J. Plant Production, Mansoura Univ., Vol. 2 (12): 1703 - 1716, 2011

RESPONSE OF GROWTH AND PETAL YIELD OF SAFFLOWER TO SOWING DATES, NITROGEN FERTILIZER,LEVELS AND TIMES OF FOLAIR APLICATION WITH NATURAL GROWTH PROMOTERS "MELAGROW"

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ABSTRACT

Two field experiments were conducted at the Experimental Station, Faculty of Agriculture, Mansoura University, during the two successive winter seasons of 2009/2010 and 2010/2011. The main objectives of this study were determining the effect of sowing dates (1st Sept., 1st Oct. and 1st Nov.), nitrogen fertilizer levels (40, 60 and 80 kg N/fed) and time of foliar application with "Melagrow" as natural growth promoter (without, one and two times) on growth and petal yield of safflower (*Carthamus tinctorius,* L.) cv. Giza 1.

The obtained results could be summarized as follows:

1. Intermediate sowing date of safflower (1st October) significantly surpassed other sowing dates (1st September and 1st November) in all studied growth and petal yield characters, except Crop growth rate "CGR", Relative growth rate "RGR" and Net assimilation rate "NAR" which produced from sowing on 1st September in both seasons.
2. Fertilizing safflower plants with 80 kg N/fed significantly increased all studied growth and petal yield and markedly recorded the highest values of these characters in both seasons. However, application of 40 kg N/fed produced the lowest values of all studied characters in the two growing seasons.
3. Foliar application with Melagrow(as a natural growth promoter) twice after 30 and 70 days from sowing significantly recorded the highest values of studied growth and petal yield characters, exclusion leaves/stem and branches ratio, CRG, RGR and NAR in both seasons. While, application of Melagrow one time after 30 days from sowing came in the second rank in this respect in both seasons. On the other hand, the lowest values of all growth and petal yield characters were resulted from the control treatment (without foliar application) in both seasons.

From the obtained data in this study, it can be concluded that sowing safflower on 1st October and mineral fertilizing with 80 kg N/fed beside twice foliar application with Melagrow as a natural growth promoter in order to maximizing its growth and petal yield under the environmental conditions of Dakahlia Governorate, Egypt.

Keywords: Safflower, *Carthamus tinctorius* L., sowing dates, nitrogen fertilizer levels, times of foliar application with natural growth promoters, Melagrow foliar application times, growth, petal yield.

INTRODUCTION

Safflower (*Carthamus tinctorius* L.) is an underutilized multi-purpose crop belonging to the family *Compositae* or *Asteraceae*. Historically, it was used for collecting petals as food coloring and flavoring, extract dyes for use to color cloth and in the carpet-weaving industry. Its oil was also used in the

paint industry. Currently, it is mainly used to extract edible oil, which is high in either linoleic or oleic fatty acids. Other common uses of safflower include medicinal and herbal tea, cosmetics, spice, vegetable, forage, cut flowers, and bird feed. After oil extraction, the safflower meal is used for ruminant feed, and can be used for poultry feed if safflower seed is de-hulled before pressing (Farran *et al.*, 2009).

It is well know that high productivity of any crop is the final goal of many factors and operations. In addition, the pronounced role of the agronomical processes such as sowing dates, nitrogen fertilizer levels and foliar application with natural growth promoters plays important effects on safflower growth. Among the different factors affecting yield, sowing date usually has a large and predominant influence. An optimal sowing date will lead to increase crop yield, but little research on safflower sowing date has been conducted in Egypt. In this concern, Badawi *et al.* (1996) found that early sowing (1st October) caused marked increases in plant height, number of main lateral branches/plant, number. There were significant differences in most characters between sowing of 1st October and that of 1st November or 1st December. Dadashi and Khajehpour (2004) reported that delay in planting from March 12 to May 10 reduced plant dry weight petal yield. The above traits increased as planting was further delayed from May 10 to June 8. Yau (2007) studied the effect of five sowing dates (from November to March) of safflower in a semi-arid, high-elevation Mediterranean site. Shoot dry matter at bud initiation, plant height and stem diameter were recorded. Results showed clearly that Lebanese farmers in the Bekaa Valley should shift the sowing time for safflower from the spring to the winter. Although sowing in November, December or January gave similar growth and seed yield. Omidi and Sharifmogadas (2010) studied the effects of sowing dates (Sept. 20, Sept 30, Oct. 10 and Oct. 20) On some traits of safflower including plant height, number of leaves/plant, leaf area index (LAI), crop growth rate (CGR), relative growth rate (RGR) and net assimilation rate (NAR), petal yield. They found that sowing dates had a significant effect on all studied traits.

