Middle Eastern and Russian Journal of Plant Science and Biotechnology ©2007 Global Science Books

Strawberry Research and Biotechnology in Iran

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ABSTRACT

Strawberry was imported into Iran about 100 years ago from France. Its cultivation area in Iran is about 3000 ha and the total production averages about 21 Kt yearly. Strawberry can be grown successfully in different parts of Iran. Also, in the South of Iran (tropical and subtropical regions), it is possible to produce an out-of-season strawberry crop in the fall and early winter. Strawberry cultivation and production in Iran has doubled in the last two decades. At present the two main regions of the country producing strawberries are Kurdistan and Golestan provinces. The majority of work on strawberries has been carried out at Shiraz University, Tehran University and at the Kurdistan Agricultural Research Center where the most active centers of strawberry research are found. The adaptation of cultivars, fruit set and quality, hydroponic production, breeding and biotechnology are top subjects that are investigated on strawberry in Iran. In this review a summary of the main findings published by Iranian strawberry researchers in these research fields are presented.

Keywords: *Fragaria*, Golestan, hydroponics, Kurdistan, waiting beds

CONTENTS

INTRODUCTION

Iran with 1,648,195 square kilometers in area is one of the largest countries in the Middle East. It is located at 25°, 3′ to 39°, 46′ latitude north and 44°, 2′ to 63°, 9′ latitude east. This location is suitable for growing various fruit crops. Iran ranks forth in the world after USA, China, and Turkey in terms of diversity of horticultural crop production (Theranifar and Sarsaefi 2002). The strawberry is a fruit that grows in a wide range of environments (Galletta and Bringhurst 1990). Strawberry was imported into Iran about 100 years ago from France. It can be grown successfully in different parts of Iran. From the northern part of Iran with a cold climate to the south with tropical and subtropical weather out-of-season production of strawberries, especially in the south, is feasible. For this purpose 'waiting beds' (a plant production system to get fruit production during late summer) production system can be used. The strawberry plants are specially treated in nursery production to grow large and to develop flower buds. They are dug out in fall and cold-stored (2 ± 2°C) until the following summer, fall and early winter when they are re-planted. Plants are allowed to fruit immediately after planting (in about 60 days). This allows growers to obtain fruit throughout the summer, fall and early winter by staggering planting dates as needed. It works best in areas with cool summers and mild fall and winter). Strawberry cultivation and production in Iran has doubled in the last two decades.

There are wild species with small and tasty fruit in the north forest of Iran (Kashi and Hekmati 1990). Unfortunately no study has so far been done on this wild species. Its cultivation area in Iran is about 3000 ha and the total production averages about 21 Kt yearly. At present strawberries are grown in two main locations namely Kurdistan and Golestan provinces with more than 2000 and 500 ha under cultivation, respectively. More than 95% of total production is produced in these two locations (Tehranifar and Sarsaefi 2002; FAO 2004). Moreover, about 20 ha of greenhouse are producing is a considerable amount of strawberry cultivation area. The majority of work on strawberry has been conducted at Shiraz University, Tehran University and at Kurdistan Agricultural Research Center. The adaptation of cultivars, propagation, flowering, fruit set and quality and hydroponic production are top priorities that are investigated on strawberry in Iran.

Recently, glasshouse production of strawberry in Iran is expanding and hydroponic systems are being increasingly used. In this system generally, different sorts of containers are used and filled with perlite, cocopeat, peat moss and leca (mineral). Both vertical and horizontal production systems are common. In the vertical system about 6 to 8 pots are placed on top of each other and nutrient solution is applied from the top and recycled from the bottom pot. Various nutrient solutions are used. Normally feeding is done twice a day along with one time irrigation by water between them. Temperature is controlled thermostatically in the greenhouse and automatic ventilation systems are few. Fan and pad systems are used to cool during hot hours of

Received: 11 February, 2007. Accepted: 10 August, 2007.

Invited Research Note

the day, and either hot water or hot air is employed to warm the greenhouse during cool hours of night.

Recently, work on tissue culture and biotechnology has been started. In this review a summary of the main findings published by Iranian strawberry researchers in this research field are presented.

ADAPTATION OF CULTIVARS

The most common cultivars that are grown in Iran are: 'Kurdistan', 'Selva', 'Camarosa', 'Pajero', 'Parus', 'Queen Elisa', 'Aliso', 'Gaviota', 'Fresno', 'Missionary', and 'Atabaky'.

Despite growing demands for strawberries in the Iranian market, adapted cultivars for different locations have not been selected. However, in recent years attempts have been made to improve the situation by introducing new cultivars and improving cultivation methods.

