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# Comparative study of different fertile groups in plums

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***Summary:*** The plum traditional fruit species in Hungary, several local cultivars was born in the different grower's districts. The author that investigated, that are morphological differences between an odds find self-fertile, self sterile (with functional stamens) and male sterile plum cultivars. For it thought about main questions of a scientific debate sown up and the study this way gave reactions totalize. There were in three fertile groups 8–8 type of feature plum cultivars in periods of 1992–2001, respectively 1993–1999. It was founded by author big odds found the troops on the basis of 9 traits between. Pistil length of self sterile cultivars very typical, such as sesquipedalian flower peduncle of the self-fertile plums and the hypoandry of male sterile cultivars. The relative stamen number and the pollen viability as well significant odds gave. The average fruit mass and sharka infection of self-fertile plums this troops extreme work. According to cultivar's averages the shark symptoms standard the right correlation the singular traits, but those one part of her with each other not shown connection.
The annuity potencies underdeveloped the troops behind and the troops within cultivar's differences had case significance. The results usable the male sterile cultivars and progeny further its investments.

***Key words:*** plum cultivars, floral biology, male and autosterility, self fertility, functional flower morphology

## Introduction

The plum age long since important fruit was in Hungary. That's easily understand also, because the parent species of European and Western Asian plums are native in Carpathian Basin, moreover were born here also new forms, local cultivars i.e. 'Lószemű szilva', 'Vörös szilva', 'Sárga vad-szilva' etc. (*Surányi,* 2004b).

The characteristics of erstwhile cultivated plums and prunes followings:

- high self-fertile or very good pollen resource
- easy propagation by seeds or sprouts
- drought and frost resistance
- good cropping
- many kinds of usability for fruits
- relative good fungi and parasite resistance
- all over the country cultivated variety

In Hungary it had been one outstanding and universal plum cultivated which the dry plain territories excluding, almost all-around of Hungary was produced. From the XVIIIth century however ever more reported, those are the growing problems and the cultivar's errors also, because symptoms of the cultivar's erosion manifested as decreasing of self fertility and cropping, towards the fruits were smaller (*Surányi,* 2006a).

There tested again by farmers more and more cultivars in gardens and domains, or they has been planted. Already there were no main criteria the plum self fertility and blue fruit skin of plums, new phenomenon was beginning: to cultivate more various plums and prunes…

In XX$^{th}$ century it's happened three considerable cultivar's change, i.e. in 1920, towards about 1970 and 1990 after. It can characterize the cultivars, those were in traditional blue plums, which European and Western Asian forms, towards medium late or late ripening. The variety's change requirements and his conception yet today again publish, which cultivars already not 'Besztercei szilva'-like (partly opposite to seven criteria) (*Surányi,* 1985 & 2004a).

The fundamental pomological and flower biological studies several incompatibility forms wrote down (*Brózik & Nyéki,* 1975), that way the male sterility forms also. Summarily, we call only attention to some of reviews (*Dahl,* 1935; *Röder,* 1940; *Tóth,* 1957 and 1967; *Rémy,* 1953; *Surányi,* 1985; *Nyéki,* 1996 and *Szabó,* 2003).

In present paper we investigated the possibilities of structural characterization, thus there are presenting cases and causes of the male sterility: fall off the androecium's formation, undeveloped the anther, the anther fall off the pollen organization, i.e. total disorder of microsporogenesis (*Astrego,* 1943; *Linskens,* 1967; *Brózik & Nyéki* 1975; *Tóth & Surányi,* 1980; *Surányi,* 1991), or there is not normal pollen tube growth (*Napp-Zinn,* 1967).

The functional problems of androecium's gene run resulting question also (*Resende,* 1967), but the degeneration of pollen cells determined extrachrosomelly. It can be the male sterility cytoplasmatic or nucleotic. This cytohistological disorder case descended on mother line (*Faludi,* 1965).

The male sterility and aberrant pollen organization almost all fruit species happens (*Nyéki & Soltész,* 1996). In the plum cultivars nor unknown the male sterility, which

here is mostly of histology origin (*Pejkić & Popović* 1973 cit. *Nyéki,* 1996; *Kozma et al.,* 2003): the tapetum overgrowth, sporangium irregularities, or blocked tetrade organization, for this reason the male function disappear from the flowers (*Cociu & Bombac,* 1968; *Cociu et al.,* 1996). Meiotic disorders caused pollen organization problems in microsporgenesis (*Randhawa et al.,* 1964).