Nitrogen is one of the most important nutrients for crop production because it affects dry matter production by influencing leaf area development and maintenance as well as photosynthetic efficiency. There are many reports indicated that nitrogen is considered as one among the most affective factors in increasing growth, yield and its components of safflower. In this respect, Ahmed *et al.* (1985) showed that plant height and number of branches/plant, CGR, RGR, NAR of safflower were increased by increasing nitrogen levels from zero to 60 kg/ha. Steer and Harrigen (1986) stated that nitrogen deficiency delayed both vegetative and reproductive phonological development, reduced leaf emergence rate and petal yield. Sary *et al.* (1987) reported that plant height, stem diameter, number of branches/plant, number of leaves/plant, fresh and dry weight of different parts/plant and leaf area index at different growth stages of safflower significantly increased by increasing nitrogen level up to 90 kg N/fed. Ezz El-Din (1989) observed that plant height, weight of different parts and number of branches/plant were increased by increasing nitrogen levels from 25 to 40 kg N/fed. He added that increasing nitrogen level up to 55 kg/fed tended to decrease the plant height.

Soundra and De (1989) recorded that plant height, number of branches/plant and dry matter production were increased by increasing the rate of nitrogen from 0 to 60 kg N/ha. El-Afandy (1990) reported that plant height, stem diameter, number of branches/plant, fresh weight of stem and leaves/plant, dry weight of stem and leaves/plant and leaf area index at 75, 105 and 135 days after sowing were significantly affected by nitrogen levels. But, the petal yield was not affected. He added that the highest mean for all studied characters were obtained by applying 90 kg N/fed. Refaat Azaa *et al.* (1993) found that application of nitrogen at the level 30 or 60 kg N/fed did not affect on petal yield. Ashoub Abla (1995) indicated that the best and economic level of nitrogen was 60 kg/fed, which increased number of leaves/plant and leaf are index. On the order hand, stem diameter and relative growth rate were not affected by different levels of nitrogen. Badawi *et al.* (1996) showed that increasing nitrogen levels up to the highest dose (75 kg N/fed) significantly increased plant height and number of main lateral branches/plant. Siddiqui and Oad (2006) evaluated the appropriate nitrogen levels for growth of safflower. Nitrogen levels tested were; 0, 30, 60, 80, 120, 150 and 180 kg/ ha. They revealed that all the crop parameters were affected significantly due to different levels of nitrogen.

A plant growth regulator is an organic compound, either natural or synthetic, that modifies or controls one or more specific physiological processes within a plant. Plant growth regulators are essential components of farming because they help in promoting the growth of the plants. Very little researches have been conducted to evaluate the effects of times of foliar application with natural growth promoters on growth and petal yield of safflower. In this regard; Ahmed *et al.* (1986) studied the effect of plant growth regulator B9 (N,N-dimethyl-amino succinamic acid) on vegetative growth of safflower plants. They showed that spraying with 500 ppm B9 increased vegetative growth. Berova and Zlatev (2000) indicated that Pacrobutracol is currently registered as Bonzi (Syngenta Professional Products, Greenboro, N.C.) or Cultar (ICI, Americans, Goldsboro, N.C.) for using on controlling the growth of many other crop species and may offer an alternative for using in field crops. Dholekar *et al.* (2001) revealed that application of 10 ppm kinetin at 20 days after sowing (DAS) stage was found significantly superior for plant height, stem diameter and number of branches/plant. TIBA although inhibited stem elongation showed significant increase in yield and yield contributing characters. Ebrahimzadeha *et al.* (2009) evaluated the effects of foliar application with exogenous plant growth regulators such as salicylic acid (SA) rates and paclobutrazol (PB) rates on the growth and development of safflower. Both SA and PB increased number of leaves/plant, total biomass, head flowers biomass and number of lateral branches. Khandagale *et al.* (2009) studied the effect of foliar spray of GA_3 and IBA rates at rosette stage on growth, morphological and physiological parameters of Safflower. Application of GA_3 at 200 ppm was found to be effective in increasing plant height, number of primary branches and leaves/plant. Whereas, application of IBA 100 ppm at 30 DAS was found to be effective in increasing leaf area. Foliar spray of IBA 200 ppm recorded higher total dry weight at all stages of plant growth. The values of

CGR, RGR, NAR and LAI were higher due to spray of growth regulators at various concentrations in all the growth stages over control.

