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Effect of Sowing Date and Various Potassium Levels on Quantitative Yield of Pot Marigold Medicinal Plant (*Calendula officinalis* L.)

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Abstract – **In order to evaluation the effect of sowing date and various of potassium levels on quality and quantity yield of Pat Marigold a field experiment was conducted at field research , Faculty of Agriculture, Mashhad Branch, Islamic Azad university, Mashhad, Iran, in during cropping season 2011- 2012. The experimental design was randomized complete block design (RCBD) arranged in a factorial with three replication. Factors were included sowing date in three levels (30 May, 9 and 19 June), and potassium (K_2O_5) in three levels (0, 40 and 80 kg/ha). Analysis of variance showed that the effect of sowing date and potassium on fresh flower yield (ton/ha), dry flower yield (Ton/ha) and essential oil were significant. Nevertheless, the effect of sowing date and potassium on percentage of essential oil were not significant. Interaction between two factors had signification effect on essential oil yield. The results of mean comparison showed that the highest fresh and dry flower yield per hectare (1.9 and 8.4 ton/h respectively) and essential yield (81.9 kg/h) were obtained in third sowing date (19 June).Also, the highest rate of all traits were obtained in 40 and 80 kg/ha of potassium .but, these levels of potassium had not significant difference, while difference with control (0 kg/h of potassium) was significant.**

Keywords – **Dry Flower Yield, Essence Yield, Fresh Flower Yield, Marigold, Percentage of Essential Oil.**

I. Introduction

Iran is a significant habitat for medicinal plants, as including climatic conditions (Omidbeigi, 2005).Pot Marigold is an annual herbaceous plant with medicinal properties planted in spring and is found biennial and with hard stem and branches seldom. This plantgrows fast, while flowers 40-50 days after emergence; flowering occurs from May to beginning cold season and it takes 70 to 120 days to flowering. The seed is an achene and its size is decreased from the end to the center of capital. The *thousand seed weight* is 10-16 g (Omidbeigi, 2000). The used parts include disk and ray flowers without bracts or all flowering shoots and seldom all parts of the plant (Zargari, 1996).Medical properties of this plant include antioxidant, Anti-inflammatory, antibacterial, anti fungal and antiviral effects (Preethi et al, 2006). Among the methods of cultivation improvement, using chemical fertilizers is one of the most effective procedures (Leilah et al, 2003). The quality and quantity of the products increases significantly through providing required elements for plants, on time and in suitable amount (Barker and Pilbeam, 2006).

Potassium is a necessary and macronutrient for all organisms and is considered as one of the most important cations in plant physiology and metabolism for its amount in plant tissue and physiological and chemical actions.Several experiments have been conducted to investigate the effect of potassium on medicinal plants and crops quality and quantity; for instance in a case on (Tagetes erecta) , Pal (2010) stated that increasing potassium affect on qualitative and quantitative yield of plant.Naderi Darbaghshahi et al (2011) noted to the meaningful effect of potassium on qualitative and quantitative yield of plant in an experiment to study the effect of potassium on *Matricaria recutita* yield.Sowing date play an important role in plant growing and effect on active substance in medicinal plants, significantly (Ghani, 2011).Applying various sowing dates results in facing to different temperature, solar radiations and day length by plant growing processes, so that impact on plants growth and yield (Dadashi and Khajepour, 2004).Ebadi et al (2009) examined three sowing dates to investigate the effect of sowing date on qualitative and quantitative yield of (*Matricaria recutita* L.) , and stated that sowing date affect on plant qualitative and quantitative yield , meaningfully.Therefore, this study was conducted aiming to investigate the effect of three sowing dates and three potassium among on Pot Marigold qualitative and quantitative yield.

II. Material and Methods

In order to evaluate the effects of sowing date and various of potassium levels on qualitative of potassium levels on qualitative and quantitative yield of pot marigold a field experiment was carried out based on Randomized Complete Block Design (RCBD) arranged in factorial with three replication at the research farm (with geographical position: 37° 33' north, 59° 11' east and altitude of 1176m above sea level) of the faculty of agriculture, Mashhad Branch, Islamic Azad university, Mashhad, Iran. During in cropping season 2011-2012

The factors of this experiment include sowing date in three times (30may, 10 and 20 June) and potassium in K_2O_5 form in three levels (0, 40 and 80 kg/h). Preparing the land contains plowing in fall and second preparation includes disc and leveler in spring, 2012. Each experimental unit in each block includes four planting rows with 60cm distance among them and 4m length. Therefore, dimensions of each unit were $4 \times 2.4 =$

9.6m^2.Also the distance between each block was 2m. So that, total area was about (26.4×16 = 422.4 m^2). Planting was conducted on mentioned dates. Planting was done in 3cm depth. The seeds were sown by hand in rows and plant density was 30 plants in 1m^2.

