

# Investigation of the Possibilities of Planting Rice with Sowing Machines

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**Abstract**— This study compares broadcasting, drone planting and machine planting methods in terms of efficiency. It was conducted on a farmer's land where rice cultivation is practised in the village of Kircasalih, Uzunköprü district, Edirne province. In the experiment, manual broadcasting, machine planting, and drone planting systems were used. The effect of the sowing systems applied on the number of seeds in the spike and yield was found to be statistically insignificant. Upon examination of the results obtained, it was observed that machine sowing provided superiority over broadcast sowing and drone sowing. This is because machine sowing results in uniform spacing between rows and uniformity within rows, leading to an optimal living space for the plant compared to other sowing systems. It was determined that planting with rice planting machines yields better results than broadcast sowing and is a preferable method as weed control and other spraying operations are easier and more efficient.

**Keywords**— Rice, Sowing machine, Drone, Yield.

## I. INTRODUCTION

In rice farming in Turkey, the traditional method of sowing is by hand scattering. Alternatively, sowing is done using sowing machines, and in recent years, the method using unmanned aerial vehicles (drones) has been implemented. Although manual broadcasting requires a high labour input, it is still preferred in some regions. Machine planting, on the other hand, is favoured by leading farmers due to its high success rate and the short time required for planting. In recent years, with the advancement of technology, drone technology has also been utilized in rice cultivation. Modern agricultural technologies in rice production also facilitate agricultural spraying operations. Unmanned aerial vehicles and similar systems, widely used abroad, have also begun to be used in Turkey. Spraying with drones is only applied to target areas, saving on pesticides and reducing costs. Furthermore, effective interventions can be made even in steep and wet areas that tractors cannot reach. Machine planting is another method that reduces the workload in rice production and increases planting efficiency. Hand broadcasting is a traditional method favoured particularly by small-scale farms. In this method, seeds are scattered by hand into water-filled trays to complete the sowing process. Although hand broadcasting requires a high labour input, it generally yields lower productivity compared to machine sowing. Nevertheless, small farmers continue to use this method as a low-cost option.

As a result, the importance of technological methods for optimizing productivity and resource use in rice production is increasing. Unmanned aerial vehicles and drone-like systems are also accelerating and making spraying processes more effective. While machine planting provides order and speed over large areas, hand broadcasting remains an important low-cost alternative. In the future, significant developments in production are expected with the more widespread use of technological approaches and the combined application of

different methods. This study compares broadcasting, drone planting and machine planting methods in terms of efficiency.

## II. MATERIALS AND METHODS

### Material

This study was conducted on a farmer's land where rice cultivation is practised in the village of Kircasalih, Uzunköprü district, Edirne province. The research site is an agricultural area with the region's typical alluvial soil structure, good surface drainage and a level terrain.

### Research Area and Soil Characteristics

The Uzunköprü region has a temperate climate with an average annual rainfall of approximately 600–700 mm. The trial area is located approximately 20 m above sea level and has a heavy-textured alluvial clay loam soil structure. Soil analyses conducted prior to planting revealed that the pH value of the area was slightly below neutral (pH 6.5–6.8) and the organic matter content was moderate (2–3%). Based on these characteristics, the region offers an agricultural environment suitable for rice cultivation, providing adequate moisture retention capacity and nutrient support. In the trial, maintenance practices such as irrigation, fertilization and weed control were applied uniformly across all plots, thus ensuring that only the rice variety differences were evaluated.

