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# EFFECTS OF DRIP IRRIGATION OF SUMMER SQUASH CULTIVATED ON THE LIGHT SOIL

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***Summary***

In the climatic conditions of Poland the temporary lack of rainfall during the vegetation season, influenced on the water deficits in the top soil level. This situation can effect on the height and quality of yields in particular years. There is estimated that in the – so called – Large Valleys Region the water deficiency ranged 200-300 mm. Production of cucurbit's vegetables in open field is strictly connected with thermal-rainfall conditions during the vegetation season. The optimal soil moisture is the very important factor for high and good quality yield. So, the production of the cucurbit plants should be connected with the irrigation installations. The aim of the study was to determine the influence of drip irrigation in cultivation of summer squash 'Danka' under light soil conditions. The trials were conducted in the years 2004 – 2006 at the experimental field in Kruszyn Krajeński near Bydgoszcz – on a soil of rye weak complex. The plot area for harvest was 9,1 m$^2$. The irrigation rates were done on the base of soil water potential according to tensiometer indications. The irrigation was started when the soil water tension was – 0,04 MPa. The fruits of the summer squash were harvested in the technological maturity in the second decade of September in each year of the study. The single weight and number of the fruits as well as marketable yield from the unit area were estimated. In the pulp the dry matter, vitamin C, sugars and carotenoids content were determineted. It was found that drip irrigation significantly increased the marketable yield of fruits. The higher yield increases were detected in the years with lower rainfalls. The significant influence of drip irrigation on the content of vitamin C and sugars was stated. The dry matter and carotenoids content were higher in the fruits from the irrigated plots, but the difference was insignificant.

**Key words:** drip irrigation, summer squash, light soil, chemical composition

## INTRODUCTION

In the climatic conditions of Poland the temporary lack of rainfall during the vegetation season, influenced on the water deficits in the top soil level. This situation can effect on the height and quality of vegetable yields in particular years. There is estimated that in the – so called – Large Valleys Region the water deficiency ranged 200-300 mm. Production of cucurbit's vegetables in open field is strictly connected with thermal-rainfall conditions during the vegetation season (Kalbarczyk 2009a,b; Kaniszewski 2005). The optimal soil moisture is the very important factor for high and good quality yield. So, the production of the cucurbit plants should be connected with the irrigation installations (Kaniszewski 2005; Rolbiecki 2004, 2007).

The aim of the study was to determine the influence of drip irrigation in cultivation of summer squash 'Danka' under light soil conditions. The experiment was conducted in the vicinity of Bydgoszcz. This region is characterized by large irrigation requirements (Kuchar and Iwański 2011; Żarski 2011; Żarski and Dudek 2009; Żarski *et al*. 2010).

## MATERIAL AND METHOD

The trials were conducted in the years 2004 – 2006 at the experimental field in Kruszyn Krajeński near Bydgoszcz – on a soil of rye weak complex. The cultivar used was 'Danka'. The seeds were sown every year in the third decade of May. The plant spacing was 1.0 m x 0.7 m. The plot area for harvest was 9.1 $m^2$. The agrotechniques and fertilization adopted were the standard used in the cultivation of cucurbit vegetables in Poland (Lisiecka 1993). Doses of potassium and phosphorus fertilization were dependent on the abundance of these nutrients in the soil. The nitrogen fertilization was supplied in three single doses – 115 kg N$\cdot$ $ha^{-1}$ total. The experimental factor studied was irrigation. Two irrigation treatments were used: O – without irrigation (control) and D – drip irrigation. Irrigation of squash plants was conducted by means of drip lines 'T-Tape' (Jeznach 2009). The irrigation rates were done on the base of soil water potential according to tensiometer indications. The irrigation was started when the soil water tension was –0.04 MPa. The fruits of the summer squash were harvested in the technological maturity in the second decade of September in each year of the study. The single weight and number of the fruits as well as marketable yield from the unit area were estimated. Chemical analyses were the following: sugars total and reducing sugars – according to Test G-24 (Talburt, Smith 1987), carotenoids according to PN-90/ – 75101/12 and vitamin C – according to PN-A-04019:1998. These analyses were done in fresh fruits, directly after harvest. The experimental data has been statistically processed by variation analysis.

