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Influence of planting date on growth, stem number formation and flower appearance of *Matthiola incana* L.

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Abstract: The study was conducted in the Akam plantation at Erbil city; University of Salahaddin Erbil – Iraq, during the growing season from October 2009 to June 2010. Plants of *Matthiola incana L.* were planted in plastic pots with a diameter of 20 cm. The experiment was accomplished in Randomized Complete Design (RCD) in three replications, the data were analysed with general linear model procedures in SAS, and the Duncan test at the level 0.05 was used for comparing the means. The experiment included 16 treatments, the combination between 4 planting dates; 01.10.2009, 15.10.2009, 30.10.2009, 15.11.2009 and selecting different number of stems; one stem, two stems, three stems, four stems, after selection of the main stems, all new shoots were removed twice a week. The growth parameters (plant height, flowering time, number of flowers, fresh and dry weight of plants) were significantly responded to planting date and number of stems. Maximum values of plant heights were obtained from (D1) 01.10.2009, while there was a decrease in heights of plants planted in (D4) 15.11.2009. Planting in (D1) led to an increase in the number of flowers. The height of plants was increased significantly at plants with one stem (S1), while the number of flowers per plant increased with an increasing number of stems (S4). The planting date did not impact on flower time.

Keywords: *Matthiola incana*, planting time, stem number, growth characteristics.

Introduction

Matthiola incana L. belongs to the *Brassicacae* family and although it is a perennial, it is mostly used as an annual plant cultivated in pots or for fresh cut. This species is native to the Mediterranean Region and the Canary Islands, from Spain to Turkey and in the south to Egypt. It produces spikes of double and single flowers in shades of rose, purple, pink and white, fruits of the size from 4 to 16 cm, erect to somewhat spreading, compressed without glands; stigma without conspicuous horns (GULLEN et al. 1995). The double flowering varieties are used for decoration, for the beauty of their flowers and their pleasant aroma (EL- QUESNI et al. 2012). It is mainly used for planting in flowerbeds in different types of gardens, and has become an economically important floral crop (HISAMATSU et al. 2000). *Matthiola incana* requires low temperature and long day for flowering (HISAMATSU & KOSHIOKA 2001). Low temperature is required rather by late flowering cultivars than by early flowering ones (FUJITA 1989).

Date of planting plays an important role in regulating growth and quality of plants. Earlier planting is beneficial as it allows plants to mature and increases the probability of harvesting prior to inclement fall weather. The mean values regarding plant height reveal that different planting dates significantly impacted on the plant height of *Gladiolus* (AHMAD et al. 2011). Vegetative growth and quality of gladiolus is improved by proper planting times which also satisfies the consumer's demands (ZUBAIR et al. 2006). CHANDA & ROYCHOUDHURY (1991) found that *Tagetes erecta* plant height, plant spread, number of primary branches, number of flowers and flower yield/plant were higher at the wider spacing but yield/ha was the highest in closer spacing. MOHANTY et al. (1993) found that planting *Tagetes erecta* in May produced a greater number of secondary branches and increased plant height and spread. Planting in September temperature produced a greater number of larger flowers per plant and per plot. Yield parameters in *Matthiola incana*, such as number of seeds per pod and number of pods per plant were lower in early-flowering breeding lines than in the late-flowering ones (YANIV et al. 1992). With delayed sowing development is accelerated because the crops encounter higher temperatures during the vegetative growth (DAMATO et al. 1994).

Disbudding is another method to achieve quality blooms. A term used in gardening to describe the process of limiting the number of flower or growth buds on plants. The purpose may be to divert food material from a number of flower buds to one or more special buds in order to encourage the development of a limited number of exceptionally fine blooms. There are many reports on favourable influence of pruning on quality of flower crop. HOLLEY (1973) recorded 10 cm increase in stem length for each millimetre increase in diameter of mother cane. CEBULA (1995) reported that high total yield could be obtained from plants pruned to one stem grown at 8 plants.m^{-2} or two- stem plants at 4 plants.m^{-2}. Among the three different stages of pinching and disbudding of *Chrysanthemum* neither pinching nor disbudding, pinching at 30 days after transplanting and disbudding (as and when needed) and foliar spray of 0.2% cytozyme (no application, 10, 20, 30 days after transplanting). Many factors were found

