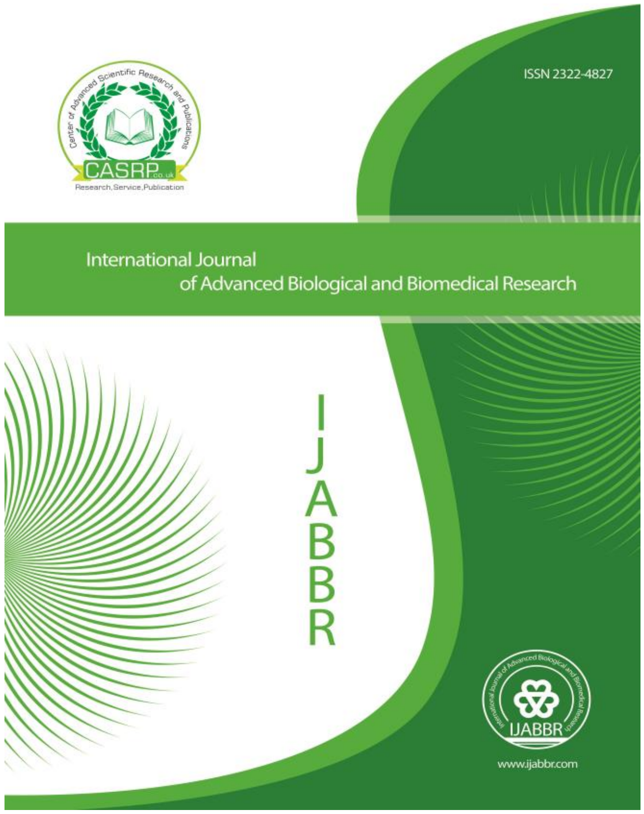
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Determination of optimum transplanting time for chamomile (*Matricaria chamomilla* L.)

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Abstract

Performance of Chamomile (*Matricaria chamomilla* L.) was evaluated on twelve transplanting dates that were arranged at 30 days interval; during 2013-2014 on experimental field of Wondo Genet agricultural research center; using RCBD design with three replications. Transplanting time exerted a very highly significant ($p<0.0001$) influence on plant height, flower yield and essential oil yield; essential oil content was significantly ($P<0.05$) influenced by transplanting time. The performance of chamomile and the amount of rainfall received on the first month of transplanting showed significant (<0.05) positive relationship with regression coefficient of (0.16). The amount of heat units received during the entire growth periods didn't showed significant relationship with the performance of chamomile. The highest and lowest flower yield was obtained from July and December transplanted chamomile respectively. Fresh flower yield varied from 0.8 t/ha to 3.84 t/ha; and the essential oil yield varied from 1.19 kg/ha to 5.56 kg/ha due to the influence of transplanting time. Transplanting chamomile during dry hot season resulted in up to 79 percent flower yield reduction as compared to wet and cool season transplanted chamomile. Chamomile showed high sensitivity to the absence of rainfall associated with higher heat units during the first month of establishments on the field. According to the results transplanting chamomile during moist and cool months is highly recommended in order to obtain maximum flower and oil yield.

Keywords: Chamomile, Transplanting dates, Season, Weather.

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1. Introduction

Roman chamomile and German chamomile are the two most popular species from the composite family that are known with a common name chamomile. The botanical names for true chamomile (German Chamomile) are either Matricaria chamomilla or Matricaria recutita L. (Singh et al., 2011). Chamomile is widely used throughout the world. Its flowers and essential oils can be used both internally and externally to treat an extensive list of conditions. Srivastava et al (2010) in their review paper reported that chamomile is used to treat conditions like wounds, ulcers, eczema, skin irritations, sciatica, rheumatic pain, hemorrhoids, diaper rash, chicken pox, inflammation of the skin, bacterial skin diseases and respiratory tract inflammation , anxiety, hysteria, nightmares, insomnia and other sleep problems and convulsions.