### Characteristics of the Climate

Located in the southeast of Edirne, the district of Uzunköprü exhibits transitional climate characteristics due to its position on the transition belt between the Marmara Region and Thrace. The district has an average annual temperature of around 14–15 °C, with summers generally hot and dry and winters cold and occasionally prone to frost. The average temperature in July is 25–27 °C, while in January it is around 2–4 °C. Although snowfall is rare, short-term snow cover can occur in higher areas. The annual total rainfall in Uzunköprü is around 600–650 mm, and this rainfall is mostly concentrated in the autumn and

winter months. While rainfall decreases in the summer months, the average humidity is around 70%, and in the winter months, high humidity and foggy days can affect agricultural practices. These climatic conditions create both advantages and limitations for rice production. Uzunköprü's hot and long summer periods provide a suitable environment for the vegetative development of the rice plant and its water-sensitive growth stages, while summer drought and insufficient rainfall increase the need for irrigation. Low temperatures and frost events in winter can limit plant development, particularly during the seedling and early growth stages. On the other hand, the district's flat agricultural areas with high water retention capacity offer significant advantages for rice cultivation. The suitability of climatic and hydrological conditions prioritises irrigation management in agricultural planning and contributes to increased productivity through the efficient use of water. In conclusion, although Uzunköprü's climate is generally favourable for rice production, summer drought and winter frost risks constitute fundamental limitations that must be taken into account in production planning.

#### Rice

The plant material used in the trial was the Cammeo rice variety. The Cammeo variety is a medium-grain, high-quality variety with high yield potential. This variety was selected for its suitability to regional conditions and good yield performance.

#### Tools and Machines Used in the Trial

In this study, various machinery and equipment were used in agricultural production processes. For soil preparation, an Orhay heavy cultivator and an Orhay light cultivator were used to work the land at different depths. İlgi laser levelling equipment was used to level the land surface. Sowing operations were carried out using both an Irtem brand double-disc, pressure-wheel seed drill and an agricultural drone. The drone was used during sowing to ensure the homogeneous distribution of seeds and was also used for spraying in plant protection applications. Thus, throughout the study, the drone was used effectively in both sowing and spraying processes.

#### Universal Sowing Machine

Pre-sowing soil preparation was carried out in two stages. In the first stage, surface and deep soil cultivation was performed using a cultivator, followed by the levelling stage. Land levelling was carried out using an İlgi brand laser levelling system, which ensured the evenness of the field surface, contributing to the homogeneous distribution of water and uniform plant emergence. The sowing process was carried out using an Irtem brand double-disc pressure wheel universal sowing machine. This machine was chosen because it offers adjustable row spacing for different seed types and high sowing accuracy. In addition, the mechanical sowing system ensured that the rice seeds were placed evenly and homogeneously in the soil.

#### Drone (Unmanned Aerial Vehicle)

In this thesis study, the DJI Agras T40 model unmanned aerial vehicle (UAV) was used for seed sowing and agricultural applications. The UAV, tested in field conditions as part of the research, is a quadcopter system designed for agricultural seed and fertiliser spreading tasks. Thanks to its high-precision

GNSS sensor and advanced automation systems, the drone can perform sowing operations quickly and efficiently. With a maximum take-off weight of 110 kg, including the spray tank, this model offers safe and efficient use in different agricultural areas with its compact dimensions and powerful motor system. The technical specifications of the unmanned aerial vehicle used in the trial are shown in Table 1.

TABLE 1. DJI Agras T40 – Technical Specifications

Specification	Details
Aircraft Total Weight	38 kg (without battery); 50 kg (with battery)
Maximum Takeoff Weight	90 kg (spraying); 101 kg (spreading)
Dimensions (Extended)	2800 × 3150 × 780 mm
Dimensions (Folded)	1590 × 1930 × 780 mm
Hovering Accuracy (RTK Enabled)	±10 cm horizontal; ±10 cm vertical
RTK/GNSS Bands	GPS, GLONASS, BeiDou, Galileo
Hovering Time (No Load)	Up to 18 minutes
Hovering Time (Full Load)	6–7 minutes
Max Wind Resistance	6 m/s
Number of Rotors	8 (4 coaxial pairs)
Spray Payload Capacity	40 kg / 40 L
Spread Payload Capacity	50 kg / 70 L
Spray Width	4–11 m
Battery Model	BAX601 – 30,000 mAh, 52.22 V
Battery Charge Time	9–12 minutes
Ingress Protection	IPX6K

