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# Analysis Of The Total Operating Time Of The DJI Agras T30 Drone In Field Treatment

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**Abstract:** This article examines the efficiency of a fine dispersion of fertilizer across agricultural lands technology by means of aircrafts. As a solution to this problem, the use of ultralight aircraft such as drones is considered appropriate.

Recently, according to conducted various field studies, air drones spraying has become an innovative approach. Particularly, the main research object of this article is to analyz the technical capabilities of the DJI Agras T30 drone and to consider the total time it spends treating a field. The impact of agrotechnical necessities on flight performance, in other words the increase of used spray volume and flight time, is also calculated in this paper.

The analysis of the calculation results shows that the actual shape of the field (its edges and corners), speed of wind, and flight directions can significantly affect the flight time. Therefore, to ensure that theoretical calculations more accurately reflect real-world conditions, it is recommended to introduce a correction coefficient into the formulas.

**Keywords:** DJI Agras T30 drone, main working time, auxiliary time, additional time, flight time, working speed, tank volume, application rate, battery replacement (or charging) time, solution refilling time, navigation (or programming) time, correction coefficient.

## Introduction

An efficient air drone fertilizer spraying requires reasonable flight performance. The manner of this performance greatly depends on such parameters as technical flight characteristics of the drone, weather conditions, landscape, physical and chemical properties of spray as well as agrotechnical necessities of the crop.

For instance, an efficient drone carries 400 liters of payload and spreads 3-4 liters of spray per hectare at low altitude across 1 square kilometer farming land.

Unfortunately, modern devices mounted on airplanes and helicopters cannot perform a required fine dispersion of spray. Moreover, the high speed of the airplanes and the great air pressure of rotating helicopter blades do not allow flights at low altitude and spray the fertilizer properly. Therefore, airplanes and helicopters have to perform flights at higher altitudes and spray more fertilizer per hectare. But the more fertilizer spraying requires the greater number of flights performed, which leads to greater expenses in terms of machine wear and decrease of aircraft flying resources. Ultimately, all these factors increase cost of flights.

As a conclusion, it is clear that a fine dispersion of spray is much more efficient than the spreading a fertilizer by means of an aircraft. Moreover, a fine dispersion spraying has to be performed by a light-weight air drone. For example, DJI Agras T30 quadcopter can spray 30 liters of spray across 3 hectares of land in one flight (7-12 minutes).

To substantiate this conclusion, let us analyze the technical capabilities of the DJI Agras T30 drone.

**Main Technical Specifications of the DJI Agras T30 Drone**

| Parameter | Value |
|---|---|
| Working speed | 4–7 m/s |
| Flight time (full load) | 15–20 minutes |
| Tank capacity | 30 liters |
| Spray rate | 10 L/ha; 15 L/ha; 20 L/ha; |
| Area covered per tank | ≈3 ha |
| Battery charging time | 10–15 minutes (with turbo charger) |
| Operational efficiency | 12–16 ha/hour (average 15 ha/hour) |

### Total Working Time of the Drone

The total operational time of the drone (Ttotal) consists of several stages. Accurately calculating this time is important for evaluating work efficiency and economic indicators. It typically includes:

**1. Main Working Time**

Flight time – the drone’s time in the air along a predetermined route and back.

Spraying time – the period during which the working fluid (fertilizer, herbicide, insecticide, etc.) is dispersed.

**2. Auxiliary Time**

Battery replacement/recharging time – when the battery runs out, it must be replaced or recharged.

Tank refilling time – time to refill the drone’s spraying tank.

Takeoff and landing time – time for ascent and descent for each flight.

**3. Additional Time**

Transport and setup time – bringing the drone to the work site.

Navigation/programming time – setting up the GPS route.

Technical preparation time – inspection, calibration, and safety checks.

Thus, the total working time can be expressed as:

$$T_{\text{total}} = T_{\text{main}} + T_{\text{auxiliary}} + T_{\text{additional}}$$

Expanded form:

$$T_{total} = T_{takeoff/landing} + T_{flight(spray)} + T_{battery} + T_{tank} + T_{navigation} + T_{transport} + T_{preparation} + T_{breaks} + T_{controlflights}$$

Now we will perform calculations for the DJI Agras T30 drone using exact figures. However, in real conditions (due to wind, field shape, flight speed, etc.) these values may vary.

**Algorithm for Calculating the Total Working Time of a Drone**

Given Parameters for Calculation

Vb = 30 L (tank capacity)

q = 10,15,20 L/ha (spray rate)

S = 10 ha (treated area)

t = 15 min (one full battery charge)

$T_{flight(spray)}$ = 4 min/ha. Flight time required for spraying one hectare

$T_{takeoff/landing}$ = 1.5 min. Takeoff and landing time for each flight

$T_{battery}$ = 3 min. Battery replacement time

$T_{tank}$ = 5 min. Refilling time (tank refilling time)

$T_{navigation}$ - Time for setting the flight path via GPS and entering the route (approximately 2–3 minutes)

$T_{preparation}$ - Technical inspection and calibration time for each flight (approximately 1.5 minutes)

$T_{transport}$ - transporting the drone and positioning it at the flight site

$T_{breaks}$ - interruptions due to safety restrictions or wind conditions

$T_{control\ flights}$ – control flights and data recording.

