 different times (1 May, 11 May, 21 May and 31 May). Plots were 3x1 m and comprised five rows with 3 m length at 20 cm spacing. During the experiment the necessary standard maintenance procedures were carried out. Diamonyum phosphate at a rate of 100 kg/ha was applied on June 13, 2017. Irrigation was carried out at field capacity on 1 July, 2017. Weeds were controlled by hand on 9 June, 2017 and 29 June, 2017.

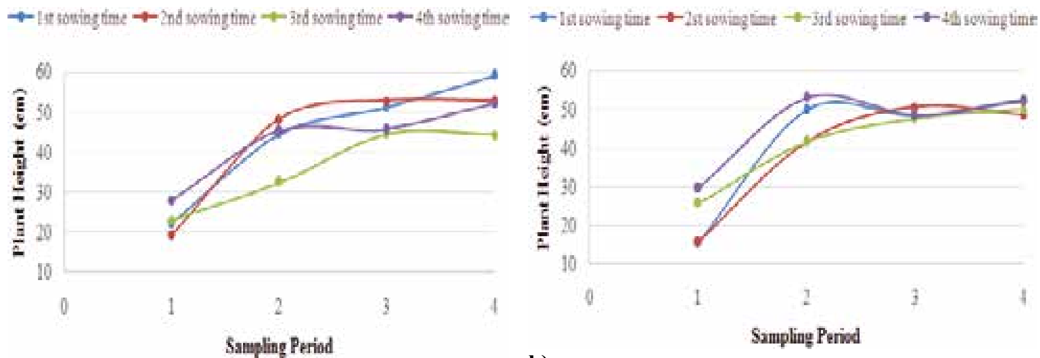
Plant samples comprising 2x50 cm lengths of adjacent centre rows were taken for growth analysis before flowering, during flowering period, after flowering and at harvesting time. After washing, ten plants were randomly selected for determination of stem length, leaf number and area and component dry weights. The plant was divided into root, stem and leaf parts and dried at 80°C for 48 hours and dry weight was determined. Statistical analysis of data was done by analysis of variance and significance assessed by calculation of least significant difference at $P < 0\pm05$ or lower.

RESULTS AND DISCUSSIONS

Plant Height

As a result of the research, it was determined as the statistically significant difference ($P<0\pm05$) between the plant height at the 1st sampling time and the plant height at the 2nd, 3rd and 4th sampling time. For Ames-26665 genotype, the longest plant height was obtained at the 4th sowing time (28 cm) in the first sampling period. At the 2nd and 3rd sampling periods, the longest plant height was obtained at the 2nd sowing time (48 and 52 cm, respectively). In the 4th sampling period, the longest plant height was obtained at the 1st sowing time (59 cm) (Figure 1a). For PI-304269 genotype: the longest plant height was obtained from the 4th planting time (29 and 53 cm, respectively) in the 1st and 2nd sampling periods. In the third sampling period, the longest plant height was obtained from the second sowing time (50 cm). In the 4th sampling periods, the longest plant height was determined as the first planting time (52.4 cm) (Figure 1b). In both genotypes, the plant height was found to increase faster from the outlet to the 2nd sampling period. After the 2nd sampling period, it was determined that the growth in the plant height continued to slow down and the harvest time reached maximum.

Although some previous studies in camelina have reported that the plant varies from 30 to 90 cm (Putnam et al., 1993; Mc Vay, Lamb, 2008; Francis, Worwick, 2009). Sadhuram et al. (2010) reported that the length of the plant is between 47.25-51.50 cm, Katar et al. (2012) between 47,88-71,22 cm, Koç (2014) is of 43.39 cm and Ayışığı (2015) varied between 30.1 and 36.6 cm. These reported results are consistent with the results obtained in this study and are in parallel.



a) b)

Figure 1. Variation of plant height depending on sampling periods: a) Ames-26665; b) PI-304269

Total Dry Matter

The increase of total dry matter was high at the early stages of plant growth but increased slowly with the advancement of plant age in all the genotypes. The cause of rapid increase of total dry matter at early stages was possibly due to emergence of considerable number of new leaves per plant and branhes per plant. Significantly higher total dry matter production was noticed in first sowing time in Ames-26665 genotypes compared to the other sowing times (Figure 2a). In addition, the lowest total dry matter accumulation was obtained in the 1st sampling period at the 2nd sowing time of the genotype PI-304269 (Figure 2b). Ahmed et al. (2005) stated that variety had significantly different effect on dry matter production. Pavlista et al. (2012) report that the total dry matter accumulation in the camelina is 0.096 gram per decare. These findings are parallel to the findings obtained from this research.