Absolutely potentially are other reasons also, than specific pathogen *Sclerotinia laxa* of apricot (*Surányi,* 1975) or plum pox of *domestica* plums (*Surányi,* 1989), over and above that by reagent (i.e. dietylene sulphate) (*Faludi,* 1965, *Napp-Zinn,* 1967).

In scientific forums, those traits can be suitable indicators for characterization of male sterility. Present study searches take this way of fundamental problem, and if positive is it, we have further question: which can be these traits?

## Materials and methods

1980–1982 between in Myrobalan B seedlings inoculated plum scions planted. The 24 cultivars investigated 3–3 trees. 1992–2001 between yearly 50–50 flower gathered, stereomicroscope underneath measured the flower and fruit peduncle length and pistil length; we were till counting the functionally (pollen producing) stamens (*Surányi,* 1970 and 1976, resp. *Faust,* 1989).

All of the cultivars of twigs about 4–600 flowers of open pollination resulted fruit value, that 8 week after finished. These the trials 1992–2001 between it's happened (9 year-old duration). The eventuality and connecting of singular data some of the morphogenetic traits with correlation counting analyze, out of four some graphically also typified (*Surányi & Erdős,* 2004b). 'Besztercei Bt. 2', 'Green Gage' and 'Stanley' as the control cultivars were of used.

There were observations 3–3 samples of each cultivar in 15% of saccharose drops, with 24 hours incubation (and in the 20 °C) on the pollen germination viability. The pollen size 5–6-times longitude pollen had cultivating pollen quality viable. The relative stamen number of the stamen number and the pistil length ratio got. These trials and measuring 1992–2001 between carried (10 year long). The main flowering and the fully ripening time stabilized and two data odds surrender the fruit development period. The little-plot plantation area everything wood one repetition reported (*Surányi,* 1983, 1991).

The measured plums were range with three fertile groups: male sterile, self sterile and self fertile cultivars. The scanned traits were analyzed in the sort of things and between groups (formally repetition without). It was analyzed relationship of singular data and possible relationship according to some of the morphogenetic traits (*Surányi,* 2006a). The gene bank orchard as a matter of fact tall biodiversity plantation area it had been; the pollination to him untold appropriate pollen donor cultivars she stood will, thus autogamy not scanned. The open pollination was investing 1993, 1996, 1997 and 1999 in year's value.

***Table 1.*** Characterization of the flowers on different fertile plums at Cegléd (1992–2001)

| Variety | Note | Peduncle length mm | Pistil length mm | Stamen number no. | Relative stamen number no./mm | Pollen germination % |
|---|---|---|---|---|---|---|
| Albatros | MS | 8.0 | 12.0 | 22.5 | 1.78 | 0.0 |
| Centenar | MS | 8.2 | 11.0 | 19.9 | 1.76 | 0.0 |
| Pescarus | MS | 7.9 | 12.4 | 21.1 | 1.68 | 0.0 |
| Sentyabrskaya | MS | 10.6 | 11.4 | 20.4 | 1.80 | 0.0 |
| Tuleu dulce | MS | 6.2 | 11.0 | 24.9 | 2.21 | 0.0 |
| Tuleu gras | MS | 5.3 | 13.6 | 18.9 | 1.40 | 0.0 |
| Tule gras korábbi | MS | 7.4 | 11.6 | 19.6 | 1.67 | 0.0 |
| Tuleu timpuriu | MS | 7.9 | 12.4 | 26.9 | 2.18 | 0.0 |
| LSD 5 % | – | 3.24 | 0.42 | 2.61 | 0.30 | – |
| | | | | | | |
| Čačanska najbolja | ss | 9.1 | 11.8 | 28.2 | 2.34 | 51.2 |
| Cambridge Gage | ss | 8.1 | 11.1 | 28.1 | 2.58 | 47.8 |
| Debreceni muskotály | ss | 6.5 | 9.5 | 27.3 | 2.84 | 51.0 |
| President | ss | 7.3 | 11.0 | 22.2 | 2.03 | 29.8 |
| Ruth Gersteter | ss | 4.9 | 10.4 | 25.9 | 2.53 | 40.1 |
| Sermina | ss | 5.3 | 10.0 | 20.6 | 2.11 | 34.9 |
| Silvia | ss | 9.8 | 11.5 | 20.4 | 1.75 | 24.8 |
| Valor | ss | 10.8 | 11.3 | 27.2 | 2.38 | 41.4 |
| LSD 5 % | – | 2.87 | 0.31 | 2.95 | 0.27 | 7.30 |
| | | | | | | |
| Besztercei Bt. 2 | SF | 14.8 | 13.5 | 21.4 | 1.57 | 60.2 |
| Čačanska rodna | SF | 11.4 | 12.3 | 28.0 | 2.26 | 52.0 |
| Ersinger Frühzwetsche | SF | 7.2 | 13.8 | 21.9 | 1.54 | 63.9 |
| Fellenberg T. 24 | SF | 9.1 | 14.6 | 24.2 | 1.50 | 53.3 |
| Ontario | SF | 9.2 | 10.7 | 27.0 | 2.54 | 64.4 |
| Richards Early Italian | SF | 7.9 | 11.4 | 24.1 | 2.13 | 45.2 |
| Sopernitsa | SF | 12.4 | 11.9 | 25.0 | 2.12 | 38.5 |
| Victoria | SF | 10.2 | 13.2 | 26.4 | 2.01 | 63.8 |
| LSD 5 % | – | 3.55 | 0.44 | 1.96 | 0.33 | 9.64 |

