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Full Length Research Paper

Growth and production potential of five medicinal crops in highlands of Balochistan, Pakistan

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Growth and production of five medicinal crops (*Foeniculum vulgare* Mill, *Linum usitatissimum* L., *Nigella sativa* L., *Anethum sowa* Benth and Hook and *Carum copticum* Benth and Hook) were evaluated at Quetta and Kalat in Balochistan during 2005. The seeds of these crops were obtained from the Arid Zone Research Center, Quetta. Various growth (plant height, branches per plant) and yield components (umbels per plant, seeds per umbels and seed yield) were recorded. Significant ($P < 0.05$) differences for growth and yield were recoded at both sites. *F. vulgare* and L. *usitatissimum* produced the highest yield at both sites (more than 1000 kg/ha). *A. sowa* and *N. sativa* seed yield recorded less than 1000 kg/ha while the seed yield of *C. copticum* was less than 700 kg/ha. The sowing of these crops in highlands of Balochistan should be carried out during the months of late February or early March to avoid the seedling damage by cold or low temperatures. Results indicate that these crops have potential of cultivation and diversification of cropping systems in Balochistan. The production can be enhanced by using new high yielding varieties with proper production technology and management practices.

Key words: Medicinal crops, seed yield, production technology.

INTRODUCTION

Medicinal and aromatic plants not only provide raw material for traditional uses but also serve as source of pharmaceuticals, herbal drugs, cosmetics and aromatherapy. Most of the world population particularly in developing countries still depends on traditional medicines (Shukla and Sinclair, 2009; Yi and Wetzstein, 2010). In Balochistan, Pakistan, most of the medicinal plants are collected from the wild and only few species are cultivated (Ahmad et al., 2008). These natural resources are depleting very rapidly due to higher extraction rates than the regeneration potential. The variable ecological conditions of Balochistan are very conducive for cultivation of some medicinal plants like *Foeniculum vulgare, Carum copticum, Linum usitatissimum, Nigella sativa* and *Anethum graveolens* on commercial scale.

F. vulgare (Fennel) belongs to the Apiaceae family, native to north of Africa, Mediterranean region, southern Europe and Asia (Wahab, 2006). Fennel is cultivated in many parts of the world like Europe, India, and Egypt (Wichtel and Bisset, 1994). Fennel plant can be annual, biennial or perennial depending on the variety (Farrell, 1985; Wichtl and Bisset, 1994). Fennel is an aromatic herb used as a condiment and flavoring in cooking. Fennel has an antifungal, antibacterial and anti-yeast activity against many pathogenic organisms (Aritomi and Kawasaki, 1984; Miura et al., 1986). Fennel also possesses diuretic, carminative, pain reducing, fever reducing, and anti-microbial actions (Mills, 1991; Matin et al., 2002). Fennel seeds contain essential oil and are used for many purposes (Leung and Foster, 1996).

C. copticum (Ajwain) belongs to the Apiaceae family, native to Egypt and cultivated around the Mediterranean Sea and south west Asia. India is the major Ajwain producing country (Wahab and Mohamed, 2007). Ajwain

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is an important culinary spice and medicinal plant used for centuries in the Indo-Pak sub-continent. Seeds are used in pickles, are anti-rheumatic, and helpful in digestion, whooping cough, and appetizer (IMHSC, 2004, 2005). Pakistan imported a total of 0.412 million kg of Ajwain during 2000 - 2001 and 2001 - 2002 by spending a huge foreign exchange of Rs. 18.55 million (IMHSC, 2004, 2005). Conversion rate of one US $ is about Rs. 88.

L. usitatissimum (Flax) also known as linseed or Alsi belonging to the Linaceae family, has been grown throughout the world for millennia. Flax is an annual plant, flowers are pure pale blue and its fruit is a round capsule containing several seeds. Various parts of the plant have been used to make fabric, dye, paper, medicine, fishing net, soap and industrial/nutritional oils (Akbar and Athar, 2006; Athar and Nasir, 2005; Sharma and Sumere, 1992). Flax can be grown in different ecologies and is environmentally friendly (Akbar and Athar, 2006; Foulh et al., 2002).

N. sativa (Kalonji) belongs to the Ranunculaceae family, is an annual herb native to Mediterranean region and also cultivated in many parts of the world like Middle East, North Africa and Asia (Ahmad et al., 2004; Akbar and Athar, 2006). *N. sativa* has been used as a spice from the ancient times. Its medicinal actions are antihypertensive (Rashid et al., 1987), antibacterial (Ara, 1999), anti-diabetic (Uddin et al., 2002, 2005), and lipid lowering (Saha et al., 2004). *N. sativa* can also serve a good source of balanced food as it contains of high proteins (21%) carbohydrates (35%) and fats ranging from 35 to 38% (Al-Awadi, 1998).

