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Full Length Research

Evaluation of American and German Chamomiles for Agronomic and Chemical Traits in Ethiopia

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Chamomile (*Matricaria chamomilla* L.) is a well-known aromatic and medicinal plant that belongs to the Asteraceae family. Flowers are the economical part for herbal preparation and essential oil production. Due to the several applications of chamomile in pharmaceutical, nutritional and sanitary industrials, chamomile was one of the most important commercial plants during the recent decades. In spite of its diverse uses, maintained for longer time and existence of suitable climatic conditions, the two chamomile types were never been evaluated for their agronomic and chemical performances in Ethiopia. Therefore, to get benefited out of its potential, this activity was set with the objective of evaluating the performances of American and German type chamomiles for agronomic and chemical traits in different locations of Ethiopia thereby for bringing the crop into cultivation. Data on plant height, flower weight per plant, flower yield per hectare, essential oil content, and essential oil yield were collected from three locations arranged in randomized complete block design with four replications. The overall combined analysis of variance revealed that the two chamomile types are statistically different on plant height, essential oil content and essential oil yield. Location exerted a significance influence on flower yield/plant, essential oil content and essential oil yield. Year and interaction effect of location by year excreted a significant influence on all parameters considered in this study. The average flower yield over all the testing locations varied from 42 to 53.51 g/plant for American and from 37.78 to 58.72 g/plant for German chamomile. The American demonstrated a percent increase value of 9.44% over the German type in essential oil content. The overall essential oil yield varied from 6.85 to 22.15 kg/ha for American chamomile and from 6.71 to 13.7 kg/ha for German chamomile. Both the American and German chamomiles demonstrated a good adaptability at all testing locations indicating the possibility of their cultivation in Ethiopia for herbal flower and essential oil production.

Key words: Chamomile, flower, essential oil, Ethiopia.

INTRODUCTION

Chamomile (*Matricaria chamomile* L.) an annual herb that belongs to the family Astraceae (Shams *et al*., 2012). It is a well-known aromatic and medicinal plant often referred to as the “star among medicinal species” (Salamon, 1992). It is native to Southern and Western Europe, North and West Asia (Reichinger, 1977; Pourohit and Vyas, 2004). It is cultivated commercially in Europe, Former USSR, North Africa Asia, North and South America and New Zealand (Salamon, 2004). It grows widely in various ecological regions of the world (Pourohit and Vyas, 2004). It may be considered as an economic substitute of the field crops, since it has adaptability to a wide range of soil and climatic conditions (Rechinger, 1977).

Chamomile is among the widely used aromatic and medicinal plants throughout the world (Baghalian, 2000).

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It has been used in herbal remedies for thousands of years, known in ancient Egypt, Greece, and Rome (Isaac, 1989). The dry flowers of chamomile are also in great demand for use in herbal tea, baby massage oil, for promoting the gastric flow of secretion, and for the treatment of cough and cold. The use of herbal tea preparations eliminated colic in 57% infants (Weizman *et al*., 1993). The powder form of chamomile flower can be applied to wounds slow to heal, for skin eruptions, and infections, such as shingles and boils, also for hemorrhoids and for inflammation of the mouth, throat, and the eyes (Fluck, 1988).

The aromatic and medicinal value of this plant is for active substances, mainly accumulated in the flowers (McGuffin *et al*., 1997; Gardiner, 1999). The flower of contain apigenine which is used as hair color (Bottcher *et al*., 2001). It also has medicinal properties such as anti-inflammatory (Pourohit and Vyas, 2004), antispasmodic, antiseptic and therapeutic use (Franke and Schilcher, 2006) and antimicrobial (Letchamo and Marquard, 1992). The essential oil of chemomile used as antibacterial, antifungicidal, as a mild sedative and for digestion problem (Gould *et al*., 1973, Pasechnik, 1996, Salamon, 1992). In addition to pharmaceutical uses, the oil is extensively used in perfumery, cosmetics, and aromatherapy, and in food industry (Lal *et al*., 1993 and Misra *et al*., 1999). Chamomile's essential oil is also a treatment for malaria and parasitic worm infections, cystitis, colds, and flu (Nemecz, 1998). It also recommended by many physicians to treat gastrointestinal spasms and inflammatory diseases of the gastrointestinal tract (Blumenthal, 1998).