It was determined sharka infection with practical value after 2 visits of orchard bi-yearly. These were followings:

1: 20% of leaf symptoms, symptom less fruits
2: 40% of leaf symptoms, only sectorally fruit symptoms
3: 60% of leaf symptoms, law symptom fruits
4: 80% of leaf symptoms, medium fruit fall
5: leaf and fruit fall, gummosis (*Surányi,* 2006a).

## Results and discussion

The European and West-Asiatic (*P. insititia*, *P. cerasifera*, *P. domestica*, *P. italica* and *P. syriaca* ) plums between not unknown the male sterility, than that stateside (for instance *Dorsey,* 1919) and Eastern Asiatic (*P. salicina* and *P. simonii*) species also (*Crane & Lawrence* 1952). There is the typical stamen number of cultivated plums 15–33 between (*Brown* 1955), but every the cases of hypoandry, every polyandry are

***Table 2.*** Stability of flower morphological data of examined plums

| Year | Peduncle length mm | Pistil length mm | Stamen number no. | Relative stamen number no./mm | Pollen germination % |
|---|---|---|---|---|---|
| 1992 | 8.0 | 12.0 | 23.8 | 1.95 | 44.0 |
| 1993 | 7.5 | 11.2 | 24.9 | 2.25 | 40.8 |
| 1994 | 8.1 | 12.3 | 22.3 | 1.84 | 44.1 |
| 1995 | 8.8 | 12.5 | 21.8 | 1.70 | 49.2 |
| 1996 | 9.0 | 13.0 | 22.0 | 1.68 | 50.3 |
| 1997 | 7.7 | 10.9 | 25.2 | 2.33 | 42.7 |
| 1998 | 8.0 | 11.5 | 24.0 | 2.06 | 55.4 |
| 1999 | 8.2 | 12.0 | 22.6 | 1.84 | 46.5 |
| 2000 | 8.4 | 12.4 | 21.9 | 1.80 | 49.2 |
| 2001 | 8.9 | 11.7 | 24.0 | 1.94 | 53.0 |
| LSD 5 % | 1.64 | 0.95 | 1.89 | 0.37 | 4.89 |

