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Effect of soil works and fertilisation on the weight of 1,000 grains in winter two-row barley

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Abstract The yielding potential of each cultivar used when sowing materialises only under soil fertility optimum conditions (10). In beer two-row barley, particular attention should be paid to the cultivation technology (soil works and fertilisation). When establishing a fertilisation plan, one needs to take into account that accumulation in grains (barley and two-row barley) takes place during a short period of time. Thus, 83% of nitrogen, 84% of phosphorus and 87% of potassium are consumed during straw formation (April and May) (10). The unilateral effect of soil works had a span of 2 g, ranging between 55.21 g when scarification + disking and 57.21 g when ploughing + disking, on the background of a low variability between these works. Depending on active substance content, there is low variation within different variable groups: 52.50-56.67 g in the group yielding 60 kg a.s./ha; 55.83-56.67 g in the group yielding 120 kg a.s./ha; 57.67-61.17 g in the groups yielding over 180 kg a.s./ha. As for grain size, the variant $N_{90}P_{90}K_{60}$ (maximum of macro elements) had a significantly higher impact than the other combinations (a yield increase of over 5.16%). The analysis of multiple regression variance regarding the impact of the three macro elements on the weight of 1,000 grains (WTG) in two-row barley in 014 shows that 99.77% of the variability of this feature is due to the influence of the three macro elements.

Key words

winter two-row barley, soil works, fertilisation, weight of 1,000 grains, production

At present, due to the increased beer consumption, the area cultivated with two-row barley has expanded: this crop is cultivated in moister climates with moderate temperatures, i.e. in those climates that favour protein accumulation (2).

Winter two-row barley is cultivated during a period of 8-10 days so that the sum of temperatures between sowing and frosting be 500-600°C. According to this requirement, the optimal sowing time for all two-row barley cultivation areas in Romania is September 20 – October 5, with the first period reserved to northern and hilly areas (12).

Beer two-row barley needs, besides its chemical content (less proteins and more starch), large grains (a WTG of 40-48 g), evenness, even sprouting and high germination energy, so that malt can be produced in short time (9).

Barley and two-row barley do not thrive on improperly worked soil: the penetration strength of the tip is low and, on hard, temped soils, sprouting is slow, uneven and many plants simply die (11).

Barley and two-row barley require high-quality soil work when preparing the germinative bed: this is why ploughing needs to be done as soon as possible. The furrows need to be even and soil works need to help soil water conservation and make up an even sowing layer (1, 4, 5, and 8).

According to Hera and Borlan (1980), when establishing the optimal fertiliser rate we need to take into account planned yield, specific consumption and soil nutrient supplies.

In malt two-row barley, we need to apply all nutrients (N, P, K) because potassium enhances the starch content in the grains (3).

Material and Method

The trial was bifactorial of the 3 x 12 type, with 36 trial plots.

The trial factors were:

- **Factor A – soil works, with the graduations:** a_1 – ploughing + GD 5; a_2 – GD 5 (2X); a_3 – scarification + GD 5;
- **Factor B – fertilisation, with the graduations:** b_1 – $N_0P_0K_0$; b_2 – $N_0P_{60}K_0$; b_3 – $N_0P_0K_{60}$; b_4 – $N_{60}P_0K_0$; b_5 – $N_{60}P_{60}K_{60}$; b_6 – $N_{60}P_0K_{60}$; b_7 – $N_0P_{60}K_{60}$; b_8 – $N_{60}P_{60}K_{60}$; b_9 – $N_{90}P_{60}K_{60}$; b_{10} – $N_{90}P_0K_{60}$; b_{11} – $N_{90}P_{60}K_0$; b_{12} – $N_{90}P_{90}K_{60}$.

The cultivar used was SALAMANDRE, of French origin.

The trial was set on a typical chernozem, slightly gleyed, slightly semi-carbonatic, medium clay clay/medium clay clay, on medium fine carbonatic loessoid deposits of the Ap-Amk-Ack-Cca-Cgo type.

