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Evaluation of Agronomic Parameters of Two Varieties of Rice (*Oriza Sativa*) with Different Planting Methods

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Abstract
The phenological determination of two varieties of rice (Oriza sativa) was proposed, with two sowing methods, water levels, agronomic behavior and the application of biological agents to control grain bruising. The design was factorial with 8 treatments and three replications, Tukey's test at 5% with three factors A, seed FL 11 and FL 12, B, broadcast sowing and transplanting, and C, water levels in 5 cm and 10 cm layers. The methods were deductive, inductive and qualitative, the problem of investment versus production is low, the genetic potential in different phases of development such as vegetative: from germination to the initiation of panicle in 54 days. The reproductive phase: from panicle formation to flowering with 30 days, and the flowering phase to maturation and harvest with 32 days, reaching an average of 112 days for the two varieties. The water layers used were 10 cm with 1000 m3/ha, and 5 cm with 500 m3/ha. Another aspect was to cultivate resistant varieties such as SENACA FL 11 and SENACA FL 12, the former being the one with the best yield. In the variables of the treatment (A2xB2xC2) with an average of 11.40 cm. In plant height, the A1xB2xC2 treatment averaged 32.17 cm, followed by the A2xB2xC2 treatment with an average of 31.07 cm. To know the ear formation, it was necessary to evaluate the plant height where the treatments were not significant.
Key words: rice, water layering, grain spotting, seed, transplanting, broadcasting.

Resumen
Se planteó la determinación fenológica de dos variedades de arroz (*Oriza sativa*), con dos métodos de siembras, láminas de agua, comportamiento agronómico y la aplicación de agentes biológicos para controlar machado del grano. El diseño fue factorial con 8 tratamientos y tres repeticiones la prueba de Tukey al 5% con tres factores A, semilla FL 11 y FL 12, el B siembra al voleo y por trasplante, el C niveles de agua en láminas de 5 cm y 10 cm. Los métodos fueron deductivo, inductivo y cualitativo el problema la inversión versus producción que es baja, el potencial genético en diferentes fases de desarrollo como vegetativa: desde la germinación hasta la iniciación de panícula en 54 días. La fase reproductiva: desde la formación de la panícula hasta la floración con 30 días, y la fase de floración hasta la maduración y cosecha con 32 días alcanzando un promedio de 112 días las dos variedades. Las láminas de agua utilizadas fueron de 10cm con 1000 m^3/ha, y la de 5cm con 500 m^3/ha. Otro aspecto fue cultivar variedades resistentes como es SENACA FL 11 Y

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SENACA FL 12 siendo la primera la que mejor rendimiento presentó. En las variables macollo en el tratamiento (A2xB2xC2) con promedio de 11,40 cm. En la altura de planta el tratamiento A1xB2xC2 con promedio de 32,17 cm seguido del tratamiento A2xB2xC2 con promedio de 31,07 cm. Para conocer la formación de espiga fue necesario evaluar la altura de la planta donde los tratamientos fueron no significativos.

Palabras clave: arroz, láminas de agua, manchado de grano, semilla, trasplante, voleo.

Introduction

Rice is the most extensive crop in Ecuador, since it occupies more than a third of the area of transitory products. In social and productive terms, the crop is also considered important for nutrition, since it provides the highest calorie intake of all cereals (FAO 2009).

Rice production management systems are considered to depend on climatic conditions, growing areas, availability of irrigation infrastructure, vegetative cycle, soil type, soil leveling and degree of technification.

According to these considerations, the Agrarian University of Ecuador, concerned about the agricultural sector, proposed as research the evaluation of agronomic parameters in the cultivation of rice (Oriza sativa) using two varieties with different methods of planting in the CUM in 20 hectares, proposing as objectives to determine the phenological expression of the varieties grown with two methods of planting, where the application of land leveling to increase crop productivity was compared and productivity was measured based on the benefit-cost ratio.

Methodology

The methods used were deductive, inductive and qualitative, and the analysis of the results were subjected to Tukey's test at 5% probability to observe if there is significance.

Factor A	Factor B	Factor C
Seed FL 11	Broadcast seeding	Water level 5 cm
Seed FL 12	Transplant sowing	Water level 10 cm

The variables studied were: two methods of direct and indirect sowing: in the first case, the seed was soaked for two days and then dispersed uniformly on the ground; in the second case, an area of land was adapted to place the seed and wait for it to germinate, and after 25 days it was ready for transplanting.

