



## TECHNOLOGY FOR A 'BABY LEAF' PRODUCTION OF A CORN SALAD AND RADICCHIO

Damijan KELC\*, Peter VINDIŠ, Jurij RAKUN, Denis STAJNKO, Miran LAKOTA

\*E-mail of corresponding author: [damijan.kelc@um.si](mailto:damijan.kelc@um.si)

University in Maribor, Faculty of Agriculture and Life Sciences, Pivola 10, 2311 Hoče, Slovenija

### SUMMARY

*Production potential of Corn salad (*Valerianella locusta*) and Radicchio (*Cichorium intybus* var. *foliosum* Radicchio Group) were studied for a 'baby leaf' young cutting leaves. Research took place in experimental plastic greenhouses, at the University Agricultural Center in Pivola. That is part of the Faculty of Agriculture and Life Sciences, Maribor. Baby leaf-young leaves are used in various salads and in the preparation of a wide variety of dishes. In the good technological conditions young leaves could grow very fast. Experimental treatments included sowing in a plateau of polystyrene with 160 holes. We tested 1 or 2 seeds per hole. Half of the experiment was fertilized with water-soluble fertilizer Rosasol N20:K20:P20, on the other half we used only water. Two different types of Klasmann substrates, tray substrate and bio potgrund were used. We weighed (g) the Radicchio yield 21st day after sowing. On the 30th day after sowing we weighed the Corn salad. Crops in the non-fertilized variant are, as was expected, lower, and the quality of the plants is lower. The higher yield was detected in a tray substrate. It is necessary to make a calculation if the additional yield in two seeds per hole covers the costs of the seeds and the costs of additional work with sowing. High density of the plants causes the greater possibility of fungal diseases, competition for light and nutrition. In this work we present the crop yield, technology that was used and overall conditions.*

**Keywords:** *substrate, greenhouse, 'baby leaf', yield*

### INTRODUCTION

Consumer demand for high-quality, fresh-cut vegetables has increased rapidly in the last decades. Fresh cut vegetables contain many vitamins and minerals which are very important in the process of metabolism in the human body. Vegetables are important part of healthy eating and provide a source of many nutrients, including potassium, fibre, folate (folic acid)

and vitamins A, E and C. Potassium may help to maintain healthy blood pressure. Dietary fibre from vegetables helps reduce blood cholesterol levels and may lower risk of heart disease (Choose my plate, 2018)

Hymans has been cultivating vegetables for a long time in similar ways that we do today in the hydroponic systems. Plants can grow directly on water or can be precise regulated by the irrigation. An amount of oxygen in the water and an appropriate level of nutrients in the growing medium is very important in production process. By 1519, when the first Spanish conquerors landed in Hernan Cortes in Mexico, the Aztecs controlled the empire in which five to six million people lived. This meant that the exploitation of land for agricultural purposes had to be strengthened. This is evident from the use of the 'chimpas' system, the so-called 'floating gardens' found on the shallow lakes of the Mexican valley. This is one of the first known hydroponics systems in the world. (Ancient Origins, 2014). In 1948 the English agricultural engineers presented hydroponics to the poor Bengals (Kogoj Osvald and Osvald, 2005).

The corn salad and radicchio production for young cut 'baby leaf' leaves in Slovenia is located in closed, temperature secured rooms on mobile tables or on the ground. The production could be also on the fields outside. The differences are between the production technologies. Glass greenhouses and plastic houses are suitable. The usual size of the production table is 2 m x 10 m. In one greenhouse 20-25 tables are mounted. If the vegetable is grown on the ground, the work is still demanding, and in this case, it is advisable to use machinery and machines adapted to sowing, cutting and picking salad, which represents a big financial contribution. In Slovenia, movable tables are mainly static and can't be moved and run across rails to another place where they would be driven across the cutting machine and cut all the table at the same time. Since this type of technology represents a great deal of time and a lot of manual work, many other procedures have been invented (figure 1).



**Figure 1** Quick cut greens harvester.

There are quite a number of companies involved in the production of cutting machines. It is also necessary to connect the technology of salad production and salad harvesting to work quickly and with the lowest possible costs. To start production, it is necessary to test the growing conditions, harvest and marketing. Investment in machine high technology is very expensive.