There are many factors that influence agronomic characteristics, biomass and essential oil yield of aromatic plants. Among these, genotype and growing conditions (Beemnet *et al*., 2011, 2013; Beemnet and Getinet, 2010; Marotti *et al*., 1994), harvesting age (Beemnet *et al*., 2011; Marotti *et al*., 1993) and spacing are primarily mentioned (Yasin et al. 2003; Khazaie *et al*., 2007; Al-Ramamneh 2009; Beemnet *et al*., 2012; Solomon and Beemnet, 2011). In Ethiopia, there exists diverse ecological condition (NMSA, 1996; Kebebew, 2003; Andargachew, 2007). Hence, it is a prerequisite to evaluate the performance of chamomiles under different locations of Ethiopia for its agronomic and chemical characters for getting optimum benefit out of the cultivation of chamomiles.

Despite diverse potential uses chamomiles, increasing interest of farmers and investors for its cultivation in Ethiopia and existence of diverse ecological conditions in the country, there exist scanty information about the production, processing and utilization technologies in Ethiopia. This lack of information is the major hindrance to exploit the potential of the plant. Therefore, in order to contribute in addressing the existing technology gaps and bringing the crop for cultivation and utilization, this activity was designed with the objective to evaluate the performance of American and German chamomiles for agronomic and chemical traits under different ecologies of Ethiopia.

MATERIALS AND METHODS

Two introduced chamomiles form America and Germany were evaluated in two regions (Oromia and SNNPRS) of Ethiopia at three locations (Debre Zeit, Hawassa and Wondo Genet) arranged in randomized complete block design with four replications according to the procedures given by Gomez and Gomez (1984) for two years from 2010 to 2012 cropping season. The descriptions of the study areas are summarized in Table 1.

Freshly harvested seeds from mature and diseases free mother plant of Wondo Genet agricultural research centre botanical garden were used for sowing. Seeding was performed in a spacing of 30 cm between rows and plants on the experimental plot having area of 6.4 m^2 with 3.6 m length and 1.8 m width. During the experiment, all agronomic practice was performed as required. No fertilizer and chemical was applied during evaluation activity.

Data on plant height (cm), fresh flower yield/plant (g), fresh flower yield/ha (kg), essential oil content (%), and essential oil yield (kg/ha) were collected and statistically tested. Essential oil content was determined on a fresh weight basis from 350 g composite flowers harvested from the three middle rows of a plot. The laboratory analysis was performed at Wondo Genet Agricultural Research Centre. Essential oil was produced by hydro-distillation as illustrated by Guenther (1972).

To statically analyze the differences in agronomic and chemical characteristics American and German chamomiles, five samples were taken from each plot. Experimental data was statistically analyzed by analysis of variance (ANOVA) using SAS PROC GLM (2002) at $P < 0.05$. Differences between means were assessed using the least significance difference (LSD) test at $P < 0.05$.

RESULT AND DISCUSSION

Variation in agronomic and chemical traits of American and German chamomiles

Mean squares from combined analysis of variance for fiver traits of American and German chamomiles tested for two years at three locations of Ethiopia are summarized in Tables 2. The performances of American and German chamomiles were found statistically different ($P < 0.05$) in plant height, essential oil content and essential oil yield over the testing locations and years. Testing year and the interaction effects of location and years were significant ($P < 0.05$) for all the characters considered in this study. Location exerted a significant

Table1. Summery of the site description used for adaptation testing of rose chamomile for yield and yield component.

Test location	Longitude	Latitude	Soil pH	Soil type	Rain fall (mm)	Altitude (M.s.s.l)	Annual Average temperature	
							Minimum	Maximum
Wondo Genet	7°19'N	38^0 38'E	6.4	Sand clay loam (Nitosol)	1000	1776	12.02	26.72
Hwassa	7°05'N	39^0 29'E	7.2	Sandy loam (Andosol)	964	1652	12.94	27.34
Debre Zeit	8°44'N	38^0 58'E	6.9	Blackheavyclay (vertisol)	851	1891	11.42	26.31

Table 2. Combined analysis of variance for five agronomic and chemical traits of American and German chamomiles tested at three location during the years from 2010 to 2012

