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## Corn salad (*Valerianella olitoria* L.) yield response to cell size of plug trays

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### ABSTRACT

The research was undertaken to determine if the plug tray cell size had an impact on plant characteristics and yield of corn salad (*Valerianella olitoria* L.). Seeds of four cultivars ('Ljubljanski', 'Holandski', 'Flavor' and 'Masse') were sown in styrofoam plug trays with 40 cells (60 ml cell<sup>-1</sup>), 84 cells (35 ml cell<sup>-1</sup>) and 160 cells (20 ml cell<sup>-1</sup>). Plants growth generally increased with cell size, though the effect varied with different cultivars. An increase in cell volume resulted in an increase in leaves height, leaves number and leaves fresh mass, as well as percentage of dry matter. Cv. 'Holandski' was obtained the highest leaves fresh mass regardless of cell volume.

**Key words:** *Valerianella olitoria*, corn salad, yield components, leaves fresh mass, percentage of dry matter

### IZVLEČEK

#### VPLIV VELIKOSTI CELICE GOJITVENE PLOŠČE NA PRIDELEK MOTOVILCA (*Valerianella olitoria* L.)

Raziskava je bila izvedena z namenom ugotoviti, ali velikost celice gojitvene plošče lahko vpliva na lastnosti in pridelok motovilca (*Valerianella olitoria* L.). Seme štirih kultivarjev ('Ljubljanski', 'Holandski', 'Flavor' in 'Masse') je bilo posejano v stiroporne gojitvene plošče s 40 celicami (60 ml/celico), 84 celicami (35 ml/celico) in 160 celicami (20 ml/celico). Na splošno je bila rast rastlin intenzivnejša z večanjem prostornine celice, medtem ko so se kultivarji različno odzivali na velikost celic. Večji volumen celice se je izrazil v večjih listih, večjem številu listov, večjem pridelku listne mase, prav tako pa tudi v večjem deležu suhe snovi. Cv. 'Holandski' je dal največji pridelok zelene listne mase ne glede na prostornino celic.

**Ključne besede:** *Valerianella olitoria*, motovilec, značilnosti pridelka, teža svežih listov, odstotek sušine

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## INTRODUCTION

Despite rich assortment of locally grown and imported vegetables in Slovenia supply of fresh and quality vegetables in winter months is poor. Such leafy vegetables as corn salad (*Valerianella olitoria* L.), which do not required high temperature and low light density, should be grown in this season of a year.

In the past vegetables were grown in greenhouse using ground beds or in outdoor ground beds. In last decades, the entire vegetable production system has received attention and changes because the necessity to improve yield and vegetable quality. Nowadays, growers have showed possibilities of vegetable production in alternative systems of production. One from possible system is also using various types of containers, primarily plug trays. With this system, each plant grows in an individual cell so there is less competition among plants and greater uniformity (NeSmith and Duval, 1998). Lee and Yang (1999) also reported that leafy lettuce, Chinese kale and water convolvulus produced from plug trays had a storage life even 3.6, and 2 days longer, respectively, than those grown in soil.

The number of plants in a tray depends on the cell size for each plant. Vegetables are commonly grown in plug trays with 30 to 300 cells (Walter et al., 2005). In general, larger cell leads to greater early yield and they are also easier to manage because the greater soil volume holds more water and nutrients. A trend among many commercial vegetable growers is toward more cells per tray (smaller cells), so that more plants can be grown in the limited space available (Vavrina, 1995). Plant responses to reduced soil volume have been reported for a wide range of crops with some conflicting data among them. There are differences in responses reported between species and even between cultivars within a species (Vavrina, 2001).

The effect of cell size and root restriction on leaf growth has been documented for tomato (Weston and Zandstra, 1986), bell peppers (Weston, 1998), cabbage (Csizinsky and Shuster, 1993), squash (NeSmith, 1993), watermelon (Liu and Latimer, 1995), lettuce (Nicola and Cantliffe, 1996), salvia (van Iersel, 1997) and rocket (Šink, 2006). To our knowledge this is the first report describing the impact of plug tray cell volume on corn salad yield.

## MATERIAL AND METHODS

The greenhouse experiment were conducted in the Experimental Field (46° 04' N, 14° 31' W, 300 m above sea level) of the Biotechnical Faculty in Ljubljana, Slovenia. The experiment was designed as a factorial complete randomised block. In each of four blocks a combination of cultivar and three root cell volume (Tab. 1) was replicated three times. Each replication consisted of a single tray. There were cultivars of corn salad that are grown commercially for fresh market in Slovenia: 'Ljubljanski' (Semenarna), 'Holandski' (Semenarna), 'Masse' (Bejo) and 'Favor' (Enza Zaden).

