DOI: 10.14720/aas.2016.107.1.20
**Agrovoc descriptors:** seed crops; crop management; sowing date; poppy seed; papaver somniferum, fertilizer application; crop yields; yields; seed characteristics

**Agris category code**: F01,f04, f08

# The impact of the period of sowing and fertilization on morphological characteristics and seed yield of garden poppy (*Papaver somniferum* L.)

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Received February 03, 2016; accepted March 29, 2016.
Delo je prispelo 03. februarja 2016; sprejeto 29. marca 2016.

## ABSTRACT

Garden poppy (*Papaver somniferum* L.) is a traditional crop that had already been cultivated in Slovenia in the past for the production of seed and oil. During its re-introduction in present time, numerous agro-technical dilemmas have been raised for the processes from sowing to harvesting and have to be studied in our present growing conditions. On the fields of the Ograjšek farm in Cerklje ob Krki two field experiments in complete randomized design had been sown in 2013 and 2014 to establish the influence of the sowing date and fertilization on morphological properties and crop yield of garden poppy seed of the Austrian variety 'Zeno 2002'. Results have shown that the average yield of seed in both trials (1643 kg/ha) is more than one time higher than the average crop yield recorded globally (700 kg/ha), proving how suitable growing conditions in the area of eastern Dolenjska are for the cultivation of poppy. Analysis of crop yield per plot showed there is no statistically significant interaction between the considered factors. The yield of poppy seed in the spring sowing term was 1742±77 kg/ha and in the autumn sowing was 1545±122 kg/ha. The difference is not statistically significant ($p$ = 0.1845). Recorded yield per plant was higher for the autumn term but that was not transferred to the total crop yield due to poor overwintering and consequentially lower plant density at the time of harvest. Both sowing dates have confirmed that exposure to light and duration of growing period had an important impact on plants height – average height of plants sown in autumn was 139±1 cm, which is more than 60 cm higher than the average height of the plants sown in spring (p = 0.0000). A strong statistical dependence of the yield of seed per capsule on diameter of the capsule was proved ($p$ = 0.0000). It can be concluded that when the capsule diameter increases by 10 mm, the seed yield increases for 2.1 g to 2.3 g with 95 % confidence. Dependence of the average seed yield on the number of lateral shoots per plant also proved to be statistically significant ($p$ = 0.0000). Linear model was used for the comparison of the four lines showed that the lines representing poppy sown in autumn and spring are statistically different for the control and for the ENTEC; the slope was higher for the poppy sown in autumn. These trials have given the first practical advice for production of garden poppy in Slovenia and should be continued for further useful results.

**Key words:** garden poppy, *Papaver somniferum*, sowing date, fertilizing, morphological properties, seed yield

## IZVLEČEK

### VPLIV ROKA SETVE IN GNOJENJA NA MORFOLOŠKE LASTNOSTI IN PRIDELEK SEMENA VRTNEGA MAKA (*Papaver somniferum* L.)

Vrtni mak (*Papaver somniferum* L.) je tradicionalna poljščina, ki smo jo v preteklosti v Sloveniji pridelovali za seme in olje. Pri ponovnem uvajanju v pridelavo se od setve do žetve pojavljajo številne agrotehnične dileme, ki jih je treba preučiti tudi v naših rastnih razmerah. Na njivi kmetije Ograjšek v Cerkljah ob Krki smo v letih 2013 in 2014 posejali dva bločna poljska poskusa z namenom, da ugotovimo vpliv roka setve in gnojenja na morfološke lastnosti in pridelek semena vrtnega maka avstrijske sorte 'Zeno 2002'. Rezultati so pokazali, da je bil povprečen pridelek semena obeh poskusov (1643 kg/ha) več kot enkrat večji od povprečnega pridelka semena v svetu (700 kg/ha), kar nakazuje na ustreznost rastnih razmer za mak na območju vzhodne Dolenjske. Analiza pridelka na parcelo je pokazala, da interakcija med preučevanima dejavnikoma ni bila statistično značilna. Pridelek semena maka v spomladanski setvi (1742±77 kg/ha) je presegel pridelek jesenske setve (1545±122 kg/ha. Razlika med rokoma setve ni bila statistično značilna ($p$ = 0.1845). Pridelek na rastlino je bil v jesenskem delu poskusa večji, kar pa se zaradi slabše prezimitve in posledično gostote rastlin ob spravilu ni izkazalo za skupni pridelek. Z rokoma setve smo potrdili vpliv osvetlitve in dolžine rastne dobe na višino rastlin - povprečna višina rastlin ozimne setve je bila 139±1 cm, kar je v povprečju več kot 60 cm višje od rastlin spomladanske setve, razlika v višini med rokoma setve je bila statistično značilna ($p$ = 0.0000). Ugotovili smo močno statistično značilno odvisnost med pridelkom semena na glavico in premerom glavice ($p$ = 0.0000), kar pomeni, da se ob povečanju premera glavice za 10 mm pridelek semen v njej pri 95 % zaupanju poveča od 2.1 do 2.3 g. Tudi odvisnost med povprečnim pridelkom semen in številom stranskih poganjkov na rastlino je bila statistično značilna ($p$ = 0.0000). Linearni model za primerjavo štirih premic je pokazal, da se premici za mak posejan jeseni in spomladi pri kontroli in ENTEC statistično razlikujeta, naklon je večji pri maku sejanem jeseni. S pomočjo poskusov smo prišli do prvih praktičnih nasvetov pri pridelavi maka v Sloveniji, s čimer kaže nadaljevati.

