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

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 (The ranifar and Sarsaefi 2002). 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
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:
bak'.

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’,
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. Sarsaei (unpub-
lished data) in ‘Kurdistan’ province reported that the pro-
duction 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
Sarsaei (unpublished data) in ‘Kurdistan’ province reported
that ‘Aliso’ and ‘Armored’ had higher fruit production when
compared to ‘Tioga’, ‘Fresno’ and ‘Sequoia’ cultivars.

FLOWERING AND FERTILIZATION

Flowering is an important step in strawberry crop produc-
tion. Eshghi and Tafazoli (2006a) reported a significan
tic 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 treat-
ment, but soon increased to the same levels in non-induced
plants (Eshghi and Tafazoli 2006b). Starch contents in shoot
tips and leaves of non-induced strawberry plants were
higher than those in induced plants on most sampling dates
during flower induction and the differentiation period (Esh-
ghi 2006; Eshghi and Tafazoli 2006b). In induced straw-
berry plants total nitrogen, calcium and manganese in-
creased 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 Shay-
bany (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 treat-
ment 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 de-
blossoming of no practical value in promoting runner pro-
duction. They suggested that runner formation was physio-
logically independent of flower initiation and that debllos-
somning had no practical value in runner production of
‘Gem’ everbearing strawberry.

Sarsaei and Ahmadi (2004) reported that suitable time
for defoliation is about 50 days after harvesting which re-
sulted in higher crop production. Nazarpour (2005) evalu-
ated 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 nutri-
ents. Both quality and quantity of fruits are similarly affect-
ed by nutrients. Attempts should be made to satisfy nutrient
requirements during flower induction period which conse-
quently affected yield and yield components.

In a greenhouse experiment (Talebnajed 1994; Taleben-
jad 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 op-
posite 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 (Talebnajed 1994; Talebnajad
et al. 2007). Chehrazi (1996) reported that Fe and Zn applica-
tion 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
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 NH4+:NO3 on strawberry
growth were studied in hydroponic production systems.
The highest fruit size was obtained with 25:75 (NH4+:NO3)
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 NO3, P, Ca, Mg and Fe
content decreased, but the amount of NO3, 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 photo-
synthetic 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 pro-
duction season normally drop sharply.

Boostani (unpublished data) reported that frozen fruits

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at -18 to -24°C maintained their quality much better than at -12°C. Sadeghi et al. (2002) evaluated the effect of different levels of pH and SO₂ 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 SO₂ 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 germinate 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 is limited, however, the presence of acari and few insects have been reported on strawberries. Red spider (Tetranychus lambi Precht 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), Rhizoc tinia fragariae, Mycosphaerella fragariae, Botrytis cinerea, Rhizopus stolonifer and Podosphaera maculatus f. sp. fragariae have been reported especially in the greenhouse; however in the open field due to low humidity their damage is limited (Banishahemi 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.

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