promising in improvement of different vegetative growth and flowering characters of *Chrysanthemum* (SANDEEP et al. 2013). Plants pruned to two stems yielded a higher number of fruits per plant (MABOKO & DU PLOOY 2009). ZHAO et al. (2014) found zinnias, yield (272 stem per plot) of first planting date was higher than planting date two (106 stem per plot). The main aim of this study determines a correlative relationship between planting date and the number of stems per plant on *Matthiola incana* L. morphological characteristics.

Material and methods

The study was accomplished in the Akam plantation at Erbil city; University of Salahaddin Erbil – Iraq, during the growing season from October 2009 to June 2010. Plants of *Matthiola incana L.* were planted in plastic pots (20 cm), the soil at the experiment site was river sand. The experiment was accomplished in Randomized Complete Design (RCD) in three replications, the data were analysed with the general linear model procedures in SAS, and the Duncan test at the level 0.05 was used for comparing the means. Four different planting dates were used in this experiment D1 (01.10.2009), D2 (15.10.2009), D3 30.10.2009), D4 (15.11.2009), while selecting different numbers of main stems S1 (1), S2 (2), S3 (3), S4 (4), after selection of the main stems, all new shoots were removed twice a week. The average temperature and rainfall during the growing time were measured (Table 1). The plants were irrigated regularly and fertilized after planting in 15.02.2010 with NPK (1) mg per pot. Data were taken in June, including plant height (cm), flowering date (days from planting to start of blooming), number of flowers (spikes), wet (fresh) and dry weight of plants (g).

Tab. 1. Mean monthly temperature (℃) and rainfall (mm) during the studying time

Month	Temperature in ºC 2009-2010		Rainfall in mm 2009-2010
	minimum	maximum	
September	19.9	28.0	0.0
October	15.2	21.0	3.8
November	10.5	18.5	1.3
December	9.0	16.5	3.5
January	5.4	12.4	113.9
February	6.3	13.8	42.8
March	9.0	18.9	30.5
April	14.9	23.9	101.5
May	19.7	30.2	12.7
June	20.2	30.7	0.0

Results

Height of plants (cm)

The presented data (Table 2) showed that planting in (D1) 01.10.2009 increased the height of plants (33.83 cm), the lowest height of plants was at

those planted on the last date (D4) 15.11.2009 and achieved follow values in average (29.08 cm). The differences between D1 and other treatments were significant (Figure 1). According to the presented values (Table 2, Figure 2), plants with one stem (S1) achieved the highest height of plants (37.92 cm) and the lowest height was in plants with three stems (S3) which recorded follow values in average (29.08 cm). The same table shows that interaction between (D3) and (S1) had the highest height of plants (43.33 cm), while plantings on another date (D4) with two stems resulted in the lowest height of plants (22.67 cm). In interaction between (D2, S1) and (D1, S4), there were no significant differences, while interaction between other treatments the differences were significant.

Flowering time (early flowering)

According to received results (Table 3), there were no significant differences between planting date and flowering time, (D3) increased days for flowering as shown in Figure 3. According to presented values (Figure 4, Table 3), plants grown with two stems (S2) needed more days for flowering in comparison with plants in other experiment combinations (S1, S4). The number of stems per plant is a factor that affects light interception by the canopy and the differences were significant with treatments given in other experimental arrangements (S1, S4) where the same flowering time (68.75 days) was recorded. According to results shown in the same Table, the interaction between followed combinations (D2, S2), (D3, S2), (D4, S2), (D3, S3), (D3, S4) there were no significant differences. Planting in D4 with S4, the flowering started earlier (57.33 days) than the other treatments.

