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EFFECT OF ORGANIC FERTILIZER ORGALIFE ON SOME YIELD AND QUALITY PROPERTIES OF RICE (*ORYZA SATIVA* L.)

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ABSTRACT

This study presents the effect of ecological fertilizer Orgalife on some yield and quality properties of two rice varieties, San Andrea and Opale, during the time period 2020-2021. In a field experiment arranged in *Zade method*, three treatments were studied: control (350kg/ha NPK) as a basic fertilizer and 200kg/ha Urea (46% N) and two variants with Orgalife foliar application in dosage: 20L/ha - variant 1 and dosage of 20L+20L/ha - variant 2. In variant 2, Orgalife was applied twice in an interval of 10 days. Biological, grain and straw yield, number of productive tillers/m^2, 1000 kernel weight of paddy and whole grains white rice and milling fractions were examined. Results were analyzed with ANOVA and LSD test. Opale's variant 2 presented significantly the highest average in both years for biological (18575kg/ha), grain (11458kg/ha) and straw yield (7115kg/ha) compared to the control lowest average. For San Andrea, significant differences were noticed for grain yield in variant 2 (8883.33kg/ha) compared to the control (7350kg/ha). Opale's variant 2 determines the highest statistically significant average (612.17) of productive tillers/m^2 for both years compared to control. For 1000 kernel weight of whole grain white rice, the averages for Opale's variant 2 (22.73 g) were on pair with the control (22.42 g), as well as the total milled rice. Opale showed approximately the same average values about the total milled rice examined in both years regardless of the treatments (69.30% variant 1, 70.05% variant 2 and 71.57% control). The results about whole grain white rice vary from 45.73% (control) to 46.75% (variant 2).

Key words: paddy, grain, yield, tillers, milling fractions.

INTRODUCTION

Rice (*Oryza sativa* L.) is one of the most important cereals in the world (Singh & Khush, 2000). For half of the world population, rice is the leading staple food and primary source of carbohydrates (Dwipaa et al., 2020). World rice production needs to double by 2030 in order to meet the ever-increasing demands for food consumption, because of the increasing population growth and improved living standards (Zeng et al., 2017). One of the major factors for the continuous growth in rice production is the usage of adequate fertilizers in the production process. Nutrient's efficacy means increased rice yield upon applications of the fertilizers (Shah et al., 2008; Basavarajappa et al., 2021). Over the years, different types of fertilizers and fertilization techniques have been investigated, since fertilization is an imperative of rice production to provide high yield and quality product. In order to produce 1000 kg of paddy rice, the optimal nutrition for balanced rice production should be reached by nutrient uptake of approximately 14.8 kg N, 3.8 kg P, and 15.0 kg K in the above-ground plant dry matter (Xu et al., 2015).

In the last few years, foliar application of fertilizers has become more interesting not only for scientific purposes but also for the practical crop production. According to some authors - the nutrition of the plants through the leaves is becoming more important because this way of fertilization provides fast absorption of the minerals and their direct effect on cell turnover; on the other side, the foliar fertilization complements the basic fertilization and, in that way, becomes a part from the integrated system of the plant nutrition plan in the crop production (Vukadinović & Lončarić, 2011). Foliar fertilizers have complex content because they contain macro elements (N, P_2O_5, K_2O, MgO), microelements (Fe, Mn, Cu, Zn, B, Mo, Co) and sometimes growth stimulants (indole acetic acid) and vitamins.

In the Republic of Macedonia rice is a strategically important cereal crop with a century's old tradition of cultivation. The rice production is concentrated in the eastern part of the country, in the Kochani valley, along Bregalnica river with an average production area of 4926.36 ha. The average yield of paddy is 4692.67 kg/ha and 23145.12 t/year average paddy production for the period 1939-2014 (Andreevska & Andov, 2015). The standard technology in rice production in the Republic of Macedonia includes basic crop fertilization, usually with mineral NPK fertilizers with application of 400-600 kg/ha. During the vegetation period in the tillering stage the rest of the N amount is applied as a supplemental fertilization (second split application) by using 150-250 kg/ha N fertilizers such as urea, ammonium nitrate or calcium ammonium nitrate (CAN) (Andov & Andreevska, 2010). The organic fertilizer Orgalife examined in this study also expressed a positive effect on the germinability and seedling growth (Spaseva et al., 2021). Except Orgalife, there were other foliar fertilizers that had been examined in rice production research in Republic of Macedonia. Hence, the results of foliar application with NPK fertilizers with trace elements such as Kristalon^{TM} Special (Andreevska et al., 2006) and Lactofol O (Andreevska et al., 2012) showed a positive effect on rice yield. Calcium based foliar fertilizers Megagreen and Herbagreen generally showed no significant effect in rice production (Dimitrovski et al., 2016, 2017).

