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Weed control on hard surfaces in The Netherlands†

Corné Kempenaar[1]* and Joop H Spijker[2]

[1]*Plant Research International, PO Box 16, NL-6700 AA Wageningen, The Netherlands*
[2]*Alterra, PO Box 47, NL-6700 AA Wageningen, The Netherlands*

Abstract: The non-agricultural use of pesticides in The Netherlands declined in the period 1986–2001 from 127 000 to 40 000 kg AI per annum. However use on pavements rose from 23% to 50% of the total non-agricultural use. To diminish the dependency on herbicides, both preventive and curative non-chemical weed control methods have been examined. In the future both mechanical and thermal methods can be improved. On a flat pavement mechanical methods are preferred because they are more effective. Two approaches are used by municipalities to lower the environmental impact of the use of herbicides on pavements. The first is to phase out the use of chemicals on hard surfaces and the second is the integrated approach in which herbicides are not prohibited, but used only on places and at times when the risk of run-off is below a mutually accepted level. Both approaches can be effective.

Keywords: prevention; non-chemical methods; pesticide statistics; phasing out; integrated approach

1 INTRODUCTION

Non-agricultural pesticides are pesticides applied in non-agricultural situations. They represent a diverse group of chemicals used to control damaging organisms in a wide range of situations and habitats. In The Netherlands, weed control on hard surfaces is responsible for the largest share of non-agricultural pesticide use.[1–3] It is believed that herbicide use on hard surfaces leads to greater contamination of surface water than would be expected.

This paper gives an overview of developments in The Netherlands in the field of weed control on hard surfaces which are aimed at reduction of herbicide use and thus of its subsequent contamination of non-target areas. Some statistics are presented in the next section of this paper. Subsequently, some studies and projects aimed at reduction of herbicide use on hard surfaces are presented. Topics such as weed preventive methods, non-chemical methods, phasing out of herbicides and an integrated approach are addressed. Finally, the developments are discussed in a broader perspective.

2 STATISTICS ON NON-AGRICULTURAL PESTICIDE USE

Statistics on non-agricultural pesticide use are limited in The Netherlands, as in many other countries. This is partly because there are many types of uses and users of non-agricultural pesticides. Results of two studies (studies 1 and 2) that quantify non-agricultural pesticide use are discussed below.

2.1 Study 1

This study had two objectives. The first was to investigate the reduction of pesticide use in public areas and the second was to investigate the reduction of pesticide residue levels in non-target areas such as surface water. In 2002, the result of the national covenant on pesticide use in public areas was evaluated.[1] In the covenant, different public services (ie municipalities, provinces, railroad, water boards, etc) agreed to reduce herbicide use and emission. Parties involved were those responsible for the maintenance of urban greens, roads, waterways, nature, etc. The reference year was 1986. The parties succeeded very well in achieving the objective of reduction of pesticide use, as indicated in Table 1, which shows data produced by the CBS (Central Bureau for Statistics) on total use of pesticides by the parties in 1986 and 2001. A reduction of 69% was achieved, much greater than the target of 43%. More than 80% of the pesticides used in 2001 were herbicides, and 50% were applied on pavements (hard surfaces). The smallest reduction in pesticide use was in this application area. In 2001, the most-used herbicides were products based on glyphosate, MCPA or dichlobenil. The largest reduction in pesticide use

* Correspondence to: Corné Kempenaar, Plant Research International, PO Box 16, NL-6700 AA Wageningen, The Netherlands
E-mail: joop.spijker@wur.nl, corne.kempenaar@wur.nl

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Table 1. Non-agricultural pesticide use by governmental bodies in The Netherlands in the years 1986 and 2001[a]

	Pesticide use (% of Total)[b]	
Nature of area	1986	2001
Urban green	30	23
Pavements	23	50
Railways	16	15
Waters	13	0
Sports fields	6	9
Others	12	3

[a] Source: Central Bureau of Statistics (CBS) in Voorschoten, The Netherlands.
[b] Total usages (kg AI) were 127 000 and 40 000 kg in 1986 and 2001, respectively.

was achieved by water boards, who have stopped using herbicides to control vegetation in waterways and on water banks.