Table 1: Dimension of cell size used to grow corn salad

Plug tray (cell m <sup>-2</sup> )	Cell depth (mm)	Cell diameter (mm)	Cell volume (ml)	Cell No. (m <sup>-2</sup> )
40	55	55	60	166
84	40	40	35	350
160	29	45	20	667

Styrofoam trays were hand-filled with commercial peat-based growing medium Klasmann Tray substrate (pH 6-6.5; N 180 mg L<sup>-1</sup>; P<sub>2</sub>O<sub>5</sub> 210 mg L<sup>-1</sup>; K<sub>2</sub>O 250 mg L<sup>-1</sup>; MgO 85 mg L<sup>-1</sup> + microelements). Two to three seeds were sown in each plug cell on February 12, 2008. Thinning was done at the second true leaf stage leaving one plant per cell. The trays were covered with a 10% shade cloth until seed germination was complete. About 2 weeks after sowing, the shade cloth was removed and plants were exposed to natural light conditions.

Greenhouse conditions and the practices used to produce the seedling were kept as near-ideal as possible. Watering was done as needed (generally four times per week). Once weekly all the plants were supplied with a water-soluble fertilizer (Peters Professional 15-15-15, Scotts Company). In the compartment, average daily temperatures were 14±2 °C. Ventilation temperature was set at 2 °C above the heating temperature set points. Relative humidity was maintained at 75±10 % using ventilation throughout the growing season. Greenhouse climate was monitored and controlled by a DGT-Volmatic System.

Corn salads were extracted from trays on 26 March, cull or diseased plants were removed. Ten plants from each treatment were randomly sampled for harvesting and measuring plant height, number of leaves per plant and leaves fresh mass. The dry matter percentage of leaves tissue was determined by drying fresh leaves for 48–52 h at 60–64.

The data are reported as mean values with a standard error (S.E.). The data were subjected to one-way or two-way analysis of variance and the differences among treatments were determined by Tukey's test ( $P < 0.05$ ). Each treatment consisted of five replicate samples.

## RESULTS AND DISCUSSION

As we expected, cell size had an even greater impact on the rate of crop development. The plants grown in the largest plug volume (90 ml–40 cells plug tray) were much higher and heavier (Fig. 2 and 3) than that grown in smaller volumes so the statistical analysis comparing average fresh leaves mass per plant, plant height (above-ground) and number of leaves per plant, between the cultivars was made separately for each size of plug volume.

When cultivars were compared by plant height (Fig. 1), statistically significant differences were found in all three plug volumes, but they are more expressed between cultivars grown in the largest plug volume (90 ml) where cv. 'Holandski' had in average the highest plants (89 mm) and cv. 'Favor' the smallest (56 mm). Cv. 'Holandski' had the highest plants also when plants were grown in middle and small size plug volume (60 and 20 ml) and cv. 'Favor', grown in 60 ml plug volume and cv. 'Ljubljanski', grown in 20 ml had the smallest plants. According to Nicola and

Cantliffe (1996), the reduced plant height was caused by the reduced water-holding and fertilizer capacity of the small medium volume.

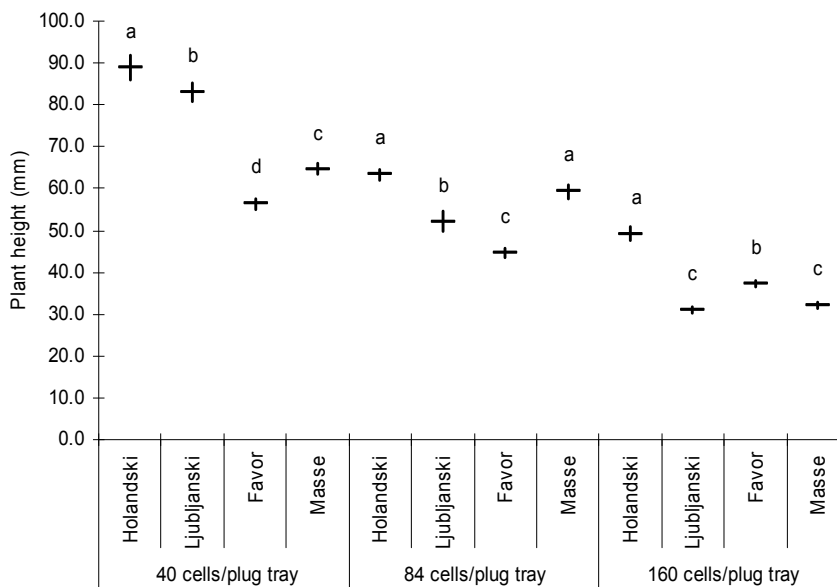


Figure 1: Influence of cell size on plants height (mm). Vertical bars indicate standard errors.