Both types of chicory can tolerate fall frosts very well, although growth in very cold weather is slow. Leafier plants and varieties are hardier, and may be cut even when completely frozen. After thawing slowly, the damaged outer leaves can be peeled away leaving the head itself in usable condition, although not necessarily marketable (Radicchio and Sugarloaf, 2016).

Dalla Costa (2011) reported that soil temperature has a crucial impact on physiological processes and growth of plants with important consequences for plant productivity and food safety including nitrate accumulation in leaf blades of leaf vegetables. The researches made temperature modulation which should help in nitrate concentration control in fresh vegetables, an important trait of product safety. Corn salad plants (*Valerianella locusta* (L.) Laterr. Cultivar Gala) were grown at three root temperatures (15, 20, and 25 °C) in a floating system. This experimental setup allowed to directly evaluate the effect of root temperature on yield and plant quality excluding the effect on soil processes and properties. Results showed that growing conditions at 20 °C of the nutrient solution led to the best plant performance in terms of yield, nitrate content at leaf level, root biomass, leaf area, and greenness with positive effects on postharvest quality, i.e., less rapid leaf loss of greenness and leaf fresh weight (FW) loss during conservation at 4 °C. Plants grown at 15 °C showed minor growth, whereas the nutrient solution at 25 °C caused stress for the plants affecting negatively the quality and yield. Overall, the results obtained showed that root temperature plays a fundamental role in several plant processes that affect yield and its quality; for hydroponic system cultivations, a level of growing-medium temperature close to that of the surrounding air seems suitable.

Petropoulos (2016) reported that there has been a growing trend towards cultivating leafy vegetables in hydroponic systems. Floating system is an alternative hydroponic system suitable for the production of baby vegetable products, ready-to eat salads and minimally processed leafy vegetables. Due to the higher and higher demand of vegetables, various production techniques are tested. Plants grow without the presence of earth. Roots can float in water, above them are polystyrene plate with plants. All nutrients are dissolved in the water and ventilation should be well organized. Often an inert rock wool medium is also used, offering space for the roots. Salad and other vegetables have been used as a sedative for centuries. Successfully cleans and regulates blood pH (reduces acidity). It is highly recommended for heart and kidney patients. (Kogoj Osvald and Osvald, 1994). It is also very useful to add carbon dioxide (CO<sub>2</sub>) every week. When it is used properly, we can increase the crop by 25%. (Dubrovka et al., 2006).

## MATERIALS AND METHODS

An autochthonous Slovenian variety, Radič Tržaški solatnik/Zuccherina di Trieste was chosen. Seeds sprout for 5-14 days. It is a chopper cutter, whose tasty fine, light green leaves are cut all year. Very good wintering. If we root the roots, we produce fine, bright yellow delicious heads. Fresh salad from summer to spring! Light green, smooth and gentle leaves grow well. After thinning, it develops pointed, green heads. We remember that the leaves remain gentle and dressed.

As a corn salad we choose a cultivar Motovilec Ljubljanski. It has dark green, long, bright and very delicious leaves. We maintain a variety in Slovenia. It originates from Ljubljana and its surroundings.



**Figure 2** Sowing the seeds in a polystyrene plateau, 160 holes, 1 seed per hole.

Treatment included sowing in a plateau of polystyrene with 160 holes per 1 or 2 seeds per hole (figure 2). After sowing, the plateau was left in the calliper (figure 3) at a temperature of 28 °C, and relative humidity of 96% until the next day. The seeds wait about 20 days for corn salad in the caliper. We have to be in the last days very careful in the calliper, because young germs would quickly ‘overgrow’. Half of the plateau was fertilized with water-soluble fertilizers Rosasol N 20: P 20: K 20, the other half of the plateau was only watered. We used two different types of Klasmann substrate, namely tray substrate and Bio potgrund. The yield of the radicchio weight (g) of one hole was weighed on the 21<sup>st</sup> and 28<sup>th</sup> day after sowing. At the Corn salad the weighing took place at 30<sup>th</sup> and 39<sup>th</sup> days after sowing. For corn salad we have weight the mass of 5 holes. With one seed we sown 4 plates in a tray substrate and 4 plates in a bio potgrund substrate. With two seeds, we also sown 4 plates in a tray substrate and 4 plates in a bio potgrund substrate. Then we split the plateau into half. One half was just watered, the other half was fertilized with Rosasol N 20: P 20: K 20, at a concentration of 3 grams per liter of water. This is 1 g of fertilizer more as we did last year at the cultivar Lettuce Ljubljanska ledenka (Kelc et. al., 2018).