As fertilization is a very important fragment in the rice production process, over the years types of fertilizers and fertilization techniques have been investigated. So, the aim of this study was to determine the effect of the foliar fertilizer Orgalife on some productive rice properties on two commonly grown rice varieties. Until now this type of fertilizer has not been used for rice fertilization in Republic of Macedonia.

MATERIALS AND METHODS

This study was conducted at the research area of the Institute of Agriculture - Skopje, Department of Field Crops, Ss. Cyril and Methodius University in Skopje, Republic of Macedonia, in the rice production region in Kochani, in a locality named Bosevica. Orgalife is a liquid organic microbiological fertilizer, which is used for foliar application. Orgalife is prepared from a Californian red worm casting base so the microorganisms are the leading quality. This fertilizer contains organic matter - 48.35%, dry substances - 2.72%, N - 2.44%, P_2O_5 - 2.43%, K_2O - 3.53% and pH is 6.83. For the purpose of this field experiment two rice varieties San Andrea and Opale were used, produced in two following years - 2020 and 2021. The effect of Orgalife fertilizer on the yield properties of rice (*Oryza sativa* L.) was examined in a field experiment arranged in design according to the *Zade method*, with 3 variants (two treatments and one control) in 3 replications. The plot size of each treatment is 500 m^2. Prior to sowing, the whole experimental field was applied with 350 kg/ha NPK fertilizer (16:16:16) as a basic fertilizer and 200 kg/ha Urea (46% N) in a separate application (before sowing and in the phase of tillering). As a control treatment, a plot of 500 m^2 was used, treated only with the NPK and Urea fertilizers. The first variant-treatment was used to examine the effect of the foliar application of Orgalife in dosage of 20L/ha (the optimal dosage is 20 L/ha), while in the second variant-treatment was applied in double dosage of 20L + 20L/ha of Orgalife fertilizer,

also by foliar application and it was applied twice in 10 days interval between the first and second application. For both variants, the basic fertilization with NPK and Urea was identical to the control, with additional foliar application of the studied fertilizer during vegetation. At the end of the vegetation when the grains were totally ripped, 3 sheaves of rice plants were harvested according to the *Quadrat method* (1 m x 1 m of rice area) as 3 replications of each treatment. On the basis of the average sample of rice sheaf of 1 m^2 rice crop area, in the laboratory were determined the following parameters: sheaf weigh, number of the productive and unproductive tillers per m^2, biological yield (sum of weight of panicle and rice straw), number of weeds, number of red rice plants and other rice varieties, weight and number of panicles, paddy weight and straw weight. The quality parameters examined in this article are total weight (1 000 grain mass) of paddy rice and white rice grains, percentage of moisture in the paddy rice and head rice milling characteristics. The milling fractions (whole grain, brokens, hulls and bran) were analyzed in a sample of 100 g of paddy rice from each replication in the laboratory head rice milling machine for 1 minute and 40 seconds per sample. The white rice yield was examined on the basis of paddy rice yield and head rice results. All the results were analyzed by ANOVA at 0.05 with 0.01 levels of probability.

RESULTS AND DISCUSSION

Biological yield

Plants are able to get nutrients for higher yield upon application of organic fertilizers. The appropriate combination of organic and inorganic nutrient sources was found to enhance the efficiency of nutrients and ultimately increased yield attributes of rice (Akter et al., 2022). This ascertainment is in accordance with our results. Hence, the Orgalife usage positively affected the biological yield. The biological yield (straw + paddy rice) at 14% grain moisture for the two varieties Opale and San Andrea is shown in Table 1. The Opale's variant 2 gave the highest biological yield average in both years (18575 kg/ha) compared to the control treatment which had the lowest average for the both years. Variant 2 showed statistically significant differences at the 0.05 and 0.01 level for the both years. This trend of highest values for the biological yield in variant 2 compared to the control was also shown in San Andrea, but the statistical differences were non-significant.