A. graveolens (Dill or Sowa) belongs to the Apiaceae family. Dill is grown as an irrigated annual crop both in temperate and tropical regions. A large number of varieties are known in cultivation (Randhwa and Kaur, 1995). Dill is characterized by long dissected leaves and compound radiating umbels. Dill seeds are traditionally used in pickling vegetables such as cucumbers and cauliflowers. The seeds have a stronger flavor than the leaves. Feathery dill leaves are also used in salads and sauces. The present study was conducted to evaluate the potential of cultivating the medicinal crops in diverse cropping systems of Balochistan.

MATERIALS AND METHODS

The experiments were conducted at two sites in Balochistan (Quetta and Kalat) during 2005. Five medicinal crops (Fennel, Ajwain, Dill, Alsi, Kalonji) were evaluated for growth and production. The seeds of these crops were obtained from the Arid Zone Research Centre, Quetta. At both sites the experiments were conducted in a randomized complete block design with three replications. The sowing was carried out with a single row hand drill. The seed rate of the different crops used: Fennel, Ajwain, Kalonji, Dill, and Alsi were 10, 8, 10, 10 and 10 kg per hectare, respectively. Six rows of each crop were planted in each replication. The row to row distance was kept at 30 cm.

At Quetta, sowing was carried out during the month of February, 2005 while at Kalat, it was during the month of March, 2005. At each site the irrigation interval was 10 to 15 days depending on the rainfall and other climatic conditions. Nitrogen and phosphorus were applied at a rate of 60 and 80 kg/ha at the time of sowing. Four central rows of each crop from each replication were harvested for estimation of production. Seed threshing and cleaning was done by manual techniques. At Quetta and Kalat, the harvesting was done in the months of June 2005 and July 2005, respectively. For each crop 10 plants at random were marked for recording various growth parameters. For seed estimation four central rows of each crop in each replication were harvested. The following different growth and yield components were recorded:

Plant height (cm): Recorded from the ground level at the top of the plant.

Branches per plant: Number of main branches per plant was counted.

Number of umbels per plants: Number of umbels per plant was counted in case of Ajwain, Fennel and Dill.

Number of capsule or fruits per plant: Number of capsule or fruits per plant was counted in case of Kalonji and Alsi.

Number of seeds/umbel: Number of seeds per umbels was counted in case of Fennel, Dill and Ajwain.

Number of seed per capsule or fruit: Number of seeds per capsule or fruit was counted in case of Kalonji and Alsi.

Seed yield: Seed yield of each crop from four central rows were measured and converted into kg/ha.

The data were analyzed in a randomized complete block design with MSTAT C package. LSD test was used to compare the means of different crops.

RESULTS AND DISCUSSION

Significant differences ($P < 0.05$) were recorded for plant height, branches per plant, number of umbels or fruit per plant, number of seed per umbel or fruit, and seed yield of different crops at Quetta (Table 1). The seed yield of different crops at Quetta ranged from 659 to 1183 kg/ha. Fennel produced the highest seed yield of 1183 kg/ha (Table 1). At Kalat, all the parameters except branches per plant were also significant ($P < 0.05$). The seed yield at Kalat ranged from 550 to 1301 kg/ha. Fennel produced significantly ($P < 0.05$) highest yield as compared to other species (Tables 1 and 2). The production trend of all the species both at Quetta and Kalat is similar with some variation in seed yield (Figure 1a and b).

All the tested crops showed production potential at both Quetta and Kalat. The application of various fertilizers may further increase the fennel yield. Wagner (1993) reported beneficial effects of N in increasing the seed yield of fennel. Combined application of 70 kg N and 60 kg S per ha significantly increased grain yield and net return from fennel (Pratap et al., 2003). Application of organic composts and mineral fertilizers on bitter fennel (*F. vulgare* var. *vulgare* Mill.) in Egypt has shown increased production and essential oil content (Khalil et al., 2008). The adverse effect of saline irrigation water

Table 1. Plant height, branches/plant, number of umbels or fruit/plant, number of seeds/umbel or fruit, seed yield per plant and seed yield (kg/ha) of five medicinal crops at Quetta.

