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# YIELD AS AN INDICATOR OF PROGRESS IN PRODUCTION OF MUSHROOMS *Agaricus bisporus* (Lange, Sing)

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**Abstract**. The total yield of mushrooms depends on the amount and quality of the applied substrate. The results given in this study concern the proportions of quality classes of mushrooms in the total yield. This study presents data on yield classes of mushrooms over the four years of the study in terms of months of the year. All the evaluated periods of culture, irrespective of the year and months, varied in terms of the volume and quality of produced explanation yield. The highest increase in yield in the successive cultures was recorded for mushrooms class Exthra. These results show that the direction of development for mushroom production was correct. The advantage of yield-forming property of phase III compost over the yield-forming efficiency of phase II. Its rate of development was not very intensive.

**Key words**: mushrooms, yield class, periods of culture

## INTRODUCTION

Analysis of development trends in the production of mushrooms was presented in terms of quarters and months in a study entitled [Gapiński et al. 2010]. It characterizes the production activity of a company in terms of months and quarters of the year. An increase in the volume of yield in kg $m^{-2}$ was higher than the trend for an increase in substrate dry matter in kg $m^{-2}$, which shows that the volume of the increase in yield was also affected by other factors. Van den Munckhof-Vedder [1996] presented the principles of a trational harvest method to ensure yield of premium quality and profitability of mushroom culture, which provided a foundation for the requirements of choice classification**.** Gerrits [1969] reported that the analysis of linear regression for yield indicates

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a significant dependence (r = 0.91) of the volume of yield on the amount of organic matter and water content in the substrate.

The sustained mushroom yields are conditioned by optimal microclimate factors inside the cultivation room and the quality of compost preparation regarding its pasteurization and conditioning [Horgos and Becherescu 2008]. Royse and Chalupa [2009] argued that the amount of additives enriching phase II compost with nitrogen and its combination rate had a significant effect on yield and an increase in biological efficiency (BE). Grogan et al. [2000] proved that selective substrate, analyzed to detect the presence of mould fungi, should not contain any other fungi except for *Scytalidium thermophilum*.

## MATERIAL AND METHODS

The experimental material comprised yields of mushrooms from 173 cultures, which were characterized in terms of the yield potential of the substrate in a study entitled Dependence of the yield of mushrooms *Agaricus bisporus* (Lange, Sing) on the applied substrate [Gapiński et al. 2010]. The present study consisted in an analysis of weight mass yield of mushrooms in terms of quality classes and its distribution throughout the year. All the collected data were analyzed statistically, together with descriptive analysis of the dependent variable (y) of yield, which made it possible to determine the effect of modification of direction for yield changes. Determination of the correlation function and regression coefficient facilitated an assessment of changes in the volume of individual yield classes in the period of years and months of the year on changes in independent variables.

Statistical analysis was conducted based on the Statistical software 6.0 Stat Soft and on the analysis of descriptive statistics of Microsoft Excel and theoretical foundations developed by Brandt [2002] and Kala [2005]. In the descriptive analysis linear regression functions were applied. The fit index $R^2$, which defines the percentage of fit of a regression function to reality, i.e. what proportion of yield of the dependent variable (y) was explained by variation of the in dependent variable (x), was applied. The statistically significant dependence was denoted on Figures as $R^2$.

In the evaluation of recorded results from studies on the volume and quality of yield the following components of descriptive statistics were used, giving the mean value, the percentage proportions of quality classes in the total yield, standard deviation, range, median, variances, average deviation from mean, minimum and maximum values of analyzed traits as well as their effect on the volume of yield. Results of studies presented here include the analysis of yield of mushrooms over a period of four years, which constitutes evidence for changes in yield quality classes and their trends, indicating progress in production of mushrooms.

