GreenariA
Go Green, Learn Green
An Agricultural Monthly e-Magazine
Volume 02, Issue 11, 2024
ISSN: 2584-153X
Article ID: G-24-1105

PHENOLOGICAL STUDIES ACCORDING TO THE BBCH SCALE

Atiya Maqbool

Division of Fruit Science, Faculty of Horticulture, Sher-e- Kashmir University of Agricultural Sciences and Technology of Kashmir, Shalimar, J&K

Corresponding Author Mail ID: atiyamaqbool28@gmail.com

Introduction

The study of plant and animal life cycle events that are brought on by environmental changes is known as phenology. The initial opening of leaf and flower buds, bug hatching, and bird migration are only a few examples of the diverse range of occurrences that are included in phenological events. Each one gives a clue about the habitat the impacted organism was in. Therefore, phenological events are great indicators of how local and global temperature and weather changes impact the earth's ecosystem. Phenomenological occurrences have long been observed and documented. Historical documents and writings, including observations from as far back as 3,000 years ago in China, were documented by XIAOQIU (2003). This custom is strongly related to the observation of the weather and its seasonal variations. Phenomenological knowledge and endeavors are likely as old as civilization itself. As farmers began to live in one place year after year, planting seeds, tracking crop growth, and collecting crops, they surely soon realized the connection between environmental changes and plant development. More than fifty specialists from many fields describe the history of phenology and its relevance in the current and future contexts in Schwartz's (2003) book Phenology: In Integrated Environmental Science. The relationship between modern agriculture and the BBCH system, as well as traditional meteorology and climatology, is developed by Bruns, Chmielewski, van Vliet (2003), and MEIER (2003).

Phenology in plants is the study of periodic biological events that are specific to plants and are influenced by seasonal and climatic variations. Examples of these events include budbreak, flushing, flowering, and fruit development. Knowledge of the phenology of a particular crop is important for its correct management. From a climatological point of view, these occurrences provide the groundwork for the interpretation of changes brought about by bioclimatic factors. From an agronomic perspective, knowing the effects of a specific microclimate allows one to anticipate how the plant will react. Lastly, from an economic point of view, phenological stage characterisation is critical to achieving high fruit quality and fruit weight, as many management techniques (such as pruning, applying fertilisers, pesticides, and bioregulators, thinning flowers and fruit before harvest, and mechanical, hand, and natural pollination) depend on the identification of specific phenological stages. These gardening techniques affect the fruit's dry matter content, size, and marketability.

History of the BBCH coding system

The need for a uniform, global scale to characterize plant developmental phases across different species gave rise to the BBCH coding system. Early phenological scales, like those developed by Troitzki (1925), Fleckinger (1948), and Baggiolini (1952), mainly focused on fruit trees and lacked a thorough examination of development phases and also utilized inconsistent symbols. In order to standardize the labeling of developmental phases among crops, Zadoks et al. (1974) developed an improved numeric decimal scale for cereals. Bleiholder et al. (1989) advanced the BBCH scale with assistance from BASF and Bayer, two agricultural businesses. Based on the Zadoks cereal scale, it offered the first consistent growth scale for both monocotyledonous and dicotyledonous plants. The scale immediately became well-known around the world, and Hack et al. (1992) added more intricate codes for other crops. The "BBCH-Monograph," which included 27 crops and was translated into several languages, provided an overview of the stages of development of the BBCH scale. Global adoption was significantly boosted when the European and Mediterranean Plant Protection Organization (EPPO) mandated its use for coding plant growth stages in official plant protection trials. Since then, a wide range of crops, including cereals, potatoes, pome and stone fruits, grapes, citrus, and olives, have adopted the BBCH scale. By eliminating issues with previous scales and enabling effective collection and processing of trial data, its standardization has promoted multidisciplinary collaboration in the fields of plant research, climatology, and agricultural management.

