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Vegetation control - Technical and management aspects

Contrôle de la végétation - Aspects techniques et managériaux
Vegetationskontrolle - technische und Managementaspekte

UNION INTERNATIONALE DES CHEMINS DE FER
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1st edition, January 1992	First issued under the title "Selection and use of weedkillers alongside railway tracks from the standpoint of environmental protection"
2nd edition, January 2004	Complete overhaul of leaflet

The person responsible for this leaflet is named in the UIC Code

Contents

Summary

Over the last 10 years new methods for vegetation control have been investigated in order to reduce maintenance costs and the impact on the environment. These methods were reviewed in a UIC study on vegetation control completed in 2002 ("Herbizidauswahl und -Anwendung im Oberbau unter Berücksichtigung des Umweltschutzes"). On the basis of this work, it was decided to conduct an extensive revision of the 1992 edition of *UIC Leaflet 723*.

The purpose of this new revised edition is to:

- offer guidance to railway infrastructure management and staff in addressing the issue of vegetation control on the railway,

- provide a short justification for the need to control vegetation,

- give an overview on different approaches used for vegetation control by railway companies, together with some basic information about vegetation control management systems.

1 - Definitions

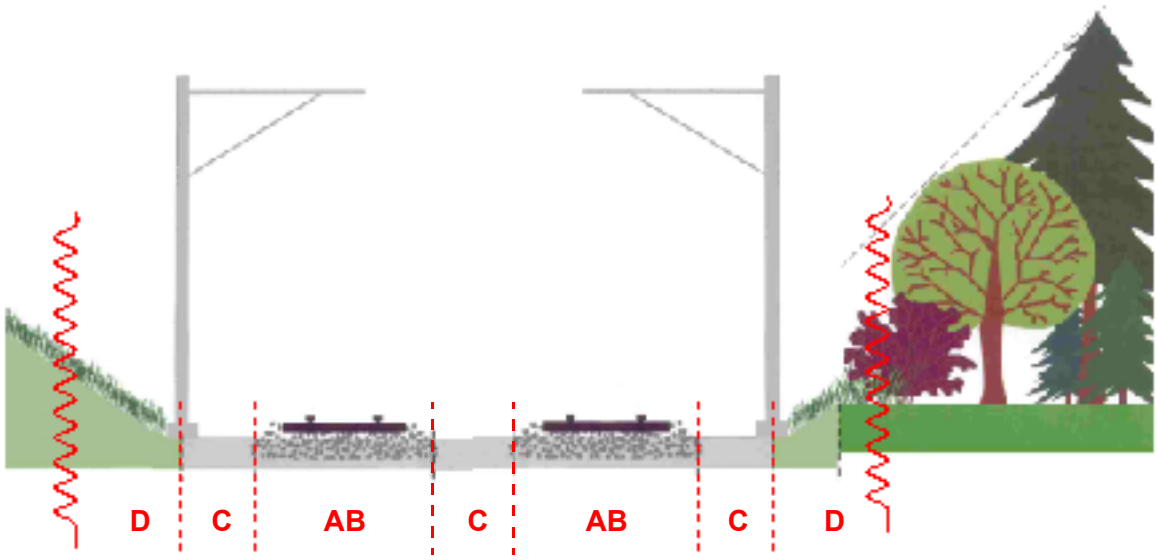

Fig. 1 - A schematic representation of the areas for vegetation control

Vegetation control areas	The railway companies often separate their railway lines into several sections to reflect differing vegetation control measures adopted, frequency of application, the varying duration of application and in some cases shared organisational responsibilities.
Area AB	*Ballast bed*: part of the track-bed made of ballast or gravel including embedded sleepers and rails. *Slab track*: concrete track-bed construction.
Area C	*Transition area*: part of the track abutting the slope on both sides of the ballast bed, includes walkway for maintenance/ inspection purposes and areas between two tracks (lines with 2 or more tracks). Drainage ditches are also built in Area C in some cases.
Area D	*Embankment*: the slopes alongside the track away from the track adjoining Area C

Maintenance in all other areas outside the embankment is not covered by this document.

2 - Need for vegetation control

In general plants tend to colonise all vegetation-free areas and therefore vegetation control is necessary for the reasons explained in the following points.

The aim of vegetation control in the different areas is:

- to keep the track (Areas AB and C) free of vegetation,
- to keep vegetation on the embankment (Area D) within certain limits.

2.1 - Within the track (Areas AB and C)

2.1.1 - Growing process within the track

The ballast bed (area AB) is usually a dry and hot place, but as time goes by the ballast attrition and the input of dirt from outside (air, wagons) leads to an increase in fine material between the ballast. As a result, the moisture content starts to increase, growing conditions for plants improve and the sub-layer may be weakened as well.

