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CULTIVATION OF *MATRICARIA RECUTITA L.* IN HIGHLANDS OF BALOCHISTAN, PAKISTAN

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ABSTRACT:- In highlands of Balochistan chamomile (*Microcephala lamellate* (Bunge) Syn. *Matricaria lasiocarpa*) is found naturally in many protected rangelands areas. However, its population is declining due to over-exploitation and un-controlled grazing. Traditionally these species are used for the treatment of fever and pain. Annual or German chamomile (*Matricaria recutita* L.), and perennial chamomile (*Chamaemelum nobile*) are the most important species all over the world due to multipurpose uses. Field experiments were conducted at Arid Zone Research Centre, Quetta to evaluate the growth and production potential of *Matricaria recutita*. Two crops a year are possible in highlands of Balochistan. The first production cycle starts from late February upto June and second production period is from August to November. Flowers are produced in flushes and picking is possible with 10-15 days interval. In irrigated conditions, maximum fresh and dry flower production at one flush was recorded 2783 and 763 kgha^{-1}, respectively. The fresh and dry flower production under natural rainfall was recorded 812 and 252 kgha^{-1} respectively, at one flush. *Matricaria recutita* survived under the cold and drought conditions of highlands of Balochistan. *Matricaria recutita* has also shown regeneration potential on marginal lands. Commercial scale production of *M. recutita* is possible in highlands of Balochistan. However, further studies are required to evaluate different genotypes/varieties, essential oil contents at various growth stages, oil extraction techniques, mechanized flower picking, drying/storage techniques and cultivation practices in the existing cropping patterns.

Key Words: German Chamomile; Fresh Flowers; Dry Flowers; Production; Cycles; Pakistan.

INTRODUCTION

Medicinal plants have a vital role particularly in the developing countries for the treatment of human and livestock diseases. The uses of medicinal plants for different purposes are centuries old and vary in different countries based on the traditional knowledge. Pakistan has a rich biodiversity of medicinal plants due to its varied climatic conditions (Anwar and Masood, 1998). However, most of the country's requirements are met by importing medicinal plants. Even, in developed countries the demand of medicinal plants is increasing. In Pakistan, mostly the medicinal plants are collected from the wild and some species are cultivated. However, due to over-exploitation and un-planned collection practices the natural resources of medicinal plants are declining very rapidly and high market value species are even close to extinction. Balochistan has also a rich flora of medicinal and aromatic plants due to its five major agro-ecological zones with 18 microclimatic conditions. The present wild production of medicinal plants is unable to meet the herbal industry demand on sustainable bases. Therefore, exploring the cultivation potential of medicinal plants in suitable ecological zones is one of the options to meet the country's demand.

Chamomile is one of the most widely used and well documented medicinal plant in the world and included in the pharmacopoeia of 26 countries (Salamon, 1992 a & b; Solouki et al., 2008). Chamomile is

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an important medicinal plant has wide adaptability over a range of climate and soils (Razmjoo et al., 2008). Chamomile is widely grown as aromatic plant in many countries of the world. The annual world consumption of chamomile flowers is more than 4000t (Franz et al., 1986). There are a number of species of chamomile spread over Europe, North Africa and the temperate region of Asia. Some of the most common species are Annual or German chamomile (*Matricaria recutita* L.) and perennial chamomile (*Chamaemelum nobile*). In highlands of Balochistan chamomile (*Microcephala lamellate* (Bunge) Syn. *Matricaria lasiocarpa* commonly called Piunphulli is found naturally in Hanna valley, Maslakh range, Muslimbagh, Kalat, Nushki, Kharan, Quetta, Chaman, Ziarat and at many other protected rangelands (Ali and Qaiser, 2002). This species is at the verge of extinction due to improper and immature flower collection (FAO, 1997).

Matricaria recutita L. (German chamomile) is an annual herb belongs to the Asteraceae family. Grows up to 36 cm and has feathery foliage with daisy like flowers. Chamomile is an important crop used for herbal tea, cosmetics, essential oil, and making herbal tinctures. Chamomile has wide adaptability over a range of climate and soils and grown in many countries of the world. There are a number of species of chamomile spread over Europe, North Africa and the temperate region of Asia. The flowers of German chamomile are used in herbal teas and one of the most popular single ingredients of herbal teas and flower extracts also used for herbal shampoos and cosmetics (Gupta et al., 2010). The main constituents of the flowers include several phenolic compounds, primarily the flavonoids apigenin, quercetin, patuletin, luteolin and their glucosides (Mckay and Jeffrey, 2006; Gupta et al., 2010).

