**Kazimierz KLIMA, Teofil ŁABZA, Andrzej LEPIARCZYK**
Agricultural University in Kraków, Department of Agrotechnology and Agricultural Ecology
al. Mickiewicza 21; 31-120 Kraków; Poland
e-mail: rrklima@cyf-kr.edu.pl

# YIELDING OF SPRING TRITICALE GROWN UNDER ORGANIC AND INTEGRATED SYSTEMS OF FARMING AND ECONOMIC INDICATORS OF ITS PRODUCTION

*Summary*

*A one factor field experiment was performed at the Experimental Station in Czyrna near Krynica, in a period from 2010 to 2013. The objective of the experimental research was to determine the yielding of spring triticale grown under the organic and integrated systems of farming and the economic efficiency of its production. Based on the experimental results, it was found that the grain yield of spring triticale grown under the organic system of farming decreased by 6% on average compared to the integrated system. The direct costs in the integrated system were 36% higher than in the organic system. The value of materials and means of agricultural production used in the integrated system was almost three times as high as that in the organic one. Under the organic system of farming, the direct surplus and the direct profitability indicator were higher compared to the integrated system.*
***Key words***: *spring triticale, organic system, integrated system, costs of production*

# PLONOWANIE I WSKAŹNIKI EKONOMICZNE UPRAWY PSZENŻYTA JAREGO W SYSTEMIE EKOLOGICZNYM I INTEGROWANYM

*Streszczenie*

*W latach 2010-2013 przeprowadzono jednoczynnikowe doświadczenie polowe w Stacji Doświadczalnej Czyrna k. Krynicy. Celem badań było określenie plonowania i efektywności ekonomicznej uprawy pszenżyta jarego w systemie ekologicznym i integrowanym. W wyniku badań stwierdzono, iż średnie zmniejszenie plonu ziarna pszenżyta jarego uprawianego w systemie ekologicznym w porównaniu z uprawą w systemie integrowanym wyniosło 6%. Koszty bezpośrednie w systemie integrowanym były o 36% większe niż w systemie ekologicznym. Wartość materiałów i środków produkcji w systemie integrowanym była blisko trzykrotnie większa niż w systemie ekologicznym. Nadwyżka bezpośrednia i wskaźnik opłacalności bezpośredniej w systemie ekologicznym osiągnęły większe wartości niż w systemie integrowanym.*
***Słowa kluczowe***: *pszenżyto jare, system ekologiczny, system integrowany, koszty produkcji*

## 1. Introduction

The application of integrated and organic system of farming [15] is one of the methods to reduce the use of chemicals in agriculture. Integrated farming (IF) combines rational agrotechnology and a limited utilization of mineral fertilizers and pesticides [9]. Owing to this approach, unfavourable effects on environment are reduced and the management effectiveness in agriculture is improved [8]. In agricultural terms, IF is a fusion of good agricultural practice, integrated plant protection, and biological improvement [10].

Although there are numerous publications on organic [7] and integrated [3] farming, the issue of how to determine the economic and agricultural aspects of growing cereals in line with the assumptions of the two above named farming systems is still open.

The objective of the experimental research was to determine the yield of spring triticale grown under the organic and integrated farming systems and the economic efficiency of its production.

## 2. Materials and methods

The subject of the experimental research pertained to a one factor field experiment performed at the Mountain Experimental Station owned by the Department of the Agrotechnology and Agricultural Ecology, situated in Czyrna near the town of Krynica (in the Beskid Niski Mountain Range, at 545 m a.s.l.). The experiment was carried out in a period between 2010 and 2013.

The factor applied included spring triticale grown under the organic and integrated systems of farming. The surface area of the experimental fields was 22 $m^2$; the experiment was repeated four times. The amount of spring triticale (Milewo variety) sown was 200 $kg \cdot ha^{-1}$ (568 pcs of grains per 1 $m^2$). Potatoes grown on a field fertilized with 33 $t \cdot ha^{-1}$ of manure were a forecrop used in the two studied systems. The spring triticale was usually sown at the beginning of the second half of April and harvested in the second decade of August. Under the integrated farming system, mineral fertilizers were applied and their mass was calculated based on such factors as, among other things, soil nutrient availability and forecrop. Prior to pre-winter ploughing, 59 $kg \cdot ha^{-}$ of $P_2O_5$ and 99 $kg \cdot ha^{-1}$ of $K_2O$ were applied. A dose of 45 $kg \cdot ha^{-1}$ of N was added prior to sowing. The grains for sowing were treated with a Vitavax 200 FS dressing preparation, its amount was 300 ml per 100 kg of grains. The growth of weeds was controlled by adding 24 g of a Granstar herbicide per 1 ha at the end of the tillering phase. The level of pest and disease infection of spring triticale was below the thresholds of biological and economic harmfulness; thus, no fungicides or insecticides were sprayed.

