Product Manual_V02

RootWave F601 Electrical Weeder





Read and follow all instructions and safety precautions in this product manual. Failure to do so may invalidate the warranty.
Keep this product manual for reference - do not throw it away

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Reference

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Designation

RootWave F601 Electrical Weeder

Copyright

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Safety information

This product manual tells you how to use the RootWave F601 eWeeder safely. Ensure that you comply with all relevant local health and safety policy and legislation when you are using RootWave F601. The following symbols are relevant to the machine:



- Indicates a dangerous voltage. Take care to avoid contact with electricity.



- Read and understand this manual.



- Maintain a safe distance



- Risk of hand crush



- Potential danger when the rotating shaft is in use



- Only trained and qualified operators can use this machine.



- Indicates the risk of a strong magnetic field. Do not operate the machine if you have or wear an electronic medical device.



- Indicates a risk of fire.



- This machine can only be serviced by authorised service personnel. Do not modify the machine.

Description

RootWave F601 Electrical Weeder ("the Machine") is a tractor implement for weeding along rows of permanent tree, vine and bush crops. It uses electricity in combination with the natural physical resistance of weeds ("eWeeding") to boil and kill them above and below the surface of the ground. High Voltages ("HV") are used to push enough energy into the weeds to result in weed kill whilst travelling at a suitable speed.

Overview

Parts

1. Power Take Off ("PTO") shaft
2. Headstock
3. Jockey wheel
4. Hydraulics hoses (see Fig. 2 & 3 for hydraulic block and hose stowage)
5. Bogey wheels
6. Boom width limiter (Fig. 1 & 6)
7. Storage box
8. Crop protection fuse
9. Isolator Switches



Figure 1. F601 Parts location

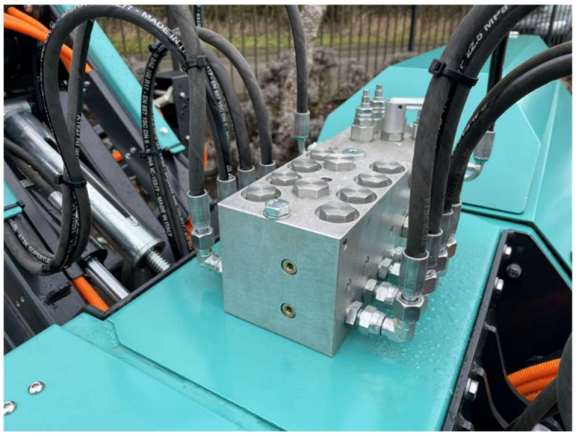


Figure 2. Hydraulic block



Figure 3. Hydraulic hose stowage when machine in storage

Human Machine Interface (“HMI”) Control Screen

1. Emergency Stop
2. Touch screen
3. Insulation breakdown warning light
4. HV power button (illuminates when HV is live)



Figure 4. Human Machine Interface (“HMI”) Control Screen

Intended use

The F601 Machine is intended to be used as tractor implement for weeding along rows of permanent tree, vine and bush crops with row widths between 1.8 metres (“m”) and 4.5 m wide.

To ensure sufficient power and efficacy, the Machine should be used with a tractor output greater than 75 Horsepower (56,000 Watts (“W”)) on its PTO.

It is recommended that the tractor has an enabled PTO seat switch; if the tractor does not have one fitted, it is recommended that one is fitted, or a suitable operational process is implemented to ensure user safety.

The Machine should only be used when the tractor is moving forward up to a maximum speed of four kph.

The Machine can be used in a range of weather conditions including strong winds; however, it should not be used when raining and when the surface of the ground is wet enough to leave a tyre imprint.

The Machine should not be used for any purpose other than designed.

Specifications

Row Width range: 1.8 m – 4.5 m

Treatment Width range: 0.4 m – 0.65 m

Power: 0 – 60,000 W

Technology: v 5.4

Training

Operators are required to have completed training on the RootWave F601 Electrical Weeder before using the Machine.

Operators should have completed the necessary training for operating tractors and be competent with using farm machinery.

Instructions

Start-up

The machine should only be set-up by trained operators and those competent in the use of farm machinery.

