

Methods of Creating Early, High Yield Cotton Varieties

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Abstract: The article presents the results of many years of research on the creation of early ripening, high-yielding, high-yielding, wilt-resistant, with the quality of type IV-V fiber with a raw weight of one box of 6.0-7.0 g of varieties and lines by various classical breeding methods. At the same time, it should be noted that in the genetic and breeding work with cotton, great success in breeding has been achieved through classical breeding methods, but at this stage it is necessary to use new effective methods in breeding, as well as to improve the methods of hybridization and selection of plants. Values are given for each hybridization method: distant ecological-geographical, interspecific, intervarietal, interline and backcrosses to obtain the source material for practical breeding. As a result of targeted selection using various breeding methods: analytical, combinational (pedigree), transgressive and backcrosses, varieties Omad, S-8284, S8286, S-8290, Gurlen and lines were created that have high yield, high fiber yield, wilt resistance and fiber quality IV-V type. The above varieties are sown in the republic this year and occupy about 100 thousand hectares.

Keywords: variety, hybrid, interspecific, intervarietal, backcrosses, transgression, pedigree, precocity, yield, hybridization methods, fiber quality, heterozygosity.

1. Introduction

Cotton is the most valuable industrial crop, a product that is widely used in many sectors of the national economy [1-2]. In this regard, the increase in the yield of cotton, mainly depends on the introduction of new, more productive varieties of cotton, with a different structure of the bush and a complex of economically useful traits [3-6]. Therefore, one of the promising areas of breeding work with cotton is the selection of varieties with different bush designs, since the design of a cotton bush in most cases determines its early maturity.

In modern cotton breeding, it is difficult to overestimate the importance of the new germplasm in the creation of early maturing, high-yielding, wilt-resistant cotton varieties. It is necessary to carefully study the culture in order to identify weaknesses that limit its value. Factors that limit the productivity of existing varieties are usually well known or can be identified using special methods developed by breeders and other researchers [7-10].

It should be noted that in the genetic and breeding work with cotton, great success in breeding has been achieved through classical breeding methods, but at this stage it is necessary to use new effective methods in breeding, as well as to improve the methods of hybridization and selection of plants in accordance with the latest achievements of genetic science [11-13] Singh.

P.V. Popov et al. [14-15] write that new approaches to solving the task of obtaining competitive cotton varieties are associated primarily with the creation of a promising genetic base variety population and breeding methods. In breeding work, great importance is attached to the analytical and synthetic methods of selection, as well as to various methods for evaluating and selecting plants for precocity, wilt resistance, fiber yield and length, and other morpho-economic and physiological-biochemical traits.

The most common selection methods in cotton breeding are individual and mass selection. The stabilizing, periodic pedigree method and other selection methods are widely used, as well as the method of analytical selection based on residual heterozygosity, and the method of transgressive selection.

2. Materials and Methods

The material for the research was distant ecological-geographical, interspecific, intervarietal, interlinear seeds

F1, F2, F3 and backcross hybrids obtained from crossing cultivars of the limiting type of fruit branches; S-8230, S-8255, No. 2 and unlimited Tashkent-1, as well as medium-sized and undersized varieties and lines S-6530, L-302, L597, L-158, L-75, L-1703, L-1858 and L-257, which have a different habit of the bush and variety C-6030 of the species *G. barbadense* L. with a zero type of fruit branches.

To study the inheritance of the phases of development of the growing season, we selected parental forms that differ sharply in early maturity, type of fruit branches and plant height: undersized mid-ripening lines: L-01, L-55 and L-8089, dwarf mid-ripening line L-02. Tall mid-season varieties C-8257 and C-8282 of the species *G. hirsutum* L. with the limiting type of fruit branches.

Crossings were carried out in parental nurseries, according to the method generally accepted in breeding institutions, with preliminary castration and isolation of flowers on the eve of their opening.

During the growing season, the following records and observations were made:

- the onset of the date of flowering and ripening;
- measurements of plant height, accounting for the number of true leaves, buds, monopodial and sympodial branches, the number of bolls, including opening on September 1. The height of the laying of the first fruit branch was determined;
- determined the rate of flowering and maturation on parental and F2 plants of limiting and non-limiting forms, as well as on parental varieties;
- carried out morphological descriptions of the plant F1, F2 and F3 according to the following characteristics: type of fruit branches, shape of the bush, leaf drooping, shape and size of bolls, and other characteristics. Similar records and observations were carried out on backcross hybrids F1B1-F5B1. In autumn, 20-box test samples were collected from hybrid plants and parental forms for laboratory analysis, which were used to determine the length and output of the fiber (fineness, strength, metric number). The data obtained were subjected to statistical processing according to the method of B.A. Dospekhov [16]. The experiments were carried out on a healthy and naturally infected wilt background, where virulent populations of the fungus *V. dahlia* prevailed for the released cotton varieties S-4727, Tashkent-1, S-6524 and Namangan-77 and other varieties.

