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The effect of plant date and density on the growth index of maize variety (ksc704) in tropical region of Kermanshah Province

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Key words: Corn, Late group, date and density of plant.

Abstract

In this test, the effect of four plant date, as main factor (23 Jun,3 July,13 July,24 July) and three plant density as sub-factor (67, 77, 87 thousands plant per hectare) investigated on commercial variety KSC 704 and with 12 attendances by designing the split plot in the tropical region of Kermanshah Province (Sare-e-pooleZahab). In this study, characters that investigated were: leaf area index, total dry weight, harvest index and grain yield. The results showed that different plant date and plant density had significant influences on weight and yield components of corn yield and corn gravest index. The maximum total dry weight was obtained during flowering. At this time, the plant had greatest leaf area, and then declined until physiological maturity. The relative growth rate in all treatments was high in the first of growth season, and then declined by the increasing of plant age. The most suitable of plant density for KSC 704 was about 77000 plants per hectare and date of 3 July that noncompetition between plants, sufficient light and nutrient availability, and finally obtained maximum grain yield. Most of the traits including biomass and grain yield was 30620 and 6986 kg/ha respectively, was awarded treatment of plant date (3 July) and plant density, 77 thousands plants per hectare.

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Introduction

The methods that are used for appointment of agricultural plant growth components, introduce as growth index. Analysis of growth is very important method in quantitative analysis of growth of plant and producing of yield, components of plant growth is studied and deter minded by help of this method and use of mathematical equations. The rate of plant growth is showing the amount of gathering of dry matter in plants and in the distinguished chronological unit in earth area. In as much as, performance of agricultural products have influenced by growth rate, in the during of growth season, therefore, in the during of plant growth course, its studying could be useful in studying of differences of performance of agricultural products (Sarmadnia and Kocheki, 1989). Entirely, the maximum of rate of plant growth is time when plant can exploit from all of environmental factors and this condition occurs when leaves covering are complete. And the percent of sunlight that absorbed by plant, is maximum (Rashed Mohasel *et al*, 1997). Plant density as main factor is recognized for determining of degree and measure competition between plants of the most important inquiring activities of researchers, it can be mentioned the finding of desirable densities that produced the most performance in area unit and in the conditions of environmental and related variety (Hashemi-dezfouli *et al*, 2005). Quality and quantity yield of corn can be increased by choosing of agricultural such as date, plant density, best consumption of chemical fertilizer and (Kogbe and Adediran, 2003).

In considering of the suitable density, costing shadow of plants decrease, consequently, light receipt and photosynthesis will reach to its greatest value. When plant density increase very much, in area unit, flowers and fruits that can grow potentially, don't come to existence and it will be barren (Sprague and Dudley, 1988). When plant density increase, plant yield decrease. The measure of decreasing of yield, as a result of light decreasing and the other environmental source is available to ever plant (Hashemi - dezfooli *et al*, 2005). The yield of dry matter in agricultural plants have direct relation to the measure of exploitation from energy of sun glowing. Plant covering has greatest efficiency. When competitions of inter plants and intra plants are minimum for receiving light. This collection receive the greatest of light amount, as a unit (Sprague and Dudley, 1988, Spedeh-vend, 2000). Efficiency of absorption of the energy of sunglow that shines on product is dependent on the measure of leaf area of production. This factor is dependent on change of density and distribution of plants in farm surface (Sprague and Dudley, 1988). Creating a suitable and useful plant covering needs to abundant precision in creating a density of suitable planting, and in considering to climate conditions of area. The most important factor of decreasing of yield as a result of immonotonousness distribution of plant in the farm surface is the competition of plant for receipt of light, when the leaf area is more than measure (density of critical leaf area), by reason of shadowing and not reaching light to low leaves, these leaves will do only. Respiration, and will have small load on top of a heavier plant, instead of photosynthesis and production. Therefore, noticing of suitable leaf surface is necessary for per yield in the specific area, as production of the most dry matter and plant photosynthesis and pure photosynthesis (Sofeian, 1998). Other study had did by cox (1996) and from among densities of 4.5, 6.75 and 9 plants in m^2, the heights index of leaf area obtain from the greatest plant density (Cox, 1996). Tollenaar and Aguidera (1992) showed that yield of corn increase in densities of between 59 to 93.5 thousands plant per hectare, to index of leaf area of 3.3 as linear (Tollenaar and Aguidera, 1992). In the study, Remison and lucas investigated the index of leaf area and performance of a precocious variety of corn (FARZ 25) and a late variety (FARAZ 23) in densities of 37.53 and 80 thousands plants per hectare in Negiria, and they reported that, when density increase, then index of leaf area, increase, but from middle parts of flowering stage. Here after, because of transfer of photosynthesis matter to place of filling out plant, index of leaf surface decrease. Also, in other study, they reported that greatest index of leaf surface in