German chamomile is easy to grow but prefer cooler climates (Foster, 1993). Essential oil is used in cosmetics, perfume and as a flavoring for confections and beverages. The principal components of the essential oil are terpenoids, bisabolol, azulenes and chamazulene (Mckay and Jeffrey, 2006). This oil is called blue chamomile because of the compound Chamazulene which is formed during the distillation process. Distillation is difficult because of the high boiling temperature of constituents, viscosity and other properties of the oil. There is significant variation in the content of different compounds of chamomile essential oils from different regions (Stanev et al., 1996). Relationship between Chamazulene content in the oil and morphological features of chamomile have been reported (Popova and Peneva, 1987). Plant secondary metabolites such as essential oils and plant extracts are studied for their antimicrobial activities and most essential oils derived from plants possess insecticidal, antifungal, acaricidal, antibacterial and cytotoxic activities (Faleiro et al., 1999).

Problems in identification and also the occurrence of adulteration in commercial samples have been found in *Matricaria chamomile* L. and its related taxa i.e *Anthemis nobilis* L. and *Cotula aurea* L. The three species of plants *Anthemis nobilis* L., *Corchorus depressure* L. and *Matricaria chamomile* are reported under only one Unani name "babuna" at different places in literature. Khan et al. (1996) reported that specimens of *M. chamomilla* (babuna) were obtained from ten local shops from Rawalpindi and Islamabad, but it was actually *Cotula* spp. In four shops, an unidentified plant in one shop, *Inula vestita* Wall ex DC in one shop and only four shops had real *M. chamomilla*.

Very limited information is available on growth and production of *Matricaria recutita* in highland Balochistan. Therefore, the present research was conducted to explore the cultivation and production potential of German chamomile in cold and dry areas of Balochistan.

MATERIALS AND METHODS

Field experiments were conducted during 2008-09 at Arid Zone Research Centre, Quetta (latitude 30° 07' N, longitude 66° 58' E, altitude 1690 m). The area has a continental Mediterranean climate (Kidd et al., 1988). Rains mostly occur in winter with great inter and intra-seasonal variations. Long term average rainfall of 200 mm has been recorded (Samiullah et al., 2000). During early spring 2008, seeds of *Matricaria recutita* were sown in six blocks of 9 m^2 by broadcast each having 1 m distance between blocks. Sowing was carried out in the last week of February, 2008. The seeds were mixed with soil and broadcasted in each block. Seed rate was 2.0 $kgha^{-1}$. Plots were irrigated at 15 days intervals. Flower picking (hand picking) was started when 50% plants had flowers and continued at 15 day's interval. In each block flowers were picked and immediately fresh flower weight was recorded. Flowers were dried in shade and dry flower weight was also recorded. Data on plant height,main branches $plant^1$ number of flowers $plant^{-1}$ were recorded at random from 10 plants in each block. Plant density was recorded by using $1m^2$ quadrat in each block. Different morphological characteristics of seedlings growth, leaves, branches, growth habit, and flowering were also recorded. The first crop production cycle was completed at the end of July, 2008.

In September, 2008 new seedlings emerged again from the soil seed bank and growth and flower picking was continued up to the end of November, 2008. Irrigation was applied at 15 days interval. Already mentioned procedure was used for recording all the parameters. After winter, 2008 all the blocks were left on natural rainfall and no irrigation were provided. Flower picking started in April, 2009 at 10 days interval and continued up to June, 2009. Climatic data information (rainfall, temperatures) was obtained from the Automatic Weather Station installed at AZRC, Quetta. Separate analysis for each production cycle was carried out. Blocks were considered as a replicate and all the data were subjected to statistical analysis using one way analysis of variance and means of different flushes days were compared by LSD at 5% significance level.

RESULTS AND DISCUSSION

Chamomile plant height at flowering stage was 19-34 cm, growth habit is erect and plant hairiness is absent. Stem color is green, stem branching is present, stem diameter was recorded 1.2 cm, stem anthocyanin is weak, number of main stem was recorded 8 while stem hairiness is absent. Leaf is semi-erect and green with alternate leaf arrangement, leaf base sheathing and leaf hairiness absent. Leaflet shape filiform, leaflet arrangement opposite, leaflet length/width and rachis length was recorded 0.6/0.4 cm and 0.7 cm, respectively. Ray floret color is white, number of ray florets is 11, ray length/width was 1/0.8 cm, disc floret color and pollen color is white, stigma anthocyanin is medium. Number of head/plant was 19, head attitude is half curved, peduncle length was 5.2 cm, peduncle hairiness is absent, head diameter including rays was 2.7 cm, receptacle shape is concave, receptacle is hollow with weak receptacle pubescence. Seed color is brown and shape elongate, seed size is very small, seed length and width was 0.4mm and 0.2mm, respectively seed curvature is weak while seed stripes absent, 1000 seed weight was 2 g.

