

Soilsteam SoilSaver 20™

Case Study

Demonstration Trial - Japanese Knotweed

Advanced Invasives

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A D V A N C E D I N V A S I V E S

Document

Interim Report: this document provides independent evaluation of Soilsteam SoilSaver 20™ process efficacy against Japanese Knotweed rhizomes under controlled field conditions.

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Advanced Invasives

Advanced Invasives is the leading invasive plant species consultancy in the UK.

We solve invasive plant species problems, with a specialist focus on Japanese Knotweed and the complex technical, legal and public relations challenges faced by governments, large landowners, private companies and global leaders in weed control technologies.

Based in South Wales, Advanced Invasives was founded in 2016 by Dr Dan Jones (PhD, MSc, BSc, MA, MEWI Cert) from Swansea University's Department of Biosciences out of a desire to set a new standard of evidence-led invasive species management.

We work across six key areas with our clients: expert witness, research & development (R&D), strategy, complex projects, continuing professional development (CPD) and expert guidance.

ai:LAB

Over a decade of academic research at ai:LAB supports our business offer, including the Taff's Well independent field research centre that was the largest of its kind, worldwide.

In 2023, in partnership with Swansea University and Complete Weed Control, we concluded a 12 year long field-trial on Japanese Knotweed control. The work is the most comprehensive undertaken in the world to date, benchmarking more than twenty of the main herbicide and integrated treatments used commercially.

The field-trial is fully supported by peer-reviewed academic papers, including '*Optimising Physiochemical Control of Japanese Knotweed*' and '*Assessing the relative impacts and economic costs of Japanese Knotweed management methods*'. This unique body of data gives us the capacity to truly redefine invasive plant management best practice and take the long-term view of invasive species problems. Our evidence-based, scientific approach helps our clients to manage invasive plant problems using less labour, lower doses of herbicide and less carbon across the whole treatment lifecycle - *we really can do a lot more with a lot less!*

1. Introduction

Japanese Knotweed (*Reynoutria japonica* var. *japonica*) is a large, robust and physiologically resilient species; in the native range growth in volcanic ash fields is subject to burial, exposure to toxic chemicals and frequent freezing (Bailey et al. in press). This resilience combined with a highly adaptable rhizomatous growth strategy allows recovery from most physical, chemical, and integrated control treatments. Importantly, as Knotweed mainly spreads through clonal plant dispersal (particularly in the UK non-native range), physical control treatments that damage and fragment the plant increase, rather than reduce, spread and dispersal (Jones et al. 2018).

In the UK Japanese Knotweed maintenance management guidance is now based on the large-scale and long-term field research work of Jones et al. (2018), while remediation is underpinned by practical principles formally stated in the UK Environment Agency (EA) guidance document The Knotweed Code of Practice: Managing Japanese Knotweed on Development Sites (2013), The Japanese Knotweed Manual (2000), and Child (1999) before this.

Effective Japanese Knotweed treatment approaches can be broadly divided into two categories:

1. **Maintenance management** - treatment with effective glyphosate-based herbicides to eliminate above ground growth on residential, commercial and development sites; also deployed at the landscape-scale due to cost-effectiveness. Undertaken to enhance environmental quality; treatment integration reduces control efficacy.
2. **Remediation approaches** - wider range of effective treatments aimed at reducing the risk of above and below ground growth (i.e., shoots and rhizome (root), respectively) principally on development sites due to higher costs. Undertaken to minimise the likelihood of growth damaging and/or interfering with the normal functions of installed structures; treatment integration does not reduce remediation efficacy.

In the UK maintenance management with glyphosate-based herbicides, dig with onsite burial/encapsulation and/or offsite disposal ('dig and dump') are the most common treatment approaches. However, pressure remains to improve treatment sustainability, particularly in the context of excavation approaches, as waste transport costs continue to rise and remaining landfill capacity declines.

There are a range of in situ thermal Invasive Knotweed treatments targeted at above ground parts of the plant to achieve rhizome depletion (e.g. flame, hot foam) and/or to disrupt and destroy below ground rhizome tissues (e.g. electrical) (Bailey et al. in press). Direct targeting of below ground parts of the plant has also been proposed using heating (soil sterilisation, microwave) and cooling (cryogenics) technologies to destroy rhizome tissues (Wigfall 2012, van Dijk and de Visser 2022, Słowiński et al. 2024). However, few of these thermal treatments have been tested against Knotweeds, and of those that have, experiments have been small scale pot or field trials i.e., testing results cannot be extrapolated to the field scale (Bailey et al. in press).

2. Methods & Results

2.1 Site: Cwmgwili Recycling Facility

Cwmgwili Recycling Facility is operated by Gavin Griffiths Group. Independent evaluation of Soilsteam SoilSaver 20™ process performance against the target species Japanese Knotweed (*Reynoutria japonica*) was performed in this location, using rhizomes (roots) sourced onsite. All equipment (i.e., Soilsteam SoilSaver 20™, excavators) was supplied by Gavin Griffiths Group and operated by appropriately accredited Gavin Griffiths Group staff under the supervision of Dr Dan Jones (Advanced Invasives).

2.2 Japanese Knotweed

Sample collection

Healthy, untreated Japanese Knotweed plants were extracted onsite by Advanced Invasives on 11/08/25; these had not been subject to any previous physical and/or chemical treatment(s). All extracted plants were stored overnight in 15 L plastic buckets to maintain plant vigour prior to treatment application.