densities of 50,100 and 150 thousands plant per hectare obtained from heights of value of density of plant and from near to 50 percent of flowering, but, it is decreasing from middle of flowering stage, hereafter, of photosynthesis matters to place of filling of plant (Remison and lucas, 1982). Condensed covering cause decreasing of absorption of light glow to plant and fooding elements and we have the decreasing of metabolism activities such as absorption, analysis and disorder in transfer of photosynthesis matters to maize (aim) and irreparable decreasing of plant yield (Cox, 1996). One of other important indices of physiologic, that is influenced of density, is the rate of plant growth (CGR). The most of speed of growth is when plants can exploit from all of enviromnetal factors. This state occurs when leaf covering complete and the percent of sunlight that attract by plant, is maximum (Rashe mohasel *et al*, 1997). One of most fundamental of management aspects of agricultural corm is determining of most suitable date of plant. In as much as, plant date is different in ever climate are, so changes occur in produce of plant growth. Different tests showed that development and growth stage of plants has important changes from planting to harvesting (Hashemi-dezfouli and Herbert, 1992b). The plant yield in late planting is influenced more than performance of dry matter. This matter showed that the effect of load date of plant don't limited to photosynthesis process, but in late plant growth stage sill be shorter and flowering occurs when, there is not sufficient time for complete maturity of maize (Reed *et al.*, 1999). The yield of dry matter is result of efficient of plant shading in sue of sun glowing in during of growing season (Daughtry and Hollinger, 1984). Gathering of dry matter shows positive correlation with seed yield. For having the greatest production, leaf area is necessary and it can increase production of dry matter via local investigations. Main aims of this investigation is account of growth equations and description of quality of reaction of commercial variety KSC 704 to environmental conditions of tropical areas of Kermanshah province. In this direction studying of plant growth procedure of corn has specific importance, in considering with analysis of gathering of dry matter. So, knowing and studying of index of growth and analysis of effective factors on performance and its growth parts are necessary.

Materials and methods

This test performed, with intention of investigation of effectiveness of four dates of plant as main factor (23 Jun,3 July,13 July,24 July) and three densities of plant as secondary factor (67, 77 and 87) on commercial variety KSC704 and with 12 treatments by designing the split plot based on RCBD in tropical region of Kermanshah province (Sar-e-poolezahab). The earth becomes water distribution, with the intention of making of plant bed after of harvesting remains of before plant and a surface plugging performed with intention of destroy budded wasted grasses and with mixing of plant remains with soil. Then, on the basis of soil test, the earth consumes 120 kg phosphor per hectare (P_2O_5) and 60 kg K_2O per hectare. The measure of fertilizer and 180 kg per hectare of pure Nitrogen (N) use in three stages. Per experimental unit was consisting of four lines that their height was 12m and distance of lines was 75 cm (sadeghi and chokan, 2004). In this test, one line from per side and two plants from first and end of per experimental unit were basis of sampling and then harvesting of plants from soil surface per formed by chance. The sizing of leaf area on three plants performed seven times and per 14 days. Once, from stage of 5-6 leaves of plants and on basis on Montgomery, formula (leaf height × greatest width of leaf × 0.75) (Montgomery, 1911). Sampling performed destructive. From per experimental unit.

Harvesting samples transfer to laboratory and the measuring of leaf area was performed. For measuring of dry weight, they throw sampling plants inside to paper bag and place them invessed, in temperature of 70°C and for 72 hours. And, it is measured with precise scale, after sending out for machine. Harvesting index (g). Performed via following equation: harvesting index= economic performance / biological performance × 100. It was needed to measure of two leaf surface factors and dry weight at

distinguished and repeated time intervals, for analysis of growth index. And the other quantities were obtained via computation of related equations. In this project, it is used to second grade equations. That shows dry weight changes and leaf area relative to time, for studying the changes of growth indices relative to time. Best equation performed between dry weight of all of aerial organs of plant, computation of rate of product growth, relative growth rate and also, leaf area index with help of spss software and with due attention to height coefficient correlation. Then, the growths indices be compute and changes procedure describe in during of growth season.