BBCH scale

Biologische Bundesanstalt, Bundessortenamt, and CHemical industry are the abbreviations that make up BBCH. Both monocotyledonous and dicotyledonous plant species, including weeds and crops, can have their phenologically comparable growth stages uniformly coded and described using this method. Scientists from the German Federal Office of Plant Varieties (BSA), the German Agrochemical Association (IVA), the Institute for Vegetables and Ornamentals, and the German Federal Biological Research Centre for Agriculture and Forestry (BBA) worked together to develop the BBCH system. The goal of this collaboration was to develop a uniform method for categorizing plant growth phases in a broad range of species.

Principles of the scale

- The general BBCH scale provides the framework within which individual scales for different plant species are developed. It can also be used for plant species for which there isn't yet a specified scale. To keep things consistent, the same identifier is given to similar phenological stages in different plant species.
- Every code has a description, and to help with identification, images are occasionally provided for important developmental phases. When discussing phenological development, the focus is primarily on the main stem, unless stated otherwise.
- The secondary growth stages, represented by 0 to 9, correspond to ordinal numbers or percentage values. Stage 3 might represent, for example, the third node, the third tiller, the third genuine leaf, or 30% of the species' total length, size, or flower opening.
- To better define these phenological growth stages, illustrative pictures were provided along with codification and description which will help farmers to identify the most accurate stage.
- Post-harvest or storage treatments are designated with code 99, whereas seed treatment before planting is coded 00.

Organisation of the BBCH scale

The entire developmental cycle of the plants is divided into ten unique and easily identifiable long lasting developmental phases (Fig 1). The numbers 0 to 9 are used in ascending sequence to describe these key growth phases (Table 1). The vast diversity of plant species may result in modifications to the growth process or even the exclusion of certain stages. For example, PGS 4 is left out of perennial woody fruit plants since it talks about the portions of the plant that are meant to be collected (much like in fruit trees, just the fruit is the economically valuable part). Similar to this, principal growth stages can sometimes occur in simultaneously and are not required to follow the numbers' precise ascending order. If both growth stages occurred in parallel, they can be shown with a diagonal stroke (see example 16/22). Depending on the type of plant, the more advanced growth stage or the major development stage of particular relevance must be chosen if just one stage is to be indicated. Since the primary growth stages usually represent durations or time spans in the course of a plant's development, they are insufficient on their own to explain precise application or evaluation dates.

Table 1: Principle growth stages

Stage	Description
0	Germination/sprouting/bud development
1	Leaf development (main shoot)
2	Formation of side shoots/tillering
3	Shoot elongation or rosette growth/shoot development (main shoot)
4	Development of harvestable vegetative plant parts or vegetatively propagated organs/booting (main shoots)
5	Inflorescence emergence main shoot/heading
6	Flowering (main shoot)
7	Development of fruit
8	Repining or maturity of fruit and seed
9	Senescence beginning of dormancy

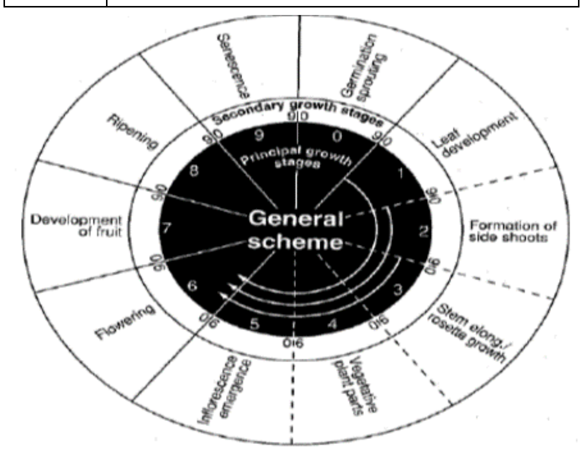

Fig 1: General Scheme of BBCH scale

If specific indications of occurrences in the primary growth stages are required, secondary stages are employed. They are characterized as brief developmental phases that are exclusive to each plant species and are passed one after the other during the principal growth stage, as opposed to the primary growth stages. Secondary growth stages are related to ordinal or percentile values which are also codified and numbered from 0 to 9. For example, in code 35, 3 represents shoot development stage while as 5 represents 50% of shoot growth. The combination of digits representing both principal and secondary stages provides a two-digit code. This code acts as a precise scale, allowing for correct identification of phenological growth stages in most plant species. By using this system, the complexity of plant development is simplified, providing a universal method to define each phase with clarity across diverse species.