Due to the very high variation of produced mushrooms in individual years and months, after a general analysis changes were described in the dependence of quality and volume of yield, occurring in each analyzed month and in a quality class, which determines profitability of production. Yield was divided according to principles adopted in the company. Yield was divided into four classes being the object of this analysis:

– Extra – mushrooms to be exported,
– I – mushrooms to be used by the industry,
– II – mushrooms to be used by the industry and for the Polish consumers,
– And class 2 – mushrooms not meeting the above mentioned standards, but frequently being a commercial product, unclassified, not meeting the EU standards.

The first three quality classes were identified in accordance with the ordinance of the Committee (EC) no. 1863/2004, where class 2 comprises mushrooms not meeting the above mentioned standards. Their volume was included in the total yield. Month was the basic experimental period in individual years. Collected data are complete, thus statistical analysis is based on actual values, with no approximations, averaging or other potential auxiliary instruments.

## RESULTS

The total production volume in the analyzed period increased greatly from 1.94 million kg in the first of the analyzed periods to over 2.4 million kg in the last year of analysis (i.e. by almost 24%). The increase in individual years was not evenly distributed; however, in each successive year the level of production was higher. In the course of the four years of the study the level of total yield was almost 8.6 million kg.

Table 1. Characteristics of harvests of yields of class Ex mushrooms
Tabela 1. Charakterystyka przebiegu zbioru plonu pieczarek klasy Ex

| Month – Miesiąc | Year of study – Rok badań | | | | Total in kg Suma kg |
|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | |
| January – Styczeń | 20 552 | 58 630 | 70 759 | 117 269 | 267 210 |
| February – Luty | 25 112 | 52 561 | 85 377 | 111 380 | 274 430 |
| March – Marzec | 26 478 | 52 600 | 102 177 | 141 829 | 323 084 |
| April – Kwiecień | 29 568 | 53 353 | 91 973 | 133 140 | 308 034 |
| May – Maj | 66 618 | 66 902 | 88 520 | 148 583 | 370 623 |
| June – Czerwiec | 63 276 | 62 611 | 130 549 | 143 452 | 399 888 |
| July – Lipiec | 99 276 | 71 274 | 86 141 | 156 973 | 413 664 |
| August – Sierpień | 102 110 | 91 674 | 86 722 | 155 933 | 436 439 |
| September – Wrzesień | 73 400 | 87 077 | 147 200 | 119 306 | 426 983 |
| October – Październik | 61 994 | 79 482 | 161 352 | 119 810 | 422 638 |
| November – Listopad | 54 056 | 92 716 | 126 291 | 124 424 | 397 487 |
| December – Grudzień | 62 849 | 103 601 | 132 939 | 119 880 | 419 269 |
| Mean – Średnia | 57 107 | 72 706 | 109 166 | 132 664 | 371 645 |
| % total yield<br>% plonu ogółem | 35.28 | 43.88 | 58.10 | 66.19 | |
| Standard terror<br>Błąd standardowy | 7 937 | 5 140 | 8 407 | 4 647 | 17 863 |
| Standard eviation<br>Odchylenie standardowe | 27 502 | 17 805 | 29 125 | 16 100 | 16 863 |
| Range – Roztęp | 81 558 | 51 040 | 90 593 | 45 593 | 169 229 |
| Biggest – Największy | 102 110 | 103 601 | 161 352 | 156 973 | 436 439 |
| Smallest – Najmniejszy | 20 552 | 52 561 | 70 759 | 111 380 | 267 210 |

In the first of the investigated periods, between individual classes of mushrooms, i.e. Ex, I and II, there was a relative balance, with the proportions of these classes being approx. 30–35% each (tables 1–3). In the course of successive years a definite advantage was observed for the production allocated solely for export. The proportion of such mushrooms in the yield increased from 35.3% to 66.2%. Quantitatively the increase in the weight of yield class Ex was huge, from 685 thousand kg in the first year to over 1.59 million kg in the fourth year, i.e. by over 130%. This increase in the proportion of class Ex yield occurred at the expense of lower quality classes of mushrooms.