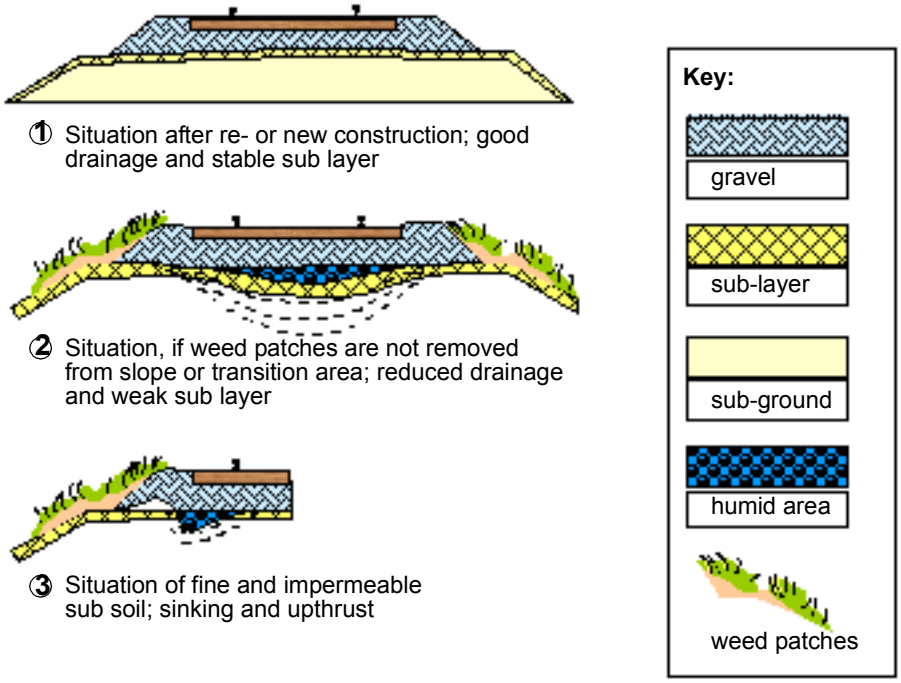

Fig. 2 - Long-term development of track under the influence of plants

Another process of vegetation development takes place in the transition area (area C), where plant growth usually starts because plants can find a suitable environment. Plants can grow in from the adjacent area either by sub-ground or above ground shoots, runners or seeds. When the vegetation reaches the base of the ballast slope, the combination of plant roots and fine material from the ballast closes the coarse pores, which may lead to reduced drainage of the ballast bed. As a consequence

the moisture content increases and sub-layers beneath the ballast may start to weaken (Figure 2). This has negative effects on the stability of the track and a potential reduction in carrying capacity.

The increased moisture further enhances plant growth due to improved growing conditions. These effects tend to occur together with other adverse factors bearing upon the track like changes in the underlying ground conditions. Currently, there is no model capable of forecasting the effect of vegetation on track stability over time.

2.1.2 - Reasons for vegetation control within the track

The main reasons for vegetation control measures within the track and the effects of plants in these areas are given in Table 1.

Table 1 : Safety, operational and economic reasons for vegetation control within the track

Safety reasons:
• Affect braking and starting power of trains, through loss of adhesion, • Reduce safety for railway workers, • Restrict sighting of ground signals (especially in rail yards) and on level crossings, • Close emergency routes, • Increase risk of fire.
Operational and technical reasons:
• Have an influence on track quality (e.g. decrease elasticity of ballast bed) which can have safety impacts, • Affect electrical signal systems along the track (by increasing humidity and thus electrical conductivity), • Impair resistance to frost (by reducing drainage efficiency of ballast bed), • Weaken sub-layers and enable material to be pumped up to the surface (thereby impairing drainage).
Economic reasons:
• Reduce life span of installation parts by more humid conditions, e.g. rusting of fastenings, shorter life of wooden sleepers, • Impede regular inspection of the track by railway workers and automated inspection systems (by concealing fixing points), • Increase maintenance tasks involving track stability (e. g. by weakening sub-layers) and the pollution of the ballast, • Shorten cleaning intervals (by increasing amount of fine material in the track).

2.2 - Embankment (Area D)

The embankment is an important area for vegetation control because the roots of vegetation may stabilise the embankment and therefore reduce the risk of erosion or failure. However, it has to be kept within certain limits to guarantee undisturbed traffic operation.

