



CORESTA Guide N° 7

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A Scale For Coding Growth Stages In Tobacco Crops



***Task Force Growth Stages and
Identification Keys for Tobacco***

A Scale for Coding Growth Stages in Tobacco Crops

1. Introduction

For a number of purposes, including traceability, crop management, experimentation, implementing Good Agricultural Practice, and for applications such as agro-meteorology and crop insurance, a clear, universally adaptable means of identifying growth stages has become increasingly important. Traditional subjective descriptors, such as *'after lay-by'*, *'knee-high'* and *'early-topping'*, which lack precision and tend to lose meaning in interpretation and translation, and those which do not take account of the influence of variety, environment and crop management on growth rate, are no longer suitable. Accordingly, the following scale, based on the extended BBCH-scale* that is universally adopted for uniformly coding phenologically similar growth stages of plants, has been developed for tobacco. It covers the full life of the crop from seed germination to harvesting and curing and is applicable to tobacco grown for its leaves as well as that for seed production.

2. Purposes of the Scale

- To replace subjective descriptions of growth stages in tobacco with a single, globally applicable numerical scale that identifies key growth stages in the crop and which conforms with that used in other crop plants.
- To provide research and development sectors in tobacco crop science as well as those in industries that service this sector with a common scheme to describe and identify growth stages important to their particular fields of activity.
- To provide extension agronomists and technical field staff with a straightforward, clear, consistent and globally understood means of identifying growth stages in relation to their role of communicating advice and information on crop management.
- To provide a common basis for recording key events in the progress of each crop for traceability purposes.

* BBCH-scale: refer to 'Growth Stages of Mono- and Dicotyledonous- Plants', BBCH Monograph, 2nd edition, 2001, ed. Uwe Meier, Federal Biological Research Centre for Agriculture and Forestry (www.bba.de/veroeff/bbch/bbcheng.pdf)

3. Basic Principles

The scale for tobacco follows the principal 'rules' of the BBCH code. It makes allowance for events and practices that, in some respects, are unique to tobacco, as follows:

- Separate phases of seedling and field production during which the continuity of stem elongation and leaf growth is interrupted by transplanting.
- Harvesting of leaves as the principal harvested product and their curing.
- Sucker growth at lower stalk internodes as a growth phase distinct from that at upper stalk internodes.
- Loss of upper leaves and the potential for stem extension as a result of topping.

In common with the extended BBCH scale, the tobacco scale deals only with clear easily recognised external morphological characteristics for describing phenological development stages and focuses principally on development of the main stem. However, crop characteristics, such as ground cover, are also considered because they are important to practices such as irrigation scheduling and pesticide application.

4. Organisation of the scale for tobacco

The entire cycle of development, from seed to harvesting and curing, is sub-divided into ten clearly recognisable and distinguishable development phases referred to as **Principal Growth Stages**.

They are numbered from 0 to 9 as shown in the following table (Overview: development stages of tobacco).

Typically, each stage covers a relatively long time span. Therefore, Secondary Growth Stages are used to identify more accurately progression in growth during each Principal Growth Stage.

For example, Principal Growth Stage 4, which covers the development of harvestable plant parts (*i.e.* ripening of leaves in the case of tobacco) is sub-divided into **Secondary Growth Stages** 0 to 9.

This results in coding for the progression of ripening as 40, 41, 42, 43, etc. to indicate no leaves ripe and then 10%, 20% and 30%, etc. leaves ripe (including those that have already been harvested), respectively (refer to the Appendix).

Table 1. Overview: development stages of tobacco

Principal Growth Stages	Meso Stage	Micro stages	Measurement	Code
0 Germination		0 - 9	Development stage	00 - 09
1 Leaf development	0 Leaf development - seedlings 1 Leaf development - field plants	00 - nn 00 - nn	Number of leaves Number of leaves	1000 - 10nn 1100 - 11nn
2 Formation of side shoots	0 Ground sucker development 1 Upper stalk sucker development	00 - nn 00 - nn	Number of suckers Number of suckers	2000 - 20nn 2100 - 21nn
3 Stem elongation and crop cover	0 Stem elongation - seedlings 1 Stem elongation - field plant 2 Crop cover within rows 3 Crop cover between rows	00 - 09 00 - 09 00 - 09 00 - 09	% typical seedling height % typical field plant height % ground cover along row % ground cover between rows	3000 - 3009 3100 - 3109 3200 - 3209 3300 - 3309
4 Development of harvestable plant parts (i.e. ripening of leaves)			% leaves ripe	40 - 49
5 Inflorescence emergence			Development stage	50 - 59
6 Flowering (main shoot)			% open flowers	60 - 69
7 Development of fruit (i.e. seed capsules)			% fully developed green capsules	70 - 79
8 Ripening of seed			% darkened capsules	80 - 89
9 Termination of crop (harvesting and curing of leaves)	0 Harvesting of leaves 1 Lamina colouring phase 2 Lamina drying phase 3 Mid-vein drying phase	00 - 09 00 - 09 00 - 09 00 - 09	% leaves harvested % lamina coloured % lamina dried % mid-vein dried	9000 - 9009 9100 - 9109 9200 - 9209 9300 - 9309

The two-digit code is adequate for identifying growth stages in Principal Growth Stages 0 (Germination), 4 (Development of harvestable plant parts – ripening of leaves), 5 (Inflorescence emergence), 6 (Flowering of main shoot), 7 (Development of fruit – seed capsules) and 8 (Ripening of seed).