Data after measurements were statistically processed; we determined the mean, the mean standard deviation and the variability coefficient:

- mean: $\bar{x} = \frac{\sum x}{n}$;
- mean standard deviation: $s_{\bar{x}} = \sqrt{\frac{\sum x^2 - \frac{(\sum x)^2}{n}}{n-1}}$
- variability coefficient: $s_{\%} = \frac{s \times 100}{\bar{x}}$

To determine the significance of the differences between the variants studied, we processed trial data with variance analysis and t test for bifactorial trials on subdivided plots (Ciulca, 2006). The significance of the differences was expressed both with symbols (*; **; ***; ^{0}; ^{00}; ^{000}) and letters (a, b, c …); we considered significant the differences between variants noted with different letters.

The relations and links between macro element rates and yield were analysed with multiple regression: $y = a + b_1x_1 + b_2x_2 + b_3x_3$, (6).

Results and Discussions

According to the variance analysis results (Table 1), both soil works and fertilisation, as well as their interactions, had considerable statistically ensured influences on the WTG in winter two-row barley in 2014. Different combinations of macro elements had the highest contribution to the variability of this feature (47.95%), superior to that of soil works (27.97%). The combined effect of both factors also had a significant influence on the WTG (14.03%), considerably lower than their separate effects. Trial results were influenced 10.05% by other variation sources (not included in the trial).

Table 1

Variance analysis of the effect of soil works and fertilisation on the WTG in winter two-row barley (2014)

Variation source	SP	GL	S^2	F test
Total	3912.12	107		
Replicate	10.5	2	5.25	1.02
Soil work	52.38	2	26.19	5.09**
Work error	20.58	4	5.15	
Fertilisation	3158.61	11	287.15	8.73**
Soil works x Fertilisation	308.13	22	14.01	2.55**
Fertilisation error	361.92	66	5.48	

Taking into account the unilateral effect of soil works, WTG had a span of 2 g with values ranging between 55.21 g when applying scarification + disking and 57.21 g when using ploughing + disking, on the background of low variability between these soil works. As for the differences between the three soil works, ploughing produced a significant increase of the WTG (about 4%) compared to ploughing and scarification, when associate with disking. When applying other soil works, the differences in WTG were low and they had no significance whatsoever (Table 2).

Table 2

WTG in two-row barley with different soil works (2014)

Soil works	WTG (g)		Relative values (%)	Difference/Significance
$A_2 - A_1$	56.33	57.21	98.46	-0.88
$A_3 - A_1$	55.21	57.21	96.50	-2.00^{0}
$A_3 - A_2$	55.21	56.33	98.01	-1.12

$DL_{5\%}$ = 1.49 g, $DL_{1\%}$ = 2.46 g, $DL_{0.1\%}$ = 4.60 g

A_1 – Ploughing + Disking (2x); A_2 – Disking (2 x); A_3 – Scarification + Disking (2x)

The mean values of this feature under the effect of different macro element combinations (Table 3) had a span of 10.67 g, ranging between 50.50 g in the control variant and 61.17 g in the variant $N_{90}P_{90}K_{60}$, on the background of low variability (5.45%). Depending on active substance content, there were low variations within different variant groups: 52.50-56.67 g in the groups with 60 kg a.s./ha; 55.83-56.67 g in the groups with 120 kg a.s./ha; 57.67-61.17 g in the groups with over 180 kg a.s./ha.

Table 3

WTG in winter two-row barley with different fertilisation rates (2014)

Fertilisation rate	WTG (g)	Compared to $N_0P_0K_0$		Compared to the mean	
		Relative value (%)	Difference/ Significance	Relative value (%)	Difference/ Significance
$N_0P_0K_0$	50.50 h	100	Control	89.78	-5.75^{000}
$N_0P_{60}K_0$	53.17 fg	105.28	2.67*	94.52	-3.08^{00}
$N_0P_0K_{60}$	52.50 gh	103.96	2.00	93.33	-3.75^{00}
$N_{60}P_0K_0$	55.17 ef	109.24	4.67***	98.07	-1.08
$N_{60}P_{60}K_0$	56.67 cde	112.21	6.17***	100.74	0.42
$N_{60}P_0K_{60}$	56.50 cde	111.88	6.00***	100.44	0.25
$N_0P_{60}K_{60}$	55.83 de	110.56	5.33***	99.26	-0.42
$N_{60}P_{60}K_{60}$	57.67 bcd	114.19	7.17***	102.52	1.42
$N_{90}P_{60}K_{60}$	59.83 ab	118.48	9.33***	106.37	3.58**
$N_{90}P_0K_{60}$	57.83 bcd	114.52	7.33***	102.81	1.58
$N_{90}P_{60}K_0$	58.17 bc	115.18	7.67***	103.41	1.92
$N_{90}P_{90}K_{60}$	61.17 a	121.12	10.67***	108.74	4.92***
Trial mean	56.25	111.39	5.75***	100	Control