Table 2. Characteristics of harvests of yields of class I mushrooms
Tabela 2. Charakterystyka przebiegu zbioru plonu pieczarek klasy I

| Month – Miesiąc | Year of study – Rok badań | | | | Total in kg Suma kg |
|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | |
| January – Styczeń | 94 076 | 29 973 | 57 764 | 29 645 | 211 458 |
| February – Luty | 41 457 | 25 985 | 46 753 | 20 882 | 135 077 |
| March – Marzec | 54 895 | 50 581 | 25 331 | 22 146 | 152 953 |
| April – Kwiecień | 54 136 | 52 100 | 27 871 | 20 564 | 154 671 |
| May – Maj | 64 960 | 43 455 | 25 021 | 19 361 | 152 797 |
| June – Czerwiec | 57 078 | 43 284 | 16 225 | 20 050 | 136 637 |
| July – Lipiec | 35 188 | 52 595 | 16 935 | 14 299 | 104 718 |
| August – Sierpień | 43 296 | 37 112 | 13 552 | 19 206 | 113 166 |
| September – Wrzesień | 46 751 | 59 201 | 18 476 | 17 819 | 142 247 |
| October – Październik | 44 888 | 76 106 | 25 894 | 30 898 | 177 786 |
| November – Listopad | 27 635 | 48 842 | 28 939 | 34 039 | 139 455 |
| December – Grudzień | 26 382 | 42 287 | 33 068 | 38 627 | 140 364 |
| Mean – Średnia | 49 228 | 46 793 | 27 985 | 23 961 | 146 777 |
| % total yield<br>% plonu ogółem | 30.41 | 28.24 | 14.89 | 11.95 | |
| Standard error<br>Błąd standardowy | 5 281 | 3 840 | 3 738 | 2 152 | 8 041 |
| Standard deviation<br>Odchylenie standardowe | 18 296 | 13 303 | 12 951 | 7 456 | 27 855 |
| Range – Roztęp | 67 694 | 50 121 | 44 212 | 25 075 | 106 740 |
| Biggest – Największy | 94 076 | 76 106 | 57 764 | 38 627 | 211 458 |
| Smallest – Najmniejszy | 26 382 | 25 985 | 13 552 | 14 299 | 104 718 |

A marked, observable seasonality was found in the production of class Ex mushrooms in the first year of the study (tab. 1). After several months of relatively low volume (approx. 20–30 thousand kg a month) a rapid increase was recorded, which led to over 102 thousand kg production of this class in August. Despite the fact that in successive months a decrease of production, consistent with seasonality, was observed, it was slight in comparison to the earlier increase. The mean production in the first year for class Ex was 57.1 thousand kg a month (total production of class Ex mushrooms – 685 thousand kg), which gives the proportion in the total production by that company at 35.3%.

Table 3. Characteristics of harvests of yields of class II mushrooms
Tabela 3. Charakterystyka przebiegu zbioru plonu pieczarek klasy II

| Month – Miesiąc | Year of study – Rok badań | | | | Total in kg Suma kg |
|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | |
| January – Styczeń | 68 932 | 65 177 | 36 229 | 61 403 | 231 741 |
| February – Luty | 47 355 | 67 199 | 29 184 | 62 898 | 206 636 |
| March – Marzec | 53 306 | 60 466 | 43 978 | 46 250 | 204 000 |
| April – Kwiecień | 47 333 | 60 422 | 85 640 | 37 010 | 230 405 |
| May – Maj | 47 507 | 63 481 | 92 183 | 29 784 | 232 955 |
| June – Czerwiec | 47 333 | 38 151 | 59 203 | 20 001 | 164 688 |
| July – Lipiec | 35 465 | 39 764 | 41 447 | 23 328 | 140 004 |
| August – Sierpień | 34 537 | 23 537 | 45 861 | 25 075 | 129 010 |
| September – Wrzesień | 46 947 | 31 101 | 38 393 | 15 800 | 132 241 |
| October – Październik | 67 845 | 40 983 | 25 629 | 29 686 | 164 143 |
| November – Listopad | 80 995 | 34 573 | 28 690 | 47 088 | 191 346 |
| December – Grudzień | 87 825 | 22 651 | 52 978 | 38 173 | 201 627 |
| Mean – Średnia | 55 448 | 45 625 | 48 284 | 36 375 | 185 733 |
| % total yield<br>% plonu ogółem | 35.28 | 28.24 | 25.70 | 18.15 | |
| Standard error<br>Błąd standardowy | 4 931 | 4 819 | 6 179 | 4 457 | 1 117 |
| Standard deviation<br>Odchylenie standardowe | 17 083 | 16 695 | 21 405 | 15 442 | 38 701 |
| Range – Roztęp | 53 288 | 44 548 | 66 554 | 47 098 | 42 945 |
| Biggest – Największy | 87 825 | 67 199 | 92 183 | 62 898 | 232 955 |
| Smallest – Najmniejszy | 34 537 | 22 651 | 25 629 | 15 800 | 190 010 |