MATERIALS AND METHODS

Two field experiments were conducted at the Experimental Station, Faculty of Agriculture, Mansoura University, during the two successive winter seasons of 2009/2010 and 2010/2011. The main objectives of this study were to determine the effect of sowing dates, nitrogen fertilizer levels and times of foliar application with natural growth promoter (Melagrow) on growth and petal yield of safflower (*Carthamus tinctorius* L.) cv. Giza 1.

Each sowing date (1st Sept., 1st Oct. and 1st Nov.) was practiced in separate experiment. Every experiment was carried out in strip plot design with three replications.

The vertical plots were assigned to three nitrogen fertilizer levels *i.e.* 40, 60 and 80 kg N/fed. Nitrogen fertilizer in the forms of urea (46 % N) was applied as a side-dressing in two equal doses, one half after 30 days from sowing and the other after 70 days after sowing.

The horizontal plots were occupied with times of foliar application with natural growth promoter (Melagrow) as follows:

1- Without foliar application (control treatment).
2- Foliar application with Melagrow after 30 days from sowing (DFS) at the rate of 50 ppm (10 g Melagrow/200 liter water/fed).
3- Foliar application with Melagrow after 30 and 70 days from sowing (DFS) at the rate of 50 ppm (10 g Melagrow/200 liter water/fed).

Melagrow is natural growth promoter extracted from pollen of cabbage flowers. It has great effectiveness of many field crops. Melagrow is combined effects of Oxen, Cytokines, Gibberellins, Ethylene and Hydrogen cyanamid. The chemical composition of Melagrow is 20 % phosphorus, 10 % potassium, 3 % boron and 0.2 % brassinolide. Natural brassinolides (0.2%) is natural plant growth promoter for all crops, which promotes growth, increases yield, improves quality, increases percentage of fruit setting, spraying before flowering can promote formation of flower buds and spraying during flowering stage can resist fruit dropping and flower dropping.

Each experimental basic unit included three ridges, each 70 cm apart and 4.0 m length, resulted an area of 8.4 m^2 (1/500 fed) in both seasons. The preceding summer crop was maize (*Zea mays*, L.) in both seasons.

Soil samples were taken at random from the experimental field site at a depth of 15 and 30 cm from soil surface before soil preparation to measure the chemical and physical soil properties as shown in Table 1.

Table 1: Physical and chemical properties of experimental site during 2009/2010 and 2010/2011 seasons.

Physical properties								
	Particle size distribution			Texture	F.C. %	P.W.P %	Available water %	Bulk Density g.cm^{-3}
	Sand%	Silt %	Clay%					
2009/2010	21.1	32.6	46.3	Clayey	32.25	16.00	16.25	1.17
2010/2011	21.2	33.5	45.3	Clayey	32.40	16.00	16.00	1.14

Chemical properties															
	O.M. %	$CaCO_3$ %	Available ppm			E.C dS.m^{-1}	Soluble cautions, meq/L				Soluble anions, meq/L				pH
			N	P	K		Ca^{++}	Mg^{++}	Na^{+}	K^{+}	CO_3^{-}	HCO_3^{--}	Cl^{-}	SO_4^{--}	
2009/2010	2.62	2.95	22	7	145	1.65	5.5	6.0	3.9	1.1	0.0	5.0	6.4	5.1	7.88
2010/2011	2.87	2.50	31	11	175	1.71	5.0	5.6	4.5	2.0	0.0	5.5	7.0	4.6	7.5

The experimental field well prepared through two ploughing, leveling, compaction, ridging, and division and then divided into the experimental units. Calcium super phosphate (15.5 % P_2O_5) was applied during soil preparation at the rate of 100 kg/fed. Potassium in the form of potassium sulphate (48 % K_2O) was added at the rate 50 kg/fed after 30 days from sowing (at the first dose of nitrogen fertilizer).

Safflower seeds were hand sown 3-5 seeds/hill using dry sowing method on two sides of the ridge in hills 30 cm apart during the aforementioned dates in the first and second seasons. Plants were thinned at the age of 30 days from sowing to obtain two plant/hill (80000 plants/fed).

Plants were kept free from weeds, which were manually controlled by hand hoeing at two times. The common agricultural practices for growing safflower according to the recommendations of Ministry of Agriculture were followed, except the factors under study.