Number of flowers

According to observed results (Table 4), we can see the highest number of flowers per plants in combination of (D1) (41.42) compared to other planting dates and the differences were significant. At plants with (S4), the highest number of flowers was recorded (46.92) while the lowest number of flowers was recorded at plants with one stem (S1), (22.17). As presented in the same Table, the interaction between (D1, S4) had the highest number of flowers per plants (64.33) compared to the interaction between (D4, S1), (21.33) and the differences between other treatments interaction were significant. There is an inverse relationship between the plant's height and number of flowers. Where the height of plants decreased, the amount of flowers increased according to the number of branches (Figure 2).

Wet weight of plants (g)

According to measured outputs (Table 5), the highest wet weight was found at plants planted in variant (D4), (14.06 g) and the lowest wet weight was recorded at plants planted in (D2), (6.13 g). Plants with more stems (S3) achieved the highest wet weight (12.87 g), compared to plants (S1) which had the lowest wet weight (8.82 g). Regarding statistical valuation, there were no significant

differences between the plants of the experimental combination (S2, S4) in the characteristic of wet weight. Interaction between (D4, S3) had the highest wet weight (16.25 g), while the lowest was in (D2, S4), (4.16 g) and the interaction between other treatment combinations was significant.

Dry weight of plants (g)

According to the recorded results (Table 6), the highest dry weight was found at plants planted in the variant (D4), (4.44 g) and the lowest dry weight was at plants planted in (D2), (0.95 g). Plants with three stems (S3) showed the highest dry weight (3.73 g) and the lowest dry weight was in planting time (S1), (1.99 g) and the differences between all treatments were significant. Interaction between an experiment variant (D4, S1, S2, S3, S4) and (D3, S2, S3) there were no significant differences, the highest dry weight was found in the interaction between (D4, S3), (4.75 g) and lowest dry weight was in the interaction between (D2, S4), (0.68 g).

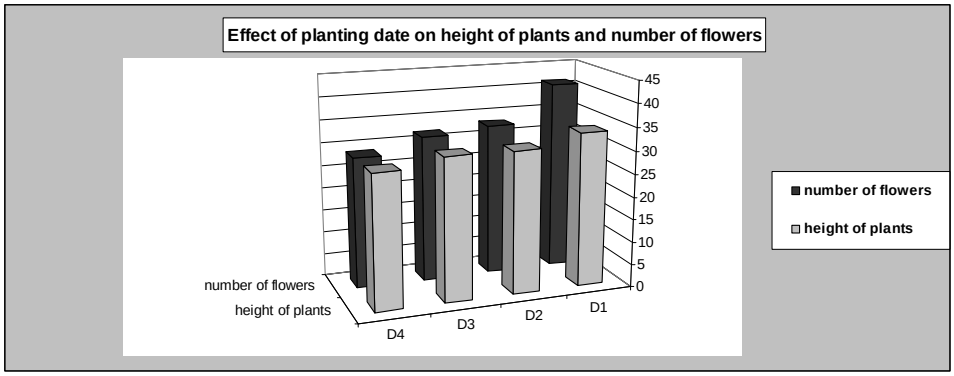

Fig. 1. Effect of planting date on height of plants and number of flowers (spikes)

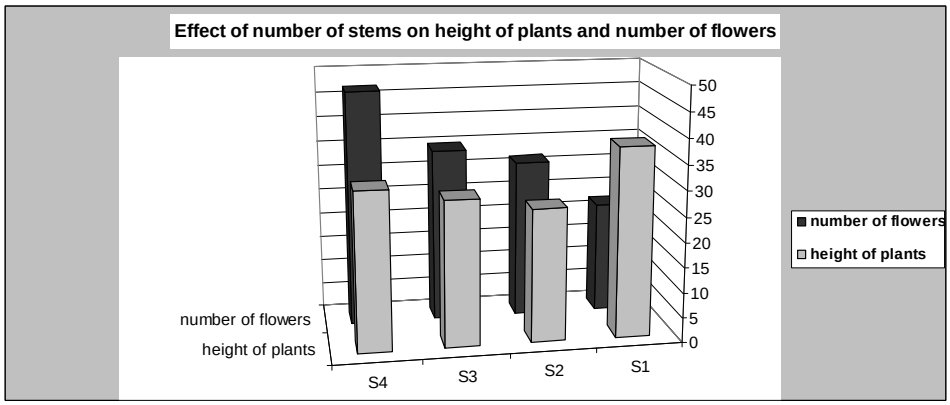

Fig. 2. Effect of number of stems on height of plants and number of flowers (spikes)