Water layers of 5 and 10 cm for which the flow calculation method was used where a 50-centimeter-long tube of 4 cm in diameter was used, twenty centimeters were drilled and these were buried in the ground, the remaining thirty centimeters on the surface where a millimeter ruler was placed to measure the water layer studied.

Variable diameter of the tillers, which was measured with the help of a millimeter tape, in the transplant sowing by transplanting, ten plants were considered per test area where the diameter of the tillers was measured 30 days after sowing, in relation to the broadcast sowing, 10 plants were evaluated in one m2 30 days after sowing.

As for the height of the plant in the transplant, ten plants of each treatment were evaluated per area of the trial, as for the alvoleo sowing, ten plants were considered in one m2 in both methods were measured with the help of a flexometer from the base to the apex of the leaf, which was expressed in centimeters, at 30 days when the spike is formed. It was determined using the scale proposed by (Rosero 1983).

Scale	Height	Consideration
1	Less than 100 cm	Semi-dwarf plants

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5	101 -130 cm	Intermediate
9	More than 130 cm	High

Source: Rosero 1983

Results

Objective 1: To determine the phenological expression of varieties grown with two sowing methods

Direct and indirect seeding

The variables studied were rice sowing, in direct and indirect forms, in addition with the analysis of the crop, it was possible to observe the genetic potential during the production in different phases in relation to the phenological expression of the varieties FL 11 and FL 12. In the vegetative phase was in a range of 52 to 54 days respectively in the two methods of sowing. The reproductive phase had a duration of 29 to 30 days where the first flush of flowers began, the maturation phase had a duration of 30 days, reaching an average development of 111 to 112 days for both varieties according to Rosero's scale is intermediate.

Vegetative phase

N°	Interaction	Treatments	Avegare
1	A1xB1xC1	Seed FL11 alvoleo 5cm of water	52,00 a
2	A1xB1xC2	Seed FL11 alvoleo 10cm of water	52,33 a
3	A1xB2xC1	Seed FL11 transplanting 5cm of water	53,33 a
4	A1xB2xC2	Seed FL11 transplanting 10cm of water	54,00 a
5	A2xB1xC1	Seed FL12 alvoleo 5cm of water	54,00 a
6	A2xB1xC2	Seed FL12 alvoleo 10cm of water	52,33 a
7	A2xB2xC1	Seed FL12 transplanting 5cm of water	53,67 a
8	A2xB2xC2	Seed FL12 transplanting 10cm of water	54,00 a

Means with a common letter are not significantly different (p > 0,05)
C.V. 1.44%

Reproductive phase

N°	Interaction	Treatments	Avegare
1	A1xB1xC1	Seed FL11 alvoleo 5cm of water	29,67 a
2	A1xB1xC2	Seed FL11 alvoleo 10cm of water	29,67 a
3	A1xB2xC1	Seed FL11 transplanting 5cm of water	29,67 a
4	A1xB2xC2	Seed FL11 transplanting 10cm of water	30,00 a
5	A2xB1xC1	Seed FL12 alvoleo 5cm of water	29,67 a
6	A2xB1xC2	Seed FL12 alvoleo 10cm of water	29,33 a
7	A2xB2xC1	Seed FL12 transplanting 5cm of water	29,67 a
8	A2xB2xC2	Seed FL12 transplanting 10cm of water	29,67 a

Means with a common letter are not significantly different (p > 0,05)
C.V. 2,48%

Maturation phase

N°	Interaction	Treatments	Avegare

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1	A1xB1xC1	Seed FL11 alvoleo 5cm of water	30,67 a
2	A1xB1xC2	Seed FL11 alvoleo 10cm of water	30,00 a
3	A1xB2xC1	Seed FL11 transplanting 5cm of water	30,67 a
4	A1xB2xC2	Seed FL11 transplanting 10cm of water	30,33 a
5	A2xB1xC1	Seed FL12 alvoleo 5cm of water	30,67 a
6	A2xB1xC2	Seed FL12 alvoleo 10cm of water	30,33 a
7	A2xB2xC1	Seed FL12 transplanting 5cm of water	30,33 a
8	A2xB2xC2	Seed FL12 transplanting 10cm of water	30,33 a