Data recorded:

A. Growth characters:

Two samples were taken during the growth period at 90 (elongation stage) and 120 (branching stage) days from sowing (DFS). Five guarded plants were chosen at random from first ridge of each plot. To measure the growth parameters the following growth characters were determined:

1. Plant height (cm).
2. Stem diameter (cm).
3. Number of main branches/plant.
4. Number of leaves/plant.
5. Stem and branches fresh weight (g) .
6. Stem and branches dry weight (g).
7. Leaves fresh weight (g).
8. Leaves dry weight (g).
9. Leaf area index (LAI). Leaf area measurement determined by the disk method using 20 disks of 1.0 cm diameter according to Watson`s (1958), and then following equation was used.

$$\textbf{LAI} = \frac{\text{Unit leaf area per plant (cm}^2\text{)}}{\text{Plant ground area (cm}^2\text{)}}$$

10. Specific leaf weight (SLW) mg/cm^2.

$$\text{SLW} = \frac{\text{Leaves dry weight (mg)}}{\text{Leaf area/plant cm}^2}$$ (Radford's, 1967).

11. Leaves/stem and branches ratio.

$$\textbf{L/SB} = \frac{\text{Leaves dry weight (g)}}{\text{Stem and branches dry weight (g)}} \times 100$$

12. Crop growth rate (CGR) in g/day: Determined according to Radford's method (1967), where**:** W_1 and W_2 refer to dry weight of plant at sampling time T_1 (90 DFS) and T_2 (120 DFS), respectively.

$$\textbf{CGR} = \frac{W_2 - W_1}{T_2 - T_1}$$

13. Relative growth rate (RGR) in g/g/day: Determined according to Watson's method (1958).

$$\textbf{RGR} = \frac{\log_e W_2 - \log_e W_1}{T_2 - T_1}$$

14. Net assimilation rate (NAR) in g/cm^2/day: Determined according to Radford's method (1967), where**:** W_1, A_1 and W_2, A_2, respectively refer to dry weight and leaf area of plant at sampling time T_1 and T_2, respectively.

$$\textbf{NAR} = \frac{(W_2 - W_1)(\log_e A_2 - \log_e A_1)}{(T_2 - T_1)(A_2 - A_1)}$$

B. Petal yield was taken at 180 and 195 days from sowing (DFS) in all sowing dates in both seasons.

1. Fresh weight of petal yield (kg/fed).
2. Dry weight of petal yield (kg/fed).

Statistical Analysis

All obtained data were statistically analyzed according to the technique of analysis of variance (ANOVA) for the strip plot design to each experiment (sowing dates), then combined analysis was done between sowing dates by means of "MSTAT-C " computer software package as published by Gomez and Gomez (1984). Least Significant Difference (LSD) method was used to test the differences between treatment means at 5 % level of probability as described by Waller and Duncan (1969).

RESULT AND DISCUSSION

Effect of sowing dates:

The statistical analysis of obtained results that presented in Tables 2, 3, 4 and 5 showed that all growth characters which estimated at 90 and 120 days after sowing *i.e.* plant height, stem diameter, number of main branches and leaves/plant, stem and branches and leaves fresh and dry weight, leaf area index (LAI), specific leaf weight (SLW), leaves/stem and branches ratio, crop growth rate (CGR), relative growth rate (RGR) and net assimilation rate (NAR) as well as fresh and dry weight of petal yield at 180 and 195 days from sowing exhibited significant effect due to sowing dates in the two growing seasons, excluding of SLW at 90 day after sowing in the first season only. Noteworthy, intermediate sowing date (1st October) resulted in the highest values of all studied growth characters at 90 and 120 days from sowing as well as fresh and dry weight of petal yield at 180 and 195 days from sowing in both seasons, except CGR, RGR and NAR in both seasons which produced from sowing on 1st September. On the other hand, the lowest means of all studied traits were recorded from sowing on 1st September at 90 and 120 days from sowing in the two growing seasons, excluding plant height (at 90 and 120 days from sowing in both seasons), leaves/stem and branches ratio (at 120 days from sowing in the first seasons), CRG, RGR and NAR (in both seasons), which obtained from sowing on 1st November. The superiority of sowing safflower on 1st October with respect to growth and petal yield may be due to the suitable weather conditions during growth stages of plant that held rapid growth and formation a good canopy able to make efficient photosynthesis consequently increasing growth traits as well as fresh and dry weight of petal. These results are in harmony with those obtained by Badawi *et al.* (1996), Dadashi and Khajehpour (2004) and Omidi and Sharifmogadas (2010).

Effect of nitrogen fertilizer levels:

From obtained results in Tables 2 through 5, nitrogen fertilizer levels significantly affected all studied characters *i.e.* growth characters (plant height, stem diameter, number of main branches and leaves/plant, stem and branches and leaves fresh and dry weight, LAI, SLW, leaves/stem and branches ratio, CGR, RGR and NAR) at 90 and 120 days from sowing as well as fresh and dry weight of petal yield at 180 and 195 days from sowing in both seasons. It can be easily consider that raising nitrogen levels markedly accompanied with obvious increase in all studied characters in both seasons. Application of 80 kg N/fed significantly resulted in the highest values of all studied characters of safflower, except leaves/stem and branches ratio in the two growing seasons. In addition, application of 60 kg N/fed produced the best results after aforementioned level in both seasons.