Estimation of the crop evapotranspiration ($ET_c$) was conducted by multiplying the crop coefficients ($k_c$) values for squash according to Paschold *et al.* (2002) by the Grabarczyk reference evapotranspiration (ETo) (Żarski 2011).

**Table 1.** Weather conditions in the vegetation period of summer squash 'Danka'

| Specification | Months | | | | | |
|---|---|---|---|---|---|---|
| | V | VI | VII | VIII | IX | V-IX |
| Air temperature (°C) | | | | | | |
| 2004 | 11.3 | 14.7 | 16.4 | 17.9 | 12.7 | 14.6 |
| 2005 | 12.2 | 14.9 | 19.4 | 16.3 | 12.7 | 15.1 |
| 2006 | 12.5 | 16.8 | 22.4 | 16.6 | 14.8 | 16.6 |
| Mean for 2004-2006 | 12.0 | 15.5 | 19.4 | 19.9 | 13.4 | 15.4 |
| Long-period average | 13.1 | 16.0 | 18.5 | 17.9 | 13.2 | 15.7 |
| Rainfall (mm) | | | | | | |
| 2004 | 44 | 36 | 42 | 86 | 25 | 233 |
| 2005 | 69 | 31 | 40 | 21 | 25 | 186 |
| 2006 | 63 | 22 | 30 | 114 | 18 | 247 |
| Mean for 2004-2006 | 59 | 30 | 37 | 74 | 23 | 222 |
| Long-period average | 40 | 52 | 63 | 51 | 45 | 251 |

Cumulated evapotranspiration of the squash crop was the highest in 2005 and the lowest in 2004 (Figure 1). In the year 2006 $ET_{crop}$ was the highest in July as well as during the first and the second decades of August.

Seasonal irrigation rates were inversely proportional to rainfall amounts. The highest seasonal water dose (125 mm) was supplied in 2005. Seasonal irrigation rates in 2004 and 2006 were lower and amounted 85 mm and 110 mm, respectively.

The mean – for the years and treatments – marketable yield of fruits amounted 48.2 t $ha^{-1}$, ranging in the investigated years from 45.06 to 50.9 t $ha^{-1}$ (Figure 2). Drip irrigation increased significantly the yield – on average for the three years – from 32.4 to 64.1 t $ha^{-1}$. The yield increased by 37.7 t $ha^{-1}$, i. e. 98 %. The highest yield increase (38.97 t $ha^{-1}$, i. e. 133 %) was obtained due to drip irrigation in 2005. In years 2004 and 2006 the yield increases caused by irrigation were lower, amounting 28.7 (i. e. 78 %) and 27.37 (87 %), respectively. Differences between the yields on drip-irrigated plots and those without irrigation (control) were statistically significant in every year. Positive results of drip irrigation on yields of vegetables have been confirmed in the experiments carried out by numerous authors (Kaniszewski and Knaflewski 1997; Kosterna *et al*. 2011, Rolbiecki 2004, 2007; Rolbiecki and Rolbiecki 2003, 2005; Rolbiecki *et al*. 2006, 2011a,b,c; Rożek 2009).