However, the codes need to be further extended in the remaining Principal Growth Stages (1, 2, 3 and 9) to enable more precise identification of the Secondary Growth Stages in each. For this purpose a 4-digit code is necessary.

These so-called meso-stages enable distinction between seedlings and field plants in Principal Growth Stage 1, ground and upper stalk suckers in Principal Growth Stage 2, stem elongation in seedling and field plants and ground cover within and between rows in Principal Growth Stage 3 and between harvesting and the three stages in curing in Principle Growth Stage 9.

The complete code for tobacco is set out in the appendix.

5. Conventions

- Growth stages refer to representative individual plants within the crop stand; also to representative individual leaves when coding for either ripeness during the field phase or for the progress in curing during the post-harvest phase.
- As a rule, a crop stand is deemed to have reached a particular growth stage when 50% of the plants have reached that stage.
- Size (e.g. stem elongation, crop cover, etc.) is indicated by relative values considered to be typical for the variety and the particular growing conditions.
- a hyphen is used to link two growth stages (e.g. 51-69 to denote the full period of growth between the stage when inflorescence is first visible in the apex and when more than 90% of flowers are open).
- a forward slash is used to record two or more co-incident stages (e.g. 1112/3103 to denote that leaf 12 of the field plant had unfolded and that, at the same time, stem length had reached 30% of its typical length).

6. Appendix : Coding for Growth Stages in Tobacco

Principal Growth Stage 0: Germination

00	Dry seed
01	Beginning of imbibition
02	
03	Imbibition complete
04	
05	Radicle emerged from seed
06	Radicle elongated, root hairs developing
07	Hypocotyl with cotyledons emerged from seed
08	Hypocotyl growing towards soil surface
09	Emergence: cotyledons breaking through soil surface



Growth stage 09

Principal growth stage 1: Leaf development (seedling)

1000	Cotyledons completely unfolded
1001	1 st true leaf unfolded
1002	2 nd true leaf unfolded
1003	3 rd true leaf unfolded
1004	4 th true leaf unfolded
1005	5 th true leaf unfolded
10..	Stages continuous till nn leaves unfolded
10nn	nn leaves unfolded



Growth stage 1000



Growth stage 1002



Growth stage 1003

Principal growth stage 1 (continued): Leaf development (field plant)

1100	transplanting
1101	1 st leaf unfolded*
1102	2 nd leaf unfolded*
1103	3 rd leaf unfolded*
1104	4 th leaf unfolded*
1105	5 th leaf unfolded*
11..	Stages continuous till final leaf unfolded*
11nn	Final leaf unfolded*

**unfolded = >4cm length*



Growth stage 1103



Growth stage 1105



Growth stage 1108



Growth stage 1110



Growth stage 1112



Growth stage 1120

Principal growth stage 2: Formation of side shoots (ground suckers)

2000	Ground sucker development
2001	1 st ground sucker visible
2002	2 nd ground sucker visible
2003	3 rd ground sucker visible
2004	4 th ground sucker visible
2005	5 th ground sucker visible
20..	Stages continuous till n th ground sucker visible
20nn	n th ground sucker visible

Growth stage 2001



Principal growth stage 2 (continued): Formation of side shoots (upper stalk/head suckers)

2100	Head sucker development
2101	1 st head sucker visible
2102	2 nd head sucker visible
2103	3 rd head sucker visible
2104	4 th head sucker visible
2105	5 th head sucker visible
21..	Stages continuous till n th head sucker visible
21nn	n th head sucker visible

Growth stage 2101



Principal growth stage 3: Stem elongation and crop cover (stem elongation – seedlings)

3000	Beginning of stem elongation
3001	Stem reaches 10% of typical length
3002	Stem reaches 20% of typical length
3003	Stem reaches 30% of typical length
3004	Stem reaches 40% of typical length
3005	Stem reaches 50% of typical length
30..	Stages continuous till 90% of typical length
3009	Stem reaches 90% of typical length

Growth stage 3005
(Clipped and not clipped)



Principal growth stage 3: Stem elongation and crop cover (stem elongation – field plant)