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However, the lowest values of all studied characters were resulted from application of 40 kg N/fed, excluding leaves/stem and branches ratio in the two growing seasons. These increases in growth and petal yield may be due to the role of nitrogen in increment chlorophyll concentration in leaves and increasing photosynthesis process, which led to improve growth consequently increasing fresh and dry weight of petal. These findings were proportionately with those reported by Steer and Harrigen (1986), Ashoub (1995), Badawi *et al.* (1996) and Siddiqui and Oad (2006).

Effect of times of foliar application with Melagrow:

Times of foliar application with Melagrow as a natural growth promoter exhibited significant effect on all studied growth characters of safflower which estimated at 90 and 120 days from sowing as well as fresh and dry weight of petal yield which estimated at 180 and 195 days from sowing in both seasons, except leaves/stem and branches ratio at 90 in the first season and 120 days from sowing in the second seasons. It can be observed that foliar application safflower plants with Melagrow twice after 30 and 70 days from sowing produced the highest values of all studied growth characters at 90 and 120 days from sowing as well as fresh and dry weight of petal yield at 180 and 195 days from sowing in the two growing seasons, exclusion leaves/stem and branches ratio, CRG, RGR and NAR, which resulted from one foliar application with Melagrow after 30 days from sowing in both seasons. Application of Melagrow one time after 30 days from sowing came in the second rank after aforementioned treatment with significant differences in respect most growth and petal yield characters in both seasons. The lowest values of studied growth and petal yield characters were resulted from control treatment (without foliar application), except CRG, RGR and NAR at both growth samples in the two growing seasons. The increases in growth and petal yield characters by foliar application twice with Melagrow that contains phosphorus, potassium, boron and brassinolide may be due to the role of macro and micronutrients in activating physiological and biochemical processes as well as the role of brassinolides in improvement growth reflecting increases in fresh and dry weight of petal. These results were parallel with those reported by Berova and Zlatev (2000), Dholekar *et al.* (2001) and Ebrahimzadeha *et al.* (2009).

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إستجابة النمو ومحصول بتلات القرطم لمواعيد الزراعة ومستويات السماد النيتروجيني ومواعيد الرش بمنشطات النمو الطبيعية (ميلاجرو)

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**** وزارة الزراعة – جمهورية العراق.**

أجريت التجربة الحقلية بمحطة التجارب والبحوث الزراعية بكلية الزراعة – جامعة المنصورة خلال موسمى ٢٠٠٩/٢٠١٠ و٢٠١٠/٢٠١١ م بهدف دراسة تأثير مواعيد الزراعة (أول سبتمبر ، أول أكتوبر وأول نوفمبر) ، مستويات السماد النيتروجينى (٤٠ ، ٦٠ و٨٠ كجم نيتروجين/فدان) وعدد مرات الرش بمركب الميلاجرو "كمنشط نمو طبيعى" (بدون رش ، الرش مرة واحدة بعد ٣٠ يوم من الزراعة والرش مرتين بعد ٣٠ و٧٠ يوم من الزراعة) على صفات النمو ومحصول البتلات للقرطم صنف جيزة ١. أجرى كل ميعاد زراعة فى تجربة مستقلة ثم نفذ كل ميعاد زراعة فى تصميم الشرائح المتعامدة فى ثلاث مكررات.

ويمكن تلخيص أهم النتائج المتحصل عليها:

١- تفوق ميعاد الزراعة المتوسط للقرطم (أول أكتوبر) على كلا الموعدين الآخرين (أول سبتمبر وأول نوفمبر) فى جميع صفات النمو تحت الدراسة بعد ٩٠ و١٢٠ يوم من الزراعة ومحصول البتلات الغض والجاف بعد ١٨٠ و١٩٥ يوم من الزراعة فى كلا الموسمين ، بإستثناء صفات معدل نمو المحصول ، المعدل النسبى للنمو والكفاءة التمثيلية فى كلا الموسمين حيث نتجت أفضل النتائج من الزراعة فى أول سبتمبر.

٢- أدى تسميد نباتات القرطم بأعلى معدل للسماد النيتروجينى (٨٠ كجم نيتروجين/فدان) إلى زيادة معنوية فى جميع صفات النمو ومحصول البتلات تحت الدراسة والحصول على أعلى القيم لتلك الصفات فى كلا الموسمين. فى حين أن التسميد النيتروجينى بمعدل ٤٠ كجم نيتروجين/فدان أدى للحصول على أقل القيم لجميع الصفات المدروسة فى كلا موسمى الدراسة.