**Calculation**. In accordance with agrotechnical requirements, we will calculate the total processing time for three different spray rates:

**A) For *q* = 10 L/ha;**

<u>*Main working time:*</u> $T_{main} = T_{takeoff\text{-}landing} + T_{flight}(T_{spraying})$;

$T_{spraying}$ – this is the time during which the drone is directly flying over the field to spray agrochemical substances (fertilizers, herbicides, insecticides, etc.). For takeoff and landing, we assume $T_{takeoff\text{-}landing}$=1.5 minutes.

The spraying time is calculated using the following formula:

The spraying time is calculated using the following formula: $T_{spraying} = \frac{S_{total}}{Q_{drone}}$ ; Drone efficiency: $Q_{drone}$=15 ha/h or 0.25 ha/min.

With one full charge, $S_1 = Q_{drone} \times t = 0.25 \times 15 = 3.75$ ha can be treated.

So, to cover an area of 10 hectares:

$S_{total}/S_1 = 10/3.75 = 2,667 \approx 3$ battery changes

end $(S_{total} \cdot q)/V_b = (10 \cdot 10)/30 = 3.333 \approx 4$ it will be necessary to refill the tank.

The main time is calculated as follows: $T_{main} = 3 \cdot 1,5 + (10/0,25) = 44,5$ minutes.

<u>Auxiliary time:</u> $T_{aux} = T_{battery} + T_{tank} + T_{navigation}$

this is the time spent on auxiliary operations performed after each cycle: replacing the battery, refilling the tank (30 L), preparing for takeoff and landing, and returning to the position. Calculation procedure:

$$T_{aux} = 3 \times T_{battery} + 4 \times T_{tank} + T_{navigation} = 3 \times 3 + 4 \times 5 + 3 \times 2 = 35 \text{ minutes.}$$

<u>Additional time (≈10-15% of main):</u>

$T_{add} = 0,1 \times 44,5 = 4,45 \approx 5$ min.

<u>Total time.</u>

In that case, the total time required to treat 10 hectares of land using the DJI Agras T30 drone:

$T_{total} = T_{main} + T_{aux} + T_{add} = 44,5 + 35 + 5 = 84,5 \approx$ 85 minutes (Approx 1 h 25 min).

**B) For q = 15 L/ha;**

When the liquid consumption is q = 15 liters per hectare, the drone's tank needs to be refilled $(S_{total} \times q)/V_b = (10 \cdot 15)/30 = 5$ times.

The main time remains unchanged: $T_{main} = T_{takeoff\text{-}landing} + T_{flight}(T_{spraying})$;

$T_{main} = 3 \times 1,5 + (10/0,25) = 44,5$ minutes.

<u>Auxiliary time:</u> $T_{aux} = T_{battery} + T_{tank} + T_{navigation}$

Calculation procedure: $T_{aux} = 3 \times 3 + 5 \times 5 + 3 \times 2 = 40$ minutes.

<u>Additional time ( ≈ 10 – 15% of main):</u>

$T_{add} = 0,1 \times 44,5 = 4,45 \approx 5$ min.

<u>Total time.</u>

In that case, the total time required to treat 10 hectares of land with the DJI Agras T30 drone at a liquid consumption rate of q = 15 liters per hectare:

$T_{total} = T_{main} + T_{aux} + T_{add} = 44,5 + 40 + 5 = 89,5 \approx$ 90 minutes (Approx 1 h 30 min).

**C) For q = 20 L/ha;**

When the liquid consumption is q = 20 liters per hectare, the drone's tank needs to be refilled $(S_{total} \times q)/V_b = (10 \cdot 20)/30 = 6,667 \approx 7$ times.

The main time remains unchanged: $T_{main} = T_{takeoff\text{-}landing} + T_{flight}(T_{spraying})$;

$T_{main} = 3 \times 1,5 + (10/0,25) = 44,5$ minutes.

Auxiliary time: $T_{aux} = T_{battery} + T_{tank} + T_{navigation}$

Calculation procedure: $T_{aux} = 3 \times 3 + 7 \times 5 + 3 \times 2 = 50$ minutes.

Additional time ( ≈ 10 – 15% of main):

$T_{add} = 0{,}1 \times 44{,}5 = 4{,}45 \approx 5$ min.

Total time:

In that case, the total time required to treat 10 hectares of land with the DJI Agras T30 drone at a liquid consumption rate of q = 20 liters per hectare

$T_{total} = T_{main} + T_{aux} + T_{add} = 44{,}5 + 50 + 5 = 99{,}5 \approx$ 100 minutes (Approx 1 h 40 min).

**Results**

**For a total field area $S_{total}$ = 10S:**

| Spray rate (q, L/ha) | Total time (min) | Approx. time (hours) |
|---|---|---|
| 10 | 84,5 | 1 h 25 min |
| 15 | 89,5 | 1 h 30 min |
| 20 | 99,5 | 1 h 40 min |

**Recommendations**

These calculations include several assumptions: tank refilling and battery replacement times. Optimizing these operations can further reduce total working time.

Field shape, wind, and flight direction also affect total time; thus, introducing a correction coefficient is recommended for more accurate estimation.

**Improvements**:

- Increase the number of batteries and use fast-charging systems (mobile or stationary).
- Employ multiple drones simultaneously for parallel operation to significantly enhance efficiency.

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