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Genetic Variability and Improvement of Strawberry

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Abstract: Strawberry (*Fragaria* spp.), belonging to family *Rosaceae*, is an important fruit crop in subtropical and temperate region. It is propagated thrugh runners and behaves perennial crop in temperate ecosystem. At ICAR-IARI, Regional Station, Shimla is maintaining large field gene bank of strawberry genotypes with diverse genotypic and phenotypic attributes. At present 105 accession are conserved and maintained at Horticultural Research farm, Dhanda, Shimla. The leading strawberry producing countries are United States, followed by China and Spain. In India, it is commercially cultivated in Himachal Pradesh, Uttar Pradesh, Maharashtra, West Bengal, Nilgiris hills, Delhi, Haryana, Punjab and Rajasthan. Nainital and Dehradun districts of Uttarakhand, Mahabaleshwar (Maharashtra), Kashmir valley, Bangalore and Kalipong (West Bengal) are the main centers of strawberry cultivation in India. It is cultivated in plains as well as in hills up to an elevation of 3000 meters in humid or dry regions, widely grown under protected and open condition in temperate and subtropical countries with maximum temperature of 22^{o} -25^{o} C in the day and 7^{o} -13^{o} C at night.

INTRODUCTION

Strawberry (*Fragaria ananassa Duch*.) is one of the most popular soft fruit and an attractive, luscious, tasty and nutritious fruit with a distinct and pleasant aroma, and delicate flavor. It has rich in vitamin C, iron, proteins, minerals Ca, P and K. Strawberry is mainly consumed as fresh fruits and also processed for making wine, jam, jelly, ice cream and soft drinks etc. Strawberries are low-growing herbaceous plants with a fibrous root system and a crown from which arise basal leaves. The leaves are compound, typically with three leaflets, sawtooth-edged, and usually hairy. The flowers, generally white, rarely reddish, are borne in small clusters on slender stalks arising, like the surface-creeping stems, from the axils of the leaves.

CENTER OF DIVERSITY

The garden strawberry (*Fragaria x ananassa* and related cultivars) is the most common variety of strawberry cultivated worldwide. It originated in Europe in the early eighteenth century, and represents the cross of *Fragaria virginiana* from eastern North America (the main native strawberry in the United States), which was noted for its fine flavor, and *Fragaria chiloensis* from Chile, noted for its large size. Cultivars of *Fragaria x ananassa* have replaced in commercial production the woodland strawberry (Fragaria vesca), which was cultivated in the early seventeenth century. It is cultivated in tropical and sub-tropical areas round the year. The leading strawberry producing countries are United States, followed by China and Spain. In India, it is commercially cultivated in Himachal Pradesh, Uttar Pradesh, Maharashtra, West Bengal, Nilgiris hills, Delhi, Haryana, Punjab and Rajasthan (Chadha, 2001). Nainital and Dehradun districts of Uttarakhand, Mahabaleshwar (Maharashtra), Kashmir valley, Bangalore and Kalipong (West Bengal) are the main centers of strawberry cultivation in India (Tyagi *et al*., 2015).

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Worldwide distribution of native strawberries (Fragaria spp.) (Hummer and Hancock 2009)

Sl No.	*Species*	*Geographic Distribution*
1	*F. bucarica* Losink.	Asia (W. Himalayas)
2	*F. daltonia* J. Gay	Asia (Himalayas)
3	*F. nubicola* Lindl.	Asia (Himalayas)
4	*F. gracilis* Losink.	Asia (N. China)
5	*F. mandshurica* Staudt	Asia (N. China)
6	*F. pentaphylla* Losink.	Asia (N. China)
7	*F. corymbosa* Losink.	Asia (N. China)
8	*F. moupinensis* (French.) Card	Asia (N. China)
9	*F. gracilis* Losink.	Asia (N.W. China)
10	*F. tibeticia* spec. nov. Staudt	Asia (China)
11	*F. innumae* Makino	Asia (Japan)
12	*F. yezoensis* Hara.	Asia (Japan)
13	*F. nipponica* Lindl.	Asia (Japan)
14	*F. iturupensis* Staudt.	Asia (Iturup Island)
15	*F. nilgerrensis* Schlect.	Asia (S.E. Asia)
16	*F. orientalis* Losink. syn. = *F. corymbose* Losink.	Asia (China, Far Eastern Russia)
17	*F. Americana* (Porter) Britton syn. = *F. vesca* (Porter) Staudt.	Europe, Asia, N. America
18	*F. viridis* Duch.	Europe, Asia
19	*F. moschata* Duch.	Europe, Asia
20	*F. chilonensis* (L.) Miller	America, S. America (Western N. America, Hawaii, Chile)
21	*F. virginiana* Miller	N. America