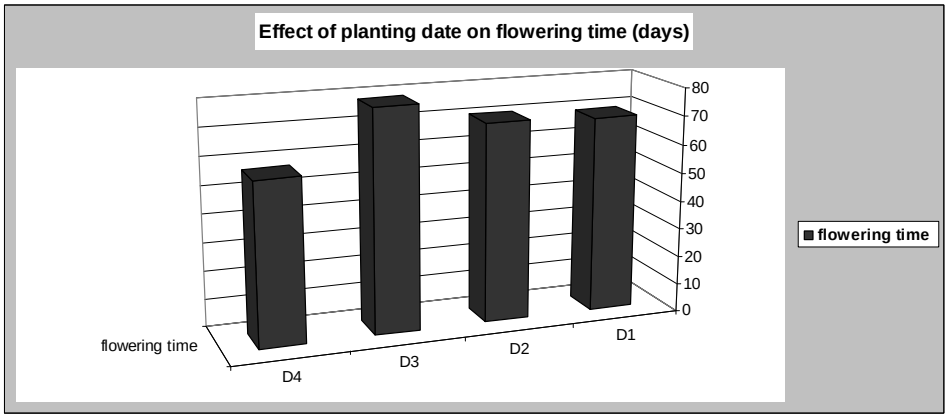

Fig. 3. Effect of planting date on flowering time (days)

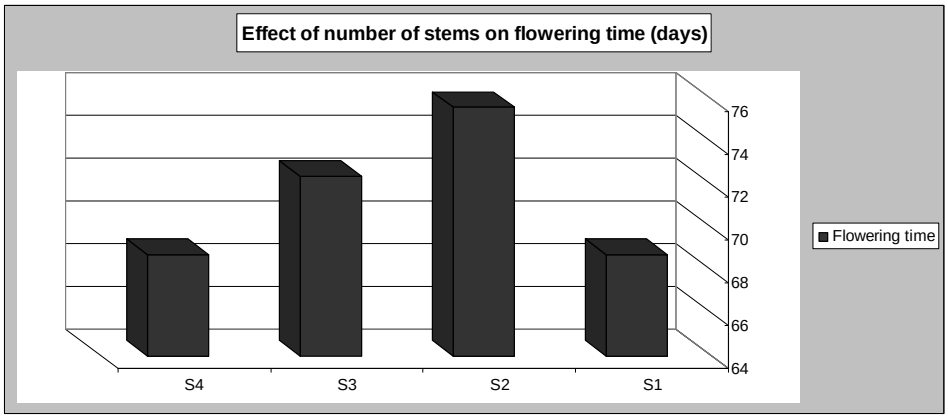

Fig. 4. Effect of number of stems on flowering time (days)

Tab. 2. Effect of planting date, stem number and interaction between them in the height of plants (cm)

Height of plants (cm)		Factor planting date				Mean stems number
		D1	D2	D3	D4	
Factor stems number	S1	37.000b	37.333ab	43.333a	34.000bc	37.917a
	S2	29.667cd	27.000de	27.000de	22.667e	26.583d
	S3	30.000cd	30.667cd	25.333de	30.333cd	29.083c
	S4	38.667ab	29.333cd	29.000cd	29.333cd	31.583b
Mean planting date		33.833a	31.083b	31.167b	29.083b	31.292

*Means not followed by the same letters are significant at 5% level of probability

Tab. 3. Effect of planting date, stem numbers and interaction between them on flowering time (days)

Flowering time (days)		Factor planting date				Mean stems number
		D1	D2	D3	D4	
Factor stems number	S1	74.000ab	68.000a-c	62.333bc	70.667ab	68.750b
	S2	70.667ab	77.000a	77.333a	77.667a	75.667a
	S3	70.667ab	75.000ab	76.000a	68.000a-c	72.417ab
	S4	69.000a-c	70.333ab	78.333a	57.333c	68.750b
Mean planting date		71.083a	72.583a	73.500a	68.417a	71.396