Over the entire analyzed period a definite upward trend was recorded for the production of class Ex (tab. 1). After the first four months of stability around slightly over 50 thousand kg, a rapid increase was observed and within the next 8 months the level of monthly production for this class increased to over 100 thousand kg in December. The mean volume of production for class Ex in the second year of the study was 72.7 thousand kg, which provides it a definite leading position in the total production of the company (a share of 43.9%). Due to the dynamic increase the coefficient of variation was 24.5%, which resulted from a much higher variation of production than the total variation in the second year of the study. The accumulated volume of production for class Ex in 2002 was 872.8 thousand kg (fig. 1).

Production of class Ex mushrooms in the third year initially showed a slight increase from 70.8 thousand kg in January to 86.7 thousand kg in August, while towards the end of the year the production of class Ex mushrooms was over 130 thousand kg, at the highest level in October (161 thousand kg). The mean monthly volume of production for the analyzed class was close to 110 thousand kg a month, which gave the share of class Ex in the total production of 58.1%. The range between the highest and lowest values was rather considerable – over 90 thousand kg. The accumulated volume of production for class Ex in the third year of the study was 1.31 million kg (fig. 1).

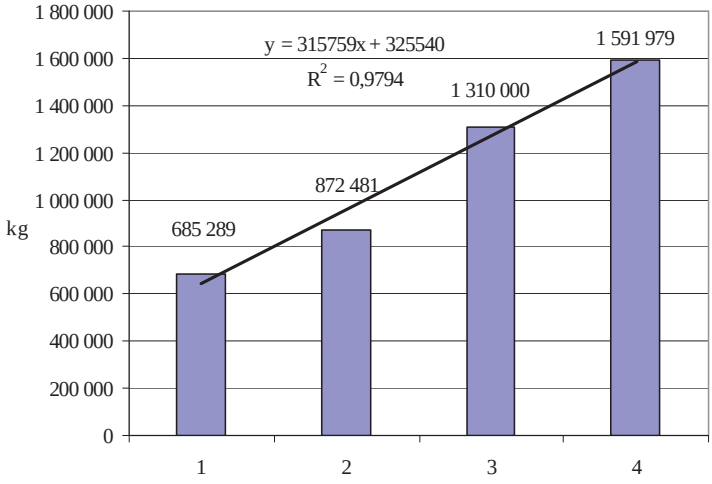


Fig. 1. Production of class Ex mushrooms in the course of the four successive years of the study
Ryc. 1. Produkcja pieczarek klasy Ex w okresie czterech lat badań