Means with a common letter are not significantly different (p > 0,05)
C.V. 1,78%

Objective 2: Evaluate water layers for pest control in rice cultivation in the CUM
For the achievement of this objective, the existing flow of the Milagro River was used, where the results show that the volumes of water used in the experimental area, applying a 10 cm layer of water, approximately 1000 m3/ha were used, which was done in two days, at the rate that the pump emits 10,368 m3/day of water, considering that with the 10 cm layer of water it was better for the rice crop. 368 m3/day of water, considering that with the 10 cm layer of water, the rice crop was better thinned, observing that, to guarantee high rice production, large quantities of water are used for flood irrigation, associated with a combustion pumping system.
Q= 12 lt/sec X 1tl/sec * 3600sec/1hr * 24hr/day * 1m3/106 lt = 10.368 m3/day

Objective 3: Describe the agronomic performance of two rice varieties with two planting methods to achieve high yields.

Macollo: The diameter of the tillers was measured using a millimeter tape at a height of 15 cm, which was expressed in centimeters. The results obtained in each of the treatments and the variables evaluated in relation to the diameter of the plant tillers at 30 days showed that the treatment A2xB2xC2 seed FL12 sown by transplanting and with an irrigation layer of 10 cm was the one with the best agronomic performance, with an average of 11 cm tillers.

Macollo at 30 days

N°	Interaction	Treatments	Avegare	
1	A1xB1xC1	Seed FL11 alvoleo 5cm of water	8,23	b
2	A1xB1xC2	Seed FL11 alvoleo 10cm of water	7,00	b
3	A1xB2xC1	Seed FL11 transplanting 5cm of water	8,04	b
4	A1xB2xC2	Seed FL11 transplanting 10cm of water	7,83	b
5	A2xB1xC1	Seed FL12 alvoleo 5cm of water	7,18	b
6	A2xB1xC2	Seed FL12 alvoleo 10cm of water	7,68	b
7	A2xB2xC1	Seed FL12 transplanting 5cm of water	7,83	b
8	A2xB2xC2	Seed FL12 transplanting 10cm of water	11,40	a

Means with a common letter are not significantly different (p > 0,05)
C.V. 11.49%

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Plant height

The height of the plant was measured from ground level to the apex of the leaf, this was done after 30 days and when the formation of spikes began, the treatment (A1xB2xC2) variety F11 planted by transplanting and with a 10 cm blade showed an average of 32.17 cm, followed by treatment (A2xB2xC2) variety F12 planted by transplanting and with a 10 cm blade, reached an average of 31.07 cm.

Plant height at 30 days

N°	Interaction	Treatments	Avegare	
1	A1xB1xC1	Seed FL11 alvoleo 5cm of water	24,57	b
2	A1xB1xC2	Seed FL11 alvoleo 10cm of water	19,67	c
3	A1xB2xC1	Seed FL11 transplanting 5cm of water	19,37	c
4	A1xB2xC2	Seed FL11 transplanting 10cm of water	32,17	a
5	A2xB1xC1	Seed FL12 alvoleo 5cm of water	22,52	bc
6	A2xB1xC2	Seed FL12 alvoleo 10cm of water	20.35	bc
7	A2xB2xC1	Seed FL12 transplanting 5cm of water	20,83	bc
8	A2xB2xC2	Seed FL12 transplanting 10cm of water	31,07	a

Means with a common letter are not significantly different (p > 0,05)
C.V. 6.70%

To know the agronomic behavior of rice in the ear formation stage, it was necessary to evaluate the height of the plant where the treatment A1xB2xC2 seed FL11 sown by transplanting and with irrigation layer of 10cm reached an average of 95.67, while the treatment A2xB2xC2 seed FL12 in sowing by transplanting and with irrigation layer of 10cm presented an average of 91.80cm, the treatments did not present significant differences.

Plant height at herringbone formation

N°	Interaction	Treatments	Avegare
1	A1xB1xC1	Seed FL11 alvoleo 5cm of water	83,13 a
2	A1xB1xC2	Seed FL11 alvoleo 10cm of water	82,70 a
3	A1xB2xC1	Seed FL11 transplanting 5cm of water	85,17 a
4	A1xB2xC2	Seed FL11 transplanting 10cm of water	95,67 a
5	A2xB1xC1	Seed FL12 alvoleo 5cm of water	89,93 a
6	A2xB1xC2	Seed FL12 alvoleo 10cm of water	86,27 a
7	A2xB2xC1	Seed FL12 transplanting 5cm of water	91,80 a
8	A2xB2xC2	Seed FL12 transplanting 10cm of water	83,63 a

Means with a common letter are not significantly different (p > 0,05)
C.V. 5.88%

To determine the nutrient needs of the plant, it was necessary to perform soil analysis in the laboratory, since the Yara CheckIT application could not be applied due to cell coverage problems.