$Y= Exp (a+bx+cx^2)$.

Where, Y is dry weight of whole of aerial organs as dependent variety and x is time as independent variety, and a and c are Regression multiplications. Therefore, relative growth rate computed to derivative of total dry weight equation, relative to time, as follows and product growth rate computed via multiplication of total dry weight and relative rate.

$RGR= b + 2cx$.

Resulted data were compared to measuring of studying qualities and with use of analysis of average of meaningful qualities with, MSTATC software and with sue of Dancan test at 5% probability level. All of necessary forms, drew with use of Excel software.

Result and discussion

In the table 1, the comparison of average of measuring qualities for both of date factor and plant density have inserted with Dancan method. In the first part of table, the effect of plant date factor (four plant date in second plant conditions of tropical region). For yield attributes and its elements showed that second plant date (3 July) have brought suitable conditions for quantitative promotion of whole of measuring qualities. Also, seed budding conditions and settlement of embryos and pollination, inoculation and best use of earth water, agricultural savings and sunlight are suitable. Corn farm ripen before of raining and winter seasons and seed moisture decrease at farm. Growth conditions showed that there was meaning full superiority at first plant conditions (23 June). And also from the other two plant date. (13 July and 24 July). So, late of corn don't have worthy of recommendation, with due attention to be short of agricultural season and starting of add season and raining. In this region, the effect of plant density factor (plant density: 67,77 and 87 thousands plants per hectare) showed that plant density of 77 thousands plant per hectare brought the better conditions for production of corn seed and for the most of measuring attributes. So that, plant yield and biomass were more than two plant densities. In the less plant condition (67 thousands plants per hectare), the amount of seed deep attributes, the number of seed in the maize, the weight of thousands seeds were more than the other two densities. But with due attention to the numbers fructiferous plants, performance of plant and biomass were more than density of 77 thousands plants per hectare. With increasing of plant density from 67 thousands plants per hectare to density of 77 thousands plants, so the most of yield attributes and yield elements will increase, and the upper densities decrease. From 6557 kg per hectare to 6952 and 6073 kg per hectare, for three mentioned densities, respectively. Namely, it had seen to increase, firstly and them. It decreases in producing of plant product of corn. This result corresponds to result of other researchers, such as, Wiley and Heath's report, Hashemi and Herbert, Sadeghi and Chokan (2004). The summary of said reports consist of reaction of corn plant to much density result in decreasing of product of per plant and increasing of yield in area unit (Wiley and Heath, 1970). In more density, total of penetration of sunlight and performance was increased by candor (Hashemi and Herbert, 1992). Plan density has influenced on performance on quality and food worth of plant. With decrease of light, the measurable material, such as seed, protein, oil and so forth will decrease.

Gathering of dry matters (DM): The results of test showed that, to increase of dry matter, the growth plant aerial part is sigmoid curved which is starts with plant slow growth, firstly, then, the procedure of

gathering of dry weight continue to be fast and linear. In this stage, the plants have two sampling of fast growth. The growth rate is slow, again and finally, it is so insignificant that it can be state that the growth rate has stop. By the way, the results showed that the most dry matter weight was brought in flowering stage to a weed after it.

Table 1. comparison of average of measurable attributes for yield and some of agricultural qualities moved from factors of plant date year, lines distances and plant density in way of Dancan and with variety of late receipt of corn KSC 704.