***Table 3.*** Fruit traits and spontenceous sharka infected status in different plum trees (1993–2000)

| Variety | Crop kg/tree | Average fruit mass g | Fruit peduncle length mm | Sharka* infection 1→5** |
|---|---|---|---|---|
| Albatros | 46.2 | 48.9 | 29.7 | 2.1 |
| Centenar | 40.8 | 60.1 | 27.1 | 1.2 |
| Pescarus | 46.1 | 58.9 | 28.0 | 1.7 |
| Sentyabrskaya | 58.2 | 50.2 | 34.2 | 2.8 |
| Tuleu dulce | 57.0 | 37.2 | 26.2 | 2.7 |
| Tuleu gras | 67.6 | 21.4 | 25.4 | 1.2 |
| Tule gras korábbi | 50.1 | 19.9 | 29.2 | 1.6 |
| Tuleu timpuriu | 44.2 | 31.5 | 27.8 | 2.0 |
| LSD 5 % | 10.55 | 13.84 | 6.14 | 0.92 |
| | | | | |
| Čačanska najbolja | 66.6 | 38.7 | 27.3 | 2.9 |
| Cambridge Gage | 60.0 | 36.3 | 26.8 | 2.4 |
| Debreceni muskotály | 59.9 | 33.5 | 28.0 | 1.8 |
| President | 40.1 | 46.8 | 27.1 | 3.3 |
| Ruth Gersteter | 67.9 | 28.3 | 24.5 | 0.2 |
| Sermina | 58.6 | 49.1 | 25.0 | 0.5 |
| Silvia | 51.3 | 54.5 | 33.1 | 0.4 |
| Valor | 40.8 | 36.2 | 34.5 | 3.1 |
| LSD 5 % | 8.19 | 10.27 | 5.93 | 1.39 |
| | | | | |
| Besztercei Bt. 2 | 62.0 | 21.5 | 22.0 | 2.4 |
| Čačanska rodna | 69.5 | 35.9 | 26.2 | 2.9 |
| Ersinger Frühzwetsche | 50.2 | 20.7 | 24.3 | 2.0 |
| Fellenberg T. 24 | 42.4 | 27.8 | 28.0 | 4.1 |
| Ontario | 55.7 | 29.6 | 22.2 | 1.8 |
| Richards Early Italian | 51.0 | 28.5 | 26.4 | 2.0 |
| Sopernitsa | 59.0 | 42.3 | 25.8 | 3.1 |
| Victoria | 41.8 | 28.4 | 27.1 | 3.5 |
| LSD 5 % | 10.10 | 8.92 | 4.87 | 1.09 |

* average of 1992, 1994 and 1995 years

** **1**: 20% of leaf symptoms, symptomless fruits
**2**: 40% of leaf symptoms, only sectorially fruit symptoms
**3**: 60% of leaf symptoms, law symtom fruits
**4**: 80% of leaf symptoms, medium fruit fall
**5**: leaf and fruit fall, gummosis

***Table 4.*** Stability of productivity and sharka status of trees

| Variety | Crop kg/tree | Average fruit mass g | Fruit peduncle length mm | Sharka* infection 1→5** |
|---|---|---|---|---|
| 1993 | 64.2 | 34.9 | 26.9 | 0.9 |
| 1994 | 65.8 | 36.8 | 27.5 | 1.2 |
| 1995 | 50.3 | 40.0 | 29.4 | 1.4 |
| 1996 | 55.8 | 38.2 | 28.6 | 0.8 |
| 1997 | 51.2 | 37.0 | 27.2 | 1.9 |
| 1998 | 64.5 | 37.9 | 28.3 | 2.0 |
| 1999 | 46.2 | 38.1 | 28.5 | 3.3 |
| 2000 | 40.8 | 37.5 | 28.6 | 3.0 |
| L.S.D. 5% | 13.66 | 7.88 | 2.91 | 1.15 |

***Table 5.*** Comparative morphological data of three plum groups (1993–1999)

| Trait | Male sterile MS | Self-sterile ss | Self-fertile SF | LSD 5 % |
|---|---|---|---|---|
| Flower peduncle length, mm | 7.7 | 7.7 | 10.3 | 2.17 |
| Pistil length, mm | 11.9 | 10.8 | 12.7 | 1.03 |
| Stamen number, no. | 21.8 | 25.0 | 24.8 | 2.97 |
| Relative stamen number, no./mm | 1.81 | 2.32 | 1.96 | 0.35 |
| Pollen germination, % | 0.0 | 41.4 | 55.2 | 6.12 |
| Fruit peduncle length, mm | 28.5 | 28.9 | 25.0 | 3.16 |
| Average fruit mass, g | 41.1 | 40.4 | 29.6 | 11.64 |
| Crop, kg/tree | 51.3 | 55.7 | 53.9 | 10.92 |
| Sharka infection, 1→5 | 1.91 | 1.58 | 2.73 | 0.93 |

***Table 6.*** Some relationship between different traits

| Relationships | r-value | p % |
|---|---|---|
| Flower peduncle length, mm – Pistil length, mm | +0.2888 | |
| Pistil length, mm – Stamen number, no. | –0.1890 | |
| Relative stamen number, no./mm – Pollen germination, % | +0.3826 | 10 |
| Flower peduncle length, mm – Fruit peduncle length, mm | +0.1982 | |
| Crop, kg/tree – Average fruit mass, g | –0.2484 | |
| Fruit peduncle lenght, mm – Average fruit mass, g | +0.4165 | 5 |
| Sharka infection, % – Pistil length, mm | +0.4064 | 5 |
| Sharka infection, % – Stamen number, no. | –0.1170 | |
| Sharka infection, % – Pollen germination, % | +0.2734 | |
| Sharka infection, % – Fruit peduncle length, mm | –0.4854 | 2 |
| Sharka infection, % – Crop, kg/tree | –0.2673 | |
| Sharka infection, % – Average fruit mass, g | –0.4130 | 5 |

in the long investigations, i.e. the functional stamen number was between 14 and 39 (cf. *Morrison,* 1964; *Surányi,* 1972; 1978; 1985, 1991).