Assembly

Follow the below instructions:

1. Attach Headstock of Machine to tractor link arms, remove jockey wheel and relocate to stowage bracket.
2. Attach PTO shaft to Machine and tractor ensuring the PTO guard and chains are correctly attached. This is not specific to the Machine and only operators who have completed PTO training should perform this. Always ensure tractor engine is turned off when connecting and removing PTO shaft.
3. Attach HMI Control Screen inside the tractor cab.
4. Plug in HMI Control Screen power cable to 3-pin 12V supply socket in tractor cab.
5. Attach control and power cables from the Machine to HMI Control Screen.
6. Attach Maypole 7-pin connector cable for rear combination lights for road use.
7. Attach hydraulic hoses from Machine to hydraulic couplers on the rear of the tractor.
8. Adjust the electrode arms and arrays to ensure optimal height and width coverage.
9. Check operation of hydraulics and make adjustments if necessary.



Figure 5. Jockey wheel re-located to stowage bracket when treating



Figure 6. Row width limiter barrel

Adjustments

When adjusting electrode arms width limiters, the tractor engine should be off and the hydraulic lock-off values engaged to avoid accidental hydraulic system operation.

Adjusting boom width of the electrode arms:

With the booms in transport position and the hydraulic lock-off valves engaged, set the width limiters (Fig 6.) to the desired width. To achieve the desired row width turn the row-width limiter barrels clockwise to reduce width and counterclockwise to extend width stopping when lined-up with the corresponding 'width' setting mark on the barrel. The width setting should achieve a 5 - 10 cm overlap at the base of tree trunk/vine on both rows when the booms are extended.

Adjusting height of electrode arrays:

The height of the electrode arrays is managed by adjusting the height of the bogey wheel(s). To set the electrodes at the appropriate height for treatment adjust height so the underside of the electrode frame array is 10 – 15 cm above the surface of the ground. If application is on particularly uneven ground, it may be necessary to increase the height of the electrodes, care should be taken to ensure that a minimum of 10 cm of each electrode remains in contact with the surface of the ground during treatment.

Use

Safety signage

Before use, please check suitable safety signage is present in the safety sign storage box (Fig. 7) and ready for operation. The operator should deploy HV warning signs if the treatment area is accessible by the public and to make other farmer workers aware that eWeeding is in operation

1. HV safety signs (located in cabinet on top of machine).
2. Isolator Switches

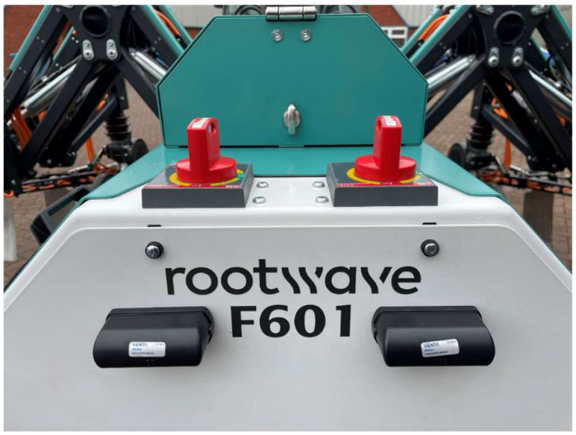


Figure 7. Safety sign storage box



Figure 8. Isolator switches in 'ON' position

The machine should only be used by trained operators and those competent in driving a tractor and using general farming machinery.

When the machine has been attached to the tractor and with the width and treatment arms adjusted the operator can proceed with the machine to the orchard/vineyard ready for application. The operator should:

1. Line-up the machine to the first row and travel forward ensuring all electrodes have passed beyond metal ground anchors and the anchored tensioning wire. Lower the electrode arrays into position checking for suitable tree/vine overlap of 5 – 10 cm.
2. Check surrounding environment ensuring there is a clear passage ahead for application, noting any bystanders and hazards.
3. Unlock and remove padlocks from isolator switches and turn to 'ON' position.
4. Check emergency stop on HMI Control Screen is disengaged.
5. Press and hold reset button on HMI Control Screen.
6. Select and turn required modules to ON position on the HMI Control Screen.
7. Set overall power required on the slider.
8. Turn PTO on and set to 540 rpm, checking correct rpm output on the HMI Control Screen. Do not use 540E as may cause the tractor to stall during application.
9. Select tractor gear ratio to achieve target speed according to conditions.
10. Travel forward and whilst simultaneously pressing HV button once to start treating (when HV is live the HV button will be illuminated). The amber beacon lights on the machine will illuminate and flash when HV is live.
11. Treat row.

When the Operator has completed treatment of the first row:

1. At the end of the row press HV button once to Turn HV off, the button light and flashing beacons on the machine will also turn off.
2. Exit row and raise bogey wheels off the ground (if necessary, retract boom).
3. Make turn and line-up for next row, extend boom and lower into place.
4. Check surrounding environment noting any bystanders and hazards.
5. Travel forward ensuring all electrodes have passed beyond metal ground anchors and the anchored tensioning wire and once passed pressing the HV button once to turn HV on.