- $DL_{5\%}$ = 2.21 g, $DL_{1\%}$ = 2.93 g, $DL_{0.1\%}$ = 3.80 g

Compared to the trial mean, only the variants $N_{90}P_{60}K_{60}$ and $N_{90}P_{90}K_{60}$ increased the WTG significantly (6.37-8.74%). In the control variant and in the variant with unilateral application of macro element, the values of this feature were significantly lower than the mean (6.67-10.22%).

Taking into account multiple variant comparisons of grain size, we see that the variant $N_{90}P_{90}K_{60}$ (maximum amount of macro elements) had a significantly superior efficacy than mot combinations (increases of over 5.16%). Likewise, applying the variant $N_{90}P_{60}K_{60}$ produced increases of over 3.16 g compared to the variants with up to 120 kg a.s./ha.

Compared to the control variant, fertilisation with macro elements had a significant effect on WTG in two-row barley in 2014, determining very significant increases of over 9.24%. We also see that yield were increasing somehow proportionally with the amount of active substance applied. Unilateral fertilisation with nitrogen had a significantly higher effect compared with unilateral separate effects of treatments with phosphorus and potassium: from this perspective, we see that applying unilaterally 60 kg of potassium had a low insignificant effect on WTG.

Taking into account the combined effect of the two factors on grain size in winter two-row barley in 2014 (Table 4 and Figure 1), we see that fertilisation had a higher effect on this feature when applying scarification + disking. In the variants fertilised with $N_{60}P_{60}K_0$ and $N_{90}P_{90}K_{60}$, land preparation had stronger effects on the variability of WTG.

Table 4

Effect of soil works and fertilisation on WTG in winter two-row barley (2014)

Fertilisation	Soil works				
	A1	A2	A3	$\bar{x} \pm s_{\bar{x}}$	$S_{\%}$
$N_0P_0K_0$	52.0 f	50.0 e	49.5 d	50.50±0.49	2.89
$N_0P_{60}K_0$	54.5 def	53.0 de	52.0 cd	53.17±0.53	2.97
$N_0P_0K_{60}$	53.5 ef	52.5 de	51.5 cd	52.50±0.46	2.65
$N_{60}P_0K_0$	56.0 cde	55.5 cd	54.0 bc	55.17±0.35	1.92
$N_{60}P_{60}K_0$	58.0 bcd	57.0 bc	55.0 bc	56.67±0.50	2.65
$N_{60}P_0K_{60}$	57.5 bcd	57.0 bc	55.0 bc	56.50±0.42	2.26
$N_0P_{60}K_{60}$	56.5 cde	56.0 cd	55.0 bc	55.83±0.41	2.19
$N_{60}P_{60}K_{60}$	58.0 bcd	57.5 b	57.5 ab	57.67±0.32	1.68
$N_{90}P_{60}K_{60}$	60.5 ab	60.0 ab	59.0 a	59.83±0.41	2.05
$N_{90}P_0K_{60}$	58.5 bc	58.0 abc	57.0 ab	57.83±0.37	1.93
$N_{90}P_{60}K_0$	59.0 abc	58.0 abc	57.5 ab	58.17±0.33	1.72
$N_{90}P_{90}K_{60}$	62.5 a	61.5 a	59.5 a	61.17±0.46	2.28
$\bar{x} \pm s_{\bar{x}}$	57.21±0.49	56.33±0.54	55.21±0.51	56.25±0.31	
$S_{\%}$	5.19	5.79	5.60	5.67	

