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Research Article

EFFECT OF OAK (*PISTACIA MUTICA* L.) AND PERSIAN TEREBINTH (*QUERCUS BRANTII* L.) LEAF-MOULDS ON VEGETATIVE AND GENERATIVE YIELD OF GREAT BABYLONIA (*TANACETUM PARTHENIUM*)

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ABSTRACT
Great Babylonia is a valuable medicine plant, which has many applications in pharmacy and medicine industries. In the present study, was evaluated the effects of culture medium type on vegetative and generative growth and essential oil of great Babylonia. For this purpose, the seedlings of great Babylonia were planted in the pots containing soil as control treatment, the mixture of soil + Oak leaf-mould (in 3:1, 1:1 and 1:3 ratios, respectively), the mixture of soil + Persian terebinth tree leaf-mould (in 3:1, 1:1 and 1:3 ratios, respectively) and the mixture of soil + Oak and Persian terebinth (2:1:1 ration, respectively). After 90 days, vegetative and generative growth indexes and essential oil amount were measured. The obtained results indicated that application of organic matters in the soil could affect quantitative and qualitative responses of great Babylonia. Generally, vegetative and generative growth indexes of great Babylonia considerably increased by the mixed application of Oak and Persian terebinth leaf-moulds in the culture medium. Totally, application the mixture of soil + Oak and Persian (2:1:1 ration) was recommended as the best treatment.

Keywords: *Great Babylonia (Tanacetum parthenium L.), Essential Oil, Oak and Persian Terebinth Leaf-mould*

INTRODUCTION
Great Babylonia [*Tanacetum parthenium* (L.) Sch. Bip] belongs to Asteraceae family and is one of the most useful medicine plants in the world. This plant is used as the ornamental plant in some countries (Berry, 1984). Great Babylonia is a low-expectation plant and is able to grow in various conditions. Great Babylonia is propagated by seed, cutting and plant division, but is usually propagated by seed in large scale. Great Babylonia seed is very small and to germinate need light. Planting its direct-seeding in main field is difficult. For industrial scale propagation, the seeds are sown before spring in the greenhouse and are protected until sufficient growth. The young plants are transferred to main field in the early to middle of spring (Bernath, 2000). Vegetative texture especially the flowered apical shoots of great Babylonia have medicinal properties (Bullock, 1999). The maximum active material is made and stored at the time of full flowering. The time of flowering in this plant is June till October (Banthorpe and Brwon, 1989). The very bitter flavor of the leaves leads to limit the edible consumption of it and sometimes is used to treat the chronic headache as a topical medicine. The dried flowers of great Babylonia are used as seasoning in confectioneries and tea. In the past, this plant had been used and recommended as analgesic, antipatriotic and anti-inflammation drags (Khan *et al*., 2003). It has been famous for curing chronic headache and rheumatism (Pfaffenrath *et al*., 2002). Essential oil is the part of active materials of great Babylonia that accumulates in the shoot mainly in the leaves and flower and its amount is lower in the stems (Rushing *et al*., 2004).
In the present study were used Persian terebinth and Oak leaf-mould as additional materials to improve soil conditions. Persian terebinth and Oak widely grow in different regions of Fars province, Iran and can be used from the fallen leaves as available and cheap resource to improve soil. Leaf-mould that is resulted from rotting of the materials such as tree leaves and the pruned lawn has a little nutritive value and is only used for lightening and permeability of the soil. To prepare leaf-mould, the dried leaves of the trees that have not thick and rough midribs such as fruit trees, Maple, Elm tree, Oak and Persian terebinth are used.