In addition to pharmaceutical uses, it is used as tea or tonic; the oil is extensively used in perfumery, cosmetics, and aromatherapy, and in food industries; due to its widespread uses as industrial additive and as a home remedy, German chamomile is the fifth top selling herb in the world Singh et al, (2011). As a result, there is a great need for cultivation of chamomile at both large and small scale farming; to address this demand maximization of the quantity and quality of flower and essential oil yield production is crucial. With this regard, several authors reported that both the quantity and quality of essential oils and herbage yield of aromatic and medicinal plants are highly influenced by environmental factors; planting time is a very crucial factor that determines the set of environmental factors that the crop will encounter during its entire growth period. Hence, planting at the right time is one of the key factors that ensure maximized benefit from the production of chamomile. However, under Ethiopian condition information is not available on the appropriate time of chamomile planting. In addition, some findings from other parts of the world found to be unclear for adoption, because the findings miss explanation about the environmental conditions that makes certain sowing date best for a crop. Thus, the current trial was initiated with the objective of determining transplanting time that offers favorable environmental conditions for chamomile production.

2. Materials and methods

The experiment was conducted during 2013- 2014 G.C. on the experimental field of Wondo Gent Agricultural research center, which is located in Wondo Genet, Southern Ethiopia, at 7^o 192 N latitude and 38^o 382 E longitudes with an altitude of 1780 m.a.s.l. The site receives a mean annual rainfall of 1000mm with minimum and maximum temperature of 10^{o}c to 30^{o}c, respectively. The soil is a sandy clay loam with an average PH of 7.2. Performance of Chamomile (*Matricaria chamomilla* L.) was evaluated on twelve transplanting dates that were arranged at 30 days interval. The first transplanting date was 13th of May 2013, then the rest 11 consecutive transplanting where done at 30 days interval till the last transplanting date April 8th, 2014. RCBD design with three replications was used for the experiment. Chamomile seeds were sown on polyethylene plastic pots when seedlings become one month old transplanting to experimental field was done. Two seedlings where transplanted per hill; Spacing between rows and hills in the rows was 60cm X 60cm. The size of individual plots was 9 m^2 with 3m X3m width and length. The experiment received supplementary irrigation during dry spells; fertilizer was not applied during the entire experiment. Data on plant height, flower yield/plant, flower yield /ha, percent essential oil content and essential oil yield/ha were critically recorded. Essential oil content and essential oil yield were determined on fresh weight basis by taking 250 g of fresh flowers. Essential oil extraction was done using hydro-distillation method. The functional relationship of the performance of chamomile with seasonal variations was assessed by regressing meteorological records during the experiment with agronomic performance of chamomile. Statistical analysis was done using SAS statistical software.

3. Results and discussion

Analysis of variance reveled that transplanting time has highly significant ($P<0.0001$) influence on plant height, fresh flower yield and essential oil yield; Essential oil content was significantly ($p<0.05$) influenced by transplanting time. Due to the influence of transplanting time; plant height values ranged from 32.3 cm to 61.5 cm, flower yield per plant ranged from 14.56 g to 69.63g, flower yield per hectare varied from 0.8 t/ha to 3.84 t/ha, essential oil content varied from 0.1 % to 0.15 %, and the essential oil yield varied from1.19 kg/ha to 5.56 kg/ha (Table 1) The highest values of plant height, fresh flower yield and essential oil yield were obtained from July transplanting followed by June and August months transplanted chamomile. The lowest plant height, fresh flower yield and essential oil yield values were obtained from December transplanted chamomile and the lower values were obtained from January transplanted chamomile (Table 1).

Table 1
Mean performance of chamomile during different transplanting dates.

Transplanting dates	PH(cm)	FFYPP(g)	FYPH(t)	EOC(W/W)	EOYH (kg)
May	49.7 cde	43.85 d	2.42 d	0.12 ab	3.07 bc
June	45.5 ed	66.05 ab	3.64 ab	0.13 a	5.02 a
July	61.5 a	69.63 a	3.84 a	0.14 a	5.56 a
August	48.2 de	65.87 ab	3.63 ab	0.103 b	3.77 b
September	56.8 ab	46.96 cd	2.6 cd	0.1 b	2.57 c
October	55.13 abc	40.94 d	2.26 d	0.1 b	2.25 cd
November	43.1 ef	37.15 de	2.05 de	0.14 a	2.95 bc
December	32.3 g	14.56f	0.8 f	0.15 a	1.19 e
January	38.6 fg	27.06 e	1.49 e	0.103 b	1.54 de
February	50.2 bcd	39.1 d	2.16 d	0.1 b	2.14 cde
March	59.9 a	54.4 c	3.0 c	0.1 b	2.99 bc
April	60.6 a	56.56 bc	3.12 bc	0.1 b	3.05 bc
CV	8.09	12.81	12.83	15.77	19.43
LSD	6.86	10.16	0.56	0.03	0.99

Means followed by the same letter with in the same column are statistically non significant at P < 0.05 according to least significant difference (LSD) test; PH= Plant height (cm), FFYPP= Fresh Flower yield/plant (g), FFYPH= Fresh flower yield/hectare (tons), EOC= Essential oil content (W/W) and EOYPH= Essential oil yield/hectare (kg).