*Means not followed by the same letters are significant at 5% level of probability

Tab. 4. Effect of planting date, stem numbers and interaction between them on number of flowers (spikes)

Number of flowers		Factor planting date				Mean stems number
		D1	D2	D3	D4	
Factor stems number	S1	23.667g-i	21.667i	22.000hi	21.333i	22.167c
	S2	35.000c-f	31.333d-h	34.667c-f	25.333f-i	31.583b
	S3	42.667bc	32.667d-g	30.333e-i	33.000d-g	34.667b
	S4	64.333a	47.000b	41.000b-d	35.333c-e	46.917a
Mean planting date		41.417a	33.167b	32.000b	28.750b	33.833

*Means not followed by the same letters are significant at 5% level of probability

Tab. 5. Effect of planting date, stem numbers and interaction between them on plant wet weight

Plant wet weight		Factor planting date				Mean stems number
		D1	D2	D3	D4	
Factor stems number	S1	8.940fg	5.967i	7.070gh	13.317c-e	8.823c
	S2	7.343gh	6.583gi	13.087c-e	13.553b-d	10.142b
	S3	11.403d-f	7.787gh	16.040ab	16.253a	12.871a
	S4	14.647a-c	4.163ij	10.563ef	13.120c-e	10.623b
Mean planting date		10.583b	6.125c	11.690b	14.061a	10.615

*Means not followed by the same letters are significant at 5% level of probability

Tab. 6. Effect of planting date, stem numbers and interaction between them on plant dry weight

Plant dry weight		Factor planting date				Mean stems number
		D1	D2	D3	D4	
Factor stems number	S1	1.847c	0.777de	1.073c-e	4.293a	1.998c
	S2	1.567cd	0.840ed	4.343a	4.413a	2.791b
	S3	3.993ab	1.497cd	4.703a	4.750a	3.736a
	S4	4.070ab	0.675e	3.330b	4.303a	3.095b
Factor planting date		2.869c	0.947d	3.363b	4.440a	2.905

*Means not followed by the same letters are significant at 5% level of probability

Discussion

Earlier planting produced longer stems found by KO et al. (1994). KHAN et al. (2008) also stated that planting time significantly influenced the vegetative growth of *Tulip*. The growth parameters (plant height, plant diameter, number of branches, as well as fresh and dry matter yield of plant herb) were significantly influenced by the planting date in *Tagetes lucida* L. (ISMAIL et al. 2013). Probably the planting schedule varies due to differences in photoperiods, temperatures and light intensity. In general, plants with one stem (S1) had a greater plant length or height than plants with two and three stems, the results agree with (HOCHMUTH 1991). Planting in October resulted in an increase in the days to flowering, the same results were published by ROBERT (2004) in *Rosa* who found out that the period for flower harvest decreased as the spring progressed. CONLEY & WIEBOLD (2003) found out that the number of days between planting and flowering decreased in *Sorghum* as planting was delayed and they came to the conclusion that the effect probably resulted from slower emergence and less rapid accumulation of heat units for early planting dates. Early spiking at high temperatures is also reported by HALEVY (1985). Planting in D4 with S4 started flowering earlier than the other treatments (57.33 days). A similar dependence was found by TOMAĽOVA and VALŠÍKOVÁ (2012) when evaluating phenological characteristics of sweet pepper. The results agree with the finding of MC CALLA (2011) who reported an increase in the number of days to inflorescence formation in *Gladiolus* under lower temperatures. Maximum temperature was recorded during plantation on the 10th of September and the 25th of September with 26.35˚C and 25.08˚C respectively, while the lowest temperature 15.85˚C was recorded during the plantation on the 10th of November. Our results agree with BLANCHARD & RUNKLE (2011) who found that plants are grown at an MDT above the optimum temperature; the flower development rate begins to decline. Plant development responses to temperature, such as flowering or leaf unfolding rate, are primarily controlled by the integrated MDT (BLANCHARD et al. 2011). The lowest number of spikes was found when the plants were planted in D4 with S1 (21.33) spikes per plant. The result disagrees with ASIF et al. (2001) who found that the number of spikes per plant also significantly varied among all treatments. It was noted that plantation between the 15th of March and the 15th of April gave more number of spikes per plant as compared to early or late planting dates in *Polianthes tuberosa*. The maximum number of florets (17.16) was recorded in variant (D2) followed by D3 (30.10.2009) with 15.83 florets in *Gladiolus grandiflorus* (ADEL et al. 2013). Similar results were found by MUKHOPADHYAY & BANKER (1981) who presented that maximum spikes per plants were obtained at plantings of *Polianthes tuberosa* planted from April to May . The number of flowers per plant increased with increasing the number of stems (S4), the same result was found by MORTENSEN & GISLEROD (1994) who also observed that hard pruning in July decreased the yield in roses. Flowering of *Celosia*, *Impatiens*, *Salvia, Tagetes* and *Viola* occurred 10, 12, 11, 4 and 12 days earlier, respectively, when seedlings were previously grown under the highest DLI compared to the lowest. Except for *Viola*, earlier flowering corresponded with the