3100	Beginning of stem elongation (transplanting)
3101	Stem reaches 10% of typical length
3102	Stem reaches 20% of typical length
3103	Stem reaches 30% of typical length
3104	Stem reaches 40% of typical length
3105	Stem reaches 50% of typical length
31..	Stages continuous till 90% of typical length
3109	Stem reaches 90% of typical length

Growth stage 3102



Principal growth stage 3 (continued): Stem elongation and crop cover (crop cover within rows)

3200	Transplanting
3201	10% of row length covered
3202	20% of row length covered
3203	30% of row length covered
3204	40% of row length covered
3205	50% of row length covered
32..	Stages continuous till more than 90% of row length covered
3209	More than 90% of row length covered



Growth stage 3207



Growth stage 3209

Principal growth stage 3 (continued): Stem elongation and crop cover (crop cover between rows)

3300	Transplanting
3301	10% of ground between rows covered
3302	20% of ground between rows covered
3303	30% of ground between rows covered
3304	40% of ground between rows covered
3305	50% of ground between rows covered
33..	Stages continuous till more than 90% of ground between rows covered
3309	More than 90% of ground between rows covered



Growth stage 3303



Growth stage 3305



Growth stage 3309

Principal growth stage 4: Development of harvestable vegetative plant parts (i.e. ripening of leaves)

40	1 st harvestable leaf fully expanded and beginning to ripen
41	10% of harvestable leaves ripe
42	20% of harvestable leaves ripe
43	30% of harvestable leaves ripe
44	40% of harvestable leaves ripe
45	50% of harvestable leaves ripe
4.	Stages continuous until all harvestable leaves ripe
49	All harvestable leaves ripe

Principal growth stage 5: Inflorescence emergence

50	Apical bud swelling but inflorescence not yet visible
51	Inflorescence visible between apical leaves
5.	Inflorescence emergence continuous till 1 st corolla visible
55	1st corolla visible but still closed
5.	Inflorescence emergence continuous till first petals visible
59	First petals visible but not yet open



Growth stage 51



Growth stage 55



Growth stage 59

Principal growth stage 6: Flowering (main stem)

60	Beginning of flowering – first petals open
61	10% of flowers open
62	20% of flowers open
63	30% of flowers open
64	40% of flowers open
65	50% of flowers open
6.	Stages continuous until all flowers open
69	More than 90% of flowers open



Growth stage 60



Growth stage 65



Growth stage 68

Principal growth stage 7: Development of fruits (i.e. seed capsules)

70	1 st green capsules formed
71	10% green capsules swollen to typical size
72	20% green capsules swollen to typical size
73	30% green capsules swollen to typical size
74	40% green capsules swollen to typical size
75	50% green capsules swollen to typical size
7.	Stages continuous till >90% seed capsules swollen to typical size
79	More than 90% green capsules swollen to typical size



Growth stage 71



Growth stage 77

Principal growth stage 8: Ripening of seeds

80	Beginning of ripening, oldest seed capsules darkening
81	10% of seed capsules darkened
82	20% of seed capsules darkened
83	30% of seed capsules darkened
84	40% of seed capsules darkened
85	50% of seed capsules darkened
8.	Stages continuous till more than 90% of seed capsules darkened
89	More than 90% of seed capsules darkened



Growth stage 81



Growth stage 88



Typical capsule – stage 81



Typical capsule – stage 88

Principal growth stage 9: Termination of crop (harvesting and curing)

9000	Lower leaves fully ripe and ready to be harvested
9001	10% of leaves harvested
9002	20% of leaves harvested
9003	30% of leaves harvested
9004	40% of leaves harvested
9005	50% of leaves harvested
900.	Stages continuous till more than 90% of leaves harvested
9009	More than 90% of leaves harvested

Principal growth stage 9 (continued): Termination of crop (harvesting and curing) – colouring phase

9100	Start of curing
9101	10% of leaf lamina coloured
9102	20% of leaf lamina coloured
9103	30% of leaf lamina coloured
9104	40% of leaf lamina coloured
9105	50% of leaf lamina coloured
910.	Stages continuous till more than 90% of leaf lamina coloured
9109	More than 90% of leaf lamina coloured

Principal growth stage 9 (continued): Termination of crop (harvesting and curing) – lamina drying phase

9200	Start of lamina drying
9201	10% of leaf lamina dry
9202	20% of leaf lamina dry
9203	30% of leaf lamina dry
9204	40% of leaf lamina dry
9205	50% of leaf lamina dry
920.	Stages continuous till more than 90% of leaf lamina dry
9209	More than 90% of lamina dry

Principal growth stage 9 (continued): Termination of crop (harvesting and curing) – mid-vein drying phase

9300	Start of mid-vein drying
9301	10% of mid-vein dried
9302	20% of mid-vein dried
9303	30% of mid-vein dried
9304	40% of mid-vein dried
9305	50% of mid-vein dried
930.	Stages continuous till more than 90% of mid-vein dried
9309	More than 90% of mid-vein dried