2.2.1 - Growing process on the embankment

Plant growth on the embankment is more or less influenced by the natural soil and climatic conditions. The embankment is usually covered by plants and such vegetation can have many **positive effects**:

- Soil coverage reduces erosion,
- Protection against wind, snow and trespass,
- Biologically and environmentally important areas, sometimes colonised with rare species,
- Links different landscapes leading to an exchange of flora and fauna (corridor function).

2.2.2 - Reasons for vegetation control on the embankment

Although vegetation in the embankment has many positive effects, it has to be kept within certain limits to guarantee undisturbed traffic operations. These negative aspects of plant growth on the embankment and the reasons for vegetation control measures in this area are given in Table 2.

Table 2 : Safety, operational and economic reasons for vegetation control on the embankment

Safety reasons:
• Certain plants reduce sighting of the track and/or signals, • Plants growing in towards the track area from the embankment lead to improved growing conditions and therefore problems, • Unstable trees foul the catenary or block the permanent way which can have impacts on operational and technical aspects, • Leaves from trees can diminish the braking power, through loss in adhesion.
Operational and technical reasons:
• Stones loosened by plant roots in rocky incisions damage rolling stock. • Some plants (e.g. bushes) can impede other maintenance work.
Economic reasons:
• Depends on the kind of plants: fast-growing, unstable plants demand higher frequency of maintenance.

3 - Measures and methods

Only those vegetation control methods that are widely used by railway companies are listed below.

3.1 - Construction/re-construction

Vegetation control methods used in construction and re-construction, including engineering methods, can have a preventative effect. They reduce plant growth by creating an unfavourable environment for plants or prevent them from growing into the track area over a long period (barrier effect). The effectiveness of these methods is much higher if they are supplemented with maintenance vegetation control methods.

As herbicide-free methods, their application (within the areas AB and C) can be necessary in ground water protection areas or other areas where the use of herbicides is restricted.

They have to be integrated into the engineering process to yield best results. For that purpose the engineering manuals should be adapted, if necessary, by the companies to consider the aspects of vegetation control. Construction methods can then be integrated into the planning process and some of these methods can be done without any additional cost (e.g. suitably positioned cable troughs or noise barriers).

Engineering methods and measures for vegetation control have the following advantages;

- A long term effect on vegetation,
- Generally prevent plant growth,
- Do not cause excessive additional costs and
- Reduce the costs of maintenance in the field of vegetation control.

Table 3 shows an overview over current engineering methods. Details of all methods (e.g. costs, duration of effects, etc.) listed below can be found in the UIC report on vegetation control (UIC "Vegetation Control" Project, Appendix 5: Details on the various vegetation control methods).

Table 3 : Overview of construction and re-construction methods

Method	Application area	Effects on plants	Examples
Lateral plant barriers/ objects impeding plant incursion	C, D	Prevents plants from growing into Area C and from there into Areas AB - not effective against plants growing in from the sub-ground	Suitably positioned cable troughs or noise barriers
Plant barriers beneath the track in general	AB, C	Prevents plants from growing up from below, additional benefit for drainage	Layer of bitumen or concrete, sheets,
Slab track	AB	Plant barriers beneath the track prevent plants from growing up from below	
Planting (with less problematic plants)	D	Competition of plants prevent the growth of undesirable species	Strongly competitive plants

3.2 - Maintenance

Vegetation control in the maintenance process can be divided into methods applied within the track and those applied on the embankment. Chemical methods are predominantly used in the track and non-chemical methods in the embankment.

3.2.1 - Within the track (Areas AB and C)

The current maintenance methods applied within the track (area AB and C) are shown in Table 4. They fall into different groups:

- **Commonly applied maintenance methods** for infrastructure may also have a positive influence on vegetation control even though they are not primarily used for vegetation control reasons (e.g. cleaning and replacement of ballast; maintenance of drainage systems). These have a strong impact on plant life along the track by creating a growth inhibiting environment for plants.

- **Non-chemical methods** actually tested, have not yielded satisfactory results in comparison with chemical methods so far. Either they cannot be applied due to operational reasons, are not efficient enough or are too expensive. Therefore some of them are used in addition to herbicides or where the use of herbicides is prohibited.

- **Chemical methods** are actually the most effective and cheapest maintenance methods. They are easy and fast enough to apply, but need well trained operators for safe use. In Table 4, no differentiation was made between different herbicides. Risks of impacts on the environment must be avoided by careful planning.