After measuring due to dimensions of each unit along with planting and grooving in both sides of each row, the examined potassium is given to soil. Irrigating was conducted after sowing. Irrigation has been repeated three days later, Assessing fresh and dry weight yield was done from two middle rows and with removing 0.5m of borders and in 2×1.2 m^2. Harvesting was conducted during growth season and in 8 steps. During harvesting, the flowers were gathered with sepals. Flowers and sepals were dried simultaneously; flowers were spread in shadow and with light width and were dried after 4 days. Measuring essence percentage was done by using 30g dried flower as chosen sample in each plot and through distillation by Clevenger. Essence yield was calculated by multiplying dried flower yield to essence percentage. The gathered data was analyzed by Mstat-C and comparing the means was done by Duncan's Multiple Range test in 5% probability.

III. Results and Discussion

The results of variance analysis was given in Table 1, so that the effect of sowing date on fresh flower yield in hectare, dried flower yield in hectare and essence yield in hectare ($P<0.01$) and the effect of potassium on fresh flower yield in hectare ($P<0.05$), dried flower yield in hectare and essence yield ($p<0.01$) were significant. The interaction of two factors was significant just on essence yield ($p<0.01$). The effect of none of factors was significant on essence percentage. Comparing the means of sowing date effect on dried flower yield in hectare indicated that most amounts (1.9 ton/h) were obtained during planting in June 20. The difference between dried flower yield on this date and two others,May30 and June10, was significant statistically but dried flower yield was not significantly different in hectare between May30 and June10; while most studies about sowing date indicate that delaying in sowing leads to decrease qualitative and quantitative yield, in an investigation on *Calendula officinalis* L. medicinal plant and *Mentha piperita* indicated that sowing date effect on dry weight of *Calendula officinalis* L. and *Menthapiperit*a was significant and delaying in sowing decreased dried flower yield (Tahmasbpourand Mohamadin, 2006). Comparing the means of dried flower yield in hectare with different potassium levels (Table 2) displays that using potassium effect on dried flower yield in hectare, positively; while the difference of dried flower yield in hectare with 40 and 80 kg potassium and control group has been significant statistically but two potassium levels was not different significantly. Positive effects on mineral elements on quantitative increase of dried flower yield in hectare have been reported in various medicinal plants(El-Sayed et al, 2012).concluded that increasing potassium results in increasing dry weight of flower, by conducting a study about the effect of three potassium levels (0,50,100 kg) on *Echinacea paradoxa* L.

Studying the effect of sowing date on fresh flower yield in hectare indicted that most amount (8.4 ton/h) was obtained during planting in 20June. The difference between fresh flower yield in hectare on this date and two others, May30 and June10, was significant statistically but fresh flower yield was not significantly different in hectare between May30 and June10; while most studies about sowing date indicate that delaying in sowing leads to decrease qualitative and quantitative yieldin an investigation about the effect of three sowing date (March 25, April 5, April 15) on *Matricaria recutita* fresh flower weight indicated that most fresh flower yield was obtained on first sowing date and its difference with two others was significant(Haj Seyyed Hadi, 2002). Comparing the means of fresh flower yield in plant with different potassium levels displays that using potassium affect on fresh flower yield in hectare, positively; while the difference of dried flower yield means in hectare with 40 and 80 kg potassium and control group has been significant statistically but tow potassium levels were not different significantly. Raising potassium amount results in increasing flower numbers in *Calendula officinalis* L. Potassium fertilizer as the third micronutrient for plant growth, plays a vital role in enzymes activities, protein synthesis and photosynthesis (Basak and Biswas, 2009). Essence percentage is one of the properties in plants affected by agricultural factors and experimental treatments.On the other hand, correlates to product yield significantly. However, several studies indicated positive effect of sowing date on essence percentage (Bagheri, 2008 & Broumand Rezazadeh et al, 2009) stated the effect of sowing date on essence in *Matricaria recutita* that was statistically significant. In addition, several studies reported ineffective sowing date on medicinal plants essence percentage that corresponds to this study (Broumand Rezazadeh et al, 2009 & Daltalab et al, 2013 & Moosavi et al,2012).In examining the effect of sowing date on essence percentage of *Trachyspermum copticum* seed, the effect of sowing date on *Coriandrum sativum* essence percentage, effect of sowing date on *Carthamustinctorius* essence percentage, respectively, reported that didn't effect on essence percentage significantly (Daltalab et al, 2013). Some studies indicated positive effect of potassium on essence percentage, this effect in *Matricaria recutita* displays that increasing potassium results in increasing essence percentage in 1% level (Naderidarbaghshahi et al, 2011).