The number of full expanded leaves often reflect the technological maturity of corn salad plants. Our result showed (Fig. 2) that a highest cell volume significant increased the number of leaves per plant. As plant population density increases, each plant produces fewer leaves per plant due to increased plant competition. However, under similar environmental conditions, the larger number of plants compensate with leaves yields per unit area similar to those in lower plant populations. In our research, it seems that the yield was affected mainly by number of leaves per plant.

When plant population density is low (40 cells tray<sup>-1</sup>), there is little, between-plant competition. The individual plants will grow larger and produce more and higher leaves. The leaves number at highest cell size was in average 50.5% greater than those above smallest cell size. The plants grown in 90 ml cell volume were the most developed and had in average from 7.5 (cv. 'Holandski') to 11.5 (cv. 'Favor') developed leaves per plants, those grown in 60 ml cell volume had from 6 (cv. 'Masse') to 9 (cv. 'Holandski') expanded leaves per plant and grown in 20 ml cell volume had only from 3.2 (cv. 'Masse') to 5.6 (cv. 'Favor') expanded leaves per plant.

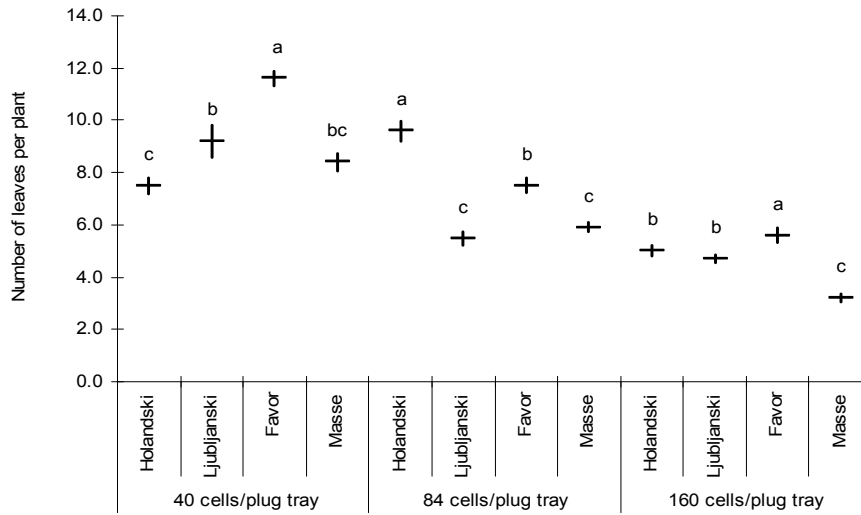


Figure 2: Influence of cell size on leaves number per plant. Vertical bars as in Fig. 1.

Statistical significant differences among cultivars were found in leaves fresh mass at all kinds of plug trays (Fig. 3). There were clear indications that cv. ‘Holandski’ was the dominant cultivar. In plug trays with 40 cells the results showed that in average the highest leaves fresh mass per plant were recorded by cv. ‘Holandski’ ( $2.7 \text{ g plant}^{-1}$ ) and there were no significant differences in average leaves mass between other cultivars grown in the same cell volume. In plug trays with 84 cells, the highest mass per plant gave also the cv. ‘Holandski’ ( $1.56 \text{ g plant}^{-1}$ ), and the lowest were recorded by ‘Favor’ ( $0.75 \text{ g plant}^{-1}$ ). The lowest mass per plant were recorded by plants grown in the smallest cell volume ( $20 \text{ ml}$ – $160 \text{ cell tray}^{-1}$ ), where the highest mass per plant were also recorded by cv. ‘Holandski’ ( $0.7 \text{ g plant}^{-1}$ ) and the lowest by cv. ‘Ljubljanski’ ( $0.3 \text{ g plant}^{-1}$ ). The differences in plant mass between cultivars were smaller, when plants were grown in the smallest cell volume ( $20 \text{ ml}$ ) in comparison with those grown in  $60$  and  $90 \text{ ml}$ , respectively. In general, plants grown in  $20 \text{ ml}$  cell had less leaves mass compared with plants grown in  $35$  and  $60 \text{ cell}$  volume. Because the plants in  $20 \text{ cell}$  volume received the same amount of fertilizer as the plants in the other cell volumes, they may have had more fertilizer stress.

Yield per plug tray is the product of leaves mass per plant and number of plants per unit area. Small cell size (higher densities) increased the number of plants per unit area, whereas at large cell size (lower densities) the plants number per unit area declined. In our research, the greater number of leaves per plant reflected in the greater yield per plug tray (data not shown).