Tafazoli and Niknejad (1971) in Shiraz compared six introduced strawberry cultivars, 'Missionary', 'Pocahantas', 'Sparkle', 'Armore', 'Dixieland', 'Tennessee Beauty' and a local cultivar ('Atabaky') for total yield, soluble solids, vitamin C content and storage life. 'Missionary' had the highest yield and 'Atabaky' the lowest. Tennessee Beauty' had the lowest vitamin C, but the longest storage life, and 'Atabaky' had the lowest soluble solids. Sarsaefi (unpublished data) in 'Kurdistan' province reported that the production of 'Fresno' (16 ton/ha) was significantly higher than the local 'Kurdistan' cultivar (4.4 ton/ha). 'Tennessee Beauty', 'SP1', 'SP22' and 'Sequoia' cultivars also had greater yield when compared to 'Kurdistan'. Behzadi and Sarsaefi (unpublished data) in Kurdistan province reported that 'Aliso' and 'Armore' had higher fruit production when compared to 'Tioga', 'Fresno' and 'Sequoia' cultivars.

FLOWERING AND FERTILIZATION

Flowering is an important step in strawberry crop production. Eshghi and Tafazoli (2006a) reported a significance increase in photosynthesis rate at 3, 4 and 5 weeks after the start of the short-day treatment (WASST). In their study, stomatal conductance, water use efficiency and mesophyll efficiency showed a positive increase at 3 and 4 WASST in induced plants. The number of runners and crowns and petiole length increased significantly in non-induced plants (Eshghi and Tafazoli 2006a). Sucrose contents in shoot tips and leaves decreased at the beginning of the induction treatment, but soon increased to the same levels in non-induced plants (Eshghi and Tafazoli 2006b). Starch contents in shoot tips, leaves and roots of non-induced strawberry plants were higher than those in induced plants on most sampling dates during flower induction and the differentiation period (Eshghi 2006; Eshghi and Tafazoli 2006b). In induced strawberry plants total nitrogen, calcium and manganese increased from 3 to 18 days after the start of the short-day treatment (DASST) (Eshghi 2006; Eshghi and Tafazoli 2007a). Eshghi and Tafazoli (2007b) suggested that the changes in free cytokinin content in shoot tips and leaves during the process of flower induction play an important role in flower induction in strawberries. Tafazoli and Shaybany (1978a) studied the effect of 21 short day inductive cycle at full bloom stage of 'Armore' and 'Missionary' strawberry cultivars on a second crop summer-fruiting. Treatments induced a second bloom 8-10 weeks after treatments in both cultivars. The second crop of 'Armore' was as large as the first, but 'Missionary' produced only a small second crop that would not be worth commercial harvesting. Tafazoli and Shaybany (1978b) reported that both GA_3 and N increased runner production and vegetative growth in 'Gem' everbearing strawberry. 'Gem' flowering and runner production appeared independent of each other with deblossoming of no practical value in promoting runner production. They suggested that runner formation was physiologically independent of flower initiation and that deblossoming had no practical value in runner production of 'Gem' everbearing strawberry.

Sarsaefi and Ahmadi (2004) reported that suitable time for defoliation is about 50 days after harvesting which resulted in higher crop production. Nazarpour (2005) evaluated the effect of soil and foliar application of paclobutrazol on strawberry. The results of her study showed that both vegetative and reproductive growths were affected by treatments. All treatments reduced leaf area with emphasis on foliar application. Yield was significantly increased with 12.5, 25 and 37.5 mg l^{-1} foliar application and 0.1 mg pot^{-1} soil drench of paclobutrazol.

STRAWBERRY PLANT NUTRITION

Strawberry is a high demanding plant with regard to nutrients. Both quality and quantity of fruits are similarly affected by nutrients. Attempts should be made to satisfy nutrient requirements during flower induction period which consequently affected yield and yield components.

In a greenhouse experiment (Talebnejad 1994; Talebnejad *et al*. 2007), effects on N, P and K and their interaction at the flower induction period on yield components of strawberry have been thoroughly investigated. Results showed that a low level of N (25 mg g^{-1} soil) significantly increased the number of flowers in trusses however opposite results obtained at a high level of N (100 mg g^{-1} soil) due to excessive vegetative growth. P at 50 mg g^{-1} soil reduced the negative effect of N on the number of flowers in the truss. The achene number of primary, secondary and tertiary fruits was increased by NPK application. The ratio of N:P was a key factor that influenced fruit weight. When this ratio was near to one, fruit weight was the highest. Maximum fruit weight was obtained at 100, 100 and 60 mg g^{-1} soil NPK respectively (Talebnejad 1994; Talebnejad *et al*. 2007). Chehrazi (1996) reported that Fe and Zn application at the flower induction period significantly increased yield and yield components, achene number and fruit weight of strawberry.