Turn machine off and detachment:

1. Turn HV off.
2. Turn PTO off.
3. Raise and retract the electrode boom.
4. Stow the electrode arrays in transport position.
5. Park somewhere safe.
6. Detach hydraulic hoses, power and control cables, HMI Control Screen and PTO shaft.
7. Attach jockey wheel to underside of machine drawbar, lower and detach headstock.
8. Apply jockey wheel brake and use the supplied chocks to prevent machine free-wheeling whilst in storage.

PTO RPM

The operator can set the PTO RPM anywhere between 380 and 590. In that range the machine will generate the voltage necessary to work. Optimal RPM will depend on the characteristics of the tractor, power generated and fuel efficiency the operator wants to reach.

Treatment schedule

The number and speed of initial treatments will depend on weed density and size. The below table (Fig. 9) is a guide for the initial treatment schedule to get to be able to move to a maintenance situation of an average of 3 eWeeding treatments per year.

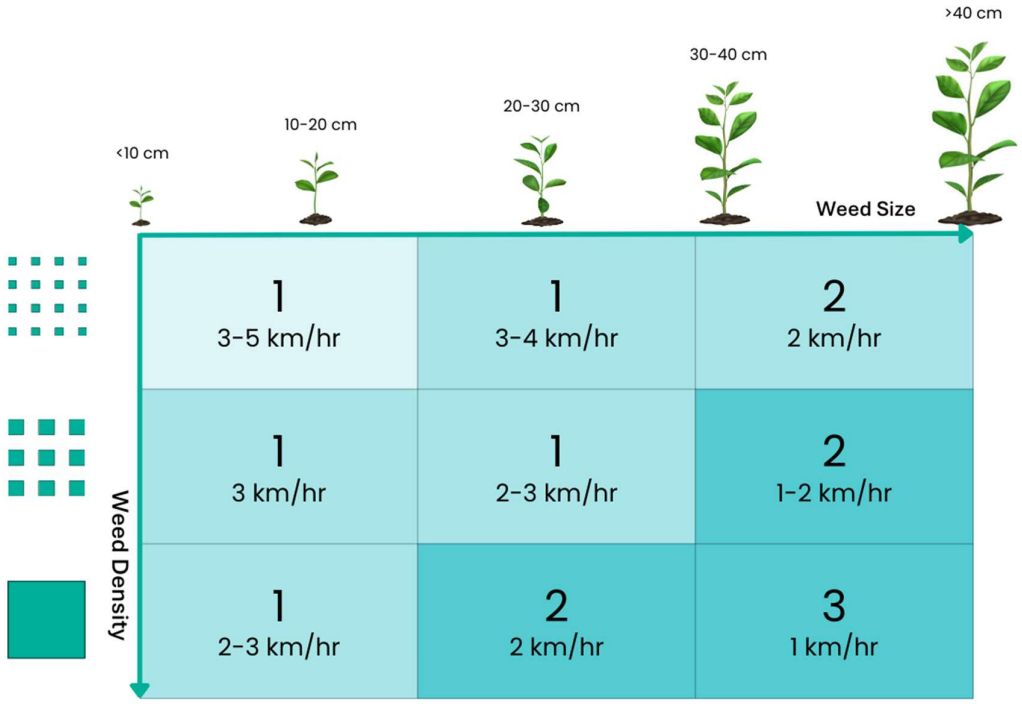


Figure 9. Initial treatment schedule based on weed density and size

Treatment schedule is based on RootWave experience from small plot field trials in UK conditions. The actual number and speed of initial treatments may differ slightly according to site specific scenario and grower requirements.

Recommendations

Treatment efficacy is optimal when the Machine is used when weeds are actively growing in dry topsoil. Weeds should be less than 20 cm tall and free from tree/vine pruning's and grass cuttings.

If practice is to apply a mulch in the treatment area the mulch should be applied soon after the eWeeding application is made during the weeding season.

Some weeds including clumps of perennial nettles, thistles and docks and plants with rhizome roots will require more power or contact time compared to smaller, succulent weeds. To increase contact time the operator can simply reduce the forward speed when treating.

It is not recommended to use the machine in wet conditions.

It is not recommended to use the machine in exceptionally dry or arid conditions as this can increase the likelihood of causing a fire.