Types of Strawberry

Sl. No.	*Chromosome numbers*	*Species*
1	Diploid species	*Fragaria daltoniana* *Fragaria iinumae* *Fragaria nilgerrensis* *Fragaria nipponica* *Fragaria nubicola* *Fragaria vesca* (Woodland Strawberry) *Fragaria viridis* *Fragaria yezoensis*
2	Tetraploid species	*Fragaria moupinensis* *Fragaria orientalis*
3	Hexaploid species	*Fragaria moschata* (Musk Strawberry)
4	Octoploid species and hybrids	*Fragaria x ananassa* (Garden Strawberry) *Fragaria chiloensis* (Beach Strawberry) *Fragaria iturupensis* (Iturup Strawberry) *Fragaria virginiana* (Virginia Strawberry)
5	Decaploid species and hybrids	*Fragaria* × *Potentilla* hybrids *Fragaria* × *vescana*

(Darrow, 1966)

Description of important genotypes (Chadha, K.L. 2001, Kishore *et al*, 2009, Shukla *et al.* 2020)

Chandler - Fruit is having high dessert quality with outstanding colour and flavor. It is very resistant to physical damages caused by rain. Plants are tolerant to viruses. It is suitable for fresh market and processing. The fruits having good TSS (12%), aciditity (0.85%), vitamin C (55.5mg/100g) and sugar content (6.1%).

Tioga - An early maturing cultivar and it is tolerant to viruses. Fruits are very large, fleshy and skin firm. Average berry weighs about 9g and it contains TSS 12.2%, acidity 0.98% and sugar 6.2%.

Torrey- It is tolerant to viruses; it produces numerous runners. Fruits are large in size, fleshy and skin medium firm, dessert quality is excellent with good TSS (12%), acidity (0.97%) and sugars (6.1%). Average fruit weight is 6.9g.

Selva - It is a day neutral cultivar and it produce off season fruits. Fruits are large, flesh, skin firm, conic to blocky in shape, dessert quality is good. The average size of berry weighs 15-18 g with 11.1% TSS, 1% acidity and 5.5% sugar.

Belrubi - Fruits are large, conical, bright red skin, some what firm, less hallow at core, high quality, sweet, slightly sub acid and attractive red flesh. The average fruit weight is 15g with TSS 11.8%, acidity 0.98% and sugars 6%. It is highly susceptible to leaf spot *(Mycosphaerella fragariae)*

Fern - It is a day neutral, early ripening and over bearing cultivar. Fruits are large, conical, slid internally, slightly hollow, skin red, flesh red, firm, flavor excellent. It tastes sweet to slightly sub acidic. Average berry weighs 20-25g with TSS 11.2%, acidity 0.88% and sugars 6.1%.

Pajaro - It is very successful under summer season. Plant tolerant to virus. Fruit is quite susceptable to physical damage caused by rain. Friuts are large, flesh very firm and red in colour. The average berry weighs 7.6g with TSS 12.2%, acidity 0.97% and sugars 5.5%.

Sweet Charli (A.L.80-456 x pajaro) - It is early maturing variety and average fruit weight is 17g. It is resistance to anthracnose and susceptible to blast, powdery mildew and mites.

Addie- It is conical shape, fruit wight 5-12g, fruit size medium, TSS 9.01^{0}brix, Yield/

plant 90-150 g, flowering during March, runner production 10-15/plant, it is susceptible to leaf Spot *(Mycoshaerella fragariae)* suitable for jam making.