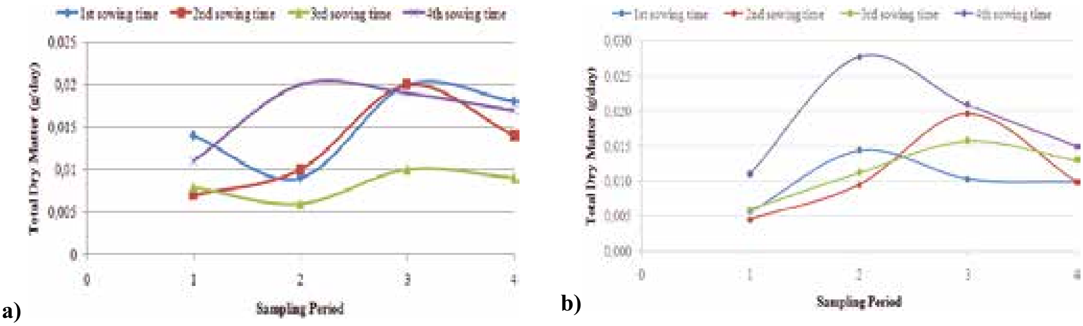


Figure 2. Variation of total dry matter depending on sampling periods: a) Ames-26665; b) PI-304269

Relative Growth Rate

As a result of the research, it was determined that there was a statistically significant difference between the 1st sampling period with the 2nd and 4th sampling periods, between the 3rd and 4th sampling periods and between the 2nd and 3nd sampling periods in terms of the relative growth rate. Relative growth rates increased in each sampling period. The greatest increase was observed in Ames-26665 genotype with a relative growth rate of 11.90% between 3rd and 4th sampling periods at the 1st sowing time. The lowest relative growth rate was found to be 0.50% growth rate between the 2nd and 3rd sampling periods in Ames-26665 genotype at the 3rd sowing time.

Higher relative growth rate was noticed at early stages of growth in all the varieties (Figure 3). These results are in agreement with the findings of Rahman (2004) in wheat. The reasons for higher relative growth rate values at early stages of growth is possibly due to the juvenility of the plants and less effects on accumulation of dry matter. Relative growth rate values decreased steadily with the advancement of plant age due to less dry matter accumulation. Decrease after flowering, capsule formation and filling of the grains are started. Finally, there is a decline in the rate of active growth during this period.

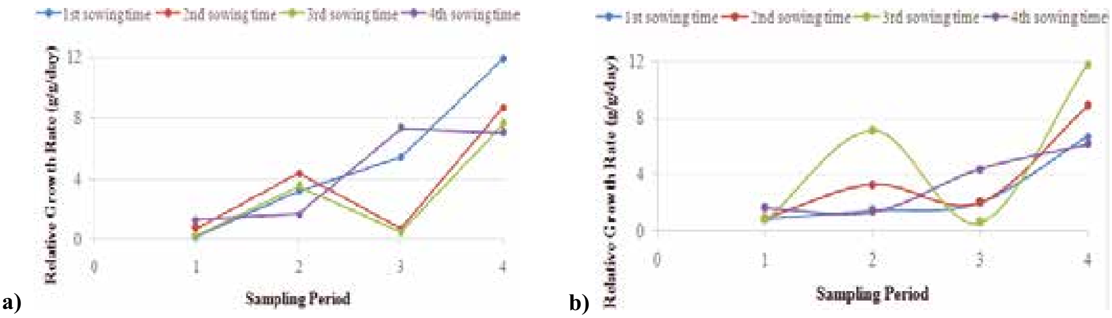


Figure 3. Variation of relative growth rate depending on sampling periods: a) Ames-26665; b) PI-304269

In the genotype Ames-26665, a statistically significant relationship was found between plant length and total dry matter amount (Figure 4a). It was determined that the plant length was the greatest at the first sowing time and the plant length decreased as the sowing time was delayed. It was also determined that when the plant height is the longest, the total amount of dry matter is the greatest, and that the total dry matter amount decreases due to the reduction in plant length. In PI-304269 genotype, the relation between plant length and total dry matter was negative and statistically insignificant (Figure 4b). The relationship between plant length and total dry matter arises differently in the two genotypes; the genetic characteristics are different and the two genotypes are affected differently from the environmental factors.

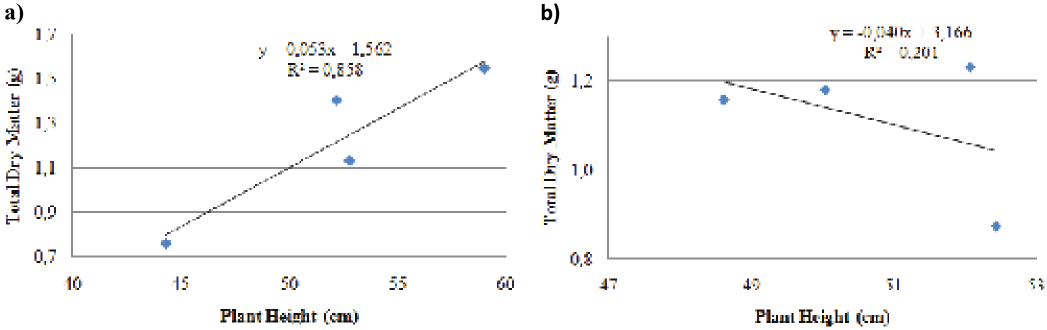


Figure 4. Relations between plant height (cm) and total dry matter (g): a) Ames-26665; b) PI-304269

CONCLUSIONS

As a result, it was determined that the longest plant length for Ames-26665 genotype was reached at the 1st sowing time, while the highest plant height at PI-304269 genotype was reached at the 4th sowing time. The maximum amount of total dry matter: Ames-26665 genotype was obtained at the first sowing time whereas PI-304269 genotype was obtained at the third sowing time. In addition, the maximal relative growth rate was obtained at the 1st sowing time in Ames-26665 genotype and 3rd sowing time in PI-304269 genotype.

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