3. Results and Discussion

The most widely used method in the creation of cotton varieties is analytical selection, which is based on the use of source material for selection from a natural variety population by decomposing them into separate biotypes. Using the method of analytical selection, L.V. Rumshevich derived from the wilt-resistant variety 8517 a relatively wilt-resistant variety 115-F, and from the susceptible variety 2034 he created varieties 131-F and 137-F with increased resistance to wilt against a naturally infected background.

Vad.Avtonomov, P.V.Popov and others created cotton varieties S-6526, S-9076 by the method of analytical selection.

The early maturing low-growing wilt-resistant variety Omad was bred by the analytical method from variety L-02, which had a vegetation period of 125-130 days, a plant height of 40-50 cm, a raw cotton weight of 6.0-6.5 g, a yield of 37.0- 38.0% and fiber length 31.5 - 34.5 mm. In terms of wilt resistance, it is inferior to the Tashkent-1 variety.

In the process of breeding work, we have bred separate families from the L-02 variety population, on which stabilizing selections were carried out for a complex of morphological and economic traits, as well as for wilt resistance.

On relatively aligned breeding families, an individual selection was carried out in order to test them for the stabilization of morphological and economic traits and wilt resistance against a natural infectious wilt background. On the best homogeneous families, repeated stabilizing selection was carried out based on marker traits and wilt resistance of plants with a complex of useful morphological and economic traits. This cycle was carried out for 5 years.

Subsequently, on the basis of this selection method, a homozygous line-158 was created, which is the ancestor of the Omad variety.

Morphological and economic characteristics of the early ripening undersized variety "Omad". The bush is pyramidal, plant height is 80-90 cm, has 1-2 monopodial branches, sympodial branches of type 1.5, green stem, non-lodging. The height of the bookmark of the first fruit branch is at the 5th node. The leaves are of medium size, 3-5-lobed, slightly pubescent, the variety is slightly leafy. The box is large (6-7 g), ovoid, elongated with a spout, the number of wings is 4-5. Fiber yield 35-36%, length 35-36 mm, fiber strength 4.5 - 4.7. The fiber is thin, white and transparent, metric number (fineness) 6000-6400, relative breaking load 28.0 - 29.0 g.s / tex, micronaire 4.4 - 4.6. Seeds are large, gray, weight 1000 pcs. seeds 130-135 g. Oil content 18-20%. The length of the growing season is 105-115 days. With good agricultural technology, the variety "Omad" gives 40.0 - 45.0

centners / ha of crop. Since 1999, it has been included in the State Register for the Samarkand, Khorezm regions and the Republic of Karakalpakstan.

Next is transgressive selection. The theoretical foundations of transgressive selection are based mainly on the third Mendelian law of independent inheritance or the law of free combination of genes [17-19]. This method is based on the fact that many breeding traits, primarily yield, early maturity, fiber yield and quality, wilt resistance, and other traits are controlled by many genes. Therefore, the combination of genes in a new genotype does not affect individual traits, but, if possible, all positive and negative traits that are determined by hereditary factors. At the same time, it should be noted that transgressive selection largely depends on the factor of chance. An increase in the number of transgressive plants with a complex of useful traits can be achieved through a preliminary study of the genetic potential of the original forms involved for crossing [20; 21].

It should be noted that different traits are controlled by different dominant and recessive genes, which, with simple intraspecific and complex crosses, can give a different combination of genes, and with distant intraspecific and interspecific crosses, a completely different combination of genes that give transgressive splitting with a new combination of traits that surpass parental forms in precocity, wilt resistance, productivity, by the mass of raw cotton of one box, by the yield and length of the fiber, which is very important for the breeding process.

