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TWC/26/15
ORIGINAL: English
DATE: August 22, 2008

UPOV

**INTERNATIONAL UNION FOR THE PROTECTION OF NEW VARIETIES OF PLANTS**

GENEVA

# TECHNICAL WORKING PARTY ON AUTOMATION AND COMPUTER PROGRAMS

## Twenty-Sixth Session
## Jeju, Republic of Korea, September 2 to 5, 2008

TRANSFORMATION OF MEASURED CHARACTERISTICS INTO NOTES FOR DESCRIPTION PURPOSES

*Document prepared by experts from France*

1. This document provides an explanation of how variety descriptions (i.e. "notes" for each characteristic) are developed in France for measured, quantitative characteristics. An explanation is made of the different approaches for vegetatively propagated, self-pollinated, hybrid and cross-pollinated varieties.

2. In the UPOV Test Guidelines, many characteristics used to describe the varieties are quantitative and are assessed by measurement. The indications used in the Test Guidelines are as follows:

QN: quantitative characteristic
MS: measurement of a number of individual plants or parts of plants.
MG: single measurement of a group of plants or part of plants.

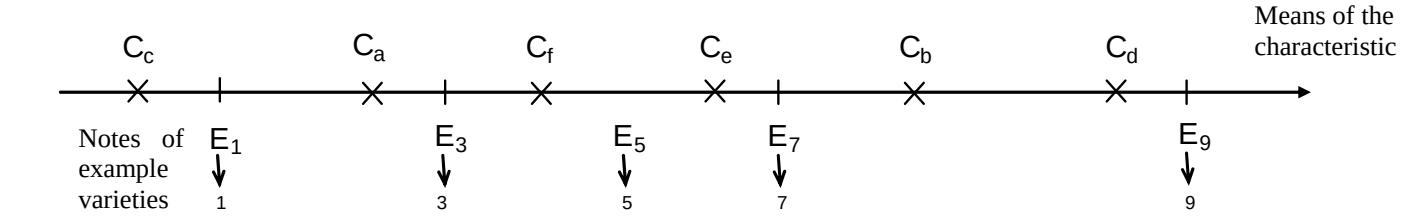
3. The first part of this document explains the general principle for making such a transformation with a simple example. The second part illustrates this principle with the use of a regression. An example of cross-pollinated varieties is given: the description of the characteristic "Plant: natural height at inflorescence emergence" for the varieties of Tall Fescue (*Festuca arundinacea* Schreb.).

Example of a simple transformation of measured characteristics into notes on the basis of example varieties

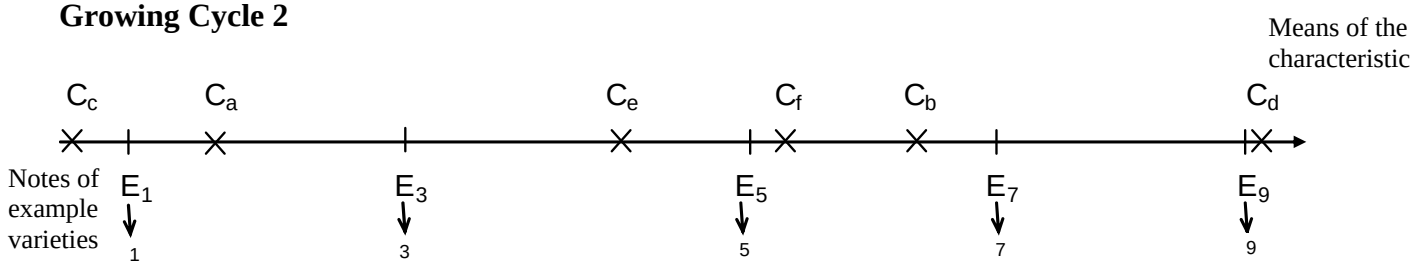
4. In order to get a clear picture, the procedure is described with an illustrative example plus some explanations. The figure below gives the means of a characteristic for candidate varieties ($C_a$ to $C_f$) and for example varieties (E1 is an example variety for note 1, E3 is an example variety for note 3…).

*Figure 1: collection of measured data on one quantitative characteristic for 6 candidate varieties (Ca to Cf) and a set of 5 example varieties (E1 to E9) (1) during 2 growing cycles.*

**Growing Cycle 1**




**Growing Cycle 2**




(1) In this presentation, one example variety is available for each uneven note in a scale from 1 to 9

5. For each growing cycle, the average values of example varieties and candidate varieties are distributed on an axis to illustrate the position of candidate varieties in relation to the example varieties and the corresponding notes. Due to environmental effect, the relative positions of candidate varieties compared to the example varieties can change from one cycle to another.