*Tóth* (1957, 1967) fond in old cultivar's collection two plums, which not produced pollen ('Golden of Esperen' and 'Blue Date'), and yet we observed the male sterility of

'Alutscha I/15' (*Surányi & Tóth,* 1976). Towards 'Alutscha Yellow' (*Randhawa & Nair,* 1960), over and above that 'Dwarf Early Yellow', 'Large Yellow' and 'Late Yellow' 100% at the rate of abnormal pollen produced (*Singh,* 1963); moreover 'Giant' type of pollen sterility is found (*Rudloff,* 1934). The 'Tuleu gras' erstwhile Rumanian local variety is also male sterile (*Constantinescu,* 1939; *Cociu* et al., 1996).

In the panel of present trials we had regard for *Szabó* (2003) through intimidated your list also warning make the variety's groups. However the mentioned room for starring Besztercei szilva male sterile clone variant not we've met, that our experiences according to delitescent latent virus presence caused, which, i.e. not genetic, but pathogen fountain-head.

There are five investigated traits of 3 fertile groups in the *Tale 1*, it was appearing case of variability within groups; so that the pistil length ('Debreceni muskotály', 'Fellenberg T. 24'), stamen number ('Tuleu gras', 'Čačanska rodna') and their ratio (SN/PL) (*Surányi,* 1970, 1976) as relative stamen number too ('Tuleu gras', 'Debreceni muskotály'). The male sterile plums not given pollen germination because of pollen absence, but it was consequence the slender pollen viability of two cultivars ('Silvia' and 'President') every year in the investigations. Thus also it was important by reason of the mathematical interpretability and security aggravations analysis use (repetition without in shape) (*Scab,* 1981).

If the stableness value of this trait in the comparison of the annual average, we found annuity differences, the base of flower peduncle length and the pollen germination also *(Table 2)*. Recent examining methodology already is findable the former recapitulative works also (*Surányi,* 1978; 1985). The *Table 3* was demonstrated tersely length examinations and results summed.

For the cultivars the situation appropriate in the orchard of gene bank insurant pollen resources, that way the crop of trees conspicuous differences not also monitored plus (CV%=17,7). However the average fruit mass was variability greater on the basis between the varieties, strangely in the event of 'Tuleu gras' and the 'Centenar'.

The crop of each trees 8 age-old mean some of the naturalized type in the event of greatly fall off the stranger results, especially 'President', 'Valor' and 'Victoria' plums. In Hungary innuendo at us not are yet typical the plum orchard sprinklings, that the less rainfall oddly justify. The prior to consequential the average fruit mass value wide falls off the West-European, Italian or American results.

The typical sharka symptoms show up to limited value regard acceptable on the surface of fruits. According to *Table 4* between 1993–2000 the average investigated traits and typical trends track; these much consequence, than on the basis of the cultivar's means. The tree crop losses and the