#### Laser Levelling Machine

İlgi Tarım is one of Turkey's leading brands in laser-guided soil cultivation and levelling machines. The 'Omega' series, in particular, stands out for its advantages such as precise surface levelling, water conservation and increased efficiency. The Omega Series machine is one of İlgi Tarım's laser levelling machines. The Omega Levelling Machine is equipped with laser and GPS technologies. In terms of technical specifications, the Omega model used has a working width of 3,5 m to 7.5 m, power requirements of 85 HP to 300 HP, and a weight of 2,420 kg.

#### 2.2. Method

##### Sowing methods

Broadcast sowing: Seeds that had been pre-germinated prior to sowing were sown by hand by people.

Universal sowing machine: The universal seeding machine was calibrated to sow 20 kg per decare.

Drone seeding: Seed sowing was carried out using the DJI Agras T40 model unmanned aerial vehicle (UAV). Seeds that had been pre-germinated prior to sowing were loaded into the drone tank. The seed output rate (output speed) per decare was set to the same value in each parcel to optimise distribution. Prior to flight, the coordinates of the plots were loaded onto the UAV via GPS-assisted automatic route planning, and flight routes were created for each plot. Flight parameters were standardised; flight altitude was fixed at 3 m, flight speed at 6–8 m/s, and spreading width at approximately 5–6 m.

The drone moved along parallel lines at a constant speed and altitude along the specified routes, scattering the seeds at equal intervals over the plots. During the application, wind speed was kept low, and the plot surface was maintained in moist soil conditions suitable for seed scattering. After the

sowing process was completed, the plots were covered with water (through irrigation) to provide the necessary moisture conditions for the seeds to germinate [1].

*Measurements related to plant characteristics*

Number of seeds in the spike: Ten plants were randomly selected from each plot at harvest maturity, and the number of berries in their clusters was counted and averaged to determine the total number [2].

Plant height: In each plot, the distance between the soil level and the tip of the ear (excluding the awn) was measured and recorded in centimetres for 10 plants randomly selected from those that had reached harvest maturity [3].

Yield: To determine the effects of different planting methods on yield, the yield will be determined by weighing the harvested product from each plot three times during the harvest period, with 1 m<sup>2</sup> harvested [4]. Plants within 5 metres of both sides of the plot and within 5 metres of the two plot boundaries will not be harvested to eliminate the edge effect of the plots [5].

*Design of experiment and statistical analysis*

The findings obtained in the study were statistically compared using the SPSS software package to determine whether there were any differences between the results, and variance analyses (ANOVA) were performed using the SPSS (Version 12.00; Chicago, IL, USA) statistical software program.

Field trials were conducted in triplicate according to randomised plots. The Tukey test ( $p \leq 0.05$ ) was used to determine whether there were any significant differences arising from the sowing methods [6]. The measurements and general appearance of the plots in the research area are shown in Figure 1.

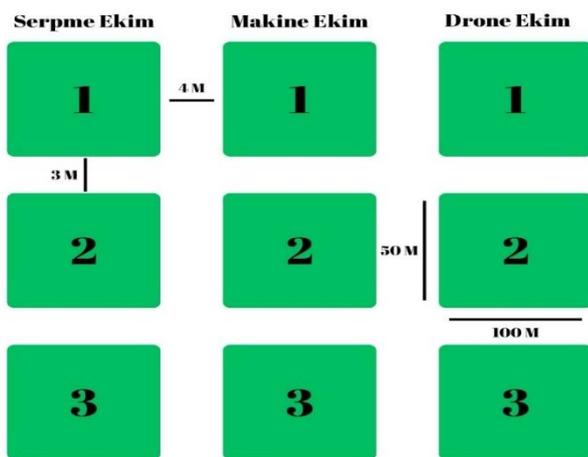


Figure 1. Distribution of planting methods according to random plots

III. RESULTS AND DISCUSSION

*Number of grains per spike*

The variance analysis of the number of grains per head among the applied sowing systems revealed that the differences between the sowing systems were statistically insignificant ( $F=3.338^{ns}$ ). The results are presented in Table 2. Among the sowing systems, a maximum of 57,93 grains were determined with the universal sowing machine, 52,13 grains with drone sowing, and a minimum of 48.30 grains with broadcast sowing (Table 3). When examining the number of seeds per ear, it was