6. $C_e$ and $C_f$ for instance are both comparable to $E_5$, but the ranking is reversed; $C_b$ is next to $E_7$ but in one growing cycle the value is lower while in the other it is higher.

7. Those examples illustrate changes in ranking that can occur in practice. Such changes can be rare in some characteristics, and more likely to occur on other characteristics, depending on genotype x environment interaction.

8. The choice of an adequate set of example varieties is essential in order to keep a good coverage of the range of variation and to avoid change in the order of the notes.

9. Depending on the agro-climatic conditions of the testing place and on the total variation of the characteristics among varieties adapted to these conditions, the full scale or only a part of it can be used.

10. With regard to example varieties, the set defined in the UPOV Test Guidelines might be used or, if it is not adapted or available, a national or regional set of example varieties can be

defined and kept as far as possible to give consistency to the system. When necessary, an example variety can be changed and replaced by a new one which is already well described with the same note in the same agro-climatic environment.

11. The final notes given to the candidate varieties take into account the position of the notes in each growing cycle in relation to the example varieties and notes.

*Table 1: Final notes given to the candidate varieties*

| Candidate variety | Description note | Explanation |
|---|---|---|
| Ca | 2 | one time close to E3, one time close to E1 |
| Cb | 7 | one time about 8, one time less than E7 |
| Cc | 1 | each time smaller than E1 |
| Cd | 9 | each time close to E9 |
| Ce | 5 | one time between E5 and E7, one time between E3 and E5 |
| Cf | 5 | two times around E5 |

Use of a linear regression for the description: Example of "plant: natural height at inflorescence emergence" for Tall Fescue varieties

12. Cross-pollinated varieties, like synthetic varieties have important within-variety variability due to the genetic structure of this kind of variety. So the expression of a characteristic should be recorded using more than one observation. In the DUS trials of forage species, records are often taken from 60 individual plants.

13. The example used is the characteristic "Plant: natural height at inflorescence emergence" for Tall Fescue varieties.

*Table 2: UPOV Test Guidelines TG/39/8 Meadow Fescue, Tall Fescue, characteristic 10*

TG/39/8
Meadow Fescue, Tall Fescue/Fétuque des prés, Fétuque élevée/Wiesen-, Rohrschwingel/Festuca pratense, Festuca alta
2002-04-17
-9-