Species	Plant Height (cm)	No. of Branches /Plant	No. of Umbels/Plant	No. of Seed /Umbel	Yield (kg/ha)
Nigella sativa	40.93 d	3.66	43.20 b	59.22 c	846 bc
Carum copticum	74.33 b	4.06	27.86 b	115.71 b	659 c
Anethum sowa	74.26 b	4.26	8.60 b	188.48 a	941 abc
Linum usitatissium	53.86 c	6.53	128.53 a	10.37 d	1088 ab
Foeniculum vulgare	101.26 a	4.73	19.93 b	78.21 c	1183 a

Means followed by different letters are significant at $p < 0.05\%$.

Table 2. Plant height, branches/plant, number of umbels or fruit/plant, number of seeds/umbel or fruit, seed yield per plant and seed yield (kg/ha) of five medicinal crops at Kalat.

Species	Plant Height (cm)	No. of Branches /Plant	No. of Umbels/Plant	No. of Seed /Umbel	Yield (kg/ha)
Nigella sativa	42.77 c	5.61 b	23.33	65.61	975 abc
Carum copticum	68.20 b	3.90 b	27.33	117.00	550 c
Anethum sowa	72.66 b	4.13 b	8.66	177.66	748 bc
Linum usitatissium	41.71 c	4.96 b	133.06	10.33	1022 ab
Foeniculum vulgare	108.73 a	14.33 a	71.66	88.30	1301 a

Means followed by different letters are significant at $p < 0.05\%$.

on sweet fennel (*F. vulgare* Mill. var. Dulce) and positive effect of organic manure has been reported by Magd et al. (2008). Irrigation of fennel with saline water (3555 ppm) under North Sinai conditions resulted in significant reduction in vegetative, flowering and fruit yield/plant (Wahab, 2006). Fennel crops sown in lines produced significantly higher seed yield due to higher umbels per plant and number of seeds per umbe l (Ayuab et al. 2008).

N. sativa seed yield ranged from 845 to 975 kg/ha at Quetta and Kalat, respectively (Tables 1 and 2). *N. sativa* landraces and current cultivars are low yielding. The high yielding varieties with improved production technology can produce seed yield of 1500 to 1800 kg/ha (Ahmad et al. (2004)). The moderate doses of nitrogen and phosphorus fertilizers also increase the seed yield (Singh and Singh, 1999). Similarly, (Ahmad et al., 2004) reported the application of 50 kg nitrogen and 40 kg phosphorous per hectare resulted in higher yield. Al-Deen and Ahmad (1997) reported that spacing between hills at a distance of 30 cm significantly increased the number of fruits per plant, seed yield, volatile and fixed oil as compared to 20 and 40 cm spacing. *N. sativa* showed a good response to the higher number of irrigations (9 irrigations fortnightly) as compared to 5 irrigations at 3 weeks interval (IMHSC, 2003, 2004).

A. sowa produced seed yield of 941 and 748 kg per hectare at Kalat and Quetta, respectively (Tables 1 and 2). Atanasov et al. (1976) observed that application of 70 kg per hectare each of N, P_2O_5 and K_2O produced maximum herbage yield and most economic oil yield in Bulgaria. In India where soils are rich in potash, 60 kg of N and 45 kg of P_2O_5 per hectare produced maximum seed yield (Gupta, 1982). Usually, five to eight light irrigations are given to the seed crop. Milky-waxy fruit maturity stage contains maximum seed oil (Zlatev, 1976); the carvone and dihydrocarvone contents accumulated rapidly in the later part of fruit maturity.

L. *usitatissium* seed production was 1088 kg/ha at Quetta and 1022 kg/ha at Kalat. This crop showed early maturity than all the other test crops. The number of fruits or capsules per plant was recoded 10 and 14 at Quetta and Kalat, respectively (Tables 1 and 2). Application of split doses of nitrogen at the rate of (200 and 150 kg/ha) resulted in a significant increase in the seed yield (1056 and 980 kg/ha respectively) as compared to 100 kg/ha nitrophos (710 kg/ha) and control treatments (664 kg/ha) (PMHPS, 2006, 2007). The seed production of *C. copticum* was low at both sides as compared to the other crops. Seed yield was recorded 659 kg/ha at Quetta and 550 kg/ha at Kalat. Ajwain crop has very long vegetative growth period and matured late as compared to all the other test crops. The low seed yield may be due to genetic potential of the available seed source. Early sowing of Ajwain (first week of October) gave higher seed yield in Peshawar region (IMHSC, 2003, 2004).