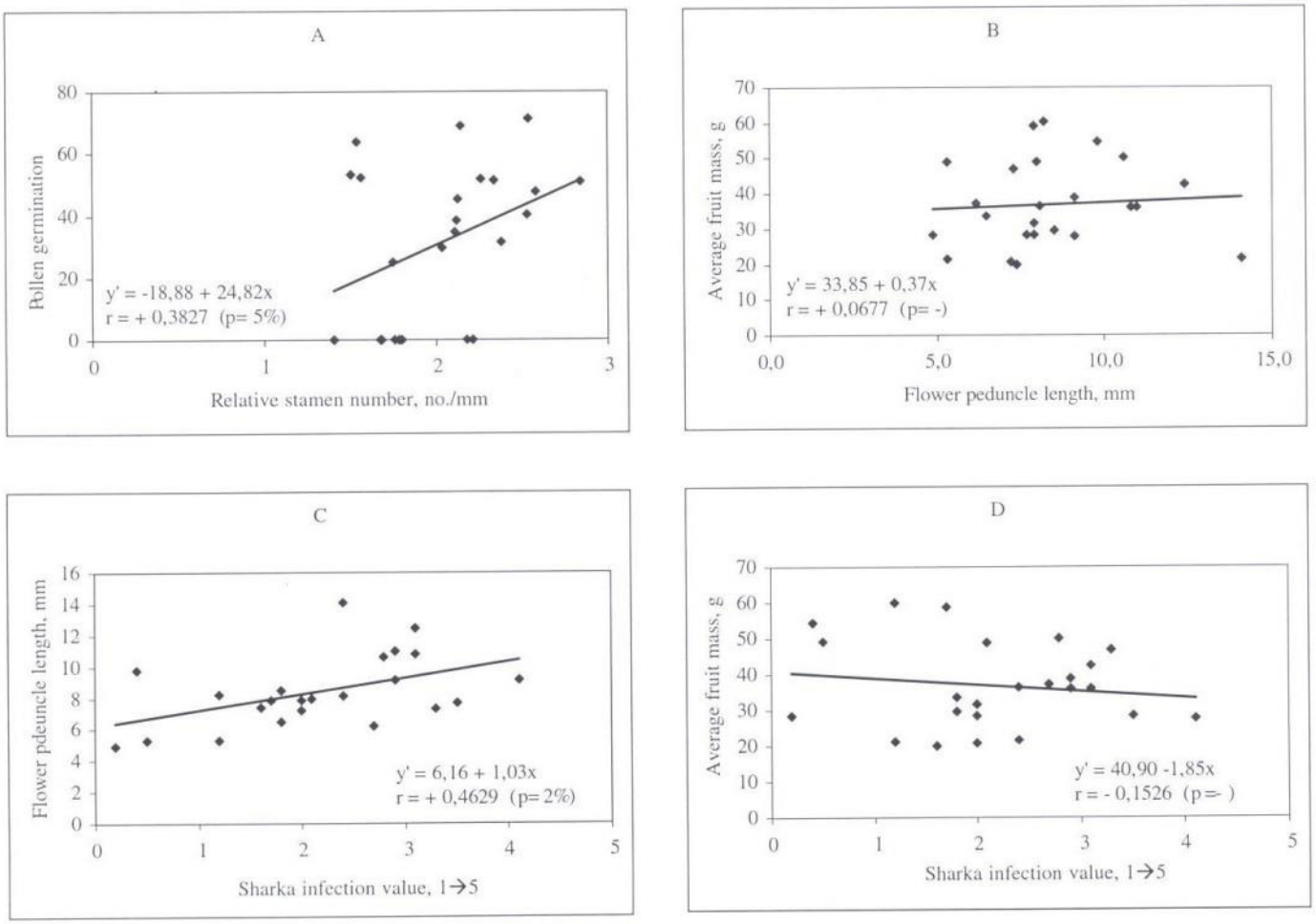


***Figure 1*** Demonstrations of some examined traits in plums

sharka contaminated strengths totally opposite direction signal, that the correlation counting only partly amplified.

The Table 5 summarized the fundamental questions in the responding very important results. The flower peduncle of plums was longest, but there fruit peduncles the shortest one, the lengthening only than 2,5-times surfboard. However, a change of the self-sterile male sterile plums was slightly less than, 4-times. On the basis of pistil length the troops much better margin, than the stamen according to.

The relative stamen but only the self sterile plums it had been salient. Too very different found pollen germination worth also. But the average fruit mass and sharka symptoms in the fruits differed only in the average of self-fertile plums shown odds other two groups compared to. The *Table 5* to that also evidence it had served, that the measured traits truly characteristics and fitter the troops amidst differences statement.

The *Table 6* and *Figure 1* good review the substantial interrelations conspectus, in the Table 6 12 correlation count results can be found. Primarily it had been the conspicuous, that mainly the sharka-contaminated and with sure traits truly interrelations sampled significant, somewhat it had been certifiable in the average of 24 type assured relationship.

The *Figure 1* was demonstrated four regress panels, the relative stamen and the pollen germination, as well as the sharka-infection value and the flower peduncle length significant correlation. The results that the examinations already starring suggest strengthen, which in this respect the sharka-infection important flower peduncle (length, but the thickness also), than indicator role (cf. *Surányi* 1996c).

Similarly to that also meritorious are hearken, that occur such stochastic interrelations, which many year mean engaged statistical safeties not given, while his attention and further trials can be start.

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