Emergency procedures

The emergency stop allows the operator to shut-off high voltage power immediately. When the emergency stop is activated the PTO should then be disengaged, the tractor turned off and parked. The operator should then check the machine and tractor do not pose a hazard and ensure all bystanders are safe. The operator should then deal with the emergency at hand, including calling the emergency services if required.

Safety gear

Operators should regularly ensure all safety gear is in good working condition.

Maintenance

When performing maintenance to the machine, the machine should be fully detached from the tractor with the hydraulic locking valves engaged. Apply jockey wheel brake and use the supplied chocks to prevent machine free-wheeling whilst in storage.

Checks

The operator should perform the following checks before using the Machine:

1. Electrode arrays in good working order, clean and free of debris.
2. Headstock, PTO shaft and hydraulic hoses are in good working order.
3. Power and control cable connectors are in good working order checking that all connections are not loose and are free from excessive wear.
4. Fire extinguisher present and usable.
5. Warning signs present and usable.

Cleaning

The Machine should be cleaned with a pressure washer regularly to avoid the build-up of dust, dirt and debris on the electrode arrays and insulators.

Mechanical maintenance

When not under direct supervision of RootWave trained engineers operators and farm technicians should only perform maintenance on the following parts:

1. Gear box oil service - check oil level (Fig. 10.) daily.
2. Grease points – grease regularly.
3. Hydraulic hoses and rams.
4. Electrode(s) replacement – as necessary.
5. Electrode flap replacement – as necessary.
6. Wheels and tyres.
7. Rear combination lights for road use.

Operators and farm technicians must not perform maintenance on any part relating to the power enclosure and HV system, including the HV cables. These parts have a tamper seal, which, if broken, may invalidate any warranty supplied with the machine.



Figure 10. Oil level indicator on gear box



Figure 11. Ceramic crop protection fuse

Cables

Operators and farm technicians should regularly check the cables to ensure they are not compromised or have excessive wear. After storage check cables for rodent damage.

Crop Protection Fuses

The F601 has been to designed to be sympathetic to orchard/vineyard infra-structure and crops, however there may be scenarios e.g. loose trellis wire, mis-placed tutor post, and large rabbit hole which result in the electrode array becoming snagged. RootWave uses ceramic insulators as crop protection fuses in case of snagging, this is to ensure that an inexpensive and easily changeable part breaks before damage is caused to the crop and/or infrastructure.

Electrode Arrays

RootWave has different electrode arrays that can be interchanged for use in different crops.

Consumables

The following parts are seen as consumables and will require changing from time to time

1. Electrodes (Fig. 12).
2. Electrode Flaps (Fig. 13).



Figure12. Electrodes



Figure 13. Electrode flaps

Servicing

The Machine should be serviced annually by a RootWave trained technician.

Transport, handling, storage

Transport

Before transporting the machine, the HV and PTO must be off, the electrode arms fully retracted, and the electrode arrays stowed and locked into their transport position.

The Machine has been certified for road-use and can be driven between fields and sites. For longer trips, it is advised it is transported a on suitable low-loader trailer or flatbed lorry ensuring that it is tied down correctly.

Storage

For long-term storage e.g. during winter, store machine inside, implementing protection to minimise risk of damage caused by rodents.

Assessing risk

Direct contact with electricity can cause physical harm or death. Observe all safety precautions provided in this manual while operating, maintaining and servicing this machine.

Ventricular Fibrillation, Respiratory Arrest and Burns from touching machine

Scientific literature suggests that 63,000 W of power is required to cause ventricular fibrillation when operating at 18,000 Hertz ("Hz") alternating current ("AC") opposed to 28 W at direct current ("DC") and 6 W at 50 Hz AC. RootWave have managed this risk by operating the Machine at 18,000 Hz with each electrode limited to 10,000 W of power, below the threshold of 63,000 W.