In certain plant species, such as cucumber, onion, potato, tomato, and banana, further subdivision is required within a principal growth stage. The two-digit code, using secondary stages from 0 to 9, may not suffice. A three-digit scale is added to the two-digit one for these situations. Another level of detail is added by this scale, which includes a mesostage in between the major and secondary stages. Figures 0 and 1 depict the growth of the main stem in this system, while figures 2 to 9 show the development of side shoots ranging from the second to the ninth order. This technique offers thorough explanations of branching patterns or permits the counting of up to 19 leaves on the main stem.

The BBCH scales enable the comparison of individual codes within the same principal growth stage, whereas higher numerical code shows a later stage of development. These codes can be arranged numerically to provide a clear list of the plant growth progression. By showing two stages joined by a hyphen, one may accurately determine the duration of particular developmental phases. For example, the code 51-69 designates the time frame from the onset of the first flower buds or inflorescence to the conclusion of flowering. This system provides a clear and structured way to track plant development.

Important scopes of uses of the BBCH scale

Taking agricultural sciences and practice as a basis, other disciplines may be able to benefit from this standard. It is applicable to areas such as botanical science, agricultural insurance and phenological observations by meteorological and climatology services.

Agriculture

BBCH scale is a two-digit numerical system which aids in distinguishing between principal and secondary stages of development. The introduction of this phenological scale for fruits serves as a valuable tool for guiding growers in the timing of various horticultural practices (such as canopy training and pruning, girdling, application of bioregulators, flower and fruit thinning, pollination techniques, fertiliser, water and pesticide application, pest and disease control measures, timely harvesting of fruits, and post-harvest processing and germplasm characterization and adaptation all of which require a good knowledge of the crop phenology to be done in the most appropriate moment..

Researchers/scientists

The scale has turned out to be helpful and practical because one of the features of this coding system is that homologous stages of different crops are given the same codes which can improve the communication between scientists, researchers and growers and allow the exchange of data and scientific results in a transparent way. It also contributes to the development of the international agrarian-scientific and interdisciplinary communication. Thus, this detailed study on different phenophases in relation to the prevailing environmental conditions can contribute to the unification and rationalization of research systems in agriculture, serve as a basis for the standardization of agronomic and eco physiological aspects and can also promote the cultivation of new fruit crops.

Uses in meteorology and climatology

Unlike the measurement of meteorological data, there has been little international standardization in the field of phenological observation as a subfield of climatology. The BBCH codes have been recognized as useful by traditional phenologists in China, North America, and Europe. Data can now be correlated to a particular phenological growth stage in meteorology and climatology. The environmental features of the climate in the area where phenological phases occur are one of the factors that are reflected in them. Therefore, the detection of climate fluctuation or climate change may be accomplished by the use of extended series of phenological observations. Establishing a European reference dataset of phenological observations for climatological applications, particularly climate monitoring and change detection, is the action's primary goal.

Artificial Intelligence

The scale also holds a significant application in the field of AI when it comes to applications related to plant identification, monitoring and phenotypic analysis. By standardizing labelling for training data, it makes it possible for AI models to identify and categorize the stages of plant growth. High-throughput plant phenotyping is made possible by integrating BBCH with AI, which enables automated picture and sensor data interpretation. AI can employ BBCH codes to remotely sense agricultural growth stages and make recommendations for irrigation and other management techniques. Furthermore, by examining growth stage patterns, AI models trained on BBCH data can forecast yields, aiding in risk management, market planning, and resource allocation decisions.

Conclusion:

Codification will help in the standardisation of phenological observations which will provide common language to the researchers from different regions and disciplines to communicate effectively and compare their results. It will also provide framework in planning and designing their experiments and understanding climate change impacts. The scale will permit the definite identification of correct time for control measures which will help the growers in planning organizing and timely execution of orchard management practices. The scale also holds a significant application in the field of AI.