Sample preparation

On 12/08/25, Japanese Knotweed plants were processed, with above ground parts of the plant removed from rhizome tissues. Suitable rhizome material of variable diameter (10 mm to 40 mm) was selected and cut to lengths of 50 mm (Figure 2.1). Each rhizome section possessed one or more rhizome buds (apical meristems) from which new stem growth could emerge. 80 rhizome sections were prepared in total; 40 for steam treatment and 40 for the untreated control.



Figure 2.1: Prepared rhizome sections of length c.50 mm (variable diameter: 10 mm to 40 mm), prior to treatment. Each rhizome section possessed one or more rhizome buds (apical meristems) from which new stem growth could emerge. 80 rhizome sections were prepared in total; 40 for steam treatment and 40 for the untreated control

2.3 Treatment testing

Pretreatment

Testing was conducted within 24 hrs of sample collection on 12/08/25. Approximately 10 tonnes of topsoil uncontaminated by Japanese Knotweed was sourced from nearby farmland for testing. All topsoil was processed through an ALLU screening bucket (50 mm) prior to treatment to remove oversized material (Bitarafan 2024).

Treatment

Equipment decontamination

Prior to treatment, the feed hopper of the Soilsteam SoilSaver 20™ was cleaned internally (physical decontamination). Decontamination was supplemented by processing 2.5 tonnes of

uncontaminated topsoil introduced into the feed hopper of the Soilsteam SoilSaver 20™ equipment using a Develon (formerly Doosan) DX235 23-tonne class crawler excavator (i.e., 'blank' run was performed).

Process start and finish times: 11:30am and 12:00pm, respectively.

Control treatment application

2.5 tonnes of uncontaminated topsoil was introduced into the feed hopper of the Soilsteam SoilSaver 20™ equipment using a Develon DX235 excavator and processed. Treated material was collected from the equipment in the bucket of a separate ('clean') Develon DX235 excavator and moved into position for treatment efficacy evaluation. Material was retained in a pile for 24 hrs post-treatment to permit further thermal treatment (i.e., residual heat), as per field operations.

Process start and finish times: 12:16pm and 12:46pm, respectively.

Steam treatment application

1.0 tonnes of uncontaminated topsoil was retained in a Develon DX235 excavator bucket, to which 40 rhizome sections were added. This material was then introduced into the feed hopper of the Soilsteam SoilSaver 20™ equipment using a Develon DX235 excavator; a further 1.5 tonnes of additional uncontaminated topsoil was subsequently introduced into the feed hopper, with all material then processed. Treated material was collected from the equipment in the bucket of a separate ('clean') Develon DX235 excavator and moved into position for treatment efficacy evaluation. Material was retained in a pile for 24 hrs post-treatment to permit further thermal treatment (i.e., residual heat), as per field operations.

Process start and finish times: 13:00pm and 13:30pm, respectively.

Material preparation to evaluate treatment efficacy

24 hrs after treatment on 13/08/25, control and steam treatment soil piles were flattened to a depth of 200 to 300 mm using a Develon DX235 excavator to promote Japanese Knotweed emergence (i.e., minimise emergence depth). 40 rhizome sections were planted in a grid across the prepared control treatment surface to a depth of 50 mm.

2.4 Results

No Japanese Knotweed rhizomes were identified growing in topsoil treated with steam 23 and 46 days after treatment (DAT) (Figures 2.3 & 2.5). In contrast, soil treated with steam and subsequently planted with 40 rhizome sections showed emergent growth 23 and 46 DAT (32 and 35 Knotweed plants, respectively; Figures 2.2 & 2.4).

Treatment evaluation (03/09/25) - 23 DAT



Figure 2.2: Untreated control 23 DAT (03/09/25). 32 Japanese Knotweed plants are emergent.



Figure 2.3: Steam treatment 23 DAT (03/09/25). No emergent Japanese Knotweed growth.

Treatment evaluation (26/09/25) - 46 DAT



Figure 2.4: Untreated control 46 DAT (26/09/25). 35 Japanese Knotweed plants are emergent.



Figure 2.5: Steam treatment 46 DAT (26/09/25). No emergent Japanese Knotweed growth.

3. Discussion

The present research demonstrates the efficacy of the Soilsteam SoilSaver 20™ for the ex situ treatment of Japanese Knotweed rhizomes in contaminated bulk soil. These results reflect the work of Bitarafan et al. (2021), who successfully treated Bohemian Knotweed (*R. × bohemica*) rhizomes using the Soilsteam SoilSaver 20™. Historically, thermal Knotweed treatments have failed to remediate below ground parts of the Knotweed plant as thermal energy is dissipated within the plant and/or the soil. In contrast, remediation efficacy using the Soilsteam SoilSaver 20™ approach is improved through extraction of contaminated material, allowing direct thermal treatment of rhizomes (i.e., these are killed).

This case study has important practical significance as current Invasive Knotweed remediation treatment approaches (particularly offsite disposal; ‘dig and dump’) are expensive, and incur significant negative environmental impacts (not least, high carbon dioxide (CO₂) emissions). Ex situ soil steaming may therefore provide a more sustainable Knotweed remediation approach particularly on development and infrastructure sites across the UK. Further research should evaluate both the efficacy and environmental burdens associated with this treatment approach under field-relevant conditions (i.e., at larger scale).

4. Sources Cited

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