attributes of attendances	the deep of seed (millimeter)	the number of seed in row	the number of raw in maize	the weight of thousands seed (gr)	Corn cob (percent)	seed humid (percent)	biologic yield (kg/hec)	Yield (kg/hec)
plant date								
23 Jun 2008	10.61ab	34.3ab	13.9 a	335.8ab	18.01ab	16.3 c	27760.1a	6592 ab
3 July 2008	11.55a	38.7 a	14.1a	348.3a	16.4 b	19.3 c	26980.2ab	6968a
13 July 2008	10.98ab	31.9 b	14.3a	340.8ab	17.8 ab	25.4 b	22070.5 b	5790 b
24 July 2008	10.10 b	33.2b	13.8a	331.2 b	22.1 a	31.1a	21190.4b	6046 b
plant density								
67000	11.42a	39.3a	14.0a	345.2a	16.5b	21.4 b	22790.5ab	6557ab
77000	10.87ab	35.6ab	14.1a	329.9ab	18.6ab	23.5ab	25870.4a	6952a
87000	10.25 b	33.8 b	13.9a	317.5 b	20.4a	26.8a	21580.3 b	6073b

Means in a column followed by the same letter are not significantly different at P≤0.01.

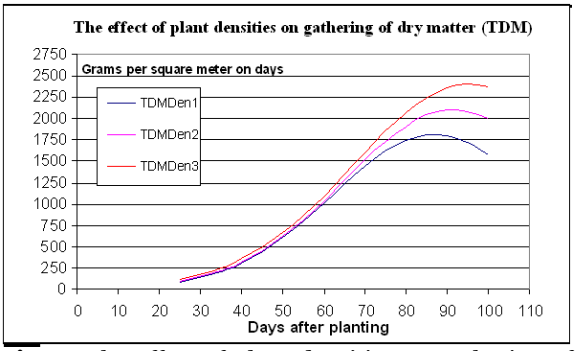

Fig. 1. The effect of plant densities on gathering of dry matter.

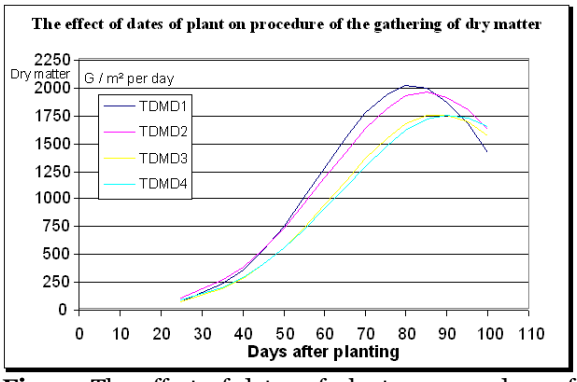

Fig. 2. The effect of dates of plant on procedure of the gathering of dry matter.

In this stage, the plant produced the most leaf area and after that, is showed the decrease procedure to reach to physiological ripeness stage. The cause of dry weight decrease of aerial organs in the last of growth season in respiration and pouring of leaves. The results showed that procedure of dry matter gathering is influenced as plant date and plant density. So that, procedure of the gathering of dry matter was increasing, as sigmoid, in all do densities and in during of growth season. But at the same time to end of growth season, the highest of measure surface of increasing of dry matter belonged to more density (8.7 plant per m^2) relative to other densities. There was in significant difference between different densities until 70 days after that, but the gathering of dry matter continued with three studying densities. The gathering of dry matter showed differences, especially in more densities (density of 8.7 and 7.7 relative to density of little than 6.7 plants per m^2). This state is better as a result of much leaf area index and desirable use of sunlight, food materials, water and photosynthesis. For example, it was computed, the most TDM in 8.7dinsity per m^2 (1550 g) (Figure 1). It was reparable, the effect of different plants date on procedure of gathering of dry matter. The date of first and second plants (23 June and 3 July) enjoyed to more dry matter gathering, relative to two the plant dates (13 July and 24 July). Namely, dates of first and second plant dates were favorable, in the glow, temperature and climate conditions of first and

second plant dates and especially second date of corm plant in the tropical region of this province (Figure 2). With increase of leaf area the measure of receiving of light and sun energy became more. Leaf area was little, and favorable amount of sun energy didn't attract, until some weeks. So, at the beginning of growing state, the increasing of plant dry weight value performed slowly, because. Farm green surface was little and abundant amounts of sun energy became useless. With entering of plant to generate growth stage, the increase of dry weight of the whole of plant performed with excess tone. Finally, with near to physiology receipting stage and the end of form growth season, the weight of whole plant decreased, because of falling of leaves. The results of some of researchers were similar to results of this test, so that, Remison and Lucas (1982).

