

## **Short Communication**

### **A new spontaneous tetraploid inter-specific hybrid in coffee (*Coffea* sp.)**

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**Abstract:** A new inter-specific natural hybrid was spotted in a private coffee plantation in Coorg District of Karnataka during the year 1998. The hybrid was observed to be a natural hybrid of a diploid tree coffee (*Coffea excelsa*) and tetraploid arabica variety S.795 (*C. arabica*) possessing resistance to coffee leaf rust disease and white stem borer with FAQ cup quality. This material is expected to be the strong genetic base for introgression of resistant genes in arabica improvement through conventional hybridization or molecular breeding.

**Keywords:** Interspecific hybrids, natural hybrids, mutants, dihaploids, polyploids

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#### **INTRODUCTION**

Changing a fickle-dam-fortune of a man or a man-made industry nurturing the millions of people striving hard to maintain their livelihood is governed by the mighty Nature. This nature plays utmost important role in sustaining ecological balance. Besides this, creation of unpredictable natural calamities involving famine, epidemic diseases, disasters etc are not ignorable and subsequently, salvation by way of showering rains, evolution of new plant materials in the form of natural hybrids [1] and mutants [2-3], reproduction of predators in agriculture is also a part of natural process. Similarly, in coffee too such phenomenons have occurred which wiped out the industry, subsequently, after a certain period of time nature revived the industry. During 19th century, several coffee plantations were destroyed by the severe attack of coffee leaf rust on arabica in Sri Lanka. This laid a bad impact on Indian plantations and prompted the growers to introduce diploid species of *Coffea* such as *C. canephora*, *C. excelsa* and *C. liberica* in India to combat the problem of leaf rust severity [1]. In a course of time, nature graced the Indian coffee growers through development of natural inter-specific hybrids like S.26 and Devamachy in India and some through introduction of such hybrids like Kalimas, Kawisari and Hibrido-de-Timor from other countries[1]. These plant materials encouraged the helpless coffee growers to revive their coffee plantations and support the industry. However, in coffee, occurrence of spontaneous hybrids and mutants of tetraploid arabica and diploid species is a common phenomenon particularly when these species are grown together [4-7]. The recent findings revealed the arabica coffee as a natural hybrid of *C. eugenioides*

and *C. canephora* or ecotype related diploid species [12]. Hibrido-de-Timor which is a natural hybrid of *C. arabica* and *C. canephora* (Bettencourt, 1973) possesses high degree of resistance to almost all rust races prevailing all over the world and being widely used in coffee breeding programme. Arabica species is well known for its self-fertile nature however, Krug and Carvalho achieved 7-9 percent cross-ability in arabica by using 'cera' mutant with yellow endosperm [13]. As far as diploid species are concerned, all are self-sterile and pollinated mainly by wind and insects [8].

Greater potential has been realized in breeding *C. arabica* with the diploid *Coffea* species such as *C. canephora*, *C. congensis*, *C. recemosa* and *C. liberica* var. *dewevrei* [9]. The release of Brazilian varieties 'Icatu' Vermello, 'Icatu' Amarello and 'Icatu' with higher resistance to leaf rust and better liquor quality are the latest examples. Beside this, the variety 'Arabusta' is largely grown in Ivory Coast [10]. The varieties Obata (IAC1669-20), Tupi (IAC 1669-33) and IAPAR 59 were recently developed by crossing arabica with HDT of *C. canephora* genetic back ground [14].

In India, "Devamachy Hybrid" a spontaneous putative hybrid of robusta x arabica was identified in a private coffee estate 'Devamachy' and was utilized to develop selections Sln.5A and Sln.5B by crossing it with Rume Sudan arabica (S.881) and S.333 one of the arabica accessions respectively. Subsequently, Sln.6 a synthetic inter-specific hybrid progeny was bred by hybridization of robusta x Kents arabica to serve the arabica growers of India with a cultivar having higher degree of leaf rust resistance (85-90 percent), high yield

potential and desirable cup characters on par with other arabica cultivars of India [1].

Likewise, one more case of evolution of elite type natural hybrid came into light during the author's visit to a private estate near Madikeri, Kodagu district of Karnataka during 1998. The plant is more than 25 year-old, resembling like a tree coffee and planted along the fence between tree coffee plants. Plant is believed to be a tetraploid natural hybrid of *C. excelsa* and *C. arabica* based on their phenotypic similarity with excelsa and arabica coffee and found to be free from leaf rust as well as white stem borer. Keeping in view, the importance of genetic potential of these plants, its commercial exploitation and breeding utilization would be more advantageous to rescue the problem of coffee leaf rust and white stem borer known for causing enormous damage to the coffee industry. A preliminary study on the physio-morphological, yield and quality parameters was undertaken and presented in this paper.

The above mentioned natural hybrid had recorded 40.00kg yield of ripe fruits per plant and exhibited resistance to coffee leaf rust (CLR) and white stem borer (WSB) as confirmed by lab tests. The plant possessed dark green arabica type foliage but leaf thickness similar to excelsa coffee. Fruits were bold weighing 234.00 gm and volume 228.00ml per 100 fruits. Ripe fruit to clean coffee outturn was poor (10.22%) as compared to the normal arabica outturn (18 – 20%) probably due to its interspecific hybrid nature as reported earlier [11]. Low fertility was also one of the main reasons for formation of higher percentage of pea berry that affected the outturn. The cup quality was found to be FAQ in one season and below FAQ in another season. This hybrid was assessed to be one of the best future breeding plant materials for arabica improvement. The arabica cultivars of higher degree rust resistance and white stem borer tolerance can be evolved by introgression of genes from this natural hybrid of tree coffee and arabica. Backcrossing the natural hybrid with arabica would be able to improve the liquor quality in the progeny.