**Ključne besede:** vrtni mak, *Papaver somniferum*, rok setve, gnojenje, morfološke lastnosti, pridelek semena

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## 1 INTRODUCTION

Poppy (*Papaver somniferum* L.) is a traditional Slovene crop that we want to re-introduce into production (Kocjan Ačko, 2015). Until the beginning of the 20th century it was mostly grown in the region of Prekmurje, on the slopes of Pohorje and in Koroška (Sadar, 1951). Similar to other traditional crops, poppy had disappeared from our fields and gardens with intensification and specialization of agricultural production. Poppy seeds that are used for the preparation of local deserts like »prekmurska gibanica« and »slovenska potica« with poppy seed filling were imported from Austria, Czech Republic and Hungary where they have managed to preserve the cultivation of poppy and improve the production with new varieties and modern agro-technical measures. Recent focus of EU agricultural policy on sustainable farming and local production has encouraged our farmers to include new and forgotten crops into the crop rotation. Company Panvita decided to sow garden poppy for the production of seed in 2007 and since then they cultivate around 20 hectares every year (personal info), on much smaller fields we can also see poppy on other fields in Prekmurje and elsewhere in Slovenia, mostly in the region of Dolenjska.

Poppy is an annual crop that grows in continental and sub-tropic climate. Different chemotypes have developed within the same somniferum *species;* each with higher or lower content of alkaloids in poppy milk (latex). Higher concentrations of alkaloids are often caused by higher growing temperatures and longer exposure to sunlight in sub-tropical conditions (Đorđevski and Klimov, 1986). In continental growing conditions that we have in Slovenia, poppy is produced for its seed with up to 50 % oil content which means that in our conditions poppy is an oil plant. Poppy production is controlled at international and also at national level for its possible misuse for the production of illicit drugs. In Slovenia production for seed and oil is allowed and poppy crops have to be registered at the Ministry of agriculture, forestry and food (Rules on requirements…, 2011). Poppy can be sown only after the Decision of the Ministry has been obtained; the Rules also provide for implementation of control measures during the growth period and at crop harvest to provide for complete traceability (Kocjan Ačko, 2015).

Poppy grows well in alluvial sandy-clayeous slightly alkaline (higher pH) soil that is rich in nutrients, especially calcium. During growing period it needs between 400 to 500 mm of rain; its highest demand for water is from the emergence phase until the beginning of flowering. Higher precipitation during the capsule maturing period can promote development of fungal infections and germination of seeds in mature capsules (Đorđevski in Klimov, 1986).

It is known that the varieties coming from northern areas of Middle and Western Europe have higher capability for overwintering (Bernáth and Németh, 1998). This means that we can sow the same variety in September as a winter crop (autumn sowing) or in early spring, when we start sowing spring crops (spring sowing). There are important morphological differences between the crops sown in autumn and those sown in spring due to different temperatures and duration of sunlight exposure in different pheno-phases of plants development and growth. The most obvious one is different height of plants that is much lower in crops sown in spring. Longer growth period of the autumn/winter crops proved as a positive factor in trials by Bernáth and Némethova (1998) giving drier mass of plants and higher seed yields (Bernáth in Németh, 1998). Slovenia is somewhere in between the two climates (Žnidarčič, 2012) and we can decide between both terms of sowing; therefore we can also expect for some crop loss caused by poor overwintering. In his book »Oljnice, korenovke, predivnice in hmelj« (Oilseeds, root vegetable, fibre crops and hops) Sadar (1951) indicates exclusively spring sowing for poppy, that has to be performed as soon as possible (beginning of March or as soon as the ground allows the use of sowing machine) to allow enough time for growth and avoid possible summer drought that can significantly reduce the crop of spring sown varieties (Németh, 1998).