The agreed emission reduction (90%) was not achieved during the covenant phase. Scientists at Alterra and Riza (Institute for Inland Water Management and Waste Water Treatment) developed a method to estimate migration to surface water of pesticides which had been applied to differing target areas.[4] They concluded that in 2001 most of this material came from the pavements, a little more than 5000 kg AI on a total of less than 6000 kg AI from all public areas. Compared with 1986, the emission was reduced by 79%. The target was 90%.

2.2 Study 2

In 2001, a study was carried out by scientists of TNO Environment, Energy and Process Innovation and Plant Research International on pesticide use in the province of Utrecht (roughly 40 km by 40 km and 5% of the total area of The Netherlands). For the different water catchment areas in this province, agricultural and non-agricultural pesticide use was estimated as well as migration to surface and soil waters.[2] In the year 2000, the total use of pesticides in the province of Utrecht for agricultural and non-agricultural purposes amounted to 52.5 and 16.5 kg AI, respectively. Nearly 50% of the non-agricultural use involved ferrous sulphate to control mosses. However, the extent of pesticide use in non-agricultural situations (which represented some 24% of the total pesticide use) varied greatly between the different water catchment areas, being 2% in an area devoted largely to agriculture and 77% in very urban situations.

3 PREVENTIVE WEED CONTROL METHODS

In co-operation with Alterra, CROW (Information and technology centre for transport and infrastructure) published the Manual 'Examples for the design of weed-inhibiting pavements' in 1997.[5]

Areas with tiles or bricks easily become infested with weeds which grow easily in the many open spaces such as occur within joints and potholes. Many herbicides kill off existing above-ground weed growth but do not prevent re-growth or germination of dormant seeds. Thus, preventive weed control is desirable, and one way of achieving this would be to eliminate such open spaces.

The manual contains design examples. Six categories can be distinguished:

(1) edgings alongside roadways, cycle tracks and footpaths,
(2) small traffic islands,
(3) extended and average size traffic islands,
(4) holes for root systems of trees,
(5) footpaths,
(6) obstacles.

The manual shows photographs of problem situations and also design drawings and three-dimensional sketches representing possibilities for improvement.

4 NON-CHEMICAL WEED CONTROL METHODS

Non-chemical weed control methods are based on mechanical or thermal damage to the plants. The former methods involve brushing and mowing, and the latter burning and using hot water or steam.

Generally non-chemical techniques are less effective and more expensive than chemical methods using glyphosate.[6,7] Glyphosate kills the whole plant, while non-chemical techniques only kill the above-ground parts of the weeds. Consequently a non-chemical treatment has to be applied more frequently to be as effective as chemical methods.

In The Netherlands some research has been done on non-chemical methods. IMAG (Institute of Agricultural and Environmental Engineering) has investigated the potential of some non-chemical methods for weed control. Vermeulen *et al*.[6] came to the following conclusions: On flat pavements mechanical methods are preferred due to greater productivity and a lower energy input. Some ideas to improve the brushing method include: aggressively treading on the pavement (mid-frequently), brushing with small brushes aimed at the joints, and cutting plants by high-pressure spraying. On vulnerable pavements and unfastened pavements, however, thermal methods are the most promising. The greatest productivity is achieved by flame burning. On loose gravel pavements, sieving of the upper layer seems to be the most promising treatment.

Other research in The Netherlands was aimed at the measurement of the direct effects of the methods on weeds. They were carried out on small paved areas. Other experimentation had the goal of testing non-chemical methods by practical experience. These experiments were implemented on a larger scale, for example on the roads and sidewalks in a complete district of a city. The results of the two studies (study 3 and 4) are presented below.