Jutogh Special- It is conical in shape, fruit weight 10-25g, TSS 7.5-9.5^{0}brix, fruit yield 150-250g/plant

Catskill-Fruit weight 9.01 g, medium in size, TSS 10.5^{0}brix, fruit yield 75.5-89.15 g/ plant, number of fruit/plant varied from 10-15.7, harvest period from 45-65 days,

Etna-Shape: Conical, fruit weight 25.37g, fruit size (LxW) 34.58X35.56 mm, TSS 8.21^{0}brix, fruit yield 256.08g/plant, No. of Fruits/plant 10.09, date of flowering-March, harvest period 101days, runner production 12.23, susceptible to leaf spot *(Mycoshaerella fragariae)*, bearing habit:annual, utility jam making.

Fair Fox- It is round in shape, fruit weight 6.01g, fruit size (LxW) 17.93x22.59mm, TSS 9.91^{0}brix, fruit yield/plant 126.27g, number. of fruits/plant 21.01, date of flowering (at Shimla, 2000 m asl) 25 March, harvest period 82 days, runner production 15.97, moderately susceptible to leaf spot *(Mycoshaerella fragariae)*, annual bearing habit.

Gorella- Conical shape, Fruit weight 7.01g, fruit size (LxW):37.50X18.05mm, TSS (^{0}brix): 9.01, Yield/plant(g): 128.37, No. of Fruits/ plant: 18.08, Harvest Period: 51 days, Runner Production: 12.03, Leaf Spot *(Mycoshaerella fragariae)*: Susceptible, Bearing Habit: Annual, Utility: Jam Making.

Larsan-Fruit weight 3.25g, TSS(^{0}brix):10.01, Yield/plant(g):59.30, No. of Fruits/plant:18.08, Harvest Period:91 days, Runner Production:34.01, Leaf Spot*(Mycoshaerella fragariae)*: Susceptible, Bearing Habit:Annual, Utility:Jam Making.

Majestic-Fruit weight 3.51g, TSS(^{0}brix):8.55, yield/plant(g):70.18, No. of Fruits/plant:20.05, Harvest Period:56 days, Runner Production:12.54, Leaf Spot*(Mycoshaerella fragariae)*: Susceptible, Bearing Habit:Annual, Utility:Jam Making

Phenomenal- Shape:Conical, Fruit Wt.(g): 3.16, TSS (^{0}brix): 9.75, Yield/plant(g): 60.26, No. of Fruits/plant: 19.01, Harvest Period: 70 days, Runner Production: 26.68, Leaf Spot *(Mycoshaerella fragariae)*: Susceptible, Bearing Habit: Annual, Utility: Jam Making

Sea Scape- Shape: Conical, Fruit Wt.(g): 11.01, TSS (^{0}brix): 11.93, Yield/plant(g): 198.95, No. of Fruits/plant: 18.07, Harvest Period: 93 days, Runner Production: 19.03, Leaf Spot *(Mycoshaerella fragariae)*: Susceptible, Bearing Habit: Annual, Utility: Fresh Fruit & Jam Making

Shimla Delicious- Shape: Long Conical, Fruit weight 4.50g, TSS (^{0}brix): 12.95, Yield/plant(g): 135.05, No. of Fruits/plant: 30.01, Harvest Period: 51 days, Runner Production:24.92, Leaf Spot *(Mycoshaerella fragariae)*: Moderately Susceptible, Bearing Habit:Annual, Utility: Fresh Fruit & Jam Making Excellent Flavour

Dana-Shape:Conical in shape, Fruit weight 9.49g, TSS (^{0}brix): 10.01, Yield/plant(g): 196.46, No. of Fruits/plant: 20.68, Harvest Period:49 days, Runner Production: 15.57, Leaf Spot*(Mycoshaerella fragariae)*: Highly Susceptible, Bearing Habit:Annual, Utility: Fresh Fruit & Jam Making

Douglas- Conical shape, Fruit weight 17.36g, TSS(^{0}brix):10.03, Yield/plant(g):209.83, No. of Fruits/plant:12.08, Harvest Period:78 days, Runner Production: 7.93, Leaf Spot *(Mycoshaerella fragariae)*: Moderately Susceptible, Bearing Habit: Ever bearing, Utility: Fresh Fruit & Jam Making

Missionary- Shape: Long Conical, Fruit Wt.(g): 5.82, TSS(^{0}brix): 9.83, Yield/plant(g): 105.23, No. of Fruits/plant: 18.05, Harvest Period: 80 days, Runner Production:25.01, Leaf Spot *(Mycoshaerella fragariae)*: Susceptible, Bearing Habit: Annual, Utility: Jam Making

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