Under the organic farming, neither mineral fertilizers nor pesticides were applied. Harrowing in spring helped with reducing weeds.

The amount of expenditures on means of production was assessed based on both the technology used in the field experiment and the effective consumption of sowing material (seed grains), pesticides, and fertilizers the amount of which was calculated proportionally to 1 ha of field surface. The costs of the applied means of production and the market value of products was taken from the Market Analyses developed by IERiGŻ-PIB (National Research Department of the Institute of Agricultural and Food Economics) [17] and from the Calculations for Agricultural Production made by the Division of Economics and Entrepreneurship, WODR in Nawojowa (Farming Advice Services in Nawojowa) [1]. The assumed prices and costs refer to the second half-year of 2013. The volume of human labour consumption was presented acc. to Klikocka et al. [6]; the costs of the agricultural treatment procedures performed were determined using a method as suggested by Muzalewski [11]. The direct surplus was calculated as a difference between the value of products produced (mean yield of grains over 4 years) and the direct costs incurred. The direct profitability indicator (production value in relation to direct costs) was computed using a method by Klepacki and Gołębiewska [5]. The labour consumption was 9.1 man-hr $\cdot$ ha$^{-1}$ in the integrated farming system, and 10.1 man-hr $\cdot$ ha$^{-1}$ in the organic system.

The experimental field consisted of a brown soil made up of flysh rock waste; the soil was from a granulometric group of medium, skeletal clays and it was classified into the 12$^{th}$ oats-potato-mountain complex of agricultural soils and into the 5$^{th}$ class of soil quality class.

A mean annual air temperature for a multi-year period is 6.1$^{o}$C; the vegetation period comprises 179 days. Considering the criteria established by Kaczorowska [4] and the monthly precipitation totals, the vegetation period in 2012 can be classified as a dry period, in 2013 as an ordinary period, in 2011 as a wet period, and in 2010 as a very wet period (Tab. 1). When based on the research results received by Ścigalska [14], it may be said that during the ongoing experiment, the most favourable precipitation distribution for spring triticale was that of 2011.

### 3. Results and discussion

With the calculated dose of mineral fertilizers applied in the integrated system, the spring triticale grain yield increased by 6% (Tab. 2). Nieróbcy et al. [12] had the same result; they reported that an average dose of mineral fertilizers, in particular of nitrogen, did not cause a substantial increase of the grain yield.

A small difference between the grain yields obtained in the organic and integrated farming systems could be attributed to the proper forecrop used in the two systems, i.e. to the potatoes grown on manure. The analysis of the synergic effect of years and farming systems showed that the biggest differences between the yields from the two farming systems were in 2013. One of the reasons thereof could lie in the precipitation deficit in July and August 2013 (Tab. 1). Insufficient humidity during the grain ripening and fill period could reduce the grain yield, especially under the organic farming system, where no mineral fertilization was applied. Ścigalska [14] pointed at that particular reason of a decreased grain yield. An economic analysis is necessary to reliably assess the production of spring triticale grown under the organic and integrated systems. It is because, at the present stage of the transformation in agriculture, the economic factor has an essential effect on agrotechnology [2].

Table 1. Monthly precipitation totals (mm) and air temperatures ($^{o}$C)
*Tab. 1. Miesięczne sumy opadów atmosferycznych (mm) oraz temperatury powietrza ($^{o}$C)*