Table 1. Biological yield (straw + paddy) for Opale and San Andrea (kg/ha)

Opale	Variant 1	Variant 2	Control	Average	LSD	
					(α 0.05) *	(α 0.01) **
2020	15350.00	16983.33**	13600.00	15311.11 a	1750.26	2651.49
2021	17850.00	20166.67**	17533.33	18516.67 b	1261.43	1910.96
Average	16600 a	18575 b	15566.7 a			
San Andrea	Variant 1	Variant 2	Control	Average	LSD	
					(α 0.05) *	(α 0.01) **
2020	16150.00	17266.67	15750.00	16388.89 b	2100.68	3182.36
2021	14366.67	14616.67	12500.00	13827.78 a	3542.08	5365.95
Average	15258.34 a	15941.67 a	14125 a			

Note: abc differences between values in a given row are statistically significant if the labels do not contain the same letter

Grain yield

It is shown that grain yield and quality has been affected significantly by growing and environmental conditions, such as water availability, temperature, fertilizer application,

drought, and salinity stresses (Chen et al., 2012). Plants fertilized with the correct amount of fertilizer resulted in more filled grains (McVicker & Walker, 1952).

The results for the grain yield in Table 2 show that variant 2 has the highest values for both years and both varieties. The variant 1 from the Opale has statistically significant differences at 0.05 level in 2020, while the variant 2 has statistically significant differences at both levels and for the both years. Grain yield average for Opale's variant 2 is 11458.34 kg/ha while for San Andrea's variant 2 is 8883.33 kg/ha. The control values are the lowest for both varieties in the first and the second year.

Table 2. Grain yield (kg/ha) for *Opale* and *San Andrea*

Opale	Variant 1	Variant 2	Control	Average	LSD	
					(α 0.05) *	(α 0.01) **
2020	9566.67*	10916.67**	8366.67	9616.67 a	810.89	1228.44
2021	11416.67	12000*	10833.33	11416.67 b	1102.41	1670.06
Average	10491.67 ab	11458.34 b	9600 a			
San Andrea	Variant 1	Variant 2	Control	Average	LSD	
					(α 0.05) *	(α 0.01) **
2020	8983.33	9266.67	8250	8833.33 b	1114.91	1689
2021	7866.67*	8500**	6450	7605.56 a	1193.99	1808.80
Average	8424.50 b	8883.33 b	7350 a			

Note: abc differences between values in a given row are statistically significant if the labels do not contain the same letter

Harvest index

Biological yield and harvest index are two valuable criteria for the assessment of the performance of cereals (Donald & Hamblin, 1976). Opale didn't present statistically significant differences between both years for the harvest index. Therefore, the use of Orgalife did not show statistically significant differences among the treatments. The situation in the San Andrea field experiment is a bit different and the results showed statistically significant differences at 0.05 level in 2020 for variant 1 and in 2021 for variant 2 (Tab 3.). Harvest index averages for Opale vary from 0.59 to 0.64, while for San Andrea vary from 0.52-0.58.

Table 3. Harvest index averages for Opale and San Andrea

Opale	Variant 1	Variant 2	Control	Average	LSD	
					(α 0.05) *	(α 0.01) **
2020	0.63	0.64	0.61	0.63a	0.07	0.10
2021	0.64	0.59	0.62	0.62a	0.03	0.04
Average	0.63a	0.62a	0.62a			
San Andrea	Variant 1	Variant 2	Control	Average	LSD	
					(α 0.05) *	(α 0.01) **
2020	0.56*	0.54	0.52	0.54	0.02	0.03
2021	0.55	0.58*	0.55	0.55	0.06	0.08
Average	0.55ab	0.56b	0.52a			

Note: abc differences between values in a given row are statistically significant if the labels do not contain the same letter

Straw yield

The Opale variety for variant 2 in 2021 has the highest straw yield average (8166.67 kg/ha) and at 0.01 level has a statistically significant difference compared to the control, while the values for the San Andrea are not statistically significant at all. Table 4. presents the highest straw yield average for variant 2 and the lowest average for control in both varieties.