4.1 Study 3

Weeds can be controlled by applying hot water to the plants. Recently, this relatively old method was revived and modern equipment was developed to be able to apply hot water to weeds in a cost-effective way. Table 2 shows results of the H_2O Hot Aqua Weeder® hot water technique tested on an experimental site in Wageningen in 2001.[8]

4.2 Study 4

In 2001 three non-chemical methods were compared in the city centre of Utrecht. Mowing, using hot water and foam, and brushing. Each method was applied three times (July, September and November). The methods were compared from a practical standpoint, so that results could be affected by factors controlling the applicability of the different methods, eg brushing and mowing are not possible near parked cars and lampposts, whereas hot water can be applied very well in such areas. Table 3 shows some results.[9]

At the beginning of the experiment (June 2001) all test areas had considerable weed coverage. Treatment with hot water gave significantly better results than brushing and mowing. The costs of the methods (in € m^{-2} $year^{-1}$) were 0.97 for using hot water, 0.57 for brushing and 0.65 for mowing.

5 HANDBOOK PHASING OUT HERBICIDES

There is already a lot of experience with non-chemical methods in The Netherlands. Many municipalities decided to ban the use of chemicals during the last two decades. In practice, however, they could not organise the non-chemical weed control successfully. There were problems with either the budget or the results.

Table 2. Performance of the H_2O Hot Aqua Weeder® hot water technique on a hard surface covered by weeds

Speed of application (km h^{-1})	Additional foam cover	Mean % of hard surface covered by weeds[a]		
		5 October 2001	17 October 2001	5 March 2002
5	No	14 a	17 a	35 a
5	Yes	6 b	8 b	35 a
7	No	13 a	19 a	41 a
7	Yes	6 b	9 b	32 a
Untreated	No	52	58	62

[a] Means per column are significantly different according to a statistical LSD-test ($P = 0, 95$) when followed by different letters.

Table 3. The performance of three non-chemical weed control methods when applied at different times[a]

Method	% Test plots[b] with only minimal weed cover when treatment was applied		
	July–October 2001[c]	December 2001[d]	April 2002[e]
Mowing	39 a	79 a	43 a
Hot water + foam	64 b	96 b	87 b
Brushing	49 a	74 a	63 c

[a] Means per column are significantly different according to a statistical LSD-test ($P = 0.95$) when followed by different letters.
[b] Treatment applied to 50–100 m^2 areas.
[c] During growing season.
[d] After growing season.
[e] Start of next growing season.

Citizens started to complain and some municipalities decided to change their policy and restarted the use of chemicals.

To help to overcome this problem a leaflet was created containing all the necessary ingredients for a successful and sustainable conversion.[10] This consisted of four parts, each of which is discussed below.

5.1 Initiative for conversion

First of all it is necessary to manage a conversion on a project base. This includes a formulation of the project targets, a sound organisation of the project by establishing a project team and leader and, last but not least, the allocation of sufficient resources. This phase is completed with the approval of the City Council.

5.2 Preparation

In the preparation phase an inventory of the current situation has to be made. This needs to be done previously in order that project targets may be set. The inventory should include the type and extent of the surface of the pavements and of the public gardens and sports fields, maintenance methods to be used, the extent of weed cover to be tolerated and any use of chemicals to be used. An example is in Table 4.

Next, the desired scenario has to be fixed. This can vary from no tolerance of any weed at all to a complete change of the type of area in that some pavements may be converted into grassed areas to avoid need for weed control. Pavements in shopping centres should always be free from weeds, while streets in industrial areas may have some weeds. Table 5 shows an example of a suitable scenario.

Table 4. Example of an inventory

Type of area	Surface (m^2)	Current aim of maintenance	Treatment(s)	Pesticides (kg AI)
Tiles	10 000	No weed at all	3 × sweeping 2 × spraying	1.5 glyphosate (RoundUp)
Small woodlands	2500	Plantation must succeed	First year 1× spreading granules; second year 1× hoeing the borders	0.4 kg dichlobenil (Casoron)

Table 5. Example of a desired scenario (main issues) for the period 2002–2005

	Public green	Pavements
Zoning	Outside the city: maintenance based on ecological principles	In 2002 pilots with different non-chemical methods of weed control
	Suburbs: mainly ground covering green	In 2003 evaluation and selection of methods
	City centre: representative green (intensively maintained)	
Reconstruction	Reconstruction of green in accordance with zoning principles	Removal of superfluous pavements
		Use of smart design techniques: Pavements with fewer joints. Location of the obstacles on the pavement, etc