Total rainfall from January to December during 2008 and 2009 was 155.32 mm and 251.68 mm, respectively. Growing season of 2009 was comparatively better for rainfall distribution. The monthly averages maximum and minimum temperatures were 39.76°C and -3.50 °C (Table 1). Four flower flushes were obtained during the first crop period from April to July, 2008. Fresh flower production was non-significantly ($P>0.05$) different among different picking dates while the dry flower production was significant ($P<0.05$). Fresh flower production ranged from 472 to 1120 kg ha^{-1} and dry flower production ranged from 228 to 653 kg ha^{-1}. Maximum dry flower production of 653 kg ha^{-1} was obtained at the second picking time (Table 2). The second crop period was from end of September to end of November, 2008. Plant density, plant height, fresh and dry flower production were significantly ($P<0.05$) different among the flow-

Table 1. Total monthly rainfall and average maximum and minimum temperatures during 2008 and 2009 at AZRC, Quetta

Month	Rainfall (mm)	Temperature (°C)		Rainfall (mm)	Temperature (°C)	
	2008			2009		
		Max.	Min.		Mix.	Min.
January	109.18	7.61	-0.42	40.26	9.93	0.89
February	8.89	13.46	-3.50	34.78	16.64	-3.10
March	0.00	24.21	8.23	31.74	22.45	8.45
April	9.12	27.07	11.95	25.12	23.69	9.94
May	0.25	33.61	17.33	9.90	35.62	18.09
June	5.07	38.20	21.53	0.00	33.85	18.89
July	0.00	39.76	22.14	0.00	38.09	22.01
August	11.43	35.05	19.50	0.00	16.21	21.17
September	0.00	33.39	16.75	0.00	33.78	16.05
October	0.00	28.90	12.37	0.00	28.07	10.92
November	0.00	21.01	4.32	0.00	21.08	5.23
December	11.38	15.89	0.23	84.88	13.67	2.32

Table 2. Growth and production of German chamomile during first crop period

Harvest	Plant density (m^{-2})	Plant height (cm)	Flowers/ plant	Fresh flower production ($kgha^{-1}$)	Dry flower production ($kgha^{-1}$)
April 30, 2008	20.23	23.45	33.45	1078.56	390.39 abc
May 15, 2008	22.00	24.60	35.00	1300.85	653.07 a
May 30, 2008	20.30	23.56	34.98	1120.64	549.21 ab
June 15, 2008	21.78	25.23	31.00	681.90	287.16 bc
June 30, 2008	20.40	24.89	28.27	472.33	228.72 c
LSD	ns	ns	ns	ns	288.60

Means followed by same letters within column do not differ significantly at 0.05 level.

ns = non significant

ers picking periods. Maximum fresh and dry flower production was 2782 and 763 $kgha^{-1}$ during the third picking period (Table 3). Under natural rainfall condition during 2009, flower picking was possible up to mid May, 2009. All the parameters (plant height, plant density, fresh flower production and dry flower production) were non-significant (P>0.05). Maximum fresh and dry flower production was 812 and 252 $kgha^{-1}$ (Table 4).

Chamomile growth and production under Mediterranean climatic conditions showed adaptability and resistance to abiotic stresses particularly cold and drought. These two are the major stresses in highlands of Balochistan limiting the crop production (Keatinge et al., 1991). The two cycle of crop production seems related to temperatures. Seeds are able to germinate within seven to nine days. Water and nutrient availability are the main abiotic factors in the Mediterranean plant communities (Carreira et al., 1992; Roda et al., 1999). Limited water is a major constraint of crop and medicinal plants productivity (Razmjoo et al., 2008). Moisture deficiency can induce physiological and metabolic changes like stomatal closure, decline in growth and photosynthesis (Flexas and Medrano, 2002). Soil water stress decreased plant height and total fresh and dry weight of *Satureja hortensis* (Baher et al., 2002). The results are in agreement with the findings of Razjmoo et al. (2008) that chamomile has wide adaptability to a wide range of climates and soil conditions. Sowing of chamomile in highland Balochistan should be carried out during late winter or early spring due to the probability of occurrence of monthly late winter and early spring rains in highland Balochistan that is around 41 and 39% respectively (Kidd et al., 1988; Samiullah et al., 2000). The early germination and emergence of chamomile in the early spring season under comparatively low temperature may allow the plants of early root initiation and seedling establishment. Cultivation of medicinal plants like chamomile in highlands of Balochistan has great potential due to favorable climatic conditions (Ahmad et al., 2008).