Table 4. Straw yield for Opale and San Andrea (kg/ha)

Opale	Variant 1	Variant 2	Control	Average	LSD	
					(α 0.05) *	(α 0.01) **
2020	6116.67	6063.33	5233.33	5804.44 a	1023.47	1550.48
2021	6433.33	8166.67**	6697.33	7099.11 b	544.13	824.31
Average	6275 ab	7115 b	5965.33 a			
San Andrea	Variant 1	Variant 2	Control	Average	LSD	
					(α 0.05) *	(α 0.01) **
2020	7166.67	7999.67	7500.00	7555.45 b	1115.38	1689.71
2021	6500.00	6116.67	6050.00	6222.22 a	2365.82	3584.03
Average	6833.33 a	7058.17 a	6775 a			

Note: abc differences between values in a given row are statistically significant if the labels do not contain the same letter

Number of productive tillers per m^2

According to the results presented in Table 5 about the number of productive tillers/m^2, the variant 2 from the Opale, determines the highest average number (612.17) during the years compared to the control and it has a statistically significant difference. For the San Andrea variety, differences between the treatments in both years compared to the control are statistically non-significant.

Table 5. Number of productive tillers/m^2 for Opale and San Andrea

Opale	Variant 1	Variant 2	Control	Average	LSD	
					(α 0.05) *	(α 0.01) **
2020	432	540	429	467 a	85.43	129.42
2021	477*	684	668	610 b	160.93	243.80
Average	454.50 a	612.17 b	548.67 ab			
San Andrea	Variant 1	Variant 2	Control	Average	LSD	
					(α 0.05) *	(α 0.01) **
2020	571	696	615	627 b	96.65	146.42
2021	436	394	498	443 a	108.45	164.30
Average	504 a	545 a	557 a			

Note: abc differences between values in a given row are statistically significant if the labels do not contain the same letter

1000 kernel weight of paddy rice

The 1000 kernel weight of paddy rice for the Opale variety varies from 31.37 g - 32.57 g (Tab. 6). The mean value differences between treated variants and the control are not statistically significant. Similar to Opale, in the results for San Andrea there is not a big difference between the variants' averages and the control (34.97 g - 35.87 g) so there is no statistically significant difference.

Table 6. 1000 kernel weight of paddy rice (g) for Opale and San Andrea

Opale	Variant 1	Variant 2	Control	Average	LSD	
					(α 0.05) *	(α 0.01) **
2020	32.13	32.23	31.37	31.91 a	2.81	4.26
2021	32.57*	32.07	31.47	32.03 a	1.04	1.58
Average	32.35 a	32.15 a	31.42 a			
San Andrea	Variant 1	Variant 2	Control	Average	LSD	
					(α 0.05) *	(α 0.01) **

2020	34.77	35.50	35.67	35.31 a	1.27	1.92
2021	35.17	34.50**	36.07	35.24 a	0.93	1.40
Average	34.97 a	35.00 a	35.87 a			

Note: abc differences between values in a given row are statistically significant if the labels do not contain the same letter

1000 kernel of whole grain white rice

The results for the weight of 1000 kernels of white rice are shown in Table 7. For the Opale variety the highest weight average was determined in variant 2 (22.73 g) while the lowest values were noted in the control (22.42 g). Beside this, the differences between the treatments are not statistically significant. The differences between the treatments are statistically significant for San Andrea in both years. Therefore, the highest mean value (26.57 g) in 2020 is noted in variant 1 at 0.05 level of probability compared to the control (26.27 g) which was the lowest one. In 2021 the situation was completely different where the highest weight average was in the control (26.63 g) and the lowest was in the variant 2 (25.47 g). But if we analyze the overall picture from the comparison between the treatments in both years the differences are not statistically significant.

Table 7. 1000 kernel weight of white rice (g) for Opale and San Andrea

Opale	Variant 1	Variant 2	Control	Average	LSD	
					(α 0.05) *	(α 0.01) **
2020	22.40	22.57	22.20	22.39 a	0.44	0.67
2021	22.87	22.90	22.63	22.80 b	0.33	0.50
Average	22.63 ab	22.73 b	22.42 a			
San Andrea	Variant 1	Variant 2	Control	Average	LSD	
					(α 0.05) *	(α 0.01) **
2020	26.57*	26.30	26.27	26.38 a	0.26	0.39
2021	25.73	25.47*	26.63	25.94 a	1.05	1.60
Average	26.15 a	25.88 a	26.45 a			

Note: abc differences between values in a given row are statistically significant if the labels do not contain the same letter

