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Washing root crops

Influence of the soil on loosening and cleaning factors

Effort required in washing root vegetables and potatoes relates to the adhesive qualities of the soil particles between one another and between soil and vegetable surface. Investigations were carried out on the dissolution characteristics of soil pellets in a water bath and under the action of water sprays to identify relationships between washing effort required and soil composition. The time required for complete dissolution of the pellets (dissolving period) was influenced by the spectrum of soil particle size, the soil moisture content during formation of the pellets, the moisture content of the pellets before washing, water pressure and the volume of water used.

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Keywords

Root crops, carrot, potato, washing, washer, soil composition

Root vegetables are mainly marketed as washed. To achieve a gentle, quick and thorough cleaning with the help of washing machines, the machine parameters must be matched to the degree of dirtiness. For this, the interaction between machine, dissolving agent water and adhering dirt must be known.

The cohesion between soil particles and the adhesion between these and the vegetable material to be cleaned both have influence on the efficacy of the cleaning process. Cohesion and adhesion depend on the type of soil and its condition [1].

Investigations on the washing of salad crops in the field underlined the relationship of nozzle design, water pressure, distance between nozzle and product and the kinetic energy of the water droplets [2, 3]. With increasing kinetic energy the cleaning effect improved. After passing a product-related kinetic energy threshold value, a product would be damaged [2, 3].

Because the interactions involved are extraordinarily diverse, experimental investigations were carried out on the dissolving by water action of soil probes from different origins.

Trial methods

For the experimental investigations, soil pellets (Ø 28.5 mm; length 6.5 mm) from soil with different granule structures and with varying moisture contents were produced. The soil pellets were dissolved in still water at differing temperatures (water bath) or under a water jet (*Fig. 1*) at constant temperature and with various nozzles. The time up to complete dissolution of the pellets was measured. The dissolution took place

- directly after production, moistened with appropriate water addition
- dried and stored dry (residual moisture around 0.4%)
- dried and re-moistened through immersion (60 s) and different treatment times (2 to 120 min, 20 h) in steam-saturated air
- dried and re-moistened through sprinkling of water (3.7 to 16 weight %) and 24 hour storage at a relative air moisture content of nearly 100%.

Dissolving of pellets in still water

The time until complete disintegration of soil pellets (dissolution period) depended decisively on soil type. The higher the proportion of sand, the faster the pellet disintegration (*Fig. 2*). The given wetness represents threshold values at which soil pellets are just able to be formed. A higher water content in the production of the pellets, and also higher water temperatures, lead to reduced dissolution periods [4].

The investigations into the dissolving of moist pellets of silty-loam sand showed that freshly produced and still elastic pellets, as well as those that had been re-moistened after initial drying, generally required considerably less dissolution times compared with dry pellets (*Fig. 3*). This meant that remoistening represented a focal point of trials in the continued investigations into dissolving dirt under wash nozzles.

Dissolving under a water jet

Investigations with the conical nozzles TG-0.7, TG-2 and TG-35 demonstrated that intensification of water action through jetting can considerably reduce the required washing time. The nozzle with the highest water throughput, TG-3.5 (throughflow 3 l/min at 5 bar) led, as expected, to the shortest dissolution period.

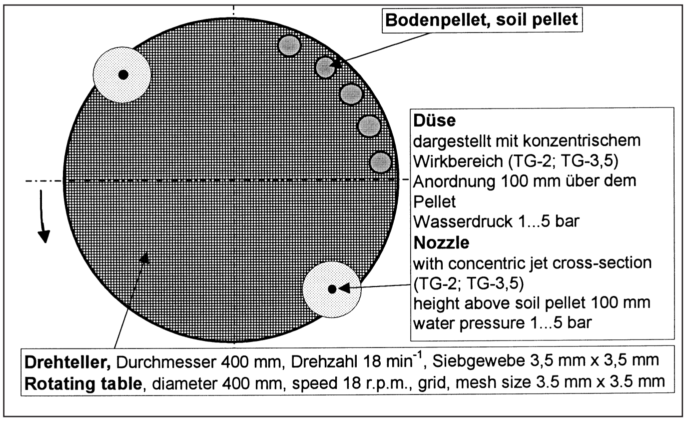
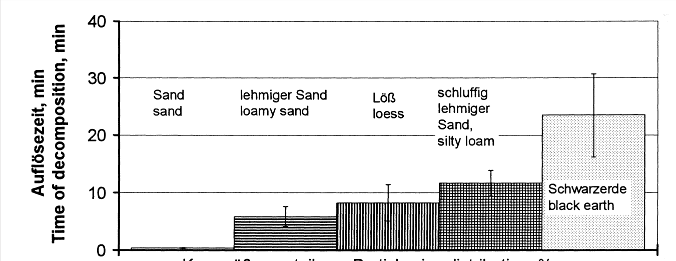


Fig. 1: Test equipment for dissolving soil pellets by spraying nozzles



≥63...<2000 µm	85	71	38	53	38
≥6,3...<63 µm	10	24	53	41	49
<6,3 µm	5	5	9	6	13
Feuchtegehalt vor dem Trocknen, Moisture content (w.b.) before drying, %	13,0	13,0	17,0	16,7	18,7

Fig. 2: Dissolving time of dried soil pellets in silent water (t = 15 °C)

Dried soil pellets from silty-loam sand which had been re-moistened 24 h before the dissolving trials were particularly difficult to dissolve when they had a moisture content of between 12 and 14% (*Fig. 4*). The result agreed with the findings regarding water bath dissolution. The dissolution period decreases in-line with increasing water pressure (Fig. 4).