observed that the plant's optimal living space was equal because the rows were evenly spaced and the plants were evenly distributed when sowing was done by machine, whereas in other sowing systems, the plant's living space was not equal because the seeds were broadcast. According to [7], in a study conducted in 2003, highlighted the advantages of machine sowing, emphasising that the plant's optimal living space is more equal compared to broadcast sowing.

TABLE 2. Variance analysis table regarding grain number in the spike

Sources of Change	df	Sum of Squares	Mean Square	F	P
Between Groups	2	141,136	70,568	3,3,38 <sup>ns</sup>	0,106
Within Groups	6	126,833	21,139		
Total	8	267,969			

TABLE 3. Descriptive statistics regarding grain number in the spike

Systems of Sowing	Mean+SS	S-Error	Min	Max	P
Sowing by hand	48,30 <sup>a</sup> +4,95	2,8618	45,0	54,0	
Machinery	57,93 <sup>a</sup> +2,70	1,5603	55,9	61,0	
Drone	52,13 <sup>a</sup> +5,61	3,2426	45,9	56,8	
Total	52,78+5,78	1,9292	45,0	61,0	

\* The difference between the averages indicated by the same letters is statistically insignificant.

*Plant Height*

When the height values of the rice plant were subjected to variance analysis, the results indicated that the difference between the planting systems was significant ( $F=11.561^{**}$ ) (Table 4). The lowest plant height was 68,13 cm in broadcast planting, 71,00 cm in planting, and 74,30 cm in planting with drones and machines (Table 5 and Figure 2).

TABLE 4. Variance analysis table related to plant height

Sources of Change	df	Sum of Squares	Mean Square	F	P
Between Groups	2	57,136	28,568	11,561 <sup>**</sup>	0,009
Within Groups	6	14,827	2,471		
Total	8	71,962			

TABLE 5. Descriptive statistics related to plant height

Systems of Sowing	Mean+SS	S-Error	Min	Max
Sowing by hand	68,13 <sup>a</sup> +2,51	1,4518	65,3	70,1
Machinery	71,00 <sup>ab</sup> +1,00	0,5774	70,0	72,0
Drone	74,30 <sup>b</sup> +0,30	0,1732	74,0	74,6
Total	71,14+2,99	0,9997	65,3	74,6

\* The difference between the averages indicated by the same letters is statistically insignificant.

*Spike Length*

The variance analysis revealed that spike length had a significant effect on sowing systems; the variance analysis results are shown in Table 6 ( $F=27.858^{**}$ ). The descriptive statistics of spike length obtained in the study are given in Table 7. It was observed that planting systems had an effect on ear spike length and that this also affected yield. The effect of planting systems on spike length is shown in Figure 3.

*Yield*

When sowing systems were subjected to variance analysis, significant differences were found between the methods (Table 8). The variance analysis revealed that the lowest yield was 872,10 kg/da for broadcast sowing, while the highest yield was 1047.70 kg/da for machine sowing (Table 9 and Figure 4).

Studies have shown that machine sowing yields higher results than broadcast sowing [8; 9; 10; 11; 12].