Higher essential oil content values were obtained from June, July, November and December transplanted chamomile. Whereas, transplanting of chamomile on remaining transplanting months gave similar essential oil content values (Table 1). The higher essential oil content and flower yield results obtained from June and July transplanted chamomile indicated that favorable conditions for herbage growth also favors increment on essential oil content ; complementarily to the current results other findings reported decrease in flower and essential oil yield when chamomile is exposed to unfavorable conditions like moisture stress (Razmjool, 2008), high temperature stress Bettery and Vomel (1992) and salt stress (Dadkhah, 2010; Razmjoo et al., 2008) In the case of November and December transplanted chamomile, higher percentage essential oil content values obtained while the flower yield results were lower, the result indicates that the availability of ample sunshine hours, high heat units and the absence of rainfall after the first month of establishment were conducive conditions for accumulation of higher percentage essential oil content. Similarly (Alberts, 2012) reported that long summer days, full sun and high heat units are favorable for chamomile essential oil production. Even though the percentage essential oil content was increased, these conditions disfavored the flower yield and also the essential oil yield, which is the product of flower yield and essential oil content. Similarly Hussain et al. (2008) observed that high temperature resulted in the decrease of oil yield of *basil,* with the highest yields in the winter and a decrease in summer.

Regression analysis of the amount of rainfall received with in the first month after transplanting with chamomile flower yield revealed that there was significant (P<0.05) functional relationship with a regression coefficient of 0.16. The flower yield and the amount of rainfall received with in the second month after transplanting also showed significant (P<0.05) functional relationship with a regression coefficient of 0.15. Whereas the analysis showed that the amount of rainfall received during the third month after transplanting had non-significant functional relationship with flower yield. On other hand, regression analysis of fresh flower yield with cumulative degree days/heat units/ received during the first month after transplanting revealed that there was non-significant functional relationship with a regression coefficient of -0.05. The regression analysis of flower yield with heat unit received during the second and third months after transplanting showed non-significant results with a regression coefficient of 0.19 and 0.11 respectively. The regression analysis showed that the amount rainfall and heat units received during the first month of transplanting have strong determinant effect on chamomile flower yield.

The current result reveled that transplanting time has highly significant influence on growth and yield of chamomile. Similarly, Mohammad et al. (2004) found significant difference on chamomile performance as a result of 10 days difference on planting time. The effect of transplanting time on chamomile is mainly associated with the amount of rainfall and heat unit received during its entire growth. Especially, during the first month of field establishment chamomile showed high sensitivity to low rainfall associated with higher heat units. Naderidarbaghshahi et al. (2013) evaluated the influence of three sowing dates on chamomile; they reported up to 70 percent yield reduction due to the effect of sowing date; which is similar to our finding that showed 79 percent yield reduction due to change of transplanting time. Iuliana and Tabara (2007) studied the effect of sowing date and cultivar type on chamomile flower yield; they found that planting time had more influence on flower yield than cultivar. Ebrahimi et al. 2011 studied the effect of temperature on chamomile seedling; according to their finding higher chamomile yield was obtained at 12 ^{o}C and lowest yield at 25^{o}C indicating that higher temperature reduces chamomile growth. Bettery and Vomel (1992) reported that late sowing of chamomile decreased flower yield due to high temperature. High temperature has detrimental effect by increasing evapo-transpiration rate, reducing the conductance of stomata and increases plants energy expenditure to absorb water (Ebrahimi et al., 2011). Pirzad et al. (2011) studied the effect of irrigation regime on chamomile and concluded that chamomile is sensitive to both excess moisture and low moisture stresses. According to the current results transplanting chamomile during cool and moist seasons is highly recommended in order to obtain maximum flower and oil yield.

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