| *Years* Lata | *Months* / Miesiące | | | | | IV-VIII | I-XII |
|---|---|---|---|---|---|---|---|
| | IV | V | VI | VII | VIII | | |
| | *Precipitation (mm)* / Opady | | | | | | |
| 2010 | 65,8 | 234,2 | 226,6 | 131,6 | 144,5 | 802,7 | 1170,7 |
| 2011 | 106,3 | 72,1 | 44,4 | 278,4 | 85,6 | 586,8 | 732,2 |
| 2012 | 56,6 | 20,6 | 167,7 | 82,2 | 63,3 | 390,4 | 715,8 |
| 2013 | 24,7 | 118,0 | 202,4 | 33,1 | 32,9 | 411,1 | 800,4 |
| 1961-1990 | 62 | 85 | 105 | 115 | 98 | 465 | 848 |
| | *Temperature ($^{o}$C)* / Temperatura | | | | | | |
| 2010 | 8,5 | 12,0 | 16,6 | 19,7 | 18,5 | 15,3 | 7,50 |
| 2011 | 8,9 | 12,3 | 17,1 | 16,3 | 17,9 | 14,5 | 7,47 |
| 2012 | 8,2 | 13,8 | 16,2 | 18,9 | 17,7 | 14,9 | 7,27 |
| 2013 | 7,2 | 13,1 | 15,5 | 18,1 | 17,7 | 14,3 | 7,30 |
| 1961-1990 | 6,2 | 11,5 | 14,2 | 16,0 | 14,8 | 12,6 | 6,06 |

*Source: own work / Źródło: opracowanie własne*

Table 2. Yield (t $\cdot$ ha$^{-1}$) of spring triticale grown under organic and integrated systems of farming
*Tab. 2. Plon ziarna (t $\cdot$ ha$^{-1}$) pszenżyta jarego uprawianego w systemie ekologicznym i integrowanym*

| Years (B) / *Lata* | Farming system *System rolniczy (A)* | | Mean value *Średnio* |
|---|---|---|---|
| | Organic *Ekologiczny* | Integrated *Integrowany* | |
| Grain Yield (t per ha) / *Plon ziarna (t $\cdot$ ha$^{-1}$)* | | | |
| 2010 | 2,88 | 3,01 | 2,94 |
| 2011 | 3,49 | 3,72 | 3,60 |
| 2012 | 2,93 | 3,09 | 3,01 |
| 2013 | 3,02 | 3,26 | 3,14 |
| Mean value / *Średnio* | 3,08 | 3,27 | 3,17 |
| LSD $_{0,05}$ / *NIR* $_{0,05}$ - | A – 0,069; B – 0,130; AxB – 0,158 | | |

*Source: own work / Źródło: opracowanie własne*

The data in Table 3 prove that the costs of farming treatment procedures under the organic farming are higher by 29% than those under the integrated system. On the other hand, under the integrated farming, the costs of materials and means of production were almost 3 times higher (Tab. 4) owing to the high costs of mineral fertilizers; those costs account for 33.8% of the total direct costs (Tab. 3). Among other things, those high costs of mineral fertilizers in the integrated system equalling 782 zł·ha$^{-1}$ (Tab. 4) caused, in the first place, that the direct surplus was negative (-91 zł·ha$^{-1}$, Tab. 5) under this farming system. Nowak et al. [13] also highlight that, as regards the general costs of cereal production, the percentage of material and production means costs (inclusive mineral fertilizers) therein is too high. Under the integrated farming, the direct costs were higher by 36% compared to the organic system (Tab. 4) and the value of products produced using the organic farming was only lower by 6% than that of those produced under the integrated system (Tab. 5). However, under the organic farming, the direct surplus without subsidies was by up to 710 zł·ha$^{-1}$ larger than that in the organic system. Under the organic farming, the direct surplus with subsidies was by up to 1140 zł·ha$^{-1}$ larger than in the integrated system.

Among other things, this is to be attributed to the fact that farmers using organic farming receive higher subsidies than farmers who apply integrated farming. Wrzaszcz and Zegar [16] report a similar result; they conclude that the organic farming could be environmental friendly and, at the same time, provide satisfactory economic indicators.

All the data ref. to the economic assessment of producing spring triticale as presented in this paper, emphasizes that the organic farming used to grow spring triticale could be more profitable than the integrated growing of that species. In the reference to available literature, there are no results of research on organic and integrated growing of spring triticale. Thus, it may be said that the result obtained by the authors of this paper is one of the first attempts in Poland to determine the productivity and economic efficiency of spring triticale production using the organic and integrated systems of farming.