Source of variation	DF	Plant height (cm)	Fresh flower yield/plant (g)	Fresh flower yield/ha (kg)	Essential oil content (%)	Essential oil yield/ha (kg)
Treatments (t)	1	228.26*	24.85ns	1574017.24ns	0.0180**	239.73**
Location (l)	2	113.76ns	986.02*	11022715.43ns	0.0250**	362.56**
Year (y)	2	639.10**	5898.22**	81759073.21**	0.0003**	324.13**
Replication	3	83.21	76.98	3848161.83	0.0001	6.26
t*l	2	40.90ns	80.29ns	1669832.78ns	0.0077**	89.43**
t*y	1	12.78ns	0.02ns	349269.30ns	0.0008**	2.09ns
l*y	2	888.61**	2826.73**	33574395.47*	0.0014**	218.97**
t*l*y	2	8.85ns	120.96ns	2884281.75ns	0.0027**	13.60ns
Error	22	57.84	183.83	4822362.2	0.0001	7.91
CV		14.53	26.91	39.60	-	21.45

*=significant at P < 0.05 level; **= highly significant at P < 0.01 level; and ns= non significant a P< 0.05 level

influence ($P < 0.05$) on flower yield/plant, and a highly significant influence ($P < 0.01$) on essential oil content and essential oil yield. This indicates these traits were influenced by a change in the environment. The significance of location effect was expected because Wondo genet, Hawassa and Debere Zeit vary in their soil type, rainfall and temperature (Table 1). In agreement to the present study, Fehr (1991) reported that every factor that is a part of the environment of a plant has the potential to cause differential performance. Likewise, Frankel *et al*. (1994) and IRRI (1996) reported that fluctuating features of the location such as rainfall, relative humidity, temperature, etc. are some of the environmental factors that cause performance variation in plants. The influence of location on agronomic and chemical traits were also reported by Beemnet *et al.* (2013) for lemon verbena (*Aloysia triphylla* L.), for coriander (*Coriandrum sativum* L.) (Beemnet and Getinet, 2010), for lemongrass (*Cymbopogon citratus* L.) (Beemnet *et al*., 2011), for Artemisia (*Artemisia annua* L.) (Belay, 2007) and Aflatuni (2005) for menthol mint (*Mentha arvensis* L.) and peppermint (*M. piperiata* L.), indicating the importance of knowing optimum growing locations before intending production of chamomiles.

Performance variation in agronomic characters of American and German Chamomiles

The overall mean performance of American and German Chamomiles tested at different locations and years demonstrated statistically similar values for plant height, fresh flower yield/plant, fresh flower yield/ha (Table 3). The overall mean values of plant height, fresh flower yield/plant and fresh flower yield/ha are 52.33 cm, 50.37 g and 5.54 t, respectively. Combined over the testing locations, fresh flower yield/plant ranged from 39.92 to 56.11 g (Table 4). The highest was recorded at Wondo Genet and the lowest at Hawassa testing locations. Considering testing years, statistically different values were recorded in the second testing year for all agronomic characters (Table 5). A respective percent increase value of 17.52, 68.14 and 74.66% was recorded in 2012 testing year for plant height, fresh flower yield/plant and flower yield/ha compared with the value obtained in 2010. In agreement with the present study, a comparable plant height values ranging from 55.5 to 58.8 cm was reported by Janczak *et al*. (2011) for two cultivars under different stimulant and foliar fertilizer treatments in Poland. Likwise, the result obtained in the current study is

Table 3. Combined mean performance of five important parameters of the two chamomile types over the testing locations and years

Varieties	Plant height (cm)	Flower weight/plant(g)	Flower yield/ha(kg)	Essential oil content (%)	Essential oil yield/ha(kg)
American Type	49.81a	49.54a	5335.0a	0.20a	15.69a
German Type	53.73a	51.20a	5753.2a	0.18b	10.53b
Mean	52.33	50.37	5544.14	0.205	13.11
$LSD_{0.05}$	6.25	9.37	5335.0	0.010	1.94

Means followed by the same letters with in the same column are statistically non significant at p<0.05 according to the least significant difference (LSD) test

Table 4. Combined mean performance of the two chamomile types under different locations over the two testing years

Locations	Plant height(cm)	Flower weight/plant(g)	Flower yield/ha(kg)	Essential oil content (%)	Essential oil yield/ha(kg)
Wondo Genet	49.92a	56.11a	6312.7a	0.24a	15.89a
Debre Zeit	51.27a	55.07a	5849.5a	0.23b	16.66a
Hawassa	55.80a	39.92b	4470.3a	0.15c	6.78b
Mean	52.33	50.37	5544.17	0.21	13.11
$LSD_{0.05}$	6.43	11.48	1859.2	0.001	2.38