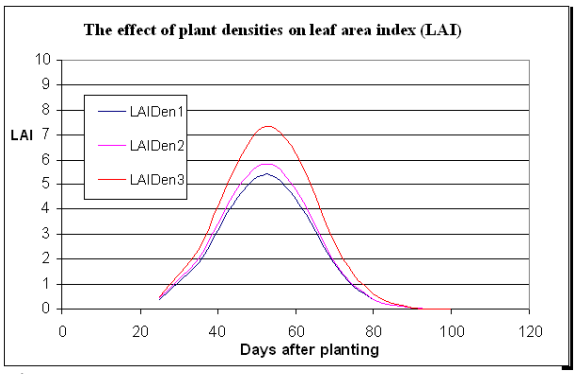

Fig. 3. The effect of plant densities on leaf area index (LAI).

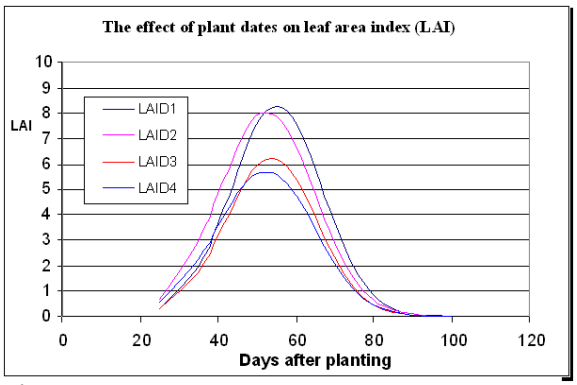

Fig. 4. The effect of plant dates on leaf area index (LAI).

Leaf area index: The changes of leaf area index, in during of plant growth season showed that the most of leaf area index was 8.7 plants per m^2 from the highest of plant density and it was 7.4 in the flowering stage, then because of inefficient and falling of low leaves of plants and with near to end of growth season, leaf area index decreased. Severely, of course a general rule has been said in all of Figures: in the earl of growth season, spreading of leaf area was slow in the different attendances, and then by pass of time and falling of leaves, it decreased. The end of growth season (Figure 3). Esechie (1992) reported that the most index of leaf area obtained in the appearance stage of flower (Eschie, 1992). In the first and second plants dates (3 July, 23 June), the leaf area index was more than other two dates. The state occurred because of light glow and sufficient glow energy in conditions of these dates. Meanwhile, when density increased, LAI amounts increased, and its cause was increasing of the numbers of plants in the area unit and increasing of leaf area in the surface unit. The most amount of LAT obtained in first and second dates, from density of plants of 87 thousands plant per hectare and about 58 days after from turning green. The least amount obtained in the late plant date (24 July) and from density of 67 thousands plants per hectare. Therefore, there was difference between various dates about of leaf area index. It has direct interference in producing of plant yield (Figure 4). Lucas reported that, there is the most index of leaf area in the densities 6.6, 8.8 and 11.1 plants per m^2 as 3.8, 4.2 and 5.7. it appears that the increasing of density is necessary, for producing of dry matter, until reach to leaf area index that it can attract 90 percent of sunlight (critical leaf area index), but the increasing of density won't result, because, additional leaves cause shadowing on the lower leaves and these leaves can't do photosynthesis of the required size of its respiration (Lucas, 1986). Therefore, it is possible that they use from photosynthesis matter of other leaves (Center and Camper, 1973). In the investigation was performed by cox (1996) on the densities of 4.5, 6.75 and 9 plant per hectare. The most measure of leaf area index obtained from the upset of plant density (Cox, 1996). Leaf area index can increase with increasing of leaf area in ever plant or with increasing of the number of plant in surface unit with attention to that the main and effective factor on growth and production of agricultural plants is the

attraction of sunlight by leaves and the conversion of its to photosynthesis matters. The increasing of measure of leaf area will cause increase the measure of light attraction and finally it result in increasing of yield.

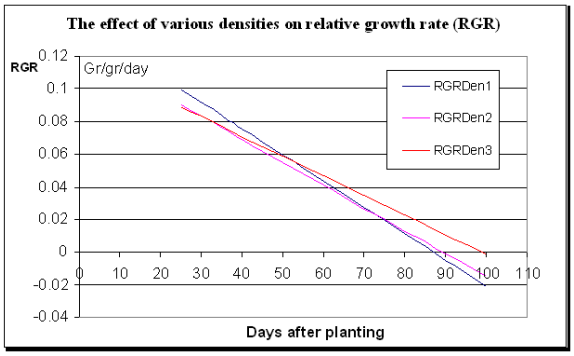

Fig. 5. The effect of various densities on relative growth rate (RGR).