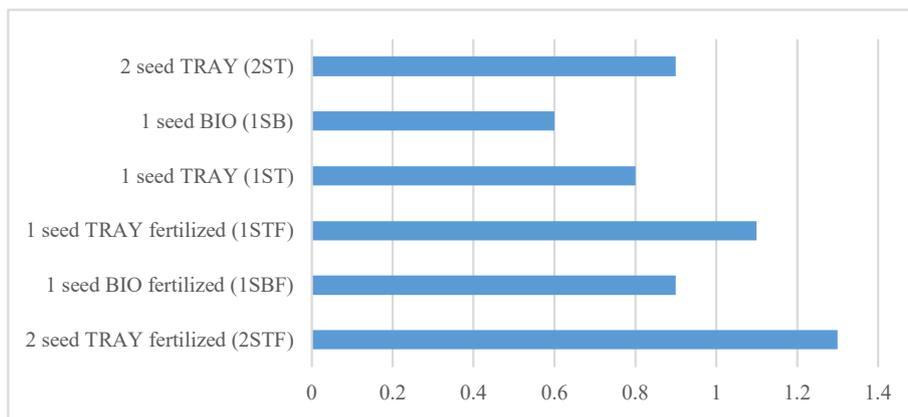


**Figure 3** Plateaus stacked in calliper at 28 degrees Celsius.

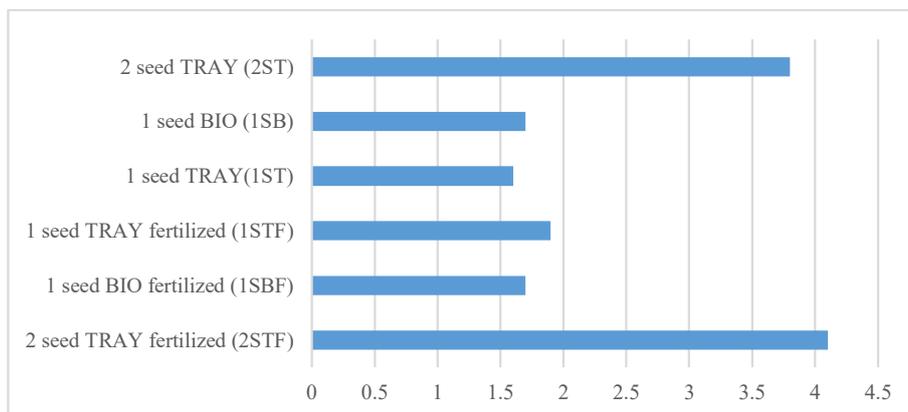
The first weighing of the Radicchio took place 21 days after sowing and the second 28 days after sowing of Radicchio. At the Corn salad the weighing took place at 30<sup>th</sup> and 39<sup>th</sup> days after sowing.

### RESULTS AND DISCUSSION

The experiment shows that Radicchio leaves are not commercial developed enough 21 days after sowing for sale, as their weight (g) is too small compared to day 28 after sowing. Crops in the non-fertilized variant (especially in the case of two seeds per hole) are expected to be too low, and the quality of the plants does not reach the market quality. We note that crops are the highest in the case when fertilizer is used. Which means that the use of fertilizers is necessary in the case of commercial growing vegetables for the market. The big difference is in the harvest on the 21<sup>st</sup> or 28<sup>th</sup> day after sowing. The two seeds in the fertilized tray substrate 21 day after sowing yield 1.3 g of the crop. Already on the 28<sup>th</sup> day the yield is 4.1 g per hole. The difference is more than 3 times.