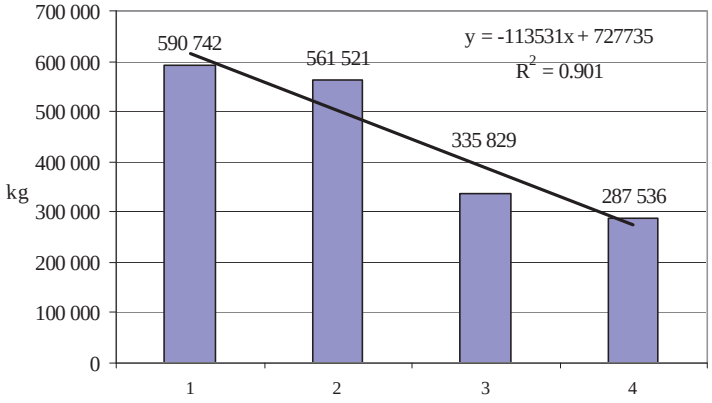


Fig. 2. Production of class I mushrooms in the course of the four successive years of the study
Ryc. 2. Produkcja pieczarek klasy I w okresie czterech lat badań

The volume of production for class Ex (tab. 1) in the fourth year of the study was characterized by a marked seasonality. During the first two winter months it fluctuated around approx. 110–120 thousand kg. In the spring-summer period a definite increase was found in the volume of production for this quality class (to approx. 140–160 thousand kg), to drop in the autumn to the previous level (approx. 120 thousand kg a month). Overall throughout the entire fourth year of the study the volume of produc-

tion for class Ex was 1.59 million kg, which gives a mean level of slightly less than 133 thousand kg a month, being on average 66.2% total production of the company in that year. The value of the range was slightly over 45 thousand kg (the lowest volume of production in February – 111 thousand kg, while the highest in July – 157 thousand kg).

A particularly big drop in the proportion of yields was recorded for mushrooms of classes I and II (figs. 2 and 3) as raw material for industrial processing. The proportion of class I mushrooms in the overall structure of the product decreased from 30.4% to less than 12%. Quantitatively in the course of four years the production of this class of mushrooms dropped by over 50%, from almost 591 thousand kg to less than 290 thousand kg.

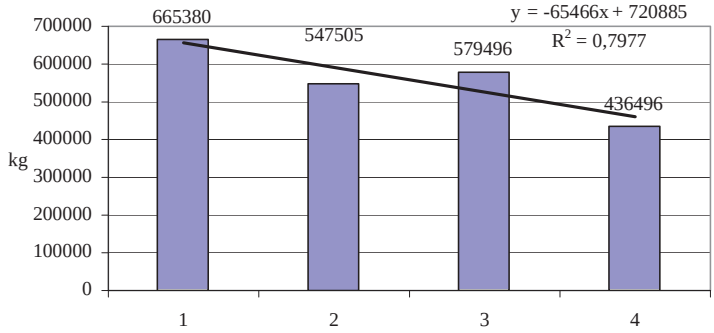


Fig. 3. Production of class II mushrooms in the course of the four successive years of the study
Ryc. 3. Produkcja pieczarek klasy II w okresie czterech lat badań

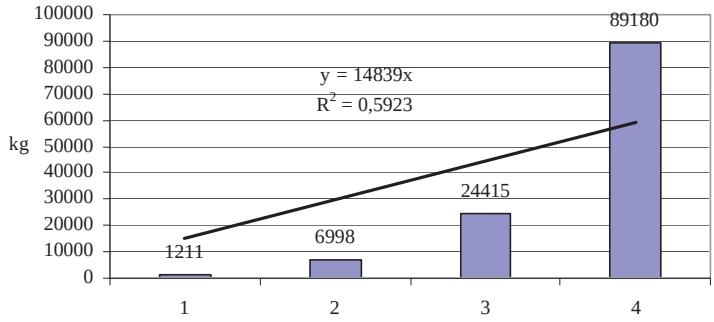


Fig. 4. Production of class 2 mushrooms in the course of the four successive years of the study
Ryc. 4. Produkcja pieczarek klasy 2 w okresie czterech lat badań

A similar situation was observed for class II (tab. 3). The drop in the share of this class was also great – from 34.3% to 18.2% total yield. The weight of yield for this class decreased from 665 thousand kg to 436 thousand kg over a four-year period, which constitutes a drop of approx. 35%. (fig. 3 and tab. 3).