٣- أظهر رش نباتات القرطم بمنشط النمو الطبيعى "ميلاجرو" مرتين بعد ٣٠ و٧٠ يوم من الزراعة للحصول على أعلى القيم لجميع صفات النمو تحت الدراسة بعد ٩٠ و١٢٠ يوم من الزراعة ومحصول البتلات الغض والجاف بعد ١٨٠ و١٩٥ يوم من الزراعة فى كلا الموسمين ، بإستثناء نسبة الأوراق/السيقان وعدد الأفرع ، معدل نمو النبات ، معدل النمو النسبى وكفاءة التمثيل الضوئى والتى نتجت من الرش مرة واحدة بالميلاجرو بعد ٣٠ يوم من الزراعة فى كلا الموسمين. أتى الرش مرة واحدة بالميلاجرو فى المرتبة الثانية بالنسبة لمعظم صفات النمو تحت الدراسة ومحصول البتلات الغض والجاف بعد معاملة الرش مرتين بالميلاجرو بفروق معنوية فى كلا الموسمين. فى حين أن أقل القيم لجميع الصفات تحت الدراسة نتجت من معاملة المقارنة (بدون رش ورقى) فى كلا موسمى الدراسة.

من النتائج المتحصل عليها فى هذه الدراسة فإنه يمكن التوصية بزراعة القرطم فى أول أكتوبر والتسميد النيتروجينى بمعدل ٨٠ كجم/فدان مع الرش مرتين بمركب الميلاجرو كمنشط نمو طبيعى وذلك للحصول على أفضل نمو ومحصول البتلات من القرطم تحت ظروف محافظة الدقهلية ، مصر.

قام بتحكيم البحث

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Table 2: Plant height, stem diameter, and number of main branches and leaves/plant at 90 and 120 days from sowing (DFS) as affected by sowing date, nitrogen fertilizer levels and time of foliar application with Melagrow during 2009/2010 and 2010/2011 seasons.

Characters / Seasons / Treatments	Plant height (cm)				Stem diameter (cm)				Number of main branches/plant				Number of leaves/plant			
	2009/2010		2010/2011		2009/2010		2010/2011		2009/2010		2010/2011		2009/2010		2010/2011	
	90 DFS	120 DFS	90 DFS	120 DFS	90 DFS	120 DFS	90 DFS	120 DFS	90 DFS	120 DFS	90 DFS	120 DFS	90 DFS	120 DFS	90 DFS	120 DFS
A- Sowing dates:																
1st September	147.4	156.6	158.7	166.8	1.19	1.24	1.30	1.33	11.55	13.37	14.37	14.74	128.8	134.5	140.0	142.8
1st October	161.3	170.4	167.3	178.2	1.31	1.37	1.42	1.46	14.03	14.88	15.55	15.77	186.2	196.7	197.4	206.4
1st November	146.5	151.8	151.7	161.2	1.25	1.29	1.35	1.38	12.85	14.03	15.18	15.22	149.2	169.9	159.6	182.3
F. test	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
LSD at 5 %	1.9	1.9	1.5	2.6	0.01	0.01	0.01	0.01	0.61	0.33	0.60	0.41	4.4	5.6	4.0	5.2
B- Nitrogen levels:																
40 kg N/fed	120.2	135.0	127.2	144.7	1.11	1.18	1.21	1.26	8.07	9.07	10.29	10.07	133.3	143.7	143.7	153.8
60 kg N/fed	154.2	161.8	161.3	171.2	1.26	1.30	1.36	1.39	13.00	14.51	15.59	15.66	152.9	163.5	164.0	173.5
80 kg N/fed	180.8	181.9	189.2	190.2	1.39	1.42	1.50	1.52	17.37	18.70	19.22	20.00	178.1	193.8	189.2	204.2
F. test	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
LSD at 5 %	1.9	1.9	1.5	2.6	0.01	0.01	0.01	0.01	0.61	0.33	0.60	0.41	4.4	5.6	4.0	5.2
C- Time of Melagrow application:																
Without	142.0	152.3	149.0	161.3	1.21	1.26	1.31	1.35	11.29	12.51	13.48	13.66	147.5	156.6	157.9	165.9
One (30 DFS)	151.4	159.4	158.7	168.7	1.25	1.30	1.35	1.39	12.66	14.14	15.07	15.29	154.5	166.1	165.4	176.5
Two(30 & 70 DFS)	161.8	167.1	170.1	176.3	1.30	1.34	1.40	1.43	14.48	15.63	16.55	16.77	162.2	178.4	173.6	189.1
F. test	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
LSD at 5 %	1.5	1.6	1.3	1.7	0.01	0.01	0.01	0.01	0.35	0.30	0.47	0.27	2.3	4.5	2.2	4.3

Table 3: Stem, branches and leaves fresh and dry weight at 90 and 120 days from sowing (DFS) as affected by sowing date, nitrogen fertilizer levels and time of foliar application with Melagrow during 2009/2010 and 2010/2011 seasons.