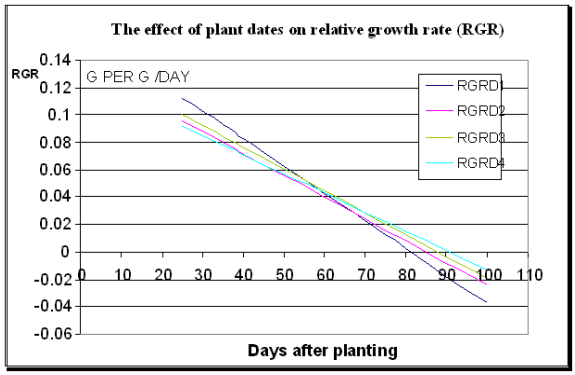

Fig. 6. The effect of plant dates on relative growth rate (RGR).

Relative growth rate (RGR): The test's results showed that relative growth rate showed increase in all of plant dates and densities in the early of growth season and it showed decrease by the pass of time and increasing of plant age. These results conform to the results of other studies of researchers (Govil and Pandey, 1998). Relative growth rate was more in the less density relative to more plant density. In the early of harvest season but this state reverse 60 days after harvest and relative growth rate of more densities (87 and 78 thousands plants per hectare) show increase relative to less plant density (67 thousands plant per hectare). The most of relative growth rate was related to density of 87000 plants per hectare. The reason of this affair was the energy of suitable sunglow and more leaf area index at the conditions of second plant date in the tropical region of province and day and night temperature difference in more density. That result is the increasing of the measure of photosynthesis relative to respiration (Figure 5). Although, relative growth rate increased in between difference surfaces of plant density, but this increase will be worthless. In the beginning of growth season, the increased of relative growth rate is connected to light penetration and sun energy penetration and less showing of leaf altogether and consequently to less plant respiration. Also, the reason of decreasing in during of farm plant season is connected to increasing of age of lower leaves, to settle shadowing of them and also additional textures in plants that they are structural textures. The difference of relative growth rate is showing of the increasing of effectiveness of plant production in lieu of plant weight unit and increasing of competition of bet wean plants in great densities relative to little densities. Therefore, increasing of plant density until 8.7 plants in m^2 of growth factors (especially light) cause the increasing of effectiveness of production in lieu of plant weight unit. The similar results are reported by some of researchers. Flenet and his colleague suggested that the reasons of decline procedure in relative growth rate were old aged of organs, the increase of carbohydrates of structural and decrease of metabolic activities in product (Flenet *et al.*, 1996). Also some of researchers reported that relative growth rate have reversed linear relation with plant age (McCullovgh *et al.*, 1994) (Figure 6). The effect of various plants dates on relative growth procedure showed that in the beginning of growth season relative to the other plants dates, the first plant date have great relative growth rate, but this state reversed 70 days after from development and growth of farm. Differences not to be seen between plant dates. In all of plants dates, the increase of plant age will cause the decreasing of relative growth and decline procedure. These results are concord to the results of the other researchers, relative growth rate of agricultural plants begin slowly just after that budding of plant, then this rate increase firstly and after that. It begins decrease (Gardner and his Colleague, 1990). In the beginning of growth season. Relative growth rate increased and it decreased by pass of time and with increase of plant

age. This result is concord to Govil and Pandy's results (1998).

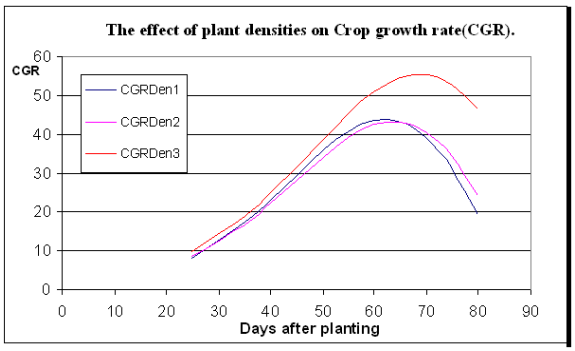

Fig. 7. The effect of plant densities on Crop growth rate(CGR).