Table 4 : Overview of methods used in maintenance within the track (areas AB and C)

Method	Application area	Costs (€ / km)[a]	Operating speed	Duration/ frequency of application
Ballast cleaning/ replacement	AB, C	5 100 - 350 000	Up to 200 m/h	
Manual weeding	AB, C	315 - 4 000 (0,04 - 2 €/m2)[b]	9 - 105 m^2/h	1 to 4 times a year
Back-pack spraying (herbicides)	AB, C, D	5 - 850[b]	Up to 5 km/h 150 - 4 750 m^2/h	Depending on herbicide used, half a year up to 2 years
Spraying train (herbicides)	AB, C, D	34 - 260 (0,01-2,5 €/m^2)[b]	Up to > 40 km/h 12 550 m^2/h - 400 000 m^2/h	
Herbicide application with rail-road vehicle	AB, C, D	196 - 300 (2 €/m^2)[b]	Up to 40 km/h 10 000 m^2/h - 50 000 m^2/h	
Selective application of leaf herbicides with spraying train[c]	AB, C	260[b]	Up to 40 km/h up to 260 000 m^2/h	

a. Comparing costs is very difficult because of varieties within one method and different wage levels in different countries, as well as different cost compilation methods. Costs per application.
b. When used on both sides of the track.
c. More details about this video detection system and other detection systems can be found in UIC study on vegetation control.

3.2.2 - On the embankment (Area D)

Table 5 shows an overview of current maintenance methods used on the embankment (Area D). The regular application of these methods is also a means of combating plant growth (e.g. the growth of plants above ground). Railway companies in some countries also use chemical methods on the embankment (see - page 7).

Table 5 : Overview of methods used in maintenance beside the track (Area D, embankment)

Method	Application area	Costs (€/m^2)[a]	Operating speed	Duration/frequency of application
Selective embankment maintenance e.g. logging	C, D	0,3 - 2	1 - 40 km/h up to 3 000 m2/h	1 year in vicinity of track, irregularly as needed every 5 to 10 years
Mowing	C, D	0,15 - 1,2[b]	Dependent on machine: Up to 5 km/h, 0,5 - 4 500 m^2/h	Every other year up to 4 times a year
Mulching	C, D	0,15- 1,0[b]	< 1 - 5 km/h 170 - 1 000 m^2/h	Once a year

a. Comparing costs is very difficult because of varieties within one method and different wage levels in different countries, as well as different cost compilation methods. Costs per application.
b. When applied on one side of the track.

3.3 - Problematic plants within the track and the embankment (Areas AB to D)

Problematic plants are plants that have to be treated by adopting a special strategy.

A list of problematic plants occurring on most railways and the strategies used to combat them are given in Table 6. More problematic plants and their treatments can be found in the UIC report on vegetation control.

NB : UIC Project "Vegetation Control", Final Report, point 8.3 Methods / strategies for combating problem plants

Table 6 : Problematic plants and proposed treatments (in no particular order).

Plant species	Latin name	Treatment
Reeds	*Phragmites sp.*	• Regular mowing in early summer (e.g. June/July), lateral plant barriers
Brambles	*Rubus fruticosus*	• Mowing in late summer (before August) up to 3 times a year or once in autumn, after mowing treatment with herbicides in autumn, sow grass in the following growing season to establish competitive vegetation
Herb robert	*Geranium robertianum*	• Manual weeding in spring (time consuming) • Use of herbicide in spring before development of seeds, second treatment in autumn recommended
Horsetail	*Equisetum sp.*	• Use of herbicide in spring before development of seeds, second treatment in autumn recommended • Structural remediation (asphalt layers), manual weeding several times a year. • Stimulate growth of competitive vegetation (grass) through regular mowing
Japanese knotweed	*Fallopia japonica*	• Use of Glyphosate combined with cutting, manual weeding for small investigations → **do not flail (cut into small pieces)**
Giant hogweed	*Heracleum mantegazzianum*	• Digging out the roots or cutting the upper part of the roots early in spring • Regular mowing before development of seeds

4 - Vegetation control management system

The aim of a vegetation control management system is the standardisation and unification of the process. This will result in a safe and efficient railway infrastructure with the following points:

- efficient use of budgets (e.g. only areas which have to be treated will be treated),
- correct methods (e.g. optimum application time and related to local situations),
- increase in transparency (e.g. information for government organisations),
- better understanding of decisions (e.g. standard decision scheme),
- detailed information about costs (e.g. how much money spent on a certain method),
- harmonisation of development and results (buying and selling intellectual property),
- responsible care (environment, workers safety).

The handling of the large volume of associated data can be supported by a computer system via a database, maps and/or a geographical information system (GIS). Video cameras and other detection systems can be used as part of such a management system to assess the vegetation coverage on the tracks before and after a treatment.