Table 3. Cost structure [%] of producing spring triticale using organic and integrated systems of farming
*Tab. 3. Struktura kosztów produkcji [%] pszenżyta jarego uprawianego w systemie ekologicznym i integrowanym*

| Specification / *Wyszczególnienie* | Farming system / *System rolniczy* | |
|---|---|---|
| | Organic *Ekologiczny* | Integrated *Integrowany* |
| Direct costs / *Koszty bezpośrednie* | 100,0 | 100,0 |
| Costs of treatments, including / *Koszty zabiegów, w tym:* | 76,9 | 47,9 |
| Soil tillage / *Uprawa roli* | 14,8 | 9,5 |
| Mineral fertilization / *Nawożenie mineralne* | | 1,1 |
| Sowing / *Siew* | 7,3 | 4,7 |
| Plant care and protection / *Pielęgnacja i ochrona* | 6,5 | 2,3 |
| Harvesting and transport / *Zbiór i transport* | 41,5 | 26,4 |
| Human labour / *Praca ludzka* | 6,8 | 3,9 |
| Materials and means of production including / *Materiały i środki, w tym:* | 23,1 | 52,1 |
| Mineral fertilizers / *Nawozy mineralne* | | 33,8 |
| Seed grain / *Ziarno siewne* | 23,1 | 14,7 |
| Plant protection products, including: / *Środki ochrony roślin, w tym:* | | 3,6 |
| Seed dressings / *Zaprawy* | | 0,6 |
| Herbicides / *Herbicydy* | | 3,0 |

*Source: own work / Źródło: opracowanie własne*

Table 4. Cost structure [PLN·ha$^{-1}$] of producing spring triticale using organic and integrated systems of farming
*Tab. 4. Struktura kosztów produkcji [PLN·ha$^{-1}$] pszenżyta jarego*

| Specification / *Wyszczególnienie* | Farming system / *System rolniczy* | |
|---|---|---|
| | Organic *Ekologiczny* | Integratet *Integrowany* |
| Direct costs / *Koszty bezpośrednie* | 1475 | 2314 |
| Costs of treatment, including / *Koszty zabiegów, w tym:* | 1135 | 1109 |
| Soil Tillage / *Uprawa roli* | 219 | 219 |
| Mineral fertilization / *Nawożenie mineralne* | | 26 |
| Sowing / *Siew* | 108 | 108 |
| Care and protection / *Pielęgnacja i ochrona* | 96 | 54 |
| Harvesting and transport / *Zbiór i transport* | 611 | 611 |
| Human labour / *Praca ludzka* | 101 | 91 |
| Materials and means of production including: / *Materiały i środki, w tym:* | 340 | 1205 |
| Mineral fertilizers / *Nawozy mineralne* | | 782 |
| Seed grain / *Ziarno siewne* | 340 | 340 |
| Plant protection products, including:/ *Środki ochrony roślin, w tym:* | | 83 |
| Seed dressings / *Zaprawy* | | 15 |
| Herbicides / *Herbicydy* | | 68 |

*Source: own work / Źródło: opracowanie własne*

Table 5. Economic efficiency indicators of spring triticale production
*Tab. 5. Wskaźniki ekonomicznej sprawności produkcji pszenżyta jarego*

| Specification / *Wyszczególnienie* | Farming system / *System rolniczy* | |
|---|---|---|
| | Organic *Ekologiczny* | Integrated *Integrowany* |
| Production value (PLN·ha$^{-1}$) / *Wartość produkcji* | 2094 | .2223 |
| Direct subsidies (PLN·ha$^{-1}$) / *Dopłaty bezpośrednie* | 1760 | 1330 |
| Value of production with subsidies (PLN·ha$^{-1}$) / *Wart. produkcji z dopłatami* | 3854 | 3553 |
| Direct costs (PLN·ha$^{-1}$) / *Koszty bezpośrednie* | 1475 | 2314 |
| Direct surplus without direct subsidies (PLN·ha$^{-1}$) / *Nadwyżka bezpośrednia bez dopłat* | 619 | -91 |
| Direct surplus with direct subsidies (PLN·ha$^{-1}$) / *Nadwyżka bezpośrednia z dopłatami* | 2379 | 1239 |
| Percentage of direct subsidies in direct surplus (%) / *Udział dopłat w nadwyżce bezpośredniej (%)* | 74 | 107 |
| Direct profitability indicator / *Wskaźnik opłacalności bezpośredniej* | | |
| Without direct subsidies / *Bez dopłat* | 1,42 | 0,96 |
| With direct subsidies / *Z dopłatami* | 2,61 | 1,53 |

*Source: own work / Źródło: opracowanie własne*

## 4. Conclusions

1. The spring triticale grain yield produced using the organic farming system decreased by 6% compared to the integrated farming system.
2. In the integrated farming, the direct costs were higher by 36% than in the organic farming.
3. The value of materials and means of production under the integrated farming system was almost three times larger than that under the organic system.
4. The direct surplus and the direct profitability indicator were larger in the organic farming than in the integrated farming.