#### **Important characteristic features:**

**Bush-** Tall type like tree coffee, drooping type branches and medium type bush spread like arabica varieties.

**Stem-** Thick and sturdy, appearance like excelsa coffee, thick primary branches, medium inter-nodal length as in excelsa coffee, fast and vigorous plant growth, stem colour brown at maturity **Leaf-** Dark green, broad and thick leaves, shape is similar to arabica, copper colour young leaves,

**Flower-** Similar to excelsa coffee

**Fruit-** Bold size, after ripening fruits turn purple, juicy fruits like arabica

**Fruit ripening-** Fruit ripening of natural hybrid coincides with arabica ripening

**Fruit yield of natural hybrid-** 40.00 kg/plant (Clones yielded 3.44 kg/plant at the age of 3years)

**Quality-** FAQ and above

**Resistance to coffee leaf rust (CLR):** Most of the rust races are prevalent in the coffee estates and leaf rust being a host specific pathogen, it exhibits its inoculum in the field indiscriminately. Therefore, the plants showing resistance under the favourable circumstances (field conditions) for CLR aggression possess comparatively higher durable resistance than the plants grown under the controlled condition. The natural hybrid identified in the private coffee plantation was found to be completely resistant to CLR under field a condition which is an important factor for selection of resistant plant material. Introgression of resistant genes in the natural hybrid was most likely due to involvement of excelsa tree coffee (*Coffea excelsa*) as a female parent.

**Resistance to white stem borer (WSB):** Besides the CLR, white stem borer is another serious problem of arabica varieties hence, breeding a new arabica variety attention is paid for the resistance to WSB. This hybrid was tested in the lab for WSB resistance at CCRI and found completely resistant to white stem borer.

Character for bronze leaf-tip colour is dominant over green colour [8]. The presence of copper leaf-tip colour in natural hybrid of tree coffee indicated the effect of dominant genes of *C. excelsa* a tree coffee species. Cultivar S.795 possesses the light bronze leaf-tip which was suppressed by the dominant genes of excelsa which expressed the copper colour in the present natural hybrid. Generally, raising the seedlings of tree coffee for planting along the border or fence is common practice in the plantations hence, it is presumed that natural tree coffee hybrid might have developed through natural crossing of excelsa tree coffee with an Arabica cultivar S.795 or Kents grown in the vicinity before 20-25 years. Further, to ascertain the authenticity about the parental lines of this natural hybrid, molecular characterization would be of much use. This hybrid needs further investigation on genetic analysis and improvement for its fruit fertility and quality traits by backcrossing with elite arabica genotypes of better quality. However, the new interspecific can be utilized as base material for breeding the new varieties resistant leaf rust and white stem borer.

**Table-1: Growth and yield parameters in Natural hybrid**

| Parameters   | Values        |
|--|---------------|
| <b>I. Growth parameter</b>                                       |               |
| 1. Stem girth (cm.)  | 4.94          |
| 2. Plant height (cm.)  | 96.2          |
| 3. Number of primaries per plant                                 | 16.2          |
| 4. Number of secondaries per primary                             | 7.04          |
| 5. Length of primary (cm.)                                       | 109.76        |
| 6. Length of secondary (cm.)                                     | 58.5          |
| 7. Total number of nodes per primary                             | 17.54         |
| 8. Number of fruiting nodes per primary                          | 12.06         |
| 9. Total number of nodes per secondary                           | 9.74          |
| 10. Leaf area (cm <sup>2</sup> )                                 | 110.5         |
| 11. Number of tertiary branches                                  | 1.32          |
| 12. Number of fruits per cluster                                 | 23.88         |
| 13. Number of flowering nodes per primary for next cropping year | 10            |
| 14. Number of flowers per node                                   | 34.38         |
| <b>II. Yield parameters</b>                                      |               |
| 1. Ripe fruit yield per plant (kg.)                              | 3.44          |
| 2. 100 fruit wt. (gm)  | 234           |
| 3. 100 fruit vol. (ml)   | 228           |
| 4. Fruit floats (%)  | 6.6           |
| 5. Wet parchment (%)   | 54.03         |
| 6. Dry parchment (%)   | 14.08         |
| 6. Outturn (fruit to clean coffee %)                             | 10.22         |
| 7. Dry parchment to clean coffee (%)                             | 72.5          |
| 8. 'A' grade beans (%)   | 35.9          |
| 9. 'B' " " "   | 0             |
| 10. 'C' " " "  | 0             |
| 11. 'PB' " " "   | 51.28         |
| 12. Cuts & Bits "  | 12.82         |
| 13. Cup quality  | FAQ and above |
| <b>III. Anatomical observation</b>                               |               |
| 1. Number of chloroplasts in stomatal guard cells                | 15.64         |
| 2. " " " " in excelsa tree coffee                                | 10.96         |
| 3. " " " " S.795 arabica   | 14.36         |
| 4. Length of stomatal guard cell in natural hybrid (cm.)         | 24.6          |

**Fig-1: A twig of natural inter-specific hybrid**



**Fig-2: Fruit size and clusters in natural hybrid**

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