Studying the effect of sowing date on essence yield indicted that most amount (81.9 kg/h) was obtained during planting in June 20. The difference between essence yield on this date and two others, May 30 and June 10, was significant statistically but essence yield was not significantly different between May 30 and June 10. Increasing essence yield in third sowing date to the first one was 25%. Comparing the means of essence yield in plant with different potassium levels displays that using potassium affect on fresh flower yield positively; while the difference of essence yield mean with 40 and 80 kg potassium and control group has been significant

statistically but tow potassium levels were not different significantly (Table 2). This finding is the same as reports by Singh et al, 2005, Stating that adding potassium in one year increases essence yield in *Cymbopogon martini*.

Table 1: Variance Analysis Effect of Sowing Date and Various Potassium Levels on Quantitative Yield of Pot Marigold Medicinal Plant (*Calendula officinalis* L.)

variation resources	DF	Fresh flower yield in plant	Dry flower yield in plant	Essence percentage	Essence yield
Repelication	2	10.22	0.23	0.03	12.28
Sowing date	2	10.42**	0.39**	0.04 ^{ns}	1328.1**
Potassium	2	6.57*	0.32**	0.02 ^{ns}	293.3**
Sowing date × Potassium	4	0.11 ^{ns}	0.07 ^{ns}	0.03 ^{ns}	284.3**
Error	16	1.41 ^{ns}	0.03 ^{ns}	0.05 ^{ns}	40.6 ^{ns}
CV		16.24	11.13	25.24	9.38

** and * indicate significance in 1% and 5%; “ns” non- significanceDuncan‘s Multiple Rangetest

Table 2: Comparing the means of sowing date and potassium on quantitative yield of *Calendula officinalis* L.

	levels	Fresh flower yield (t/h)	dried flower yield (t/h)	essence yield (kg)
Sowing date	May 30	6.4 ^{b}	1.5 ^{b}	60.1 ^{b}
	June 10	6.8 ^{b}	1.5 ^{b}	61.7 ^{b}
	June 20	8.4 ^{a}	1.9 ^{a}	81.9 ^{a}
Potassium (kg)	0	6.2 ^{b}	1.4 ^{b}	62.4 ^{b}
	40	7.6 ^{a}	1.7 ^{a}	67.5 ^{a}
	80	7.7 ^{a}	1.8 ^{a}	73.8 ^{a}

Means with same letters don’t include significant difference due to Duncan‘s Multiple Rangetest in 5% level.

Table 3: Interaction of sowing date and potassium on essence yield of *Calendula officinalis* L.

Sowing date	Potassium (kg)	Essence yield (kg/h)
May 30	0	48.5^{c}
	40	66.3^{b}
	80	65.5^{b}
June 10	0	68.4^{b}
	40	52.1^{c}
	80	64.6 ^{b}
June 20	0	70.4^{b}
	40	83.9^{a}
	80	91.4^{a}

Means with same letters don’t include significant difference due to Duncan‘s Multiple Rangetest in 5% level.

Examining the effect of potassium and sowing date indicated that most essence yield was obtained in sowing date, June 20, and 80kg potassium. However, the difference between treatment on June 20 and 40kg potassium was not significant; the least essence yield was observed on June 10 and May 30 and when not using potassium (Fig 3).

IV. Conclusion

In this study, sowing date and using potassium effect on most properties significantly. Despite of several studies results that indicated delaying sowing date decreases most qualitative and quantitative properties, in this study the third sowing date (June 20) displays better results than two other sowing dates, May 30 and June 10. Therefore the results are devoted to the experimental area and according to the fact that this experiment was occurred in one year and so the effects of annual investigations (time) cannot be generalized, unless obtaining same results in repeating a similar experiment. In this study using potassium effect on measured properties, positively. Positive effects of potassium as one of three macronutrients in feeding plants that reported in several examinations; it may results from important effects of this element through physiological processes, for example, potassium plays a vital role in plant, at least 50 enzymes in potassium. Among vital roles of potassium, osmotic role of this element in enhancing water usage for plants can be named, in a way that with enough potassium, stomata cells act well as their opening and closing is done due to moisture conditions; also cell osmotic adjustments is done well and enhances water usage efficiency. In this study, the statistical difference between 40 and 80kg potassium was not observed, while similar experiments had same results. Using 40kg potassium can be more suitable.

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