In the ambient conditions, leaf-mould is used after 8-12 months, but 3-4 years old leaf-mould is better. Regarding all medicinal plants, the best and the most suitable fertilizer amount will be the rate that in addition to increase yield, did not lead to reduce secondary metabolites (Barker, 1986). The physical, chemical and biological process of culture medium affects the existent conditions to absorb and metabolism of nutrient elements (Hornok, 1992). About great Babylon, application of 440 kg/ha nitrogen considerably increased fresh and dry weight of the plants as well as Partenolide amount (Dufault *et al*., 2003). Application of 40-50 kg/ha nitrogen in company with irrigation is necessary after the first harvest of vegetative organ (Bernath, 2000). Likewise, maximum yield of vegetative organ and Partenolide obtained in application of 189 kg/ha phosphorus (default *et al*., 2003). In recommendation of nutrient requirements for great Babylonia has been mentioned 50-70 kg/ha potassium (Bernath, 2000). Ebadi *et al.,* (2010) evaluated the effect of culture medium on yield and active materials of *Satureja hortensis* and they measured plant height, stem diameter, root length, root dry weight, shoot fresh and dry weight and percentage of essential oil yield. Their results indicated that the highest plant height obtained in perlite 15% and the greatest shoot dry weight was observed in control treatment (soil) but the highest essential oil was relative to coco-peat 5% medium. According to the obtained results, it seems adding 15% v perlite to soil is suitable for this plant. Najafi *et al.,* (2008-2009) assessed the influence of fertilizer treatments on the number and dry weight of *Matricaria shamomile* L. flowers. They used chemical, biological and mycorrhiza fertilizers and found that the effect of different fertilizer treatments was significant on number and dry weight of *Matricaria shamomile* L. flowers in various harvest and application of biological fertilizers especially mycorrhiza were effective to improve growth and yield of this plant. Sadeghi *et al.,* (2012) evaluated the effect of urea and vermin-compost fertilizers on the yield of flower and seed and amount of macro elements in *Althea officinalis* L. and reported that application of vermin-compost had effective role on increasing leaf area and flower weight in plant and seed yield. Likewise, their results indicated effective role of application urea fertilizer in significant increasing of flower weight and seed yield but interaction between vermin-compost and urea was not significant on yield of *Althea officinalis* L. Kiafar *et al.,* (2013) examined the effect of some organic fertilizer such as manure, manure vermin-compost and sawdust vermin-compost on yield components and quantitative and qualitative characteristics of essential oil in *Lippie citriodora* L. plant and found that application of organic fertilizers significantly ($p<0.05$) increased the active materials of Spathulenol and Eugenol than control. Sharifi-Ashoorabadi *et al.,* (1997) evaluated the effect of organic and chemical fertilizers on yield of fennel and reported that the influence soil fertility method was significant ($p<0.01$) on total biomass production and amount of seed and straw.

MATERIALS AND METHODS

The used plant materials in this study were the seedlings of great Babylonia (*Tanacetum parthenium*). The seeds were supplied from Horticulture Branch of Shiraz University and were planted in greenhouse nursery placed in Larestan region of Fars province. The used medium to germinate seeds was including Oak leaf-mould and soil (1:1). Uniform seedlings at 6-leafs stage were transferred to the 5-litres pots containing different media based on the experiment treatments. One plant was planted in each pot. The leaf-moulds were supplied from Ghaemieh region, Fars province. At first, the rotten leaf-moulds were powdered and sieved. To obtain desirable volume ratios, leaf-moulds were mixed with the sieved soil. In the present study, culture media were consisting soil as control treatment, the mixture of soil + Oak leaf-mould (in 3:1, 1:1 and 1:3 ratios, respectively), the mixture of soil + Persian terebinth tree leaf-mould (in 3:1, 1:1 and 1:3 ratios, respectively) and the mixture of soil + Oak and Persian terebinth (2:1:1 ration, respectively). The evaluated traits were including flowering time (number of day from transplanting to flowering), measuring biomass such as shoot fresh and dry weight, plant height, lateral shoot number (flowered shoots and suckers), crown diameter, flower number, flowered shoot weight and essential oil yield. Essential oil was extracted by using distillation with water by Clevenger device (European Pharmacopoeia, 1975). The present study was performed in completely randomized design with three replications. There were five pots in each replication. The obtained data was analyzed by SAS 9.1

software and the means were compared by using Duncan's multiple range test (DMRT) in $p<0.05$ probability level.

RESULTS AND DISCUSSION

Results

Total Plant Biomass

Effect of culture medium was significant ($p<0.01$) on total dry weight of great Babylonia (Table 1). Table 2 show the changes of total plant weight in different culture media. Based on the data of the table 2, the greatest plant dry weight (38.33 g) obtained in culture medium soil + Oak + Persian terebinth mould (2:1:1) and the lowest (21.66 g) in control treatment.

Shoot Growth Indexes

Crown diameter and lateral shoot number significantly ($p<0.01$) influenced by culture medium type (Table 1). The lowest crown diameter was observed in soil medium (3.76 mm) and the highest (7.50 mm) in soil + Oak + Persian terebinth mould (2:1:1). The maximum lateral shoot number (5.0) was observed in soil + Oak + Persian terebinth mould (2:1:1) medium and the lowest (2.3) in soil medium. Plant shoot height did not influenced by culture medium but adding organic matter to soil caused to increase crown diameter (Table 2).