Irrigation water with five different salinity levels (0, 84, 168, 252, 336 mmol L^{-1}) was tested on chamomile potted experiment. Increased salinity caused reduction in the number of branches per plant, flowers per plant, peduncle length, head diameter, fresh and dry flower weight and essential oil content of chamomile. Chamomile tolerated 84 mmol NaCl (Razmjoo et al., 2008). Whereas, Baghalin et al. (2008) tested five different salinity levels (0, 4, 8, 12 and 16 dsm^{-1}) on chamomile in a potted experiment and observed reduction in fresh flower production with increase in salinity level. However, saline irrigation water had no significant effect on oil quantity and quality. Drought also caused a significant reduction in plant height, number of branches, flowers, peduncle length, head diameter, fresh and dry flower weight and essential oil content. Chamomile tolerated 4 days interval irrigation without severe reduction in flower yield and oil content in a field experiment (Razmjoo et al., 2008). A row to row spacing of 30 cm have higher fresh flower production (2.61 tha^{-1}) compared to broadcast (1.06 tha^{-1}) at Peshawar (Annual Report, 2006-07).

Improved varieties for flower and oil production of chamomile like Bodegold, Goral, Bona and new Bona, Lutea developed either by mutation or hybridization are cultivated in Slovakia and other European production areas (Falzari, 2007). Bodegold is a tea variety with high flower production. Goral is a tetraploid variety with large flowers and produces oil with 65% bisabolol oxide and 35% alpha bisabolol. Bona and new Bona produces oil high in

Table 3. Growth and production of German chamomile during second crop period

Harvest	Plant density/m^2	Plant height (cm)	Flowers/ plant	Fresh flower production ($kgha^{-1}$)	Dry flower production ($kgha^{-1}$)
September 23, 2008	22.16 ab	25.28 b	9.37 c	2406.85 ab	499.13 b
October 09, 2008	12.33 c	34.00 a	29.66 a	1989.86 b	482.48 b
October 27, 2008	25.16 a	31.45 a	18.28 b	2782.03 a	763.12 a
November 10, 2008	19.16 b	31.16 a	17.73 b	789.95 c	449.55 b
November 25, 2008	12.16 c	32.10 a	21.33 b	237.72 c	98.79 c
LSD	5.45	4.37	6.05	622	214

Means followed by same letters within column do not differ significantly at 0.05 level.

Table 4. Growth and production of German chamomile under natural rainfall conditions during 2009

Harvest	Plant density/m^2	Plant height (cm)	Flowers/ plant	Fresh flower production ($kgha^{-1}$)	Dry flower production ($kgha^{-1}$)
March 16, 2009	23.50	19.78	16.60 b	386.35 b	106.89 b
March 26, 2009	22.66	22.55	16.23 b	812.81 a	184.89 a
April 06, 2009	21.16	21.00	25.39 a	396.35 b	104.88 b
April 16, 2009	22.33	22.00	23.51 ab	734.00 a	219.34 a
May 06, 2009	21.83	21.35	7.80 c	70.99 c	22.10 c
LSD	ns	ns	8.32	130.20	54.01

Means followed by same letters within column do not differ significantly at 0.05 level.
ns = non significant

chamazulene. Lutea is a high oil producing variety (1.0-1.2%) compared with Bona (0.95%). Lutea is also adapted to arid environments (Falzari, 2007). In Slovak Republic chamomile is planted in a crop rotation system to minimize weed problem either red clover or wheat is used in the rotation prior to chamomile. The seed is generally broadcast to produce an even cover. High densities are preferred for increased flower production (Falzari, 2007). Foliar application of iron and zinc at stem elongation and flowering of chamomile improved both flower and essential oil content in calcareous soils (Nasiri et al., 2010). German chamomile has exhibited wide adaptability under the prevailing environmental conditions and stresses of highlands of Balochistan. Two crops a year is possible with 10 to 15 days flower picking intervals. Chamomile has regeneration potential from the soil seed bank and can be grown on marginal lands under favorable climatic conditions. Flower picking and drying must be carried out with care to maintain quality of the crop.

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