## 5. References


[1] Bednarz B., Pobereżnik B., Pisarz A., Żardecka G. 2012. Kalkulacje produkcji rolniczej. WODR Karniowice.
[2] Felczak T. 2014. Czynniki kształtujące wartość uzyskiwanego dochodu z rodzinnego gospodarstwa rolnego. Roczniki Naukowe SERiA, t. XVI, z. 4: 80-84.
[3] Jaśkiewicz B. 2014. Wpływ integrowanej technologii produkcji na plonowanie dwóch odmian pszenżyta ozimego w warunkach monokultury zbożowej. Fragm. Agron., 31(4): 28-36.
[4] Kaczorowska Z. 1962. Opady w Polsce w przekroju wieloletnim. Prace Geogr., IG PAN, 33: 1-107.
[5] Klepacki B., Gołębiewska B. 2002. Opłacalność produkcji ziemniaków jadalnych. W: Produkcja i rynek ziemniaków jadalnych. Red. J. Chotkowski. Wyd. Wieś Jutra, Warszawa.
[6] Klikocka H., Głowacka A., Juszczak D. 2011. Wpływ zróżnicowanych sposobów uprawy roli i nawożenia mineralnego na efekty ekonomiczne uprawy jęczmienia jarego. Fragm. Agron., 28(2): 44-54.
[7] Klima K., Łabza T., Lepiarczyk A. 2014a. Participation of elements of cropping in the forming of the crop of glumiferous oats grown using traditional and organic systems. Journal of Research and Application in Agricultural Engineering, vol. 59(3): 115-118.
[8] Klima K., Łabza T., Lepiarczyk A. 2014b. Rolnicze i ekonomiczne aspekty uprawy jęczmienia jarego w systemie konwencjonalnym i integrowanym. Fragm. Agron., 31(2): 26-41.
[9] Korbas M., Mrówczyński M. 2011. Metodyka integrowanej ochrony pszenżyta ozimego i jarego. Wyd. IOR-PIB, Poznań.
[10] Królikowska M.A. 2012. Jakość bulw ziemniaka odmiany Zeus nawożonego wsiewkami międzyplonowymi w integrowanym i ekologicznym systemie produkcji. Rozprawa doktorska. Uniwersytet Przyrodniczo-Humanistyczny w Siedlcach.
[11] Muzalewski A. 2009. Koszty eksploatacji maszyn. Wyd. IBMER Warszawa.
[12] Nieróbca P., Grabiński J., Szeleźniak E. 2008. Wpływ intensywności technologii uprawy zbóż w płodozmianie zbożowym na efektywność produkcyjną I ekonomiczną. Acta Sci. Pol. Agricultura, 7(3): 73-80.
[13] Nowak A., Haliniarz M., Kwiatkowski C. 2014. Aspekty ekonomiczne wybranych technologii produkcji pszenicy jarej. Roczniki Naukowe SERiA, t. XVI, z. 2: 200-205.
[14] Ścigalska B. 2001. Plonowanie pszenżyta jarego w zmianowaniu i monokulturze na glebie kompleksu żytniego dobrego. Zesz. Nauk. AR w Krakowie, ser. Rozprawy, z. 274, 98.
[15] Saha S. 2010. Soil Functions and Diversity in Organic and Conventional Farming. Sociology, Organic Farming, Climate Change and Soil Science. Sustainable Agriculture Reviews, 3: 275-301.
[16] Wrzaszcz W., Zegar J.S. 2014. Sprawność ekonomiczna wybranych form rolnictwa przyjaznego dla środowiska przyrodniczego. Roczniki Naukowe SERiA, t. XVI, z. 1: 226-232.
[17] Zalewski A. (red.). 2013. Analizy rynkowe. Rynek środków produkcji dla rolnictwa. Stan i perspektywy. MRiRW, ARR, IERiGŻ, Warszawa.



***The project was performed within the activities as pointed out in the Statutes; Topic No. 3124: Effect of agrotechnological factors on yielding of plants and impact of habitat conditions.***
***Projekt wykonano w ramach Działalności Statutowej, temat nr 3124: Wpływ czynników agrotechnicznych na plonowanie roślin i oddziaływanie siedliskowe.***