**Figure 4** Radicchio production per hole (g) on the 21<sup>st</sup> day after sowing



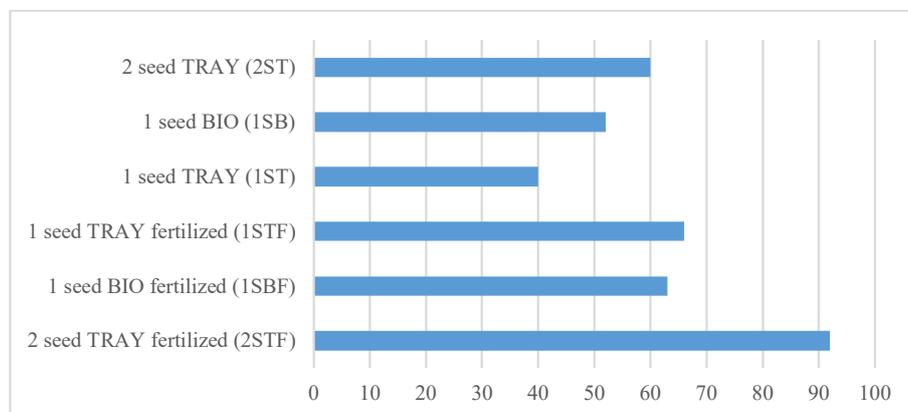
**Figure 5** Radicchio production per hole (g) on the 28<sup>st</sup> day after sowing

A very big difference is also when using 2 or 1 seeds per hole. Day 28 in the fertilized tray substrate and 2 seeds give us 4.1 g of crop to the hole. If we use one seed, the yield is reduced to 1.9 g. There is a very large difference indicating that in the case of Radicchio, sowing of two seeds should be used, because only in this way we can expect competitive crops for the market production. Compared with our previous study on salad (Kelc et. al., 2018), this means that the price of additional seed represents a cost that would be recovered in the production process. At the Radicchio production, we recommend the sowing of two seeds into one hole in a 160-hole polystyrene plate. It is interesting that if the fertilizer is used, the difference in the higher yield is only 7.3%, which is really small and hardly covers the extra work and fertilizer costs. It may be better if we can test the effect of fertilizer after the first cut in the next growing period. The level of fertilizer in the substrate would be significantly smaller and the additional fertilizer would be very welcome. Due to the higher price of the bio substrate and smaller crops, we recommend for a Radicchio tray substrate or some comparable substrate.

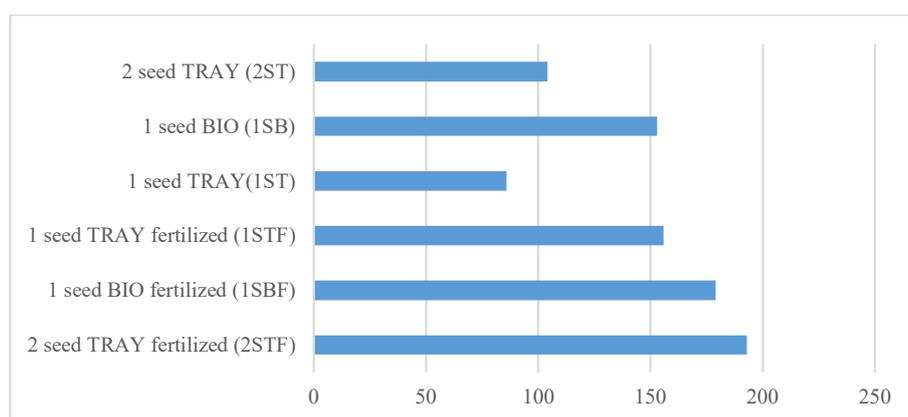
Petropoulos (2016) reported that increasing the N application rate resulted in an increase of fresh weight of the above-ground parts of lettuce. Total yield ranged between 12.0 to 41.9 kg m<sup>-2</sup> of fresh 'baby leaf' leaves. Richardson and Redgrave (1992), reported that not only temperature but also nitrogen fertilizer rate may affect head weight and total yield of lettuce grown in a glasshouse. Kotsiras et al. (2016) find out significantly lower total yields than at the present study. This was 4.0 to 9.0 kg m<sup>-2</sup> of fresh weight. Difference could be attributed to the different lettuce types (Lollo Rosso and Batavia) and plant densities (20- 30 plants m<sup>2</sup>), comparing to further study. There was also a clear indication that harvest practice significantly affected storage life (SL), relative fresh weight (RFW) and visual appearance rating (VAR) of all lettuce types.