Whole grain white rice yield and milling fractions for Opale

The Opale variety in Table 8 showed the following results for the whole grains yield and the rest of milling fractions: In 2020 and 2021 variant 2 showed the highest whole grains yield average (46.75%) and lowest brokens average (23.30%). The total milled rice average varies from 68.30 g to 71.77 g and the differences between treatments are not statistically significant. More than a few factors are commonly known as possible reasons for the breakage of rice during milling. Cracking of the grain is known to be one factor, since delayed harvesting and threshing and too rapid drying always increase the number of broken grains. Immature and chalky grains also are considered to break relatively easily. Moisture content and infestation equally appear to be contributing factors. Also, shape and hardness of the grains contribute to grain breakage, since long-grain and soft varieties are usually believed to be more susceptible to breakage than short-grain and hard varieties. On the other hand, the type and design of the milling equipment also may influence milling results. Rice breakage is related to milling conditions, particularly the prevailing relative humidity, the temperature and the extent of milling (Kashi, 1969).

Table 8. Milling fractions: whole grains, brokens, bran, and hull (%) for *Opale* variety

Opale						LSD	
Milling fractions	Year	Variant 1	Variant 2	Control	Average	(α 0.05) *	(α 0.01) **
Whole grains (%)	2020	32.70	48.03	43.30	41.34 a	8.75	13.26
	2021	41.53	45.47	48.17	45.06 a	3.05	4.62
Average		37.12 a	46.75 b	45.73 b			
Brokens (%)	2020	35.60	21.20	28.47	28.42 a	5.99	9.08
	2021	28.77**	25.40	23.20	25.79 a	2.97	4.5
Average		32.18 b	23.30 a	25.83 a			
Total milled rice (%)	2020	68.30	69.23	71.77	69.77		
	2021	70.30	70.87	71.37	70.85		
Average		69.30	70.05	71.57			
Bran (%)	2020	10.20	10.93	10.37	10.50 b	3.07	4.64
	2021	8.87	8.57	8.80	8.74 a	1.19	1.81
Average		9.54 a	9.75 a	9.58 a			
Hull (%)	2020	21.50	19.83	17.87	19.73a	1.81	2.74
	2021	20.83*	20.57	19.83	20.41 a	0.91	1.38
Average		21.17b	20.20ab	18.85 a			

Note: abc differences between values in a given row are statistically significant if the labels do not contain the same letter

Whole grain white rice yield and milling fractions for San Andrea

The results in Table 9 presented that the whole grain white rice values vary from 69.78% (variant 1) to 70.60% (control). The control showed the highest total milled rice average (71.44%) and the lowest brokens average (0.83%).

Table 9. Milling fractions: head rice yield (whole grains), brokens, bran, and hull (%) for San Andrea variety

San Andrea						LSD	
Milling fractions	Year	Variant 1	Variant 2	Control	Average	(α 0.05) *	(α 0.01) **
Whole grains (%)	2020	68.87	70.27	69.97	69.70 a	1.71	2.58
	2021	70.70	70.07	71.23	70.67 a	1.22	1.84
Average		69.78 a	70.17 a	70.60 a			
Brokens (%)	2020	0.93**	0.57	0.37	0.62 a	0.32	0.49
	2021	1.53	1.70	1.30	1.51 b	0.54	0.82
Average		1.23 b	1.13 ab	0.83 a			
Total milled rice (%)	2020	69.80	70.84	70.34	70.33		
	2021	72.23	71.77	72.53	72.18		
Average		71.02	71.31	71.44			
Bran (%)	2020	8.67	8.53	9.83	9.01 a	1.47	2.22
	2021	8.77	7.70	7.83	8.10 a	1.17	1.77
Average		8.72 a	8.12 a	8.83 a			
Hull (%)	2020	21.53	20.63	19.83	20.67 a	2.47	3.75
	2021	19.00	20.53	19.63	19.72 a	1.23	1.87
Average		20.27 a	20.58 a	19.73 a			

Note: abc differences between values in a given row are statistically significant if the labels do not contain the same letter

CONCLUSIONS

This study was conducted to evaluate the bioefficacy of the liquid organic fertilizer Orgalife, on some yield and quality properties on rice. The treatment of Opale and San Andrea rice varieties with Orgalife (once and double foliar application) had a significant impact on the biological, grain and straw yield, harvest index, number of productive tillers/m^2, 1000 kernel weight of whole grain white rice. The fertilizer Orgalife did not show significant impact on the head rice and 1000 kernel weight of paddy rice. There are many environmental factors (effect of cold water, temperature amplitudes) that determine the rice grain quality.

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