The share of class 2 mushrooms was initially slight in the product structure of mushroom weight (tab. 4), as it accounted for only 0.06%. In the following years this share increased rapidly with an increase in the total yield to reach 3.7%. It is still a negative element, as the volume of this increment indicates an increasing role of this class in the production of that enterprise. Quantitatively in this case a dramatic increase in yield was recorded, from 1.2 thousand kg to over 89 thousand kg.

Table 4. Characteristics of harvests of yields of class 2 mushrooms
Tabela. 4. Charakterystyka przebiegu zbioru plonu pieczarek klasy 2

| Month – Miesiąc | Year of study – Rok badań | | | | Total in kg Suma kg |
|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | |
| January – Styczeń | 88 | 1 499 | 70 | 8 803 | 10 460 |
| February – Luty | 74 | 1 704 | 194 | 8 075 | 10 047 |
| March – Marzec | 56 | 1 414 | 163 | 6 992 | 8 625 |
| April – Kwiecień | 19 | 582 | 646 | 6 880 | 8 127 |
| May – Maj | 19 | 405 | 1 172 | 7 223 | 8 819 |
| June – Czerwiec | 146 | 301 | 201 | 7 125 | 7 773 |
| July – Lipiec | 331 | 220 | 125 | 8 414 | 9 090 |
| August – Sierpień | 301 | 377 | 147 | 7 007 | 7 832 |
| September – Wrzesień | 30 | 185 | 261 | 5 724 | 6 200 |
| October – Październik | 68 | 162 | 3 482 | 8 366 | 12 078 |
| November – Listopad | 67 | 63 | 11 350 | 8 255 | 19 735 |
| December – Grudzień | 12 | 86 | 11 604 | 6 317 | 18 019 |
| Mean – Średnia | 101 | 583 | 2 451 | 7 431 | 10 567 |
| % total yield<br>% plonu ogółem | 0.06 | 0.35 | 1.30 | 3.71 | |
| Standard error<br>Błąd standardowy | 31 | 172 | 1 247 | 272 | 1 204 |
| Standard deviation<br>Odchylenie standardowe | 107 | 597 | 4 322 | 943 | 4 172 |
| Range – Roztęp | 319 | 63 | 11 534 | 3 079 | 13 535 |
| Biggest – Największy | 331 | 1 704 | 11 604 | 8 803 | 19 735 |
| Smallest – Najmniejszy | 12 | 63 | 70 | 5 724 | 6 200 |

The accumulated volume of production for class 2 in the fourth year of the study was 89.2 thousand kg, which accounts for approx. 3.7% total production in the investigated period. The relatively high stability and a lack of a specific trend were visible in relation to the production of class 2 over the entire year. Throughout the whole analyzed period the production of this class of mushrooms ranged from 5.7 thousand kg in September to 8.8 thousand kg in January (tab. 4). The mean over the entire year was 7.4 thousand kg, while a relatively high volume of this yield indicates an insufficient control of the production process and inappropriate harvesting. In the earlier years the total yield of this class of mushrooms was not significant.

The summary analysis of commercial classes of yield of mushrooms in terms of months showed relatively high fluctuations in each year, as well as a certain seasonality

of the production volume (fig. 5). Irrespective of these differences the yield of class Ex showed a significant upward trend. The yield of mushrooms of classes I and II was also characterized by a similarly insignificant downward trend.