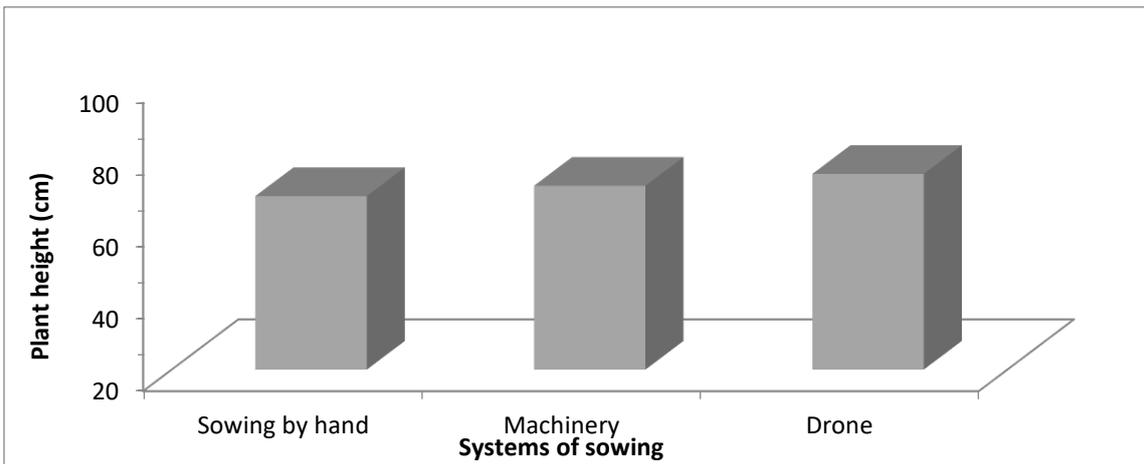


Figure 2. Effect of planting systems on plant height

TABLE 6. Variance analysis table for spike length

Sources of Change	df	Sum of Squares	Mean Square	F	P
Between Groups	2	6,996	3,498	27,858**	0,001
Within Groups	6	0,753	0,126		
Total	8	7,749			

TABLE 7. Descriptive statistics for spike length

Systems of Sowing	Mean+SS	St-Error	Min	Max
Sowing by hand	14,70 <sup>a</sup> + 0,36	0,2082	14,4	15,1
Machinery	16,63 <sup>b</sup> + 0,32	0,1856	16,4	17,0
Drone	14,83 <sup>a</sup> + 0,37	0,2186	14,4	15,1
Total	15,38 + 0,98	0,3281	14,4	17,0

\* The difference between the averages indicated by the same letters is statistically insignificant.

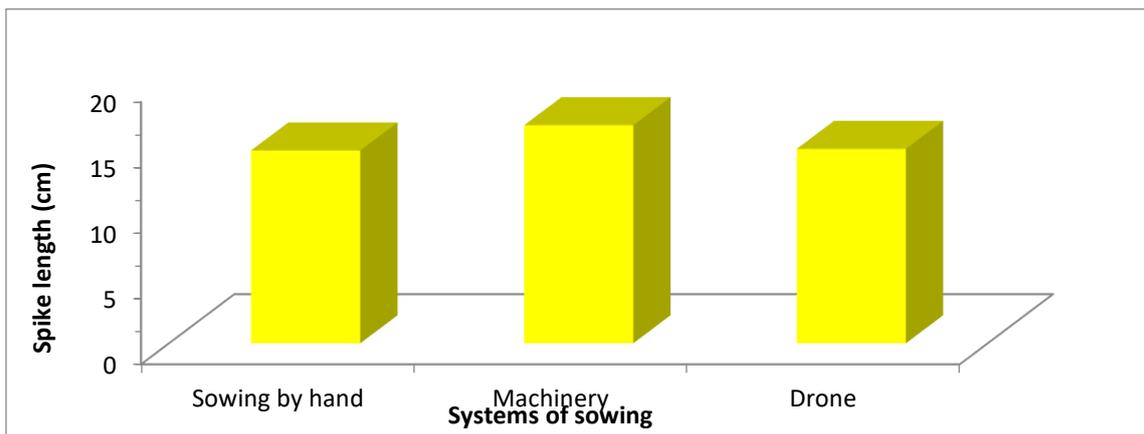


Figure 3. Effect of planting systems on spike length

TABLE 8. Analysis of variance table for grain weight in the cluster

Sources of Change	df	Sum of Squares	Mean Square	F	P
Between Groups	2	46500,942	23250,471	153,765**	0,000
Within Groups	6	907,247	151,208		
Total	8	47408,189			