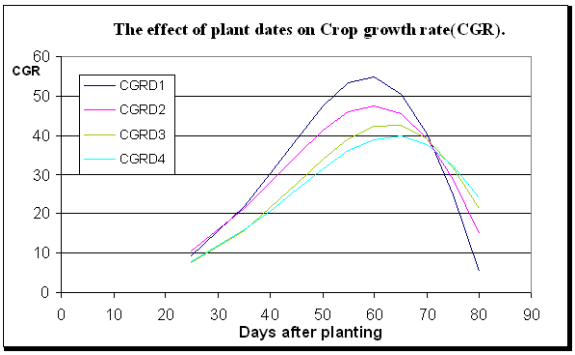

Fig. 8. The effect of plant dates on Crop growth rate(CGR).

Crop growth rate(CGR) : The comparison of changes procedure of plant growth rate in hybrid (KSC 704) for different densities showed that the most of crop growth rate are obtained in every three densities and before of the beginning of flowering stage until a weed after in. and after that the measure of its decrease to reach to physiology stage. Crop growth rate begin, 25 days after from budding. The plant rate in growth is slow, in the beginning of growing stage until stage of leaves 12 and then it entered to fast growth stage (Figure 7). The most of growth rate obtained from the greatest of density (8.7 plant per m^2), on the basis of the results of this test and from among densities 6.7, 7.7 and 8.7 plant per m^2. Attendances that plant in upper densities had great crop growth rate. The greatest of measure crop growth rate of plant was obtained in densities of 8.7 plants per m^2 and with measure of 58.7 gr/m^2 in day. And the least of its obtained in the density of 6.7 plant in m^2. From about 50 days after budding in farm, the rate of crop growth was great, relative to other densities and for density of plant of 8.7 plant per hectare and it showed more crop growth rate, in the last of agricultural season of farm physiology receipt, and the reason of it is, the great plant number in area unit and perform suitable photosynthesis with attention to glow of sunlight and attract of energy. This affair causes the increase of leaf area in earth surface unit. With attention to be suit of sunglow and to attract of sun energy in the tropical regions of province, plant density has the great performance efficiency. In this conditions, the measure of photosynthesis is great relative to respiration that cause to save simulate and finally to increase of plant growth rate (Figure 8). In second half of harvest season or in generative growth stage, the crop growth rate decrease and its reason is the increase of depreciation of light inside of leaf layers. Because it cause that the measure of light attraction and the energy of sun active decreased (Figure 8). The Figure of the effect of plant date on changes procedure of plant growth rate in hybrid single cross (KSC 704) in second conditions of plant in the tropical regions of Kermanshah province showed that the most crop growth rate in ever four plant dates was slow until stage of 10 to 12 leaves, but from this stage after, it had fast procedure until pollination stage. It showed the decreasing state, at the next stage. The connection of between crop growth rate and the days after from greening in various dates showed that the most of dates reached to its maximum about 65 day after of greening of the measure of relative growth rate and this time was encounter to production of the maximum of leaves numbers and begin of generative stage of plant. The greatest of crop growth rate obtained in first date (23 June) and the beast amount of it is seen in fourth plant date (24 July) (Figure 8). In summary, the production of great product can attribute to suitable density of plant in yield unit suitable plant date and photosynthesis in area unit of leaf. This affair occurs because of the better covering of farm surface and the better use of plants from light, water and food elements existing in earth at suitable time. With due attention to these results, suitable density of plant for hybrid KSC 704 suggested about 77000 plants per hectare in 3 July and in the tropical

region of Kermanshah. These works stated that there is the increasing in the weight of plant group in surface unit and time unite that it uses in analysis of growth and produce of yield. For C_4 plants, such as corn, it is about 50-60 gr/m² in day. Plant growth rate increased by pass of time and with increasing of LAI. The most plant growth rate obtained favorable. But when LAI is little, the measure of plant growth rate that was dependent to LAI. Decreased , because of falling of leaves. Therefore, there as one of laving of plant growth rate amount was incomplete of plant covering and it increased with increasing of plant leaf area and light attraction.

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