For corn salad we have 39 days after sowing at least 2 times higher yield than 30 days. The difference in weight is 101 grams. This is high and it is highly recommended to cultivate 39 days after sowing. A very good results were achieved with bio substrate in growing corn salad. In the case of fertilizing the bio and tray substrate and using of 1 seed in the bio substrate and 2 seeds in the tray substrate, the bio-substrate has only 7% smaller yield. Here it is very important to do another experiment with sowing 2 seeds in a bio substrate. It is assumed that the yield in this case would be even better than the tray substrate. This suggests that before starting the production it is advisable to do a search of several different methods of production.

Our sowing plates have a dimension 520 mm x 323 mm. On a table of 20 m<sup>2</sup>, lay 120 plates. 590 g can be the best result for corn salad on one cultivation plateau. At 1 m<sup>2</sup>, we had 6 plateaus. This represents 3540 g per 1 m<sup>2</sup> of greenhouse surface in 39 days. Price for 1 kg of a Corn salad is at local market 12 €. This would mean 42 € revenue per square meter. If we made a big effort, we could have 9 growth cycles throughout the year. 378 € is a hypothetical profit in one year per 1 m<sup>2</sup> of surface. If we have a medium-sized greenhouse of 10 m x 20 m, we could earn on 180 m<sup>2</sup> of 68 040 € in one year on the assumption that we would sell all the production at the market, or at home for 12 €/kg. Corn salad can't be grown throughout the year, but we could earn a profit, because of the combination in the culture where we can expect the price of 8 €/m<sup>2</sup>. So, the profits would be reduced by some 30%. For a 'baby leaf' lettuce we can get 8 €/kg and for Radicchio at least 10 €/m<sup>2</sup>. Earnings would still be very nice, 47,600 € per year. Of this income, the entire family could live. For young families that are thinking of having a Farm, this news is very encouraging.



**Figure 6** Corn salad production per hole (g) on the 30<sup>th</sup> day after sowing



**Figure 7** Corn salad production per hole (g) on the 39<sup>th</sup> day after sowing

### CONCLUSIONS

In the research greenhouses of the University Agricultural Center at the Faculty of Agriculture and Life Sciences Maribor, we have tested the production potential of Corn salad (*Valerianella locusta*) and Radicchio (*Cichorium intybus var. foliosum* Radicchio Group). We planted 1 and 2 seeds in a 160-hole plate with polystyrene. Half of the plates were fertilized with Rosasol N20:P20:K20. We used two Klasmann substrates, a tray substrate and a bio potgrund. The yield per hole (g) was weighed on the 21st and 28th day after sowing for Radicchio and at 30<sup>th</sup> and 39<sup>th</sup> days after sowing for Corn salad. At the Radicchio production, we recommend the sowing of two seeds into one hole. Leaves are not developed enough 21 days after sowing for sale, as their weight (g) is too small compared to day 28 after sowing. The highest yield we achieved at day 28 with 2 seeds and with use of fertilizer. For Corn salad we have 39 days after sowing 2 times higher yield than 30 days. It is highly recommended to cultivate till day 39. A very good results were achieved with bio substrate in growing corn salad, with almost the same quantity of crop as a tray substrate. We also propose fertilization

at each watering in the amount of 3 g of fertilizer per liter of water. We estimated that an additional crop with two seeds does cover the cost of additional seeds. The production of young cutting leaves has potential to be very interesting and a well-accepted strategy on the competitive market. For farms, it can represent significant income as a basic or additional activity.

### ACKNOWLEDGEMENTS

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