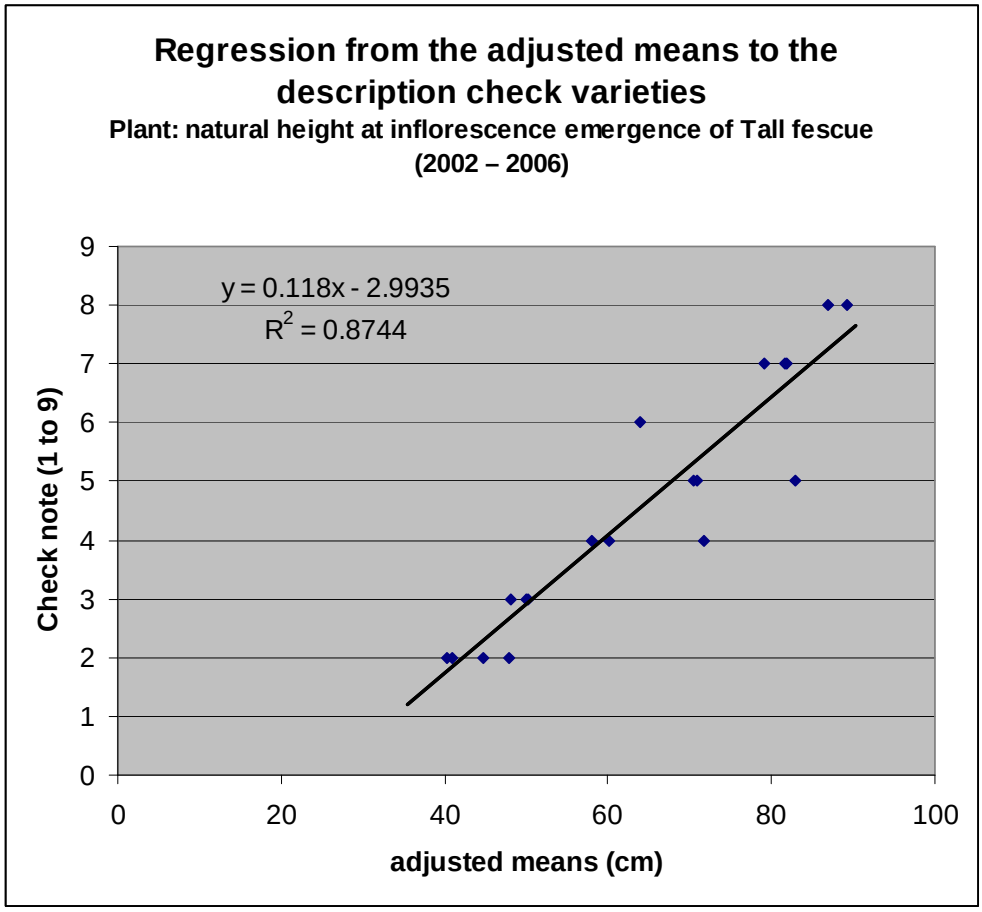
| | Plot[1)] Parcelle[1)] Parzelle[1)] Parcela[1)] | English | français | deutsch | español | Example Varieties Exemples Beispielssorten Variedades ejemplo | Note/ Nota |
|---|---|---|---|---|---|---|---|
| 10. | A MS | **Plant: natural height at inflorescence emergence** | **Plante: hauteur naturelle à l'épiaison** | **Pflanze: natürliche Höhe bei Erscheinen der Blütenstände** | **Planta: altura a la emergencia de la inflorescencia** | | |
| | | short | basse | niedrig | baja | Eldorado (F.a.), Bundy (F.p.) | 3 |
| | | medium | moyenne | mittel | media | Adventure (F.a.), Cosmos 11 (F.p.) | 5 |
| | | long | haute | hoch | alta | Ibis (F.a.), Preval (F.p.) | 7 |

14. In measurements of single plants (MS) in spaced plant trials (A), a statistical procedure recommended by UPOV is the Combined Over Years Distinctness (COYD) analysis. This method takes into account variations between years. The COY D provides, for each measured characteristic, adjusted means for the reference varieties and the candidate varieties.

15. For the purpose of the description, we transform these adjusted means to notes. We use a linear regression from the adjusted means to "description check varieties". The description check varieties are already well described example varieties (i.e. example varieties in the UPOV Test Guidelines or national example varieties).

16. The graph in Figure 2 shows the regression from the adjusted means to the description note. In this case, 4 varieties had been described with the note 2, 2 varieties with note 3 etc.

*Figure 2: linear regression from the adjusted mean to the description check variety*




17. In this example, the regression square ($R^2$) is equal to 0.8744, which is a good value for this characteristic on Tall Fescue. Generally we consider the regression valid if $R^2$ is higher than 0.6. Then, we calculate a predicted note with the equation of the regression (see fig.2 above). In this example the equation is:

Predicted note = 0.118 x adjusted mean - 2.9935.

From this we can compute the description note.

*Table 3: Adjusted mean and description note for the characteristic natural height at inflorescence emergence of Tall Fescue varieties. The complete table is provided in the Annex*

| Variety name | Adjusted mean (cm) | Check description note | Predicted note | Description note |
|---|---|---|---|---|
| C1 | 35.50 | . | 1.19423 | 1 |
| BONAPARTE | 44.71 | 2 | 2.28068 | 2 |
| ELDORADO | 47.90 | 2 | 2.65699 | 3 |
| C2 | 48.15 | . | 2.68648 | 3 |
| MONTSERRAT | 48.15 | 3 | 2.68648 | 3 |
| MURRAY | 50.29 | 3 | 2.93893 | 3 |
| C3 | 52.78 | . | 3.23266 | 3 |
| TOMAHAWK | 54.80 | . | 3.47095 | 3 |
| BORNEO | 58.11 | 4 | 3.86141 | 4 |
| C4 | 58.94 | . | 3.95932 | 4 |
| BARDAVINCI | 60.28 | . | 4.11739 | 4 |
| VILLAGEOISE | 62.07 | . | 4.32855 | 4 |
| C5 | 62.13 | . | 4.33563 | 4 |
| DANIELLE | 63.97 | 6 | 4.55268 | 5 |
| DIVYNA | 64.54 | . | 4.61992 | 5 |
| C6 | 69.54 | . | 5.20975 | 5 |
| GARDIAN | 70.55 | 5 | 5.32889 | 5 |
| EMERAUDE | 70.91 | 5 | 5.37136 | 5 |
| CENTURION | 71.81 | 4 | 5.47753 | 5 |
| SZARVASI 56 | 73.18 | . | 5.63914 | 6 |
| BARCEL | 79.41 | . | 6.37406 | 6 |
| DULCIA | 81.63 | 7 | 6.63594 | 7 |
| LUNIBELLE | 81.85 | 7 | 6.66190 | 7 |
| C7 | 86.57 | . | 7.21869 | 7 |
| BARIANE | 87.02 | 8 | 7.27177 | 7 |
| C8 | 87.44 | . | 7.32132 | 7 |
| APRILIA | 89.28 | 8 | 7.53837 | 8 |
| C9 | 89.65 | . | 7.58202 | 8 |
| FLEXY | 90.31 | . | 7.65988 | 8 |