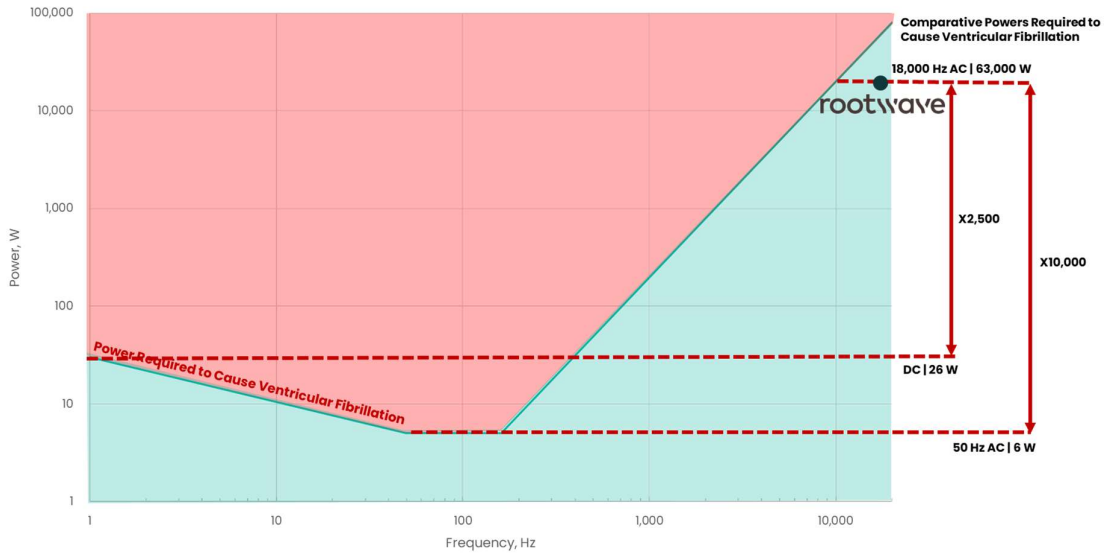


Figure 14. Ventricular fibrillation risk

- Respiratory arrest may occur following extended direct physical contact to high voltage.
- Skin may be damaged if contact is made with the electrodes.

>> Operators and bystanders must not touch or approach the machine and its electrodes when HV is live (flashing amber beacons) and the Machine operational.

>> Operators must turn the PTO and HV off before they leave the tractor cab or when a bystander approaches the machine.

>> Bystanders should stand far enough away such that they would not touch the machine if they accidently fell over with their arms outstretched.

>> Any maintenance to the HV system must only be performed by RootWave technicians or RootWave authorised engineers.

Metal infrastructure

During treatment, the electrodes are likely to touch conductive infrastructure, i.e. metal posts and wires, along the rows of crops. Energy will be transferred to the infrastructure. Metal post infrastructure is often bonded together and regularly earthed meaning the voltage is unlikely to raise above dangerous thresholds. If the conductive infrastructure is not earthed, then contact could cause ventricular fibrillation, respiratory arrest and burns.

>> Bystanders should avoid touching any metal infrastructure along the rows the machine is treating.



Figure 15. Metal infrastructure in vineyard



Figure 16. Metal infrastructure in orchard

Combustible material

Electrical arcs can be formed when there is a physical gap between the electrode and the weed and/or ground. If arcs occur in the vicinity of sufficiently dry and combustible material a fire can occur. RootWave has mitigated this risk using its anti-arcing pulsing technology. However, a risk remains in the height of summer where there is excess dry and combustible material.

>> The default mode of the machine is pulsing mode, if the Operator deems that the risk of causing a fire is negligible they can choose to use continuous mode.

>> The Machine should not be used after grass mowing during a period of hot, dry weather or if there is excess dry and combustible material present in the treatment area e.g. under the vine row and under tree-row

>> Operators should be extra vigilant when using the Machine in very dry conditions.

>> A suitable dry powder fire extinguisher should fitted in the tractor cab and be easily accessible. The dry powder extinguisher should be suitable for:

- *5A - solid materials such as paper, wood, cardboard, plastics*
- *34B - flammable liquids or liquefiable solids such as paint, oil, wax*
- *C - flammable gases such as natural gas, LPG*
- *fires involving electrical equipment*

Implantable medical devices

In tests the Machine has not caused interference with any surrounding electrical equipment, including radios, mobile phones and tractors. The risk of the RootWave F601 Machine causing interference to implantable medical devices is therefore anecdotally low. However, this has not been measured in a test chamber and therefore it is advised for operators and bystanders to be extra cautious.

>> *Until it can be scientifically qualified, operators and bystanders who have an implantable medical device such as a pacemaker must not be near the Machine when it is operational*.

Mechanical

As with other agricultural machinery the Machine when attached to a tractor has the potential to cause significant harm to a person if it physically contacts a person when moving or manoeuvring.

>> *Operators should be aware of bystanders and their surroundings when using the machine and manoeuvre the Machine appropriately*.

>> *Bystanders should make themselves clearly visible to the operator and be aware of the tractor and Machine. Bystanders should be aware of potential blind spots and position themselves appropriately at a safe distance*.