Generative Growth Indexes

Culture medium type significantly affects the number of flowering shoot, weight of flowering shoot and flower number in plants (Table 1). In every three above cases, the lowest amounts were relative to soil culture medium (control) and adding organic matter to soil led to significant increase of generative growth indexes but the highest amounts obtained from the treatments containing leaf-mould. The greatest flowering shoot number (8.3), flowering shoot weight (38.3 g) and flower number (115.3) was observed in soil + Oak + Persian terebinth leaf-mould (2:1:1) medium (Table 2).

Number of Day to Flowering (Flowering Time)

Medium type significantly affects flowering time of plant (Table 1). The lowest day to flowering (60.33 days) was observed in the cultured plants in soil medium. Adding organic matter to soil increased day to flowering. The highest day to flowering was observed in the media containing Oak and Persian terebinth leaf-mould especially in soil + Oak + Persian terebinth (2:1:1) (79.3 days) (Table 2).

Essential Oil Yield in 100 m^2

The yield of essential oil in 100 m^2 significantly was influenced by culture medium type (Table 1). Adding Oak and Persian terebinth leaf-mould to medium caused to significant increase of great Babylonia essential oil amount, so that the highest essential oil amount (183.1 g) was observed in the medium containing soil + Oak + Persian terebinth (2:1:1) and the lowest (85.5 g) in the cultured plants in control treatment (Table 2).

Discussion

Great Babylonia tolerates wide range of medium condition exception unsuitable drainage and flooding conditions (Bullock, 1999). This plant is among medicinal plants that grow in the soils having moderate texture and containing calcium. Great Babylonia can be grow in non-fertile soils but applying suitable fertility management is necessary to increase crop and keeping commercial quality (Banthorpe and Brown, 1989). The used soil in the present study had coarse texture. Amounts of mineral elements in this soil were in a balancing limit but amount of total nitrogen was little. The both used leaf-moulds in the present study had no more differences with together in viewpoint of mineral elements and physical properties, so that nitrogen amount in Oak leaf-mould was higher than Persian terebinth leaf-mould. Maybe due to the high nitrogen level in the Oak leaf-mould than Persian terebinth leaf-mould, growth of shoot in plants grown in two medium be different. Enhancement of growth indexes of great Babylonia following to increasing nitrogen amount in the treatments containing Oak and Persian terebinth leaf-moulds indicate that contrary to previous conception (Bullock, 1999), this plant need to the soils with suitable drainage and application of nutrients. According to a report, application of 100 kg/ha nitrogen compared to non-application of nitrogen caused to increase 3-6 percent dry matter in great Babylonia

(Bullock, 1999). Application of 150 kg/ha nitrogen significantly increased plant height, main shoot number, fresh and dry shoot yield and essential oil of great Babylonia (Hassani, 2004).

Table 1: Analysis of variance in relation to the evaluated characteristics

S.V	D.F	Mean Square (M.S)								
		Total biomass	lateral shoot number	Crown diameter	Shoot height	Flowered shoot number	Flowered shoot weight	Flower number	Flowering time	Essential oil yield
Treatment	7	106.8**	2.4**	5.1**	1001.5^{ns}	6.0**	59.2**	874.4**	156.4**	4037.2**
Error	16	1.6	0.2	0.4	1069.1	0.4	0.6	15.5	2.3	144.2
C.V %		4.2	11.3	10.1	11.3	9.4	2.4	4.1	2.2	8.9

^{ns} and ** not significant and significant ($p<0.01$), respectively

Table 2- Mean comparison of the evaluated characteristics as influence by different ratios of culture medium