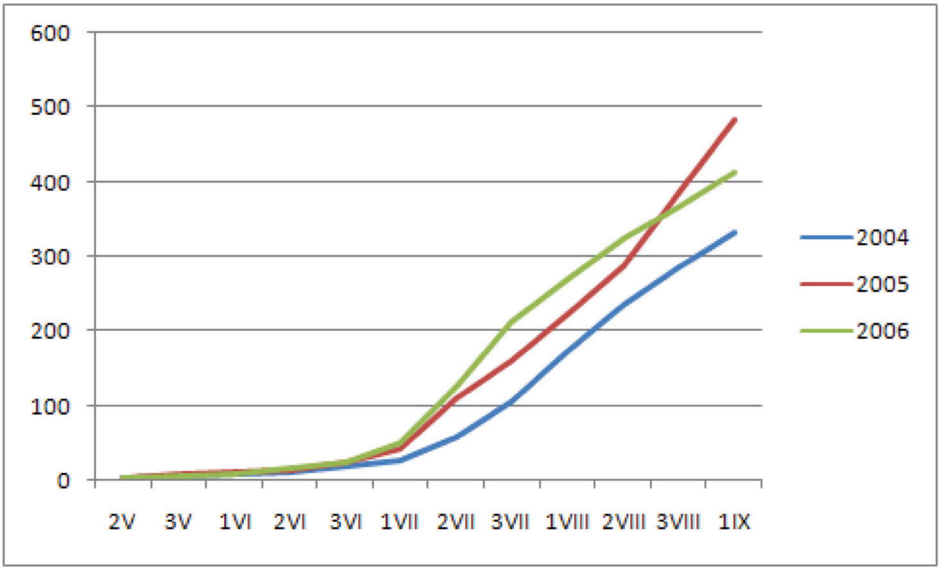


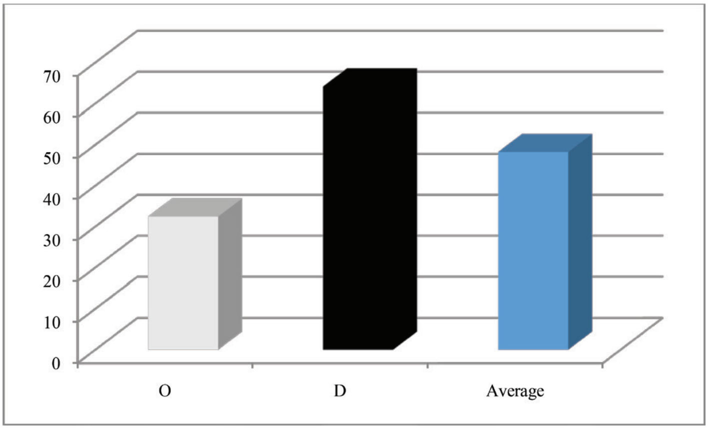

**Figure 1.** Cumulated $ET_{crop}$ in particular years of the study (mm)

## RESULTS AND DISCUSSION

The mean fruit weight noted on non-irrigated plots was 1.43 kg, ranging from 1.26 to 1.7 kg (Figure 3). Depending on the year of the study, the fruit weight increased due to irrigation from 0.52 kg to 1.0 kg, i. e. from 41 % to 71 %. Differences between the fruit weight on drip-irrigated plots and that on non-irrigated stands were statistically significant in every year. The average fruit weight on irrigated plots amounted 2.0 kg, ranging in the years of the study from 1.78 to 2.4 kg.

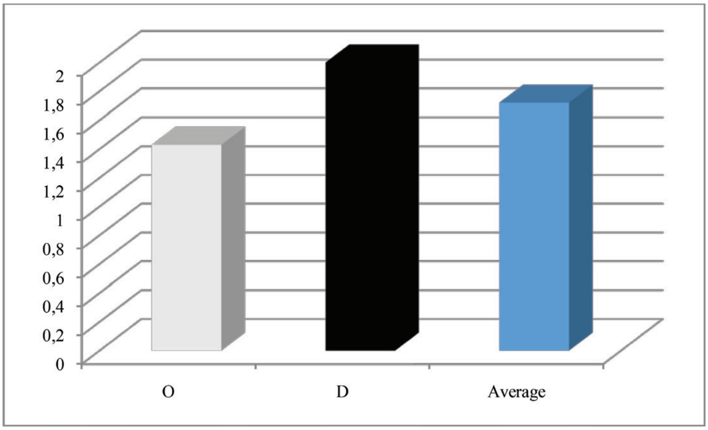
Drip irrigation increased significantly the number of marketable fruits per plant (Figure 4). The fruit number noted on irrigated plots was every year significantly higher than that on control plots. The highest difference (> 1) was obtained in 2005. Biesiada *et al*. (2006) noted distinctly higher number of fruits per plant (> 4). Beneficial results of drip irrigation on the fruit weight and number of cucurbit vegetables were obtained also in our previous investigations conducted in the vicinity of Bydgoszcz (Rolbiecki 2004, 2007; Rolbiecki and Rolbiecki 2003, 2005; Rolbiecki *et al*. 2006, 2009, 2011b,c).

The fruits from irrigated plots were characterized by significantly higher morphometrical indices (Table 2). Drip irrigation increased both the vertical and the horizontal diameter of fruits as well as the pulp thickness.