From the inventory and the desired scenario the steps to be taken are described. These could be:

- converting pavement into grass
- preparation of 'closed' pavement, to avoid weed growth, once and for all
- removal of obstacles on the pavement, which prevented the use of alternative weed control, eg streetlights, traffic signs, etc
- zoning

In the guidelines a standard activity table is available containing all measures which can be taken (communication, set-up of a monitoring and reporting system).

5.3 Realisation (pilot project in one or two districts)

The realisation of the proposed project is a very demanding affair and requires efforts from both the municipality and its inhabitants. Therefore a pilot study involving one or two districts of the city should be considered.

5.4 Realisation in the entire municipality

After evaluation of the pilot projects, the project can be scaled up to the entire municipality.

6 AN INTEGRATED APPROACH

In 2000, a project was started in The Netherlands to develop and implement a system of integrated weed control on hard surfaces that uses herbicides only on places where their use would not cause adverse effects to the environment or to the costs of production of drinking water. In this large project, the Dutch association of drinking water producers (VEWIN), a water purification board (ZHEW), Monsanto Europe, different research institutes (coordination is done by Plant Research International) and several municipalities and contractors are working together. Herbicides are not prohibited in this approach, but are only used on places and at times when the risk of run off is below a mutually accepted level.[11]

Over the period 2002 to 2004 practical guidelines for this approach are being tested in more than 10 municipalities. Criteria tested are efficacy, run-off of herbicides, practicality and costs. The first results are promising. Herbicide concentrations in surface waters near test quarters were far below MTC values for glyphosate (MTC = maximum tolerable concentration). It took a little more effort to control the weeds in some test quarters because on some areas herbicides were not allowed to be used. Costs of weed control increased by *ca* 10% (preliminary estimate) but the level of control was always good. In one test quarter, extensive observations on herbicide run-off were made. The run-off factors for glyphosate were 5.6% and <1%, respectively following the spring and autumn weed-control rounds.

The aim of this project is to complete the guidelines for the integrated approach by the end of 2004. All information will be put into a decision support system on the internet. Also, a registration module is being developed. Details on the project can be found on www.dob-verhardingen.nl.

7 DISCUSSION AND FUTURE PERSPECTIVE

Herbicide use on hard surfaces has been a theme in The Netherlands since the 1970s when adverse side-effects of pesticides became evident. Since then, several policies have been implemented and actions undertaken to reduce pesticide use, emission and dependency in The Netherlands. In short, these policies and actions were aimed at stimulation of alternative control methods, reduction/prohibition of bad practices and early phasing-out of pesticides, which have a great effect on the environment. Though much has been achieved during the past 30 years, pesticide reduction plans are either still ongoing or being initiated in The Netherlands.

In this paper, a few studies and projects in the field of weed control on hard surfaces aimed at reduction of herbicide use and emission have been highlighted. These studies have contributed to the achievement of more sustainable management of hard surfaces. How sustainable management of hard surfaces in The Netherlands will be in the future is uncertain. Further reduction of herbicide emission is possible. Use of glyphosate is allowed on hard surfaces till 2012 by the pesticide registration authority in The Netherlands. However, if too much glyphosate (concentrations >MTC; or concentrations which complicate the extraction of drinking water from surface water) is detected in surface waters too often, the registration will be ended before 2012. However, some water boards indicate that they have found a legal basis to prohibit herbicide use on hard surfaces. This leads to

uncertainty, but, hopefully, the situation will be solved by a legal judgement. As long as glyphosate is allowed in The Netherlands, simple economic principles will determine how weed-control will be done in most cases. The use of glyphosate is much more cost-effective than non-chemical methods, so that managers of hard surfaces are tempted to apply glyphosate. The integrated approach described in this paper is of interest to these managers because it balances economy and ecology in relation to weed control on hard surfaces.

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