- Soil works $DL_{5\%}$ = 3.74 g, $DL_{1\%}$ = 4.95 g, $DL_{0.1\%}$ = 6.43 g
- Fertilisation $DL_{5\%}$ = 3.82 g, $DL_{1\%}$ = 5.07 g, $DL_{0.1\%}$ = 6.58 g

A_1 – Ploughing + Disking (2x); A_2 – Disking (2 x); A_3 – Scarification + Disking (2x)

Are considered significant the differences between combinations noted with different letters (a, b, c …)

When working the soil with ploughing + disking (2x), fertilization generated a span of 10.5 g with limits between 52 g in the control variant and 62.5 g in the variant $N_{90}P_{90}K_{60}$. Thus, the variant treated with maximum amount of active substance produced a WTG significantly superior with over 6.64% to most variants except for $N_{90}P_{60}K_{60}$ and $N_{90}P_{60}K_{0}$. Applying unilaterally 60 kg of phosphorus and potassium had a lower insignificant effect on yield.

When only disking the soil, treatment variability ranged between 50 and 61.5 g (in the control variant and in the variant treated with maximum amount of macro elements, respectively). Here again, unilateral fertilisation with 60 kg of phosphorus or potassium had no significant influence on grain size in winter two-row barley in 2014. In exchange, applying unilaterally 60 kg of nitrogen a.s./ha had a significantly equal efficacy as treatments with 120 kg a.s., no matter the nature of the combinations. Fertilising with maximum rates generated a significant increase of the WTG compared to the variants treated with up to 180 kg a.s./ha.

When using scarification + disking, treatments with fertilisers determined a variation of 10 g of the WTG. Compared to the control variant, applying unilaterally 60 kg of phosphorus or potassium produced an insignificant alteration of this feature of 2-2.5 g, while applying unilaterally nitrogen had a more consistent increase of the WTG of 4.5 g. Treatments with 180-230 kg a.s./ha produced increases of 15.15-20.2% of this feature. In general, no matter the soil work or treatment, only variations above 60 kg of active substance had significant effects on grain size in winter two-row barley in 2014.

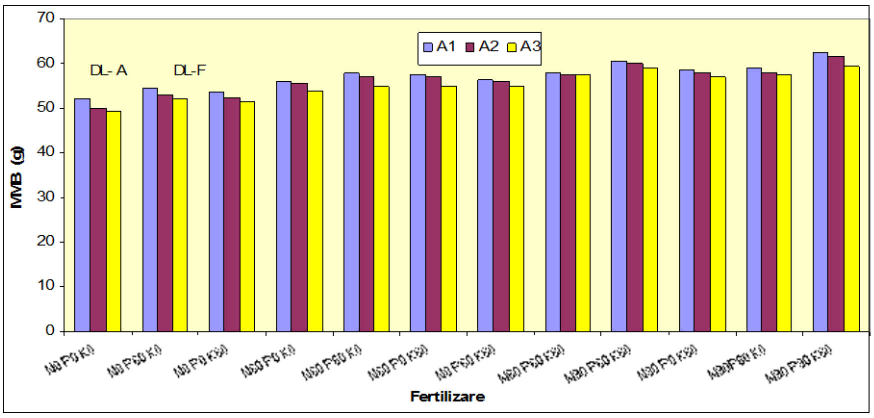

Fig. 1. WTG in winter two-row barley with different soil works and fertilisation rates (2014)

Multiple regression variance analysis regarding the influence of the three macro elements on WTG in winter two-row barley in 2014 (Table 5) show that 99.77% of the variability of this feature I due to the influence of the three macro elements. Among treatments, nitrogen fertilisation had a predominant distinctly significant contribution (74.82%) to grain size, followed by phosphorus fertilisation (14.73%), while potassium fertilisation had a lower though statistically ensured influence (8.22%).