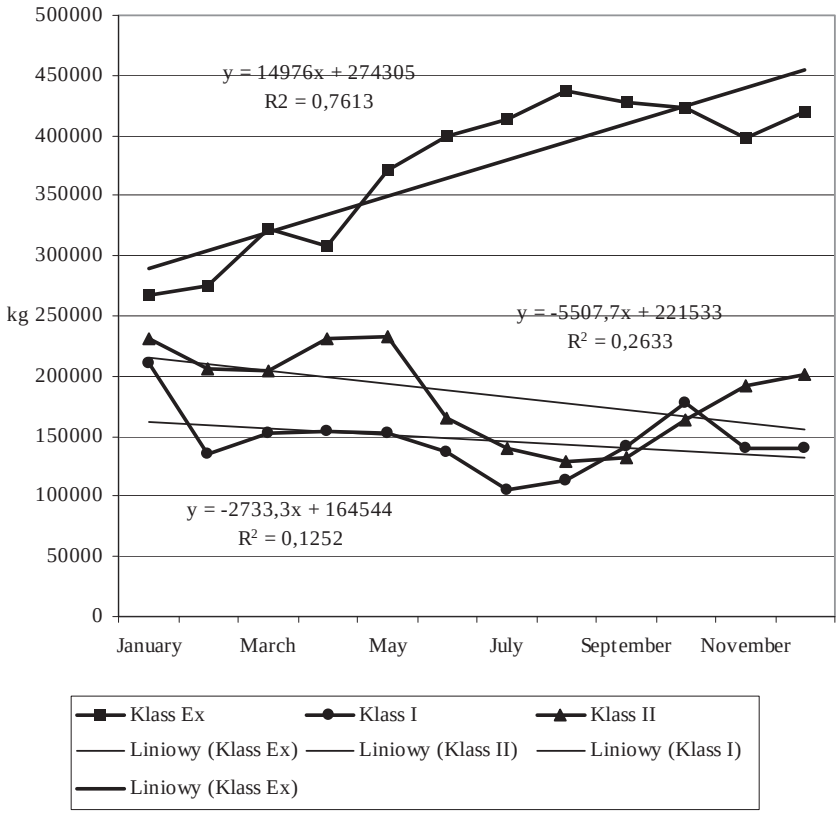


Fig. 5. A dependence of mean marketable yield of commercial quality classes of mushrooms in the course of a year and their trends

Ryc. 5. Średni plon handlowych klas jakości pieczarek w ciągu roku i ich trendy

As it may be observed on the basis of the above analysis, the direction of the economic activity in that enterprise was definitely pro-export. The mean volume of production allocated to export (class Ex) initially exceeded 50%, to increase later to as much as over 66%. On the other hand, the production of mushrooms for the processing industry decreased considerably, with the mean level of slightly over 20%. Also the proportion of production to be sold on the domestic market was decreasing from year to year. At the same time, the structure of shares of the two classes of the product to be used on the domestic market also changed, as the proportion of class I decreased and the share of class 2 increased.

However, generally we may observe the division into the winter season (a high production of mushrooms) and the summer season (a low production of mushrooms). Very big seasonal fluctuations resulted in the high value of index of scatter, while the mean volume of production for the entire year was 36.4 thousand kg a month. The accumulated volume of production for class II exceeded 436 thousand kg, which in the fourth year of the study accounted for less than 18.2% total production. The lowest level was recorded in September (15.8 thousand kg), while the highest in February (62.9 thousand kg).

## DISCUSSION

Production of mushrooms has recently shown an intensive development in terms of the technological process and technical conditions. In Poland mushroom production in the last two decades equaled in terms of the total efficiency of production that of leading EU countries. Progress was achieved owing to specialization. Initially mushroom producers purchased required components of the substrate and covers, prepared the substrate, ran the culture, harvested mushrooms and sold the yield. At present, thanks to specialization, each of these stages is performed by specialist firms and the producers run culture and harvest mushrooms.

Factors determining the success of mushroom culture are multi-factor. Analyzed characteristics of analyzed yields showed significant differences in the proportions of individual quality classes in the total yield, irrespective of the analyzed year and month.