Yield

The results of the analysis show that the yields in relation to productivity, the treatment (A2XB2XC2) FL12 seed sown by transplanting and with an irrigation lamina of 10 cm was the one that achieved the highest results with 48 bags per hectare of 210 pounds on average.

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Plant height at herringbone formation

N°	Interaction	Treatments	Avegare	
1	A1xB1xC1	Seed FL11 alvoleo 5cm of water	44,00	c
2	A1xB1xC2	Seed FL11 alvoleo 10cm of water	45,33	bc
3	A1xB2xC1	Seed FL11 transplanting 5cm of water	46,00	abc
4	A1xB2xC2	Seed FL11 transplanting 10cm of water	45,00	ab
5	A2xB1xC1	Seed FL12 alvoleo 5cm of water	46,00	abc
6	A2xB1xC2	Seed FL12 alvoleo 10cm of water	46,00	abc
7	A2xB2xC1	Seed FL12 transplanting 5cm of water	46,67	ab
8	A2xB2xC2	Seed FL12 transplanting 10cm of water	48,00	a

Means with a common letter are not significantly different (p > 0,05)
C.V. 1,72%

Objective 4: To apply a technological package in rice cultivation using biological agents to control grain bruising.

The presence of Rhizoctonia solani and Burkholderia glumae diseases was determined in the rice crop, where the antagonistic fungus Trichoderma spp was applied to control these diseases. Data were obtained using an arbitrary scale where 0 = No presence and 1 = presence of disease. It was concluded that the causal agents were controlled after the application of the antagonist, where low incidence was presented.

It was observed that seeds F11 and F12 sown by transplanting with 5 cm and 10 cm of water layer did not present Rhizoctonia solani and Burkholderia glumae diseases.

Plant height at herringbone formation

N°	Interaction	Treatments	*Rhizoctonia solani*	*Burkholderia glumae*
1	A1xB1xC1	SeedFL11 alvoleo 5cm of water	1	0
2	A1xB1xC2	SeedFL11 alvoleo 10cm of water	0	0
3	A1xB2xC1	SeedFL11 transplanting 5cm of water	1	0
4	A1xB2xC2	SeedFL11 transplanting 10cm of water	0	0
5	A2xB1xC1	SeedFL12 alvoleo 5cm of water	0	1
6	A2xB1xC2	SeedFL12 alvoleo10cm of water	0	1
7	A2xB2xC1	SeedFL12 transplanting 5cm of water	0	0
8	A2xB2xC2	SeedFL12 transplanting 10cm water	0	0

Arbitrary scale No pathogen present = 0 and Presence of pathogen = 1

Discussion

The behavior of the rice crop differs in each phenological stage of development in addition this will depend on the genetic potential being so the studied varieties Fl11 and FL12 presented excellent development in relation to the tillering and plant height at thirty days but not at the time of forming the ear which agrees with the statement by (Lopez, M 2018), who indicates that the analysis phases of the rice crop should consider the genetic potential of rice during production in the different phases of development as vegetative, reproductive and maturation..

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Knowing that rice is demanding in water for its development, the research took advantage of the flow of the Rio Milagro, being the volume of water used in the experimental area of approximately 1000 m3/ha where a layer of 10cm was applied, noting that the flow emitted by the pump is 12 Lt/second Q= 12 lt/sec X 1tl/sec X 3600seg/1hr X 24hr/1dia X 1m3/106 lt = 10. 368 m3/day, knowing that to guarantee high production of this grass, large quantities of water are used for flood irrigation, associated with a combustion pumping system. This is in agreement with Peñafiel (Peñafiel, 2012), who states that rice is a semi-aquatic crop, which demands a greater amount of water than any other grass, and these vary according to climatic conditions, crop management, soil type and vegetative cycle, it is estimated that rice cultivation requires between 880 and 1240 mm of water. It also agrees with what was stated by (Suarez, 2015), which indicates that the soil should be kept flooded for up to 15 to 20 days before harvest, except on the date when cultural work such as weed control and fertilization is carried out. And with what is stated by (Chatel, 2010) which indicates that irrigation should be applied to the crop throughout its biological cycle which can be by gravity with the use of pumping system and maintain it with a permanent layer of water as the water supply is the most important factor in production.