The results of the study of paired intraspecific and interspecific hybrids F_1 - F_8 and backcross hybrids $F_1 B_1 - F_5 B_1 - F_4 B_2$ and $F_3 B_3$ and subsequent generations show that the splitting of transgressive plants with a complex of useful morphological and economic traits (early maturity, yield, fiber yield and length, boll size, wilt resistance, plant height, and other traits) is about 1-2 percent in each hybrid combination. At the same time, it should be noted that transgressions are observed only when one or both parents do not have a genotype that provides an extreme degree of a pronounced phenotypic trait. There is a transgression of phenotypes, when continuous hereditary or non-hereditary changes fluctuate around a certain average value, and variability with incomplete dominance of monogenically controlled traits in which the distribution curves of hybrid individuals go beyond the parental forms, both left and right side.

The analysis of complex hybrids obtained by crossing hybrids of the first generation with each other gives a large number and a wider shaping process in the manifestation of transgressive plants of breeding value. Similar results were obtained in distant intraspecific and interspecific hybrids. F_2 and in subsequent generations, as well as in backcross hybrids $F_2 B_1$, $F_1 B_2$ and $F_1 B_3$. Segregation in F_2 and in subsequent generations is diverse if the initial forms selected for hybridization differ from each other in a large number of traits, and therefore in many genes that control these traits.

As a result of various breeding methods, we have created transgressive ultra-early (with a growing season of 95-105 days), high-yielding, high-yield (40.0 - 43.0%) and with IV-V fiber quality, with a raw cotton weight of one box of 6, 0 - 7.0 g. Families and lines that have a relatively high resistance to natural virulent populations of the *Verticillium* fungus, where the zoned variety C-6524 is affected by wilt in general by 65-80% and to a strong degree by 40-50%.

Thus, on the basis of the conducted research, it can be noted:

- transgressive selection is somewhat narrowed during pair crossings, when parental forms differ greatly in geographical origin, in genetic control of traits, in particular, yield, early maturity, fiber yield and length, and other traits that are controlled by several or many genes;
- the greatest success in transgressive breeding is achieved with backcrosses or saturating crosses, as well as with complex hybridization by repeatedly crossing F_1 hybrids with each other in order to genetically enrich transgressive offspring;
- on the basis of transgressive selection, laboratory staff obtained a large breeding material based on the transgressive selection method, which has high early maturity (with a growing season of 97-117 days), high yield (38.2 - 43.5%) and quality of type IV-V fiber, which are superior to grade C-6524.

Pedigree method. Pedigree method based on multiple individual selection and constant verification of selected plants by offspring. Since the pedigrees of plants are known for a number of generations when working with this method, pedigrees will allow us to study the genetics of the traits of cotton for each plant, as well as to effectively conduct practical selection. When breeding by the pedigree method, the selection of elite plants begins with the second hybrid generation (F_2), in F_3 the selected plants are sown individually (families). After the F_3 severe culling of the worst families in the remaining families, the individual selection of the best ones in terms of early maturity, yield, mass of raw cotton of one box of plants is again carried out with a similar study of their offspring in subsequent generations $F_4 - F_5$, etc. After that, families that have homogeneity in terms of the morphological and economic complex of traits for which selection is carried out. In F_5 or in F_6 can be called a line. They undergo a comparative test according to the type of selection and control nursery, competitive and state variety tests.

Using this method, we have bred new early ripening high-yielding varieties S-8284, S-8286, S-8290, Gurlen and lines that have high yield, high fiber yield, wilt resistance and IV-V type fiber quality.

Thus, the advantages of the pedigree method are:

- allows in early generations to get rid of a large amount of unpromising material;
- makes it possible to evaluate individual selections from F₂ to linear material;
- allows you to quickly achieve the homozygosity of the linear material for one or more morphological and economic traits.

The early maturing variety S-8286 was created by the synthetic pedigree method from the hybrid combination L-3146 x L-158. The length of the growing season is 115-120 days. The shape of the bush is conical, plant height is 95-105 cm, sympodial branches are 1.5 - 2.0 types, the stem is green, does not lodge. The height of the laying of the first fruit branch is at the 5-6 node, it has 1-2 monopodial branches. Leaves of medium size, 3-5-lobed, green, pubescent. The box is large (6.2 - 6.5 g), elliptical in shape, with a spout, the number of wings is 4-5. Fiber yield 37.5 - 38.5%, length 33.0 - 33.5 mm, fiber strength 4.5 g.s., metric number (thinness) 6010, relative breaking load 26.7 - 27.0 g. s / tex, micronaire 4.6. Seeds are large, gray in color, weight of 1000 seeds is 121-125 g. Oil content is 20-21%. With good agricultural technology, the C-8286 variety yields 43.0 - 44.0 centners / ha of crop. Authors: Amanturdiyev A.B. and others. Currently, the variety C-8286 is sown in the Samarkand region on 13,800 hectares. The genealogy of this variety is shown in fig.