Romanens [1999], when reporting results of analyses for two thousand substrate samples during the filling of the production hall, showed than at the conventional preparation of the substrate, despite certain seasonal changes, we may obtain substrate with constant parameters throughout the year, thus providing constant yields. In this study recorded results of the evaluated yields showed very big differences between maximum and minimum values. Bayer [2006] reported that in order to achieve a maximum yield it is necessary to reconstruct the micro flora destroyed during the sanitation phase. The results presented within this study prove that the biological efficiency of the substrate was not always completely comparable, which could have been one of the causes for non-uniform yielding. Grogan et al. [2000] showed that selective substrate, analyzed in terms of the presence of mould fungi, should not contain any other fungi except for *Scytalidium thermophilum.*

Steineck [1982] reported that the yield of mushrooms depends on the amount of substrate per 1 $m^2$ culture area, while Royse [2010] stated that it depends on the amount of the commercial additive enriching phase II substrates. Results presented in this study for the volume and quality of yield at a similar amount of the substrata showed significant differences in yield. Middlebrook [2004] reported than in Holland starting from 1993 mushrooms have been grown solely on phase III substrate. In Poland in 2003 only less than 20% production was cultured on phase III substrate, but this proportion has been regularly increasing and according to INTERIA.PL/PAP in 2010 Poland was the biggest producer of mushrooms in the European Union. Such an approach is justified, which is

confirmed by the results concerning yield recorded in this study, which were characterized by a significant, regular increase in the yield of premium quality mushrooms.

According to Noble [2008] substrate moisture content of 72% after pasteurization ensures the best growth rate for mushrooms. Results concerning moisture content showed in studies and presented in the previous study were lower and varied, which may – among other things – explain the variation in yield, since moisture content deviations of 1% above or below optimal value reduce yield by 0.5 kg $m^{-2}$. All the presented results of the study were characterized a markedly higher range of moisture content. Van den Munckhof-Vedder [1996] presented principles of a rational harvesting method to provide yield of highest quality and profitability of mushroom culture. Presented results differ significantly from the recommendations of that author, particularly in terms of the volume of proportions of respective classes.

Overstijns [1981] reported that the introduction of bulk substrate preparation ensures the required supply of uniform substrate. Deming [2001] was of an opinion that it is the mushroom producer that provides the basis for the development of mushroom growing. If any observations and remarks of mushroom producers do not reach substrate producers, then such a dependence is irrational. Only mutual, constant exchange of information between mushroom producers, substrate producers and the scientific community may guarantee proper conditions for development of good production and high quality mushrooms. Recorded results of the study show that such dependencies have not yet been adequately appreciated in Poland.

## CONCLUSIONS

1. All the evaluated periods of culture, irrespective of the year and month, varied in terms of the volume and quality of total yield.
2. The highest increase in yield in the four years of the study was found for class Ex mushrooms.
3. At the highest total yield a simultaneous significant increase was found for the production of unclassified mushrooms, which still constitutes a negative element.
4. Recorded results show that the direction of development for the production of mushrooms was proper, but its development rate was not very intensive.

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## PLON JAKO WSKAŹNIK POSTĘPU W PRODUKCJI PIECZAREK *Agaricus bisporus* (Lange, Sing)

**Streszczenie**. Wysokość ogólna plonu pieczarek zależy od ilości i jakości podłoża. Przedstawione wyniki dotyczą udziału poszczególnych klas jakości pieczarek w plonie ogólnym. Praca prezentuje wyniki masy klas plonu pieczarek w okresie czterech lat badań w zależności od miesięcy. Wszystkie oceniane okresy uprawy, niezależnie od lat badań i miesięcy w roku, były zróżnicowane pod względem wielkości oraz jakości uzyskanego plonu. Największy wzrost plonu w kolejnych dalszych uprawach wykazywały pieczarki klasy Ex. Wyniki dowodzą, że kierunek rozwoju produkcji pieczarek był coraz bardziej efektywny, ale jego stopień postępu mało intensywny, ponieważ w okresie badań plon klasy Ex wzrósł o 132%, ale nadal jest stosunkowo duży udział pieczarek klas gorszej jakości.

**Słowa kluczowe**: pieczarki, klasy plonu, okresy uprawy

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