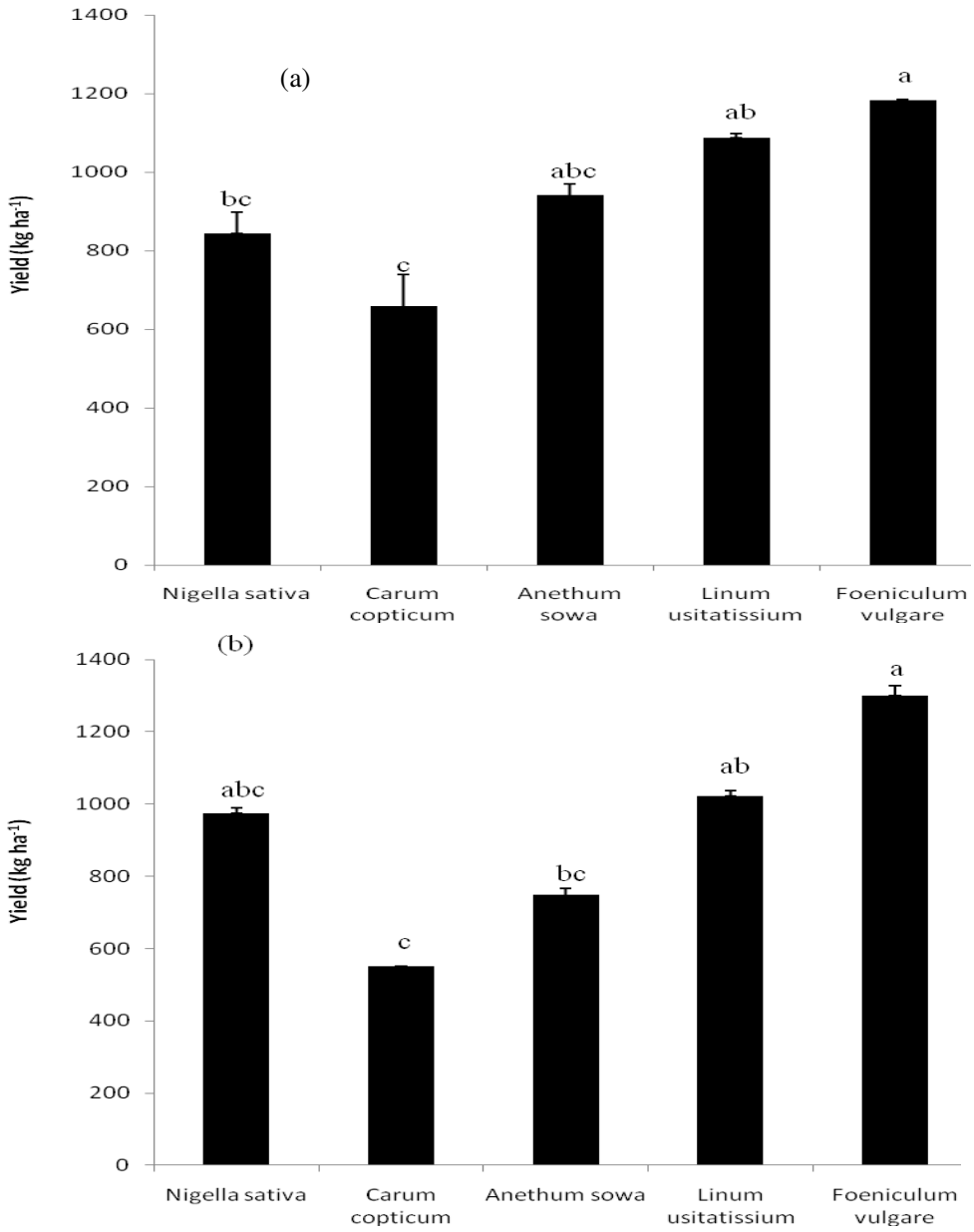

Figure 1. Seed yield of different medicinal crops at (a) Quetta (b) Kalat. Different letters shows significant difference at $p < 0.05$.

The environment can have pronounced effect on the productivity, yield and biochemical properties including phenolic contents and antioxidant capacity of various culinary and medicinal herbs. Yi and Wetzstein (2010) conducted a study on various medicinal crops and concluded that the leaves from thyme, sage, spearmint and peppermint grown in greenhouses showed significantly higher total polyphenolic content and antioxidant capacity than those grown under field conditions, with a threefold difference being observed in peppermint. Results from the present study indicate that various medicinal crops (Fennel, Ajwain, Dill, Alsi, Kalonji) have potential of cultivation and diversification of cropping systems in Balochistan. The production of these medicinal crops can further be enhanced by using new high yielding varieties with proper production technology and management practices.

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