Characters / Seasons / Treatments	Stem and branches fresh weight (g)				Stem and branches dry weight (g)				Leaves fresh weight (g)				Leaves dry weight (g)			
	2009/2010		2010/2011		2009/2010		2010/2011		2009/2010		2010/2011		2009/2010		2010/2011	
	90 DFS	120 DFS	90 DFS	120 DFS	90 DFS	120 DFS	90 DFS	120 DFS	90 DFS	120 DFS	90 DFS	120 DFS	90 DFS	120 DFS	90 DFS	120 DFS
A- Sowing dates:																
1st September	222.2	267.7	235.9	277.8	74.0	89.9	78.7	96.1	84.1	103.0	88.9	110.4	28.59	33.73	30.42	36.90
1st October	323.6	343.5	337.5	348.5	107.5	120.7	112.8	123.9	146.8	149.4	153.4	156.6	48.59	47.70	51.76	51.82
1st November	283.9	305.2	296.7	315.3	91.7	104.8	98.6	109.5	113.4	118.5	119.9	126.8	36.39	38.89	40.21	42.60
F. test	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
LSD at 5 %	7.3	11.4	8.3	6.3	2.3	2.0	2.5	2.2	2.9	4.3	2.6	3.5	0.83	1.12	1.07	1.48
B- Nitrogen levels:																
40 kg N/fed	199.0	212.7	210.3	218.3	65.4	71.7	70.4	75.8	86.3	80.6	91.3	87.5	28.49	26.74	30.92	29.31
60 kg N/fed	269.9	300.9	282.0	312.9	88.7	105.9	94.1	110.6	111.5	124.3	118.1	132.6	37.02	39.91	39.81	44.02
80 kg N/fed	360.8	402.8	377.8	410.3	119.1	137.9	125.7	143.1	146.5	165.9	152.8	173.7	48.06	53.66	51.66	58.00
F. test	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
LSD at 5 %	7.3	11.4	8.3	6.3	2.3	2.0	2.5	2.2	2.9	4.3	2.6	3.5	0.83	1.12	1.07	1.48
C- Time of Melagrow application:																
Without	246.5	265.3	259.0	271.5	81.2	91.5	86.6	95.8	102.2	108.0	108.2	114.9	33.96	35.13	36.84	38.62
One (30 DFS)	270.5	306.9	282.5	316.9	89.0	106.0	94.2	110.8	114.7	124.0	121.1	132.3	38.07	40.33	40.83	44.17
Two(30 & 70 DFS)	312.7	344.1	328.6	353.2	103.0	117.9	109.3	122.9	127.4	138.9	132.7	146.6	41.54	44.86	44.72	48.54
F. test	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
LSD at 5 %	5.2	8.1	4.4	4.8	1.8	1.6	1.3	1.5	2.1	2.7	2.0	2.6	0.68	0.82	0.72	0.96

Table 4: Leaf area index (LAI), specific leaf weight (SLW), leaves/stem and branches ratio at 90 and 120 days from sowing (DFS) and crop growth rate (CGR) as affected by sowing date, nitrogen fertilizer levels and time of foliar application with Melagrow during 2009/2010 and 2010/2011 seasons.