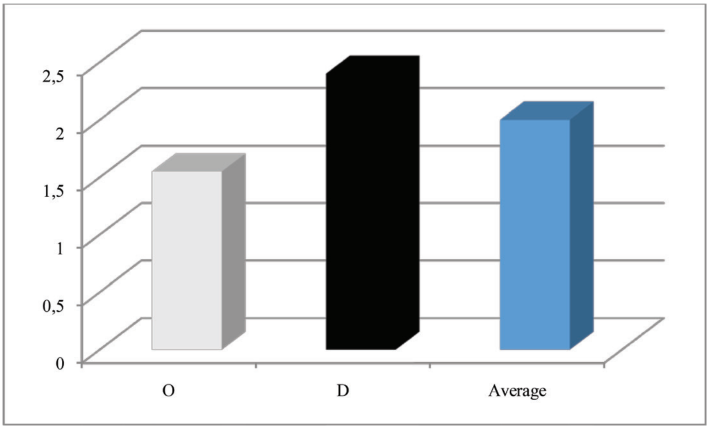

$LSD_{0.05}$ – 4.211

**Figure 2.** Marketable yield of fruits average in the years 2004-2006 ($t \cdot ha^{-1}$)




$LSD_{0.05}$ – 0,283

**Figure 3.** Fruit weight average in the years 2004-2006 (kg)




$LSD_{0.05}$ – 0,425

**Figure 4.** Number of fruits per plant average in the years 2004-2006 (pcs)

**Table 2.** Morphometrical characteristics of fruits in the years 2004-2006

| Specification | Ø vertical (cm) | Ø horizontal (cm) | Pulp thickness (cm) |
|---|---|---|---|
| O | 1.4 | 1.61 | 1.64 |
| D | 2.4 | 2.69 | 2.13 |
| Average | 1.0 | 1.52 | 1.64 |
| $LSD_{0,05}$ | 0.894 | 0.333 | 0.221 |

**Table 3.** Chemical properties of fruits in the years 2004-2006

| Specification | Dry matter ($g\cdot100\ g^{-1}$) | Vitamin C ($mg\cdot100g^{-1}$) | Monosaccharides ($g\cdot100\ g^{-1}$) | Total sugars ($g\cdot100g^{-1}$) | Carotenoids ($mg\cdot100g^{-1}$) |
|---|---|---|---|---|---|
| O | 3.83 | 3.76 | 5.78 | 10.32 | 2.59 |
| D | 4.26 | 5,48 | 6.85 | 12.38 | 3.25 |
| Average | 4.04 | 4.62 | 6.31 | 11.35 | 2.92 |
| $LSD_{0,05}$ | n.s. | 1.57 | 0.94 | 1.54 | n.s. |

Chemical properties of fruits were influenced by drip irrigation (Table 3). Drip irrigation significantly increased the vitamin C content as well as that of sugars – both monosaccharides and total sugar. The fruits harvested from plants grown under drip irrigation were also characterized by higher contents of dry matter and carotenoids. But it should be noted that the differences between the irrigated and control samples were insignificant. Opposite tendency – decreased DM contents in fruits of 'Makaronowa Warszawska' and 'Pyza' cultivars grown under drip irrigation – reported Wojdyła *et al.* (2007). In the study of Nawirska *et al*. (2008) the DM content in cv.'Danka' fruits was higher – about 8%. In the study carried out by Danilcenko *et al*. (2011) the DM content in *Cucurbita pepo* fruits depended on the cultivar.

The tendency of higher content of carotenoids in fruits obtained from drip-irrigated plots is confirmed by the results of Wojdyła *et al.* (2007). Also in trials conducted by other authors (Wadas and Mioduszewska 2011) the amount of rainfall during the 'Makaronowa Warszawska' and 'Pyza' squash vegetation period significantly differentiated the content of β-carotene in their fruits. Kołota and Adamczewska-Sowińska (2011) reported that *Cucurbita pepo* (zucchini) fruit yield and its quality may also depend on the kind of mulch. Significance of cultivar in shaping the chemical properties of fruits as well as their diameter was noted in the study of Grzeszczuk *et al.* (2003).

## CONCLUSIONS

It was found that drip irrigation significantly increased the marketable yield of fruits of summer squash 'Danka'. The higher yield increases were detected in the years with lower rainfalls. The significant influence of drip irrigation on the content of vitamin C and sugars was stated. The dry matter and carotenoids contents were higher in the fruits from the irrigated plots, but the differences were insignificant.

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