A vegetation control management system should follow the steps shown in Figure 3. Since every railway must create its own individual system, the points listed below are examples.

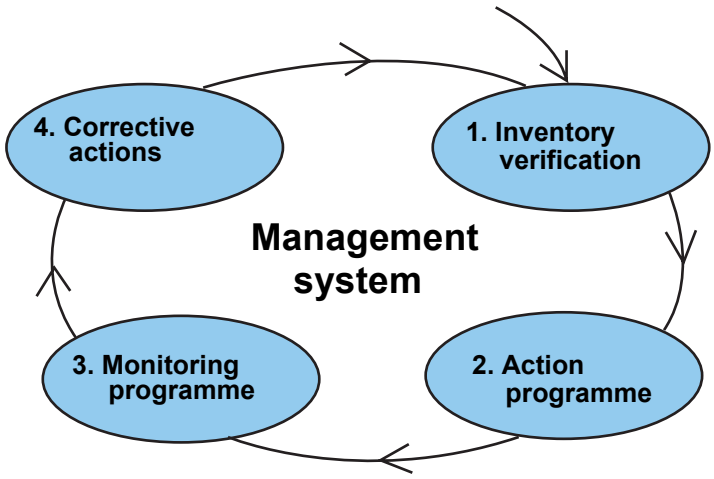

Fig. 3 - Management system

4.1 - Inventory verification (Step 1)

To establish a management system, some basic data is needed about the surrounding and the location of the railway line:

- accessibility for certain machines,
- topography (embankment, cutting, level crossing, etc.),
- line-km,
- environmental aspects such as sensitivity of the area (e.g. ground water protection area, nature conservation area, etc.).

In order to apply a vegetation management system, the first step is to record the amount and kind of vegetation present in the track and the embankment. Standardised record methods should therefore be used within the railway company to allow a comparison and/or to establish a technical detection system in addition to manual inspections.

The vegetation growth in the track (area AB and C) can be described in different ways:

- vegetation coverage as a percentage of total area,
- list of plant species (underlining problematic plants),
- coverage of problematic plants as a percentage of the total area,
- state of infrastructure (e.g. drainage system).

The determination of the vegetation status in the embankment (area D) is more complicated and hence more parameters are needed:

- type of vegetation,
- list of problematic plants and their rate of occurrence,
- age of trees and bushes,
- condition of plants, especially trees,
- distance between certain plants (e.g. trees) and the track,
- vegetation pressure toward the track.

4.2 - Action programme (Step 2)

The results from Step 1 help to decide whether vegetation control is needed. The individual regulations and aims of each railway company will have an influence on this decision. If there is a need for vegetation control the appropriate measures and methods have to be selected. It must be recognised that the earlier any treatment starts (independent of method) the higher the efficiency of the method and the lower the costs.

When selecting the appropriate method(s), all areas (AB to D) should be taken into account. The decision as to which method(s) is/are best suited should be based on the operating parameters of each method (see point 3 - page 6) and the information in the following checklist.

Within the track (Area AB and C) - check, if

- constructions are planned. Demands of vegetation control and constructional methods should be involved in the planning and construction process, because they are most effective in new or re-construction;
- constructional methods are already used;
- the drainage system is working properly;
- all track areas have to be treated;
- vegetation occurring needs a special strategy for treatment (see point 3.3 - page 8);
- local conditions (like water protection areas or infrastructure data) rule out certain methods;
- combination with other vegetation control measures is possible.

In the embankment (Area D) - check, if:

- a measure working from outside the track is applicable;
- plants occurring need a different strategy for treatment (trees other than shrubs, for example);
- local conditions (like nature conservation areas or the infrastructure data) rule out certain methods;
- combination with other vegetation control measures is possible.

Any adaptations to train timetables can be made, when linking the operating parameters of the methods with the line information. As well as this information about vegetation control measures, it should be determined if the work can be done in combination with other maintenance work in order to reduce track occupation/possession.

4.3 - Monitoring programme (Step 3)

After applying the different method(s) for vegetation control a supervision should include the following points:

- type of method applied (especially chemicals: type, dose, quantity of spray, etc.),
- description of machines, techniques used (spraying train, rail-road vehicle, back-pack spraying, mowing machines, etc.),
- date of application, frequency,
- location of application (line, part of line and area AB, C and/or D),
- effectiveness of application of method,

- costs of application,

- date and method of checks.

4.4 - Corrective actions (Step 4)

This information will then allow quality and environmental checks to be carried out and will also serve as a basis for future planning when changes are required. The cost of maintenance can thus be kept to a minimum.

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