Means followed by the same letters with in the same column are statistically non significant at p<0.05 according to the least significant difference (LSD) test

Table 5. Combined mean performance of five important parameters of two chamomiles cultivars over two testing years and locations

Trial Years	Plant height(cm)	Flower weight/plant (g)	Flower yield/ha (kg)	Essential oil content (%)	Essential oil yield/ha(kg)
2010	56.54a	63.17a	7051.2a	0.210a	16.11
2012	48.11b	37.57b	4037.1b	0.203b	10.11
Mean	52.325	50.37	5544.15	0.21	13.11
$LSD_{0.05}$	5.25	9.37	1518.1	0.001	1.94

Means followed by the same letters with in the same column are statistically non significant at p<0.05 according to the least significant difference (LSD) test.

within the range of Dastgheibifard *et al*. (2014), who reported a shoot height range between 37.6-85 cm for experiment conducted under different cow manure vermicompost levels in Iran. A relatively lower plant height range between 18.33 and 28.08 cm was reported by Shams *et al*. (2012) for three genotypes of German chamomiles tested in Iran. A shorter plant height range from 14.8-34.5 cm was reported by Gosztola *et al*. (2006) for chamomile populations in Hungary. Ahmad *et al*. (2011) also reported a lower value of plant height range from 23.45 to 34 cm and a fresh flower yield up to 2.78 t/ha for chamomile cultivated in Pakistan. Pirzad *et al*. (2011) also reported a relatively lower a dry flower yield from 0.77-1.24 t/ha for experiment conducted in Iran under different irrigation regime and plant density. A relatively higher fresh flower yield/plant ranging from 93.9-117.2 g was reported by Hendawy and Khalid (2011) for untreated experiment conducted in Egypt. A relatively higher plant height of 85 cm and fresh flower yield up to 6.35 t/ha was reported by Nidagundi and Hedge (2007) at a spacing of 20 by 30 cm in South India. The variation in agronomic characters in chamomile may be due to the variation in genotype, environment, soil, climatic factors. The existence of variation in agronomic characters due to genotype/cultivar, edahphic and climatic conditions in which the chamomile is grown was also reported by Nidagundi and Hedge (2007). As the value obtained in this experiment demonstrated relatively higher and comparable flower yield form the different reports, it is possible to cultivate spearmint in Ethiopian for the production of spearmint herbal leaf.

Performance variation in chemical characters of American and German Chamomiles

Compared among the tested cultivars, the highest essential oil content and essential oil yield was recorded for American chamomile demonstrating a respective percent increase value of 11.11 and 49% on essential oil content and essential oil yield over the German chamomile. The values for essential oil content and essential oil yield ranged from 0.18 to 0.2% and 10.53 to 15.69 kg/ha, respectively. The overall highest value for essential oil content (0.24%) was recorded at Wondo Genet and the lowest value (0.15%) was recorded at Hawassa. Averaged over the testing locations, the highest (16.66 kg) essential oil yield/ha was recorded at Debre Zeit and the lowest at Hawassa (34.85 kg). Compared with second testing year, a respective percent increase value of 3.45 and 59.35% on essential oil content and essential oil yield was demonstrated in first testing year. A relatively comparable range of essential oil content ranging from 0.17-0.35% and a wider range of essential oil yield from 4.8 to 19.2 kg/ha was reported by Hendawy and Khalid (2011) for experiment conducted on organic and chemical fertilizer in Egypt. A wide range of essential oil content from 0.2 to 1.5% was reported by Hendawy and Khalid (2011) for experiment conducted on organic and chemical fertilizer in Egypt. A wide range of essential oil content from 0.24 to 2.0% was reported by Thorne Research, Inc (2008) foe German chamomile flowers. Pirzad *et al*. (2011) reported a lower essential oil yield range from 5.81-8.06 kg/ha, respectively. A lower essential oil yield of 6.36 kg/ha was reported by Nidagundi and Hedge (2007) cultivated at a spacing of 20 by 30 cm in South India. The difference in essential oil content and essential oil yield may be due to genotypes/cultivars, edaphic factors, climatic factors such as temperature, rainfall and light. Fahmy (1955) and Langston and Leopold (1954) mentioned that climatic factors such as temperature, day length, humidity and rainfall, affected oil content of aromatic plants. As both American and German chamomiles demonstrated a comparable performance in essential oil content and essential oil yield, it is possible to use the two cultivars for the production of herbal flowers and essential oil in Ethiopia.

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