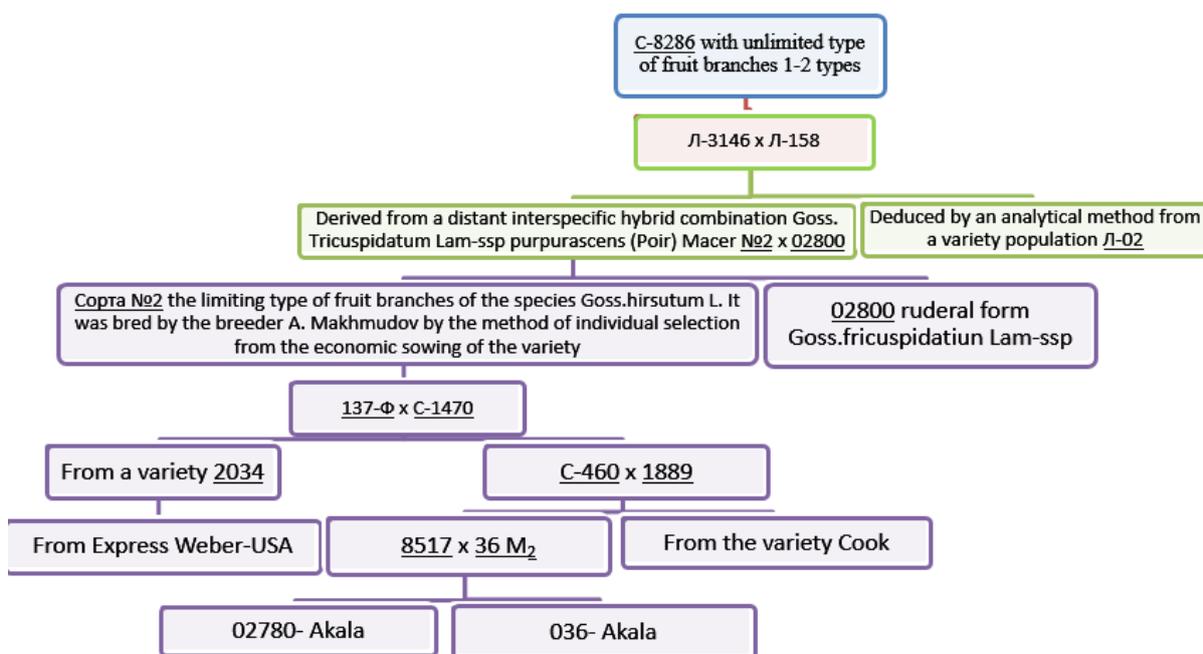


Figure 1. Genealogy of the cotton variety C-8286.

Numerous samples and varieties are involved in the creation of the cotton variety C-8286. Line L-3146 participating as a maternal form was obtained from a distant interspecific hybrid combination of Goss. tricuspidatum Lam-ssp purpurascens (Poir) Macer No. 2 x 02800, in turn, variety No. 2 with the limiting type of fruit branches of the Goss.hirsutum L. species was isolated from C-4727, which has an unlimited branching type. The paternal form is the L-158 line, which was bred by the analytical method from the L-02 population variety.

Backcross is a method of backcrosses or saturating crosses. This method in plant breeding requires the fulfillment of three requirements:

- 1) it is necessary to select a hybrid combination or a breeding family-line that would need improvement in one or a few traits;
- 2) it is necessary to find donor parents who will have the traits that the recurrent parent lacks, and it is desirable that each of these traits be determined by one or a few genes;
- 3) the number of saturating crosses should be sufficient to fix the trait. This method created new families, the data of which is given in the table:

- the length and quality of the fiber is at the level or exceeds grade C-6524 (33.8 mm). It should be noted that the

biological length of the fiber in grade C-6524 is 34-35 mm. Some reduction in fiber length is associated with the degree of damage to the wilt. The length of the fiber in the created families ranges from 35.3 to 37.8 mm;

- according to precocity - families 24, 338, 633, 220, 300, 379, 393, 438, 748, 906, 1049, 1165, 1200, 1306 and 1490, in which the duration of the growing season from 50% germination to 50% maturation ranges from 98 to 110 days. According to the yield of raw cotton per plant - families 24, 36, 300, 393, 561, 885, 906, 1049, 1165, 1214, 1306, 1376, 1396 and 1458 in which it is 120-133 g;