Conclusions

18. The two procedures described make it possible to take into account the environmental effect on the expression of the characteristics and also the interaction between variety and environment.

19. Thus the comparison between varieties tested in different environments and years is made possible. This transformation of measured data into notes makes it possible to store the description in a database and to screen varieties within the reference collection.

20. The examples selected illustrate two simple ways to obtain coherent notes, the first without any computations, the second with computations that can be performed without the need of a statistical package.

21. More sophisticated methods have been described, such as the DESC program from the United Kingdom. Procedures needing statistical packages have been used in France as well, and will also be used in future. The choice of an appropriate procedure results from discussion between crop experts and IT experts or statisticians, and is a compromise between the needs, the variability, and ease of use.

[Annex follows]

# ANNEX

ADJUSTED MEAN AND DESCRIPTION NOTE FOR THE CHARACTERISTIC NATURAL HEIGHT AT INFLORESCENCE EMERGENCE OF TALL FESCUE VARIETIES.

| Variety name | Adjusted mean (cm) | Check description note | Predicted note | Description note | Variety name | Adjusted mean (cm) | Check description note | Predicted note | Description note |
|---|---|---|---|---|---|---|---|---|---|
| C1 | 35.5 | . | 1.19423 | 1 | NAIROBI | 56.1 | . | 3.6243 | 4 |
| BEAGLE 1 | 39.7 | . | 1.68968 | 2 | TOMCAT 1 | 56.23 | . | 3.63964 | 4 |
| FARANDOLE | 40.37 | 2 | 1.76872 | 2 | TAR HEEL | 56.52 | . | 3.67385 | 4 |
| ASTERIX | 41 | 2 | 1.84303 | 2 | NINJA | 56.54 | . | 3.67621 | 4 |
| C2 | 41.17 | . | 1.86309 | 2 | ELEGANCE | 56.57 | . | 3.67975 | 4 |
| CORONADO | 44.05 | . | 2.20283 | 2 | IDEFIX | 57.25 | . | 3.75996 | 4 |
| BONAPARTE | 44.71 | 2 | 2.28068 | 2 | COCHISE | 57.66 | . | 3.80833 | 4 |
| SILVERADO | 44.86 | . | 2.29838 | 2 | WOLFPACH | 58.07 | . | 3.85669 | 4 |
| BARLEXAS | 45 | . | 2.31489 | 2 | BORNEO | 58.11 | 4 | 3.86141 | 4 |
| NOVO | 46.37 | . | 2.4765 | 2 | ELISA | 58.66 | . | 3.92629 | 4 |
| C3 | 46.38 | . | 2.47768 | 2 | MIRO | 58.75 | . | 3.93691 | 4 |
| C4 | 46.77 | . | 2.52369 | 3 | ADOBE | 58.77 | . | 3.93927 | 4 |
| ELDORADO | 47.9 | 2 | 2.65699 | 3 | C14 | 58.94 | . | 3.95932 | 4 |