Regarding the agronomic behavior of rice, the plant height was evaluated where the treatment A1xB2xC2 seed FL11 planted by transplanting and with irrigation layer of 10cm reached an average of 95.67, while the treatment A2xB2xC2 seed FL12 planted by transplanting and with irrigation layer of 10cm presented an average of 91.80cm, the treatments did not present significant differences. This agrees with what was stated by (Vásquez & Jinez, 2019) who indicates that the variety SFL - 0011 was the one that obtained the highest value with 71cm, which differs from the varieties FL. Arenillas and SFL 09 whose values were 60 and 75.5 cm respectively. In relation to the variety SFL-09 where it indicates (Delgado, 2004 cited by, Vásquez, J. 2019), that it reached a height of 108 cm, at physiological maturity near harvest, data taken 30 days after transplanting.

To determine the need of nutrients that the plant needs, it was necessary to perform soil analysis in order to apply the adequate dose in a timely manner. This is in agreement with what was stated by (Peñafiel, D 2019) who states that the rice plant needs adequate doses of nutrients for its development, which must be supplied from the soil. In addition, this allows rationalizing the use of fertilizers according to the critical levels established for the soil analysis zone.

Conclusions

The cultivated rice varieties FL11 and FL12 have an average phenological cycle of 112 days, which is unquestionable if planted by transplanting or direct sowing.

Maintain a water level of 10 cm for these to achieve excellent yields, in addition to considering that the leveling of the ground makes the water level remain uniform, avoiding higher water levels in certain areas, which causes drowning and loss of seedlings and therefore low yields.

In the results obtained and analyzing the two planting systems, the cultivated varieties FL11 and FL12 have good agronomic performance, but the FL 12 variety showed better characteristics, which is why it should be cultivated by transplanting and with an irrigation lamina of 10 cm.

In order to know the fertilization levels, soil analysis should be carried out, which allowed the fertilizer to be distributed adequately during the different stages of phenological development of the crop, thus avoiding unnecessary expenses.

The F11 seed sown by transplanting and with an irrigation lamina of 10 cm showed zero incidences of Rhizoctonia solani and Burkholderia glumae diseases, as did the F12 seed sown by transplanting and with a water layer of 5 and 10 cm.

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The following conclusions emerged from the results of the study:

- The cultivated varieties of rice FL11 and FL12 have an average phenological cycle development of 112 days, which is indisputable to be planted by transplanting or direct seeding.
- Maintain a 10 cm water layer for these to achieve excellent yields, in addition to considering that the leveling of the soil makes the water layer remain uniform, avoiding a higher water level in certain areas, which causes drowning and loss of seedlings and therefore low yields.
- In the results obtained and analyzing the two planting systems, the cultivated rice varieties FL11 and FL12 have good agronomic performance, but the FL 12 variety showed better characteristics, which is why it should be cultivated by transplanting and with an irrigation layer of 10 cm.
- In order to know the fertilization levels, soil analysis should be carried out, which allowed the fertilizer to be distributed adequately during the different stages of phenological development of the crop, avoiding unnecessary expenses.
- The F11 seed sown by transplanting and with an irrigation lamina of 10 cm presented zero incidences of Rhizoctonia solani and Burkholderia glumae diseases, as well as the F12 seed sown by transplanting and with a water layer of 5 and 10 cm.

Recommendations

Based on the results obtained, it is recommended to cultivate FL-11 and FL-12 varieties in the study area.

- Planting should be done by transplanting, since it achieves a better bud and plant height, in addition to obtaining better yields, such as 48 bags of 210 pounds per hectare.
- In the case that river water was used, good use should be made of the water and a water level of 10 cm should be maintained, considering that the water source is not the company's own.
- Fertilization should be applied according to soil analysis to avoid unnecessary use of fertilizers and according to the needs of the crop.
- The F11 and F12 varieties should be grown by transplanting and with 5 cm and 10 cm of water because they are resistant to Rhizoctonia solani and Burkholderia glumae diseases.

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