- in terms of fiber yield - families 56, 109, 379, 393, 438, 465, 828, 906, 1376, 1458 and 1629, in which it ranges from 39.1% to 43.8% g;

- according to the length and quality of the fiber - families 338, 633, 36, 109, 220, 280, 379, 393, 561, 828, 885, 906, 1306, 1376, 1396, 1458 and 1490 for which it is 35.4 - 37.8 mm;

- according to the mass of raw cotton of one box of families 36, 393, 561, 885, 906, 1214, 1306, 1376 and 1396, in which it is 130 - 150 g;

- by weight 1000 pcs. family seeds from 338, 806, 748, 828, 1214, 1376, 1396 and 1458, in which it is 130 - 140 g.

The early maturing variety S-8284 was created by a synthetic method from a backcross hybrid combination (L-158 x S-6530) x L-158. The length of the growing season is 105-117 days. Pyramidal bush, plant height 95-105 cm, sympodial branches of type 1-2, green stem. The height of the laying of the first fruit branch is at the 5th node, it has 1-2 monopodal branches. The leaves are of medium size, 3-5 lobed, light green in color, the surface of the leaf is slightly pubescent. The box is large (6.4 - 6.7 g), ovoid, with a spout, the number of valves is 4-5. Fiber yield 38.0 - 38.5%, length 34.5 - 35.5 mm, fiber strength 4.5 g.s., metric number (thinness) 6150, relative breaking load 28.5 - 29.5 g. s / tex, micronaire 4.4 - 4.5. Seeds are large, gray in color, weight of 1000 seeds is 130-140 g. Oil content is 19 - 20%. With good agricultural technology, the C-8284 variety meets the requirements of IV-type. Authors: Kim R.G. and others.

The early maturing variety S-8290 was created by a synthetic method from a complex hybrid combination (L-75 x L-158) x S-6530. The length of the growing season is 115-117 days. The shape of the bush is conical, plant height is 90-100 cm, sympodial branches are 1.0 type, the stem is green. The height of the laying of the first fruit branch is at the 5-6th node, it has 1-2 monopodal branches. Leaves of medium size, 3-5 lobed, green, pubescent. The box is large (6.0 - 6.1 g), rounded in shape with a spout, the number of valves is 4-5. Fiber yield 36.8 - 37.0%, length 33.2 - 33.6 mm, fiber strength 4.6 g.s., metric number (thinness) 5963, relative breaking load 26.1 - 26.5 g. s / tex, micronaire 4.7. Seeds are large, gray in color, weight of 1000 seeds is 120-140 g. Oil content is 20-21%. The yield of the variety S-8290 is 42.0-45.0 c/ha. This variety is sown in Ferghana, Jizzakh, Samarkand and Tashkent regions on a total area of about 80,000 hectares. Authors: Kim R.G. and others.

4. Conclusion

1. The method of transgressive selection somewhat narrows the hybrid population during pair crossings, when parental forms differ greatly in geographic origin, in genetic control of traits, in particular, yield, size of the box. These traits are controlled by several or many genes;

- the greatest success in transgressive breeding is achieved with backcrosses or saturating crosses, as well as with complex hybridization by repeatedly crossing F1 hybrids with each other in order to genetically enrich the transgressive offspring.

2. The pedigree method makes it possible to quickly achieve homozygosity for one or more morphological and economic traits, since these advantages are manifested mainly in the selection for quantitative traits available for visual assessment, which allows the breeder to isolate the maximum of homozygous valuable families and lines from one or more hybrid combinations for a short time.

3. The method of backcrossing or saturating crosses (backcross) is most effective in transferring traits with high heritability. In most cases, disease resistance is highly heritable, often determined by one or more genes that act in the presence of disease. Based on the method of return and saturating crosses, we have created line and family varieties that are unique in early maturity, yield, fiber yield and quality, in terms of raw cotton weight of one box, as well as with complex resistance to new virulent populations of the fungus *Verticillium* and *Fusarium*.

4. We recommend the pedigree method and the method of backcrossing or saturating crosses to create new transgressive early maturing, wilt-resistant, high-yielding varieties and lines of cotton that will have a high yield of IV-V fiber quality.