| C5 | 48.15 | . | 2.68648 | 3 | FILIPPA | 58.94 | . | 3.95932 | 4 |
| MONTSERRAT | 48.15 | 3 | 2.68648 | 3 | ARMINDA | 59.13 | . | 3.98173 | 4 |
| NESTORIX | 48.17 | . | 2.68884 | 3 | LUEUR | 59.47 | . | 4.02184 | 4 |
| PURE GOLD | 48.21 | . | 2.69356 | 3 | GREENZEAL | 59.61 | . | 4.03836 | 4 |
| LEPRECHAUN | 49.43 | . | 2.83748 | 3 | ESTIVADA | 59.65 | . | 4.04308 | 4 |
| O.GOLD | 49.99 | 3 | 2.90354 | 3 | GUISANE | 60.07 | 4 | 4.09262 | 4 |
| REGIMENT | 50.27 | . | 2.93657 | 3 | BARDAVINCI | 60.28 | . | 4.11739 | 4 |
| MURRAY | 50.29 | 3 | 2.93893 | 3 | DARCY | 60.3 | . | 4.11975 | 4 |
| LABARINTH | 50.46 | . | 2.95898 | 3 | PIXIE | 60.56 | . | 4.15042 | 4 |
| DYNASTY | 50.87 | . | 3.00735 | 3 | DENISE | 60.64 | . | 4.15986 | 4 |
| DEBUSSY1 | 50.95 | . | 3.01678 | 3 | C15 | 61 | . | 4.20233 | 4 |
| BARBIZON | 51.41 | . | 3.07105 | 3 | MAX | 61.35 | . | 4.24362 | 4 |
| MASTERPIECE | 51.42 | . | 3.07223 | 3 | APACHE | 61.67 | . | 4.28137 | 4 |
| TULSA | 51.42 | . | 3.07223 | 3 | WRANGLER | 61.86 | . | 4.30378 | 4 |
| MEANDRE | 51.43 | . | 3.07341 | 3 | TALENT | 61.96 | . | 4.31558 | 4 |
| C6 | 52.78 | . | 3.23266 | 3 | VILLAGEOISE | 62.07 | . | 4.32855 | 4 |
| SAVOY | 52.94 | . | 3.25153 | 3 | C16 | 62.13 | . | 4.33563 | 4 |
| C7 | 53.25 | . | 3.2881 | 3 | IZELLA | 62.24 | . | 4.34861 | 4 |
| C8 | 53.78 | . | 3.35062 | 3 | FALCON I | 63.03 | . | 4.4418 | 4 |
| BRAVO | 54.05 | . | 3.38247 | 3 | C17 | 63.11 | . | 4.45123 | 4 |
| TALISMAN | 54.25 | . | 3.40607 | 3 | ODYS | 63.32 | . | 4.47601 | 4 |
| PLANTATION | 54.33 | . | 3.4155 | 3 | GRANDE | 63.77 | . | 4.52909 | 5 |
| C9 | 54.34 | . | 3.41668 | 3 | DANIELLE | 63.97 | 6 | 4.55268 | 5 |
| C10 | 54.57 | . | 3.44382 | 3 | DIVYNA | 64.54 | . | 4.61992 | 5 |
| C11 | 54.77 | . | 3.46741 | 3 | KORD | 64.8 | . | 4.6506 | 5 |
| TOMAHAWK | 54.8 | . | 3.47095 | 3 | OLGA | 65.13 | . | 4.68952 | 5 |
| BARLEROY | 55.01 | . | 3.49572 | 3 | KILIMANJARO | 66.49 | . | 4.84996 | 5 |
| KONTIKI | 55.19 | . | 3.51695 | 4 | AMALIA | 66.68 | . | 4.87237 | 5 |
| C12 | 55.33 | . | 3.53347 | 4 | SUSANA | 66.79 | . | 4.88535 | 5 |
| EMPRESS | 55.49 | . | 3.55234 | 4 | OLIVINE | 67 | . | 4.91012 | 5 |
| BARFELIX | 55.93 | . | 3.60425 | 4 | FINELAWN | 67.29 | . | 4.94433 | 5 |
| C13 | 55.93 | . | 3.60425 | 4 | BARLEDUC | 67.38 | . | 4.95494 | 5 |
| MURIETTA | 55.97 | . | 3.60897 | 4 | LUDICAL | 67.57 | . | 4.97736 | 5 |
| ENDEAVOR | 56.04 | . | 3.61722 | 4 | JAGUAR | 67.89 | . | 5.01511 | 5 |