Iron chlorosis is one of the main limiting factors for production of strawberry in calcareous soils. Karimi (1999) investigated the effect of sulfuric acid application on growth and iron uptake of strawberry plants grown on a calcareous soil. In his investigation sulfuric acid increased leaf area, chlorophyll content and primary and secondary fruits weight. The highest weight of primary and secondary fruit and total yield per plant were obtained at 30 g sulfuric acid plus 10 mg Fe per kg soil.

Effect of different ratios of NH_4^+:NO_3 on strawberry growth were studied in hydroponics production systems. The highest fruit size was obtained with 25:75 (NH_4^+:NO_3) ratio and the lowest was to 0:100 treatment (Seedler Fatemi 2005). Taghavi *et al*. (2005) reported that different levels of Fe and B had no effect on strawberry yield, however by increasing Fe and Zn concentrations total N, K and B content in leaves increased and NO_3, P, Ca, Mg and Fe content decreased, but the amount of NO_3, total N, P and Mg in fruits increased.

In recent years, attention has been drawn to develop a sustainable agriculture and hence the natural materials as soil amendments are applied to improve physical and chemical properties of soil. Application of natural zeolite (1, 2 and 3 g zeolite/kg soil) increased the available N, P, K, Ca and Mg of the medium. Zeolite also increased net photosynthetic rate, fresh and dry weights of shoots and roots, fruit weight and number of achenes in strawberries (Abdi *et al*. 2006).

POST-HARVEST

There are insufficient processing factories in the growing regions. Moreover, since strawberries are highly perishable the transport system is not well equipped to deliver fresh fruits to faraway markets. Therefore, prices during the production season normally drop sharply.

Boostani (unpublished data) reported that frozen fruits

at -18 to -24ºC maintained their quality much better than at -12ºC. Sadeghi *et al*. (2002) evaluated the effect of different levels of pH and SO_2 on stability of color during concentrated juice production from strawberry fruits. They reported that stability of anthocyanin and ascorbic acid was maintained best at pH = 3 and SO_2 at 100 mg l^{-1}.

TISSUE CULTURE AND BIOTECHNOLOGY

This field of strawberry research is fairly new in Iran. Mozaffari at Kurdistan University (Kurdistan province, Iran) is currently working on three projects namely: a) Study on anther culture in several strawberry genotypes, b) Study of production of virus-free strawberry cultivars by tissue culture and thermotherapy methods, and c) Evaluation of proper micropropagation method of strawberry through tissue culture.

Enayati at Shiraz University is simultaneously working on tissue culture of strawberry.

Riazi (2004) studied the germination of seed produced by self- and cross-pollination of strawberry *in vitro* using MS medium. Intact seeds and cut seeds were used. Intact seeds did not germinate after 40 days in the MS medium, whereas cut seeds containing embryos started to geminate after 1 week.

PESTS AND DISEASES

Since strawberry growing regions in Iran are restricted to a few provinces, strawberry pests and diseases are not widespread. Therefore information on pests and diseases are limited, however, the presence of acari and few insects have been reported on strawberries. Red spider (*Tetranychus lambi* Pretchard and Baker) has long been recorded from Mazandaran and Kurdistan provinces by various authors (Khalilmanesh 1980). Biological studies and natural predators have not been carried out in Iran, though it has been recorded as an important pest of banana in Australia (Pinese and Elder 2006).

Low temperature-growing fungi (leather rot), *Rhizoctinia fragariae*, *Mycosphaerella fragariae*, *Botrytis cinerea*, *Rhizopus stolonifer* and *Podosphaera maculatus* f. sp. *fragaria* have been reported especially in the greenhouse; however in the open field due to low humidity their damage is limited (Banihashemi 2007, pers. comm.). Strawberry viruses (*Strawberry yellow virus*) have also been reported by Izadpanah (1983).

Attempts are being made by the authorities to persuade the limited use of pesticides, fungicides and herbicides as much as possible, and organic farming is highly recommended by the government.

CONCLUDING REMARKS

Strawberries are delicious fruits containing a high vitamin C content. Strawberry cultivars both in the greenhouse (out-of-season) and in the open are expanding in Iran. Attempts are made in terms of both introducing new cultivars and selection suitable for production. New methods of cultivation and breeding new varieties adapted for different locations is of prime importance.

The outdoor production of ever-bearing strawberries in areas with a cold summer and indoor production in areas with a mild autumn and winter is under consideration.

Proper packaging and careful marketing so that fresh fruit with healthy appearance are of prime importance in successful strawberry growing.

Fruit processing factories for production of jellies, jam and frozen fruits should be installed. The main production areas should stabilize price especially at the peak of production. The transport system should be improved and refrigerated cargos should be employed.

Virus-free plants via tissue culture and healthy mother plants need to be developed. Biotechnology in the direction of developing bigger fruits with high quality and firm fruit for long distance markets should be employed.

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