Table 2. The main economic features of the best backcross hybrid families F5B1 and F6B1

№	№ family	Varieties and hybrid combinations	Speed, days	Raw cotton yield per plant, city	Mass of chl-cheese. one box. G.	Ex. fibers, %	fiber length,MM	Weight 1000 pcs.sem.g	Mic	Str	Len
1	2	3	4	5	6	7	8	9	10	11	12
1	St	C-6542	117	58.0	4.8	36.0	33.8	104	4.7	31.5	1.13
2	24	F ₆ (F ₁₂ Л-3714хС-9072)хОмад	105	120	6.0	38.0	33.7	120	4.5	34.6	1.17
3	56	F ₆ (F ₁₂ С-4880хУйчи-2)хОмад	112	116	8.8	40.0	33.8	134	4.6	37.9	1.19
4	338	F ₆ (F ₁₃ Л-3714хС-9072)хОмад	107	114	8.7	36.8	35.0	132	4.4	32.3	1.25
5	633	- // -	108	101	8.6	37.0	35.0	129	4.3	33.6	1.23
6	36	F ₅ B ₁ (F ₁ Омад х Л-44)хОмад	113	132	6.6	35.3	37.1	128	4.4	33.3	1.24
7	109	F ₅ B ₁ (F ₁ Омад х Л-614)хОмад	114	115	6.8	42.4	37.6	119	4.7	31.8	1.19
8	220	F ₅ B ₁ (F ₁ С-8284хС-5621)хС-8284	99	116	5.8	38.6	36.4	110	4.3	31.7	1.28
9	280	- // -	102	107	6.4	37.3	37.6	107	4.1	35.0	1.27
10	300	F ₅ B ₁ (F ₁ С-8284хЛ-44)хОмад	105	120	6.0	38.0	33.3	110	4.5	32.3	1.18
11	379	- // -	103	118	5.9	40.6	35.0	119	4.6	32.4	1.27
12	393	F ₅ B ₁ (F ₁ С-8284хС-6771)хС-8284	106	131	6.6	43.3	34.6	126	4.7	31.7	1.18
13	438	- // -	104	113	6.7	43.3	34.7	112	4.5	32.9	1.27
14	465	F ₅ B ₁ (F ₁ С-8284хЛ-614)хЛ-614	112	104	6.2	40.3	34.2	119	4.2	32.7	1.25
15	568	- // -	113	127	6.2	38.2	35.3	119	4.4	35.4	1.29
16	806	F ₅ B ₁ (F ₁ Л-155 х С-5621) х Л-155	109	117	6.9	37.6	34.0	130	4.7	32.9	1.19
17	748	- // -	110	102	6.7	38.2	34.4	140	4.8	34.4	1.14
18	828	- // -	113	99	6.0	40.0	37.8	130	4.8	31.5	1.24
19	885	F ₅ B ₁ (F ₁ Л-155 х Л-44) х Л-155	114	129	6.5	38.8	36.2	119	4.8	34.3	1.21
20	906	F ₅ B ₁ (F ₁ Л-155	105	128	6.4	42.9	35.1	120	4.3	31.3	1.18

		x C-6771) x JI-155									
21	1049	F ₅ B ₁ (F ₁ JI-842 x JI-44) x JI- 842	98	120	6.0	38.3	34.4	110	4.6	31.4	1.19
22	1165	F ₅ B ₁ (F ₁ JI-408 x JI-44) x JI- 408	109	120	6.0	38.8	34.2	110	4.8	29.3	1.17
23	1200	F ₅ B ₁ (F ₁ JI-408 x C-6771) x JI-408	102	109	5.5	38.6	34.6	126	4.5	28.2	1.13
24	1214	F ₅ B ₁ (F ₁ JI-408 x JI-614) x JI- 408	112	127	6.4	38.4	33.4	130	4.8	33.3	1.12
25	1306	F ₅ B ₁ (F ₁ JI- 1708 x C- 5621) x JI- 1708	109	127	6.4	36.4	36.4	128	4.9	34.2	1.17
26	1376	F ₅ B ₁ (F ₁ JI- 1708 x JI-44) x JI-1708	114	133	6.7	39.0	35.0	140	4.4	35.0	1.14
27	1396	- // -	115	133	6.0	38.3	36.4	130	4.6	33.6	1.18
28	1458	- // -	117	120	6.0	39.1	35.8	130	4.8	33.3	1.16
29	1490	F ₅ B ₁ (F ₁ JI- 1708 x C- 6771) x JI- 1708	110	114	5.8	35.9	35.4	120	4.8	32.5	1.15
30	1629	F ₅ B ₁ (F ₁ JI- 1708 x JI-44) x JI-1708	118	110	6.7	39.7	33.8	126	4.8	30.1	1.10

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