| Variety name | Adjusted mean (cm) | Check description note | Predicted note | Description note | Variety name | Adjusted mean (cm) | Check description note | Predicted note | Description note |
|---|---|---|---|---|---|---|---|---|---|
| MUSTANG | 67.99 | . | 5.0269 | 5 | DAUPHINE | 79.98 | . | 6.4413 | 6 |
| PROSPER | 68.56 | . | 5.09414 | 5 | BARELITE | 80.22 | . | 6.46961 | 6 |
| LOFA | 68.91 | . | 5.13543 | 5 | BARADISO | 80.25 | . | 6.47315 | 6 |
| SINFONIA | 68.99 | . | 5.14487 | 5 | BARCARELLA | 80.26 | . | 6.47433 | 6 |
| C18 | 69.54 | . | 5.20975 | 5 | FELINA | 80.45 | . | 6.49674 | 6 |
| TERROS | 69.81 | . | 5.2416 | 5 | METSOVO | 80.72 | . | 6.5286 | 7 |
| SEINE | 70.06 | . | 5.27109 | 5 | BELFINE | 80.88 | . | 6.54747 | 7 |
| LIPALMA | 70.25 | . | 5.2935 | 5 | JORDANE | 80.9 | . | 6.54983 | 7 |
| GARDIAN | 70.55 | 5 | 5.32889 | 5 | BARCELINA | 81.02 | . | 6.56398 | 7 |
| LIFEMA | 70.67 | . | 5.34305 | 5 | MOLVA | 81.12 | . | 6.57578 | 7 |
| ACHILLES | 70.85 | . | 5.36428 | 5 | MYLENA | 81.14 | . | 6.57814 | 7 |
| EMERAUDE | 70.91 | 5 | 5.37136 | 5 | MADRA | 81.52 | . | 6.62297 | 7 |
| PAULITA | 70.93 | . | 5.37372 | 5 | DULCIA | 81.63 | 7 | 6.63594 | 7 |
| TACUABE | 71.34 | . | 5.42209 | 5 | LUNIBELLE | 81.85 | 7 | 6.6619 | 7 |
| FESTORINA | 71.63 | . | 5.4563 | 5 | KORA | 82.54 | . | 6.74329 | 7 |
| CENTURION | 71.81 | 4 | 5.47753 | 5 | CARMINE | 82.89 | . | 6.78458 | 7 |
| FLORINE | 72.35 | . | 5.54123 | 6 | TUSCANY | 82.93 | 5 | 6.7893 | 7 |
| PERUN | 72.59 | . | 5.56954 | 6 | HYKOR | 83.11 | . | 6.81053 | 7 |
| SZARVASI 56 | 73.18 | . | 5.63914 | 6 | TIMA | 83.19 | . | 6.81997 | 7 |
| KASBA | 73.56 | . | 5.68397 | 6 | AMELIE | 83.53 | . | 6.86008 | 7 |
| MAXIMISE | 74.29 | . | 5.77008 | 6 | EXELLA | 83.56 | . | 6.86362 | 7 |
| STRAND | 74.87 | . | 5.8385 | 6 | C19 | 84.01 | . | 6.9167 | 7 |
| BAROLEX | 75.64 | . | 5.92933 | 6 | SONI | 85.5 | . | 7.09247 | 7 |
| KORINA | 75.77 | . | 5.94467 | 6 | C20 | 85.99 | . | 7.15027 | 7 |
| MARTIN II | 75.77 | . | 5.94467 | 6 | VENUS | 86.35 | . | 7.19274 | 7 |
| ADVANCE | 75.92 | . | 5.96236 | 6 | C21 | 86.57 | . | 7.21869 | 7 |
| FELINE | 76.35 | . | 6.01309 | 6 | C22 | 86.69 | . | 7.23285 | 7 |
| FUEGO | 76.6 | . | 6.04258 | 6 | BARIANE | 87.02 | 8 | 7.27177 | 7 |
| NORIA | 76.6 | . | 6.04258 | 6 | C23 | 87.44 | . | 7.32132 | 7 |
| PASTELLE | 76.69 | . | 6.0532 | 6 | C24 | 87.53 | . | 7.33194 | 7 |
| NOBEL | 77.02 | . | 6.09213 | 6 | APRILIA | 89.28 | 8 | 7.53837 | 8 |
| EMERYS | 78.26 | . | 6.2384 | 6 | C25 | 89.65 | . | 7.58202 | 8 |
| LUTINE | 79.12 | 7 | 6.33985 | 6 | FLEXY | 90.31 | . | 7.65988 | 8 |
| BARCEL | 79.41 | . | 6.37406 | 6 | | | | | |

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