The occasional practice of softening the dirt shortly before washing was simulated in that the soil pellets were dipped for 60 s in water and subsequently stored for a time. After storage times of up to two hours pellet cores were still dry and the dissolution period only very slightly less than with completely dry pellets. Storage times of 20 h in almost saturated air led to soaked-through pellets and notably higher dissolution speeds. The average moisture content of the soaked pellets was 9.3 ± 1.1%.

Conclusion

Root vegetables grown on sandy soil are relatively easy to wash. With an increasing content of fine particles in soil, the difficulties increase. For this reason it is important for the manufacturers of washing machines to know the properties of the regional root crop growing soils. Soil pellets can serve in the investigation of cleaning efficiency where, according to a still-to-standardise system, they are dissolved either only in a water bath or under a nozzle on a simple test station. The choice of washing machine and equipment should be made according to what is most suitable for the most difficult soil conditions to be met.

For soil that is difficult to wash-off, washing machines should be used that treat the product with water jets for at least a part of the operation [5]. The water jet that makes contact with the product surface must have enough energy to loosen the dirt, must not, however, damage the product.

The short-time softening led to no notable reduction in cleaning time. When, however, there is time and room for longer periods of soaking (> 60 s) and softening available, so that final wetness exceeds the critical point, such softening can shorten washing time in the machine. The time required for soaking and softening depends on the thickness of the dirt layer and its moisture content.

Washing with warm water considerably reduced the washing time. On energy grounds, this method is only practical when the warm water is available as a by-product from other technological processes [5].

The investigations up until now have produced important directives towards achieving a potentially efficient cleaning operation with the help of washing nozzles. The results are not enough, however, to give concrete guidance for particular cases regarding the choice and positioning of suitable nozzles inside the machine. Continuing investigations should have as centrepoint the connections between the contact pressure of the water jet on the surface of the product and the dissolution period with tactile foil sensors for measurement [6]. Conclusions should include statements about cleaning efficiency in relation to water jet contact pressure and specific amount of water used, independent of nozzles utilised.

Literature

Books are signified with •

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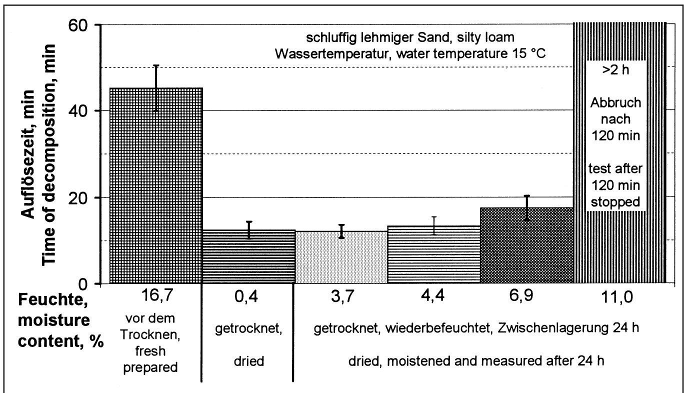

Fig. 3: Dissolving time of silty-loam sand pellets in silent water depending on moisture content

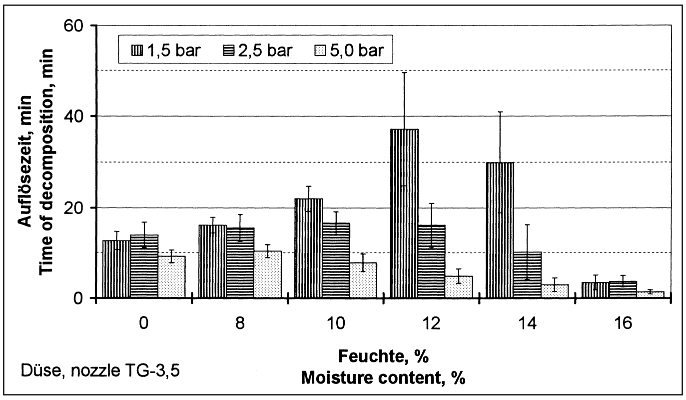

Fig. 4: Dissolving time of soil pellets under a water jet depending on moisture content and water pressure (nozzle TG-3,5)