TABLE 9. Descriptive Statistics for Grain Weight in the Cluster

Systems of Sowing	Mean+SS	St-Error	Min	Max
Sowing by hand	872,10 <sup>a</sup> + 10,11	5,8387	860,8	880,3
Machinery	1047,70 <sup>c</sup> + 14,11	8,1505	1032,5	1060,4
Drone	948,77 <sup>b</sup> + 12,33	7,1195	935,7	860,2
Total	956,189 + 76,98	25,6602	860,8	1060,4

\* The difference between the averages indicated by the same letters is statistically insignificant.

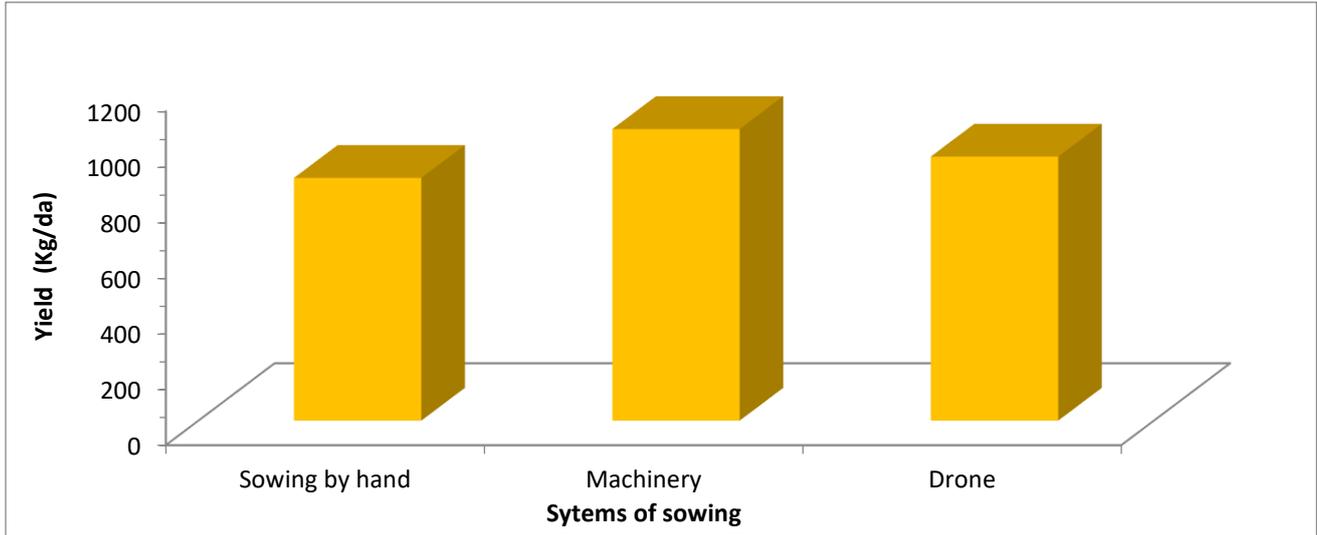


Figure 4. Effect of planting systems on yield

#### IV. CONCLUSION

The effect of the sowing systems applied on the number of seeds in the spike and yield was found to be statistically insignificant. Upon examination of the results obtained, it was observed that machine sowing provided superiority over broadcast sowing and drone sowing. This is because machine sowing results in uniform spacing between rows and uniformity within rows, leading to an optimal living space for the plant compared to other sowing systems.

It was determined that planting with rice planting machines yields better results than broadcast sowing and is a preferable method as weed control and other spraying operations are easier and more efficient. Machine planting is increasing day by day in the region and is a preferable method.

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