Table 5

Multiple regression variance analysis between WTG in winter two-row barley and nitrogen phosphorus and potassium fertilisation (2014)

Variability source	SP	GL	S^2	F test
Regression	101.10	3	33.70	F=116.71**
Rate of N (x_1)	77.37 (74.82%)	1	77.37	F=267.95**
Rate of P (x_2)	15.23 (14.73%)	1	15.23	F=52.74**
Rate of K (x_3)	8.50 (8.22%)	1	8.50	F=29.44**
Other source	2.31 (2.23%)	8	0.29	
Total	447.24	11		

$y = 51.09 + 0.062x_1 + 0.04\ x_2 + 0.03\ x_3$; $R^2 = 0.9977$; $R^2_a = 0.9693$; $R = 0.9888$; SDE = 0.54 g; DW = 2.09

The regression model adopted for the analysis of the relations between WTG and different macro elements show a strong statistical ensurance (error = ±0.54 g) if we take into account that with no fertilisation the value I about 51.10 g. The number of measurements corresponded to this type of stud because the values of the two coefficients were very close. Taking into account that the Durbin-Watson index I above 1.4, possible errors are not self-correlated and the order of macro elements in the regression equation did not influence the estimated value of WTG.

Conclusions

Research regarding the influence of soil works and fertilisation rates on WTG allow us to draw the following conclusions:

1. Soil works and fertilisation rates and the interaction between the two factors had a considerable statistically ensured influence on WTG in winter two-row barley in 2014.
2. The unilateral effect of soil works had a span of 2 g with values ranging between 55.21 g when using scarification + disking and 57.21 g when using ploughing + disking, with low variability between these two soil works.
3. Depending on the content of active substance, there was low variation within the different variant groups: 52.50-56.67 g in variants treated with 60 kg a.s./ha; 55.83-56.67 g in variants treated with 120 kg a.s./ha; 57.67-61.17 g in variants treated with over 180 kg a.s./ha.
4. As for grain size, the variant $N_{90}P_{90}K_{60}$ (maximum mounts of macro elements) had a significantly higher effectiveness than the other combinations (yield increase of over 5.16%). Likewise, the variant $N_{90}P_{60}K_{60}$ produced yield increase of over 3.16 g compared to the variants with up to 120 kg a.s./ha.
5. The analysis of multiple regression variance regarding the influence of the three macro elements on WTG in winter two-row barley in 2014 shows that 99.77% of the variability of this feature is due to the influence of the three macro elements.
6. Nitrogen fertilisation had a distinctly significant predominant contribution (74.82%) on grain size; it was followed by phosphorus fertilisation (14.73%), while potassium fertilisation had a lower, though statistically ensured contribution (8.22%).

Bibliography

1. Alda S., 2004 – *Agrotehnică şi herbologie.* Editura Eurobit, Timişoara.
2. Bîlteanu Gh., 1974 – *Fitotehnie.* Editura Didactică şi Pedagogică, Bucureşti.
3. Bîtleanu Gh., Bîrnaure V., 1979 – *Fitotehnie,* Ed. Ceres, Bucureşti.
4. Cârciu Gh., 2003 - *Agrotehnică.* Editura Agroprint, Timişoara.
5. Cârciu Gh., 2006 - *Managementul lucrărilor solului,* Editura Eurobit Timişoara
6. Ciulca S., 2006 - Metologii *de experimentare în agricultură şi biologe.,* Ed. Agroprint, Timişoara
7. Hera Cr. şi Borlan Z., 1980 – Ghid pentru alcătuirea planurilor de fertilizare, Ed. Ceres, Bucureşti
8. Manea D.N., 2006 - *Agrotehnică şi herbologie*, Editura Eurobit Timişoara.
9. Muntean L.S., Borcean I., Axinte M., Roman G.V., 2001 – *Fitotehnie,* Ed. ”Ion Ionescu de la Brad”.
10. Tarjoc F.N., 2011 – Cercetări privind influenţa fertilizării asupra producţiei şi calităţii orzului şi orzoaicei folosite pentru industria berii, Teză de doctorat, Timişoara, Cond. Ştiinţific:prof. univ. dr. Tabără Valeriu
11. Zamfirescu N., Velican V., Văluţa Gh., 1956 – *Fitotehnie,* Ed. Agro-silvică Bucureşti, pag. 329 – 371)
12. (https://www.gazetadeagricultura.info).