Characters / Seasons / Treatments	LAI				SLW (mg/cm^2)				Leaves/stem and branches ratio				CGR (g/day)	
	2009/2010		2010/2011		2009/2010		2010/2011		2009/2010		2010/2011		2009/2010	2010/2011
	90 DFS	120 DFS	90 DFS	120 DFS	90 DFS	120 DFS	90 DFS	120 DFS	90 DFS	120 DFS	90 DFS	120 DFS		
A- Sowing dates:														
1st September	0.296	0.457	0.306	0.474	0.180	0.141	0.188	0.149	0.389	0.378	0.392	0.388	0.731	0.820
1st October	0.477	0.501	0.497	0.516	0.185	0.186	0.197	0.207	0.443	0.418	0.467	0.462	0.593	0.613
1st November	0.370	0.482	0.389	0.498	0.184	0.152	0.193	0.162	0.395	0.371	0.404	0.391	0.530	0.468
F. test	*	*	*	*	NS	*	*	*	*	*	*	*	*	*
LSD at 5 %	0.001	0.020	0.010	0.020	-	0.008	0.006	0.011	0.018	0.014	0.015	0.029	0.147	0.132
B- Nitrogen levels:														
40 kg N/fed	0.344	0.428	0.359	0.442	0.148	0.129	0.165	0.148	0.414	0.401	0.435	0.436	0.373	0.406
60 kg N/fed	0.383	0.489	0.400	0.509	0.183	0.155	0.188	0.164	0.410	0.376	0.419	0.397	0.668	0.692
80 kg N/fed	0.416	0.524	0.434	0.538	0.219	0.195	0.225	0.206	0.403	0.390	0.410	0.408	0.813	0.802
F. test	*	*	*	*	*	*	*	*	*	*	*	*	*	*
LSD at 5 %	0.001	0.020	0.010	0.020	0.006	0.008	0.006	0.011	0.018	0.014	0.015	0.029	0.147	0.132
C- Time of Melagrow application:														
Without	0.368	0.462	0.383	0.478	0.168	0.149	0.182	0.160	0.406	0.387	0.424	0.416	0.546	0.526
One (30 DFS)	0.382	0.485	0.398	0.501	0.184	0.159	0.193	0.174	0.418	0.401	0.431	0.419	0.686	0.751
Two(30 & 70 DFS)	0.393	0.493	0.411	0.509	0.198	0.171	0.204	0.184	0.403	0.379	0.410	0.405	0.622	0.623
F. test	*	*	*	*	*	*	*	*	NS	*	*	NS	*	*
LSD at 5 %	0.003	0.014	0.005	0.015	0.004	0.006	0.005	0.009	-	0.013	0.008	-	0.102	0.106

Table 5: Relative growth rate (RGR), Net assimilation rate (NAR), fresh and dry weight of petal yield at 180 and 195 days from sowing (DFS) as affected by sowing date, nitrogen fertilizer levels and time of foliar application with Melagrow during 2009/2010 and 2010/2011 seasons.

Characters / Seasons / Treatments	RGR (g/g/day)		NAR (g/cm^2/day)		Fresh weight of petal yield (kg/fed)				Dry weight of petal yield (kg/fed)			
					2009/2010		2010/2011		2009/2010		2010/2011	
	2009/2010	2010/2011	2009/2010	2010/2011	180 DFS	195 DFS	180 DFS	195 DFS	180 DFS	195 DFS	180 DFS	195 DFS
A- Sowing dates:												
1st September	0.099	0.102	0.675	0.756	37.11	38.82	40.43	44.49	25.16	27.71	29.20	33.07
1st October	0.088	0.089	0.585	0.607	56.00	59.59	60.71	65.80	36.07	42.61	43.14	47.84
1st November	0.086	0.083	0.502	0.444	43.54	46.88	48.29	53.27	28.40	36.33	36.24	41.36
F. test	*	*	*	*	*	*	*	*	*	*	*	*
LSD at 5 %	0.010	0.007	0.140	0.127	0.47	0.58	0.77	0.89	0.34	0.60	0.46	0.44
B- Nitrogen levels:												
40 kg N/fed	0.074	0.076	0.358	0.391	40.85	44.10	45.82	49.83	26.84	31.47	32.62	36.97
60 kg N/fed	0.097	0.098	0.634	0.654	45.81	47.88	49.93	54.29	29.62	35.71	36.08	41.02
80 kg N/fed	0.102	0.100	0.771	0.761	49.98	53.31	53.68	59.44	33.18	39.47	39.87	44.29
F. test	*	*	*	*	*	*	*	*	*	*	*	*
LSD at 5 %	0.010	0.007	0.140	0.127	0.47	0.58	0.77	0.89	0.34	0.60	0.46	0.44
C- Time of Melagrow application:												
Without	0.085	0.083	0.522	0.501	44.05	46.91	48.58	52.84	28.59	34.10	34.98	39.52
One (30 DFS)	0.096	0.100	0.651	0.715	45.51	48.43	49.60	54.48	29.95	35.69	36.18	40.84
Two(30 & 70 DFS)	0.092	0.091	0.589	0.591	47.07	49.94	51.25	56.23	31.10	36.86	37.41	41.91
F. test	*	*	*	*	*	*	*	*	*	*	*	*
LSD at 5 %	0.008	0.006	0.099	0.104	0.33	0.36	0.34	0.31	0.21	0.32	0.23	0.24