Characteristics / Medium	Total biomass	lateral shoot number	Crown diameter	Shoot height	Flowered shoot number	Flowered shoot weight	Flower number	Flowering time	Essential oil yield
Control	21.8^{f}	2.3^{f}	3.8^{c}	13.6^{a}	4.3^{e}	26.0^{e}	69.0^{f}	60.3^{e}	85.5^{f}
Soil + Oak LM (3:1)	33.3^{c}	3.7^{bcd}	6.5^{ab}	15.7^{a}	7.0^{bc}	33.4^{c}	104.3^{b}	70.0^{c}	145.8^{bc}
Soil + Oak LM (1:1)	33.3^{c}	4.0^{bc}	6.8^{ab}	17.9^{a}	7.3^{ab}	34.6^{c}	111.3^{a}	74.0^{b}	163.5^{ab}
Soil + Oak LM (1:3)	35.6^{b}	4.3^{ab}	7.2^{a}	21.5^{a}	7.7^{ab}	36.3^{b}	112.3^{a}	77.3^{a}	172.0^{a}
Soil + PT LM (3:1)	23.3^{f}	2.7^{ef}	4.5^{c}	25.0^{a}	5.0^{de}	27.0^{e}	79.3^{e}	62.3^{e}	93.3^{ef}
Soil + PT LM (1:1)	26.3^{e}	3.0^{def}	5.8^{b}	27.0^{a}	5.3^{de}	29.2^{d}	86.3^{d}	63.0^{e}	110.8^{de}
Soil + PT LM (1:3)	30.0^{d}	3.3^{cde}	6.5^{ab}	27.8^{a}	6.0^{cd}	30.0^{d}	97.3^{c}	66.3^{d}	129.2^{cd}
Soil + Oak + PT LM (2:1:1)	38.3^{a}	5.0^{a}	7.5^{a}	30.3^{a}	8.3^{a}	38.3^{a}	115.3^{a}	79.3^{a}	183.1^{a}

Means in each column, with same letter, have not significant difference ($p<0.01$) of DMRT.
LM: Leaf mould, PT: Persian terebinth.

In the other study that was done in USA, the results showed that application of 440 kg/ha nitrogen compared to 220 and 330 kg/ha nitrogen significantly increased fresh and dry weight of plants as well as Partenolide amount in great Babylonia (Dufault *et al*., 2003). After the first shoot harvesting, application of 40-50 kg/ha nitrogen along irrigation is necessary (Bernath, 2000). Furthermore, increasing growth and biomass of plants following application of organic matter in soil can be related to increase phosphorous absorption. Generative growth indexes of great Babylonia such as flowering shoot number, flower number, flowering shoot weight and number of day to flowering significantly was difference in various media. Often, flower yield indexes were higher in the treatments that vegetative growth had been induced. Certainly, application of organic matter in soil caused to delay flowering (10-15 days) so that this effect was observed in the culture media containing leaf-mould that vegetative growth had been induced. Generally, although these plants later reached to flowering stage, but more flower formation and more essential oil yield compensated this seduction. Maybe the reason of late flowering in the high-growth plants could be related to presence more amount of nitrogen and reduction of C/N ration. High levels of nitrogen/carbon in plants lead to induce vegetative growth and delay flowering time. Following high vegetative growth in such plants, will initiate more generative growth points, which will cause to increase flowering indexes in them. The limit effects of Persian terebinth leaf-mould in the treatment soil + PT leaf-mould (3:1) on improving great Babylonia growth can be related to improve soil physical conditions

and increase roots permeability. In the treatment, regards to low amount of PT leaf-mould, probably its allelopathic effects has been very little. There was significant difference between culture media in viewpoint of essential oil amount and yield in 100 m^2. Essential oil is a part of active materials of great Babylonia plant that it accumulates in shoots mainly in the leaves and flowers and its amount in lower in the stems (Rushing *et al*., 2004)

In this manner, increasing essential oil yield in the media that induced growth of leaf and flower (media containing Oak leaf-mould) it seems logical. In the previous studies, it had been showed that plant essential oil amount decrease in stress conditions (Fonseca *et al*., 2006). Generally, dependence of great Babylonia essential oil yield to environmental conditions is an accepted function. Efficiency of great Babylonia essential oil yield is different depending on growth condition and is variable from 0.3 to 0.83% (Hendriks *et al*., 1996; Askin *et al*., 2005). In the preset study, efficiency of essential oil was 0.7-0.9%. The highest essential oil obtained in the media containing leaf-mould. The results demonstrated that the soil mixtures have effective role in the changes of essential oil amount.

Conclusion

Application of soil mixtures than control, had more effect on yield and other vegetative and generative characteristics of great Babylonia, moreover, the obtained essential oil yield in these treatments was more than 100% soil treatment. Based on the above cases, by reduction of chemical fertilizers portion in production of agricultural crops and more utilization of media containing organic matter could be deduce the costs of medicinal and agronomical crop production and could be reduce environment pollutions arising from application of chemical compounds and could be keep or increase soil fertility. The obtained results in this study indicated that application of Soil+ Oak + Persian terebinth leaf-mould (2:1:1) has been the highest enhancement on yield as well as the greatest influence on increasing soil organic matter.

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