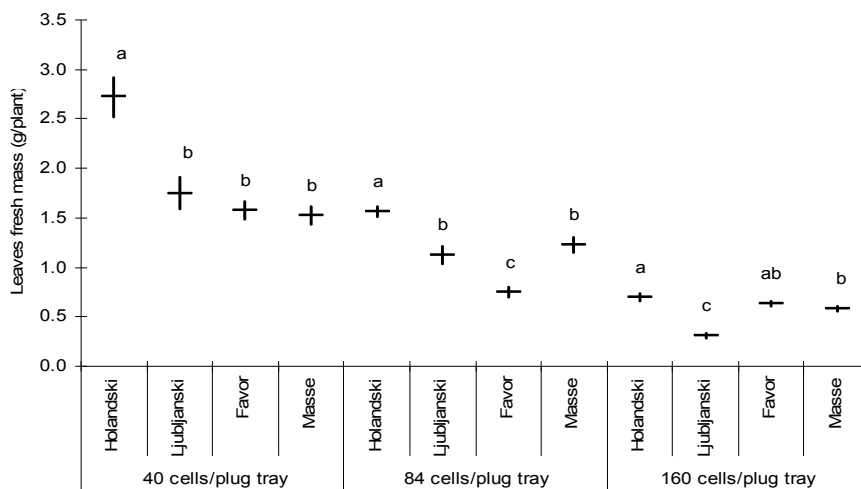


Figure 3: Influence of cell size on leaves fresh mass ( $\text{g plant}^{-1}$ ). Vertical bars as in Fig. 1.

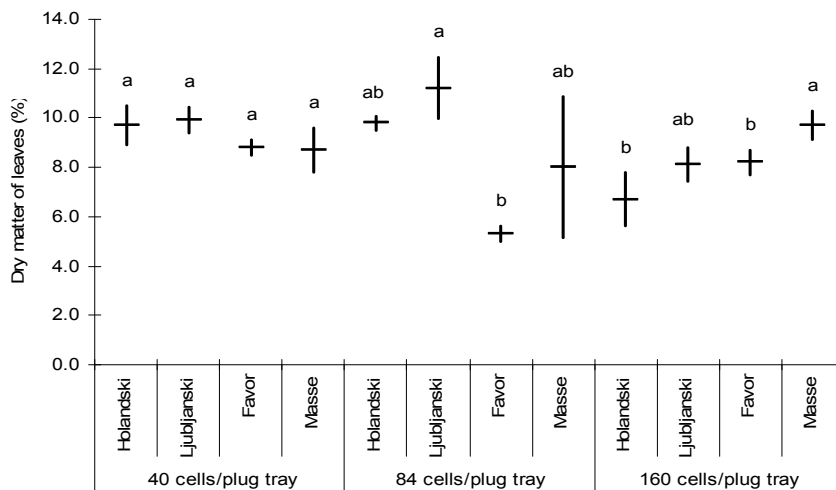


Figure 4: Influence of cell size on the percentage dry matter of leaves (%). Vertical bars as in Fig. 1.

The dry matter content is the ratio between dry and fresh weight expressed as a percentage. According Raupp (2000) and Karić et al. (2005) percentage of dry matter of leaves is an important reference parameter, and is somewhat significant as well to a consumer who does not want to buy watery products. In our experiment, the cell size did not have significant and consistent effect on this parameter. In spite of this fact, there were tendencies for the dry matter content to decrease slightly as the cell volume was decreased. In other words, as plant population density increases, each plant produces less dry weight. The portion of dry matter decreased from

9.30% at 60 ml cells (40 cells tray<sup>-1</sup>) to 8.20% at 20 ml cells (160 cells tray<sup>-1</sup>). These results are in agreement with those obtained by Žnidarčič et al. (2007) on cabbage. On the other hand, our results are not conformity with the findings of Agele et al. (1999) on tomato and Siomos (1999) on pak choi.

## CONCLUSIONS

From the above results it can be concluded:

- all factors measured – plant height, leaf number and leaves fresh mass per plant – decreased as the cell volume decreased;
- restrictions in root growth reduces dry weight of leaves;
- most optimal plug tray for corn salad growing is 40 cells plug tray;
- cv. ‘Holandski’ (Semenarna) was considered as a suitable cultivar for growing in plug trays;
- last but not least, growing corn salads in plug trays has more advantages. For example, there are fewer weed problems, and the cropping time is shorter because of faster and better growth in artificial media. Furthermore, corn salad grown in plug trays need little or no chemical pesticide, this can be seen as a model of hygienic vegetable production

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