Like for other crops, soil has to be analysed before sowing. Quantity of nutrients depends on soil type, climate and previously grown crop. Quantities of micro-nutrients can vary significantly, however average recommended quantity of fertilizers per one hectare of poppy crop is 140 to 160 kg of nitrogen, 70 to 110 kg phosphorus ($P_2O_5$) and 80 to

100 kg potassium ($K_2O$). All the nutrients are added with organic and mineral fertilizers (Đorđevski and Klimov, 1986). Relatively short growing period of spring poppy requires the use of easily accessible mineral fertilizers. Application of more than 80 kg of nitrogen per hectare can cause numerous negative effects like flattening of plants, higher incidence of pests and diseases (Ruminska, 1973, quoted after Németh, 1998). With less developed root system poppy has to be fertilised with smaller quantities of nitrogen several times. The highest requirement for nitrogen is in the period between the rosette phase and beginning of flowering, since that is the period of rapid growth and high green mass production (Bernáth and Németh, 1998).

The purpose of our research is to establish whether growing conditions in Krško basin (eastern Slovenia) are suitable for cultivation of poppy and to evaluate the influence of two different terms of sowing and three different nitrogen fertilizers on the yield of seed.

## 2 MATERIALS AND METHODS

### 2.1 Design of trials and description of variety

During the growth period of 2013/2014 two field trials with poppy crops have been conducted on the fields of Ograjšek family farm in Cerklje ob Krki. The first trial has been sown on September 14, 2013 (autumn sowing term) and the second one on March 22, 2014 (spring sowing term). Both trials were set in complete randomized blocks design with four treatments in three repetitions. In addition to one control plot with no fertilization the influence of fertilizers on yield of crop was tested with application of three different mineral fertilizers (NPK 15-15-15, KAN in ENTEC® (N-26)). Quantities of added fertilizers per plot corresponded to 60 kg N per hectare. Calculation of added quantities of mineral fertilizers is presented in Table 1. Size of individual plot was 6 m x 4.6 m, that is 27.6 $m^2$. To minimise the influence of plot edges at the time of harvest, we separately collected poppy capsules from the edge (40 cm wide) so that the real surface of one testing plot was 19.1 $m^2$ and data from this surface were used to calculate the yield of seed per hectare.

**Table 1:** Quantities of mineral fertilizers for addition of 60 kg N/ha

| Type of mineral fertilizer | NPK 15-15-15 (kg) | ENTEC® (26 % N), (kg) | KAN (27 % N), (kg) |
|---|---|---|---|
| Quantity corresponding 60 kg N/ha | 400 | 230.8 | 222.2 |
| Quantity per plot (27.6 $m^2$) | 1.1 | 0.64 | 0.62 |

For our trial the Austrian variety of 'Zeno 2002' was selected, one of the most popular and widely used varieties for poppy seed production in the area of Middle Europe, suitable also for autumn sowing (Backsaaten, 2014).

### 2.2 Sowing, cultivation and harvesting

Soil was treated classically with tillage and harrowing. Before sowing 500 kg/ha of NPK 5-20-30 was applied; sowing field was then fine treated with rotating harrow. Seed of 'Zeno 2002' poppy variety was sown with Amazone D7 seed drill to 12.5 cm row spacing with 2 kg of seed per hectare. The testing field was sown as one whole unit and testing plots were formed later when shoots started to grow and prolongate, that is just before fertilization. Crop was treated against weeds with Callisto 480 SC in the amount of 0.21 l/ha. Fertilization was done manually when rosettes with approximately 20 leaves had formed. Capsules were also collected manually; on every plot capsules were first cut off and then crushed. Seeds were cleaned; all green parts, capsule walls and other impurities were removed with sieve of 1.5 x 1.5 mm.

Before harvest 20 plants were randomly selected on every plot to measure the selected morphological parameters (plant height, number of lateral shoots, width and height of capsule, seed mass of one individual capsule). The number of

plants per $m^2$ was counted at the time of harvest (density) and weighted the total crop per plot.

### 2.3 Growing conditions in Cerklje ob Krki

Climate in Cerklje ob Krki is moderately continental with mean annual temperature around 10 °C. Mean July temperatures are around 20 °C and January average is around -1 °C. Annual quantity of precipitation in Cerklje is around 1000 mm.

Soil on the testing field is eutric brown soil and is very common in the plains of Slovenia. It originates from deposits of bigger rivers. By texture the soil is classified as sandy-clayeous (ICPVO, 2015). Soil pH was measured at 5.6, which is slightly too low in light of general guidelines for the preservation of soil fertility and also considering the growing requirements of poppy plants.

### 2.4 Statistical analysis

Results of the trial (yield of seed per testing plot, number of plants per $m^2$, plant height, number of lateral