development of fewer nods below the first flower. Flower bud number and plant shoot dry weight at first flowering decreased as the seedling DLI increased in all species except for flower number of *Tagetes* (PRAMUK & RUNKLE 2005). Temperature primarily controls plant developmental rate and thus production time, but it can also interact with light quantity to affect crop quality attributes such as flower number, branching, and biomass production (VAID et al. 2014). Both early and late planted *kenaf* (*Hibiscus cannabinus*) exhibited similar growth rates so that the greater biomass production of the early planting can be attributed to the larger period available for growth (DANALATOS & ARCHONTOULIS 2004). Planting in (D4) (15.11.2009) was the reason to increase plant wet and dry weight. Planting dates vary because of differences in photoperiods, temperatures and light intensity. Temperature is one of the main environmental variables that determine time to flowering. Although, temperature is the most important factor controlling the rate of plant development, other factors such as water and light availability and day length (DL) may modify its effects.

Correlation and Path analysis was carried out by ALI et al. (2009) to study the effects of yield component, growth and dry matter partitioning traits on seed cotton yield under optimum sowing date 10 May compared with 1- June and 10-June, but disagree with AL-DALAIN et al. (2012) who prove that the fruit weight was not significantly affected by planting date. Plants with three stems (S3) increased the plant wet and dry weight. The same result was obtained by JOVCICH et al. (1998) when total plant dry weights were higher in four and two than in single-stem in sweet pepper plants.

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References

ADIL M., AHMAD W., AHMAD K. S., SHARIF J., SHEHZAD M.A., SAWAR M.A., SALMAN M., GHANI M.I. & IQABAL M. (2013): Effect of Different Planting Dates on Growth and Development of *Gladiolus grandiflorus* under the Ecological Conditions of Faisalabad, Pakistan. Journal of Agricultural Research 1(3):110-117.

AL- DALAIN S.A., ABDEL- GHANI A.H., AL-DALAEEN J.A. & THALAEN H.A. (2012): Effect of planting date and spacing on growth and yield of fennel (*Foeniculum vulgare* Mill.) under irrigated conditions. Pak J. Bio1. Sci. 15 (23): 1126-1132.

AHMAD I., KHATTAK A., ARA N. & ULAMIN N. (2011): Effect of planting dates on the growth of Gladiolus corms in Peshawar. Sarhad J. Agric. 27(2): 195-199.

ALI H., AFZAL M. N. & MUHAMMAD D. (2009): Effect of sowing dates and plant spacing on growth and dry matter partitioning in cotton (*Gossypium hirsutum* L.). Pak. J. Bot. 41(5): 2145-2155.

ASIF M., QASIM M. & MUSTAFA G. (2001): Effect of planting dates on growth, Flowering and corm characteristics of tuberose (*Polianthes tuberosa*). International Journal of Agriculture & Biology 03(4):391-393.

BLANCHARD M.G. & RUNKLE E.S. (2011): Quantifying the thermal flowering rates of eighteen species of annual bedding plants. Sci. Hortic. 128: 30–37.

BLANCHARD M.G., RUNKLE E.S. & Fisher P.R. (2011): Modelling plant morphology and development of petunia in response to temperature and photosynthetic daily light integral. Scientia Horticulturae 129: 313–320.

CHANDA S. & ROYCHOUDHURY N. (1991): The effect of time of planting and spacing on growth, flowering and yield of African marigold (*Tagetes erecta* L. cv. Siracole). Horticultural Journal 4(2): 53-56.

CEBULA S. (1995): Optimization of plant and shoot spacing in greenhouse production of sweet pepper. Acta Horticulture 12: 321-328.

CONLEY S.P. & WIEBOLD W.J. (2003): Grain sorghum response to planting date. Online. Crop management doe: 10.1094/CM- 2003-0204-01-RS.

DAMATO G., BIACO V.A. & LATERZA M. (1994): First result of plant density and nitrogen rate on yield and quality of Florence fennel (*Foeniculum vulgar* Mill . var. Azotericum Thell.) seeds. International Symposium on Agrotechnics and Storage of Vegetative and Ornamental Seeds. Bari, Italy

DANALATOS N.G. & ARCHONTOULIS S.V. (2004): Potential growth and Biomass productivity of Kenaf (*Hibiscus cannabinus* L.) under central Greek conditions: II. The influence of variety, sowing time and plant density. 2nd World Conference on Biomass for Energy, Industry and Climate Protection, 10-14 May, Rome, Italy, 319-322.

EL-QUESNI F. E.M., MAZHAR A.A.M., ABDUL EL AZIZ N.G. & METWALLY S.A. (2012): Effect of compost on growth and chemical composition of *Matthiola incana* L. under different water intervals. Journal of Applied Sciences Research 8(3): 1510-1516.

FUJITA M. (1989): Studies on establishment of cropping system in common stock (*Matthiola incana* R. Br.) Spec. Bull. Wasayama Agric. Expstn. 1: 1-93.

GULLEN J., ALEXANDER J.C.M., BRADY A., BRICKELL C.D., GREEN P.S., HEYWOOD V.H., JÖRGENSEN P.M., JURY S.L., KNEES S.G., LESLIE A.C., MATTHEWS V.A., ROBSON N.K.B., WALTERS S.M., WIJNANDS D.O. & YEO P.F. (1995): The European Garden Flora. Cambridge University. Great Britain, 138-139.

HALEVY A. H. (1985): *Gladiolus*. p. 63-70 In: Halevy A.H. (ed.): Handbook of Flowering, Vol. III, CRC Press. Boca Raton.

HISAMATSU T., KOSHIOKA M., KUBOTA S., FUJIME Y., KING W.R. & MANDER L.N. (2000): The role of Gibberellin biosynthesis in the control of growth and flowering in *Matthiola incana.* Physiologia Plantarum 109: 97-105.

HISAMATSU T. & KOSHIOKA M. (2001): Regulation of flowering in stock *Matthiola incana* (L.) R. Br. By manipulation of Gibberellin biosynthesis. JARQ 35(4):263-269.

HOCHMUTH G. J. (1991): Fertilizer Management for Greenhouse Vegetables. p 13-31. In HOCHMUTH G. J (ed.) Florida Greenhouse Vegetable Production Handbook Vol. 3. University of Florida, Institute of Food and Agricultural Services, Circular SP 48.

HOLLEY W. D. (1973): Pruning and development of roses. Bulletin of Colorado Flower Growers Association 273: 1-3.

ISMAIL R. F., KANDEEL A. M., IBRAHIM A. K. & OMER E. A. (2013): Effect of planting date and plant spacing on growth, yield and essential oil of Mexican marigold (*Tagetes lucida* L.) cultivated in Egypt. Journal of Applied Sciences Research 9(1): 330-340.

JOVICICH E., CANTLIFFE D.J. & HOCHMUTH G. J. (1998): Plant density and shoot pruning on yield and quality of summer greenhouse sweet pepper crop in North central Florida. Horticultural Sciences Dept., University of Florida, 1251 Fifield Hall, PO Box 110690, Gainesville, FL 32611- 0690.

KHAN F. U., JHON A. Q., KHAN F. A. & MIR M. M. (2008): Effect of planting time on flowering and bulb production of tulip conditions in Kashmir Indian J. Hort. 65(1): 0972-8538.

KHOKHAR Z., HUSSAI I., KHOKHAR B. & SOHAIL M. (2010): Effect of planting date on yield of Wheat genotypes in Sindh. Pakistan J. Agric. Res. 23(3): 103-107.

KO J.Y., KIM S.K., UM N.Y., HAN J.S. & LEE K.K. (1994): Planting times and corm grades of *Gladiolus gandavensis* for retarding culture in high land. RDA J. Agric. Sci. Hort. 36(1): 430-434.

MABOKO M. M. & DU PLOOY C. P. (2009): Effect of stem and fruit pruning on yield and quality of hydroponically grown tomato. African Crop Science Conference Proceedings 9: 27-29.

MCCALLA A. G., WEIR J. R. & NEATBY K. W. (2011): Effects of temperature and sunlight on the rate of elongation of stems of maize and gladiolus. Canadian Journal of Research 17(11): 388-409.

MOHANTY C. R., BEHERA T. K. & SAMANTARAY D. (1993): Effect of planting time and planting density on growth and flowering in African marigold (*Tagetes erecta* L). Journal of Ornamental Horticulture 1(2): 55-60.

MORTENSEN L. M. & GISLEROD H. R. (1994): Effects of summer lighting, plant density, and pruning method on yield and quality of greenhouse roses. Gartenbauwissenschaft. 59: 275-279.

MUBHOPADHAYAY A. & BANKER G. J. (1981): Effect of time of planting on growth, flowering and bulb production in tuberose cv. "single". Indian Inst. of Hort. Res. Bangalore.

PETTIGREW W.T. (2002): Improved yield potential with an early planting cotton production system. Agronom. J. 94: 997-1003.

PRAMUK L.A. & RUNKLE E.S. (2005): Photosynthetic daily light integral during the seedling stage influences subsequent growth and flowering of *Celosia*, *Impatiens*, *Salvia*, *Tagetes* and *Viola*. Hort. Science 40 (5): 1336-1339.

ROBERT G. (2004): Single stem *Rose* research at the University of Kentucky. Kentucky Agricultural experiment station, Floriculture Research Report 23-04: 1-9

SANDEEP K., SANJAY K. & PUSHKAR N. (2013): Effect of pinching, disbudding and foliar spray of cytozyme on growth and flowering behaviour of annual chrysanthemum (*Chrysanthemum carinatum S*chousb). Progressive Horticulture 45(2): 326-330.

TOMAĽOVA D. & VALŠÍKOVÁ M. (2012): Effect of varieties and cultivation methods on the pepper (*Capsucum annuum*) yield quantity and quality. Proceeding of Student Scientific Conference, Nitra 25 April, 2012, p. 52-57, ISBN 978-80-552-0888-6.

VAID T.M., RUNKLE E.S. & FRANTZ J.M. (2014): Mean Daily Temperature Regulates Plant Quality Attributes of Annual Ornamental Plants. Hort. Science 49: 574-580.

YANIV Z., ECKER R. & SCHAFFERMAN D. (1992): Earliness and lateness of flowering in *Matthiola incana*, and their relationship to oil quantity of mature seeds. Israel Journal of Botany. 41: 4-6.

ZHAO Y., GU M., BI G., EVANS B. & HARESS R. (2014): Planting Date Effect on Yield of Tomato, Eggplant, Pepper, Zinnia, and Snapdragon in High Tunnel in Mississippi. Journal of Crop Improvement. 28(1): 27-37, DOI: 10.1080/15427528.2013.858283.

ZUBAIR M., WAZIR F.K., AKTAR S. & AYUB G. (2006): Planting dates affect floral characteristics of gladiolus under the soil and climatic conditions of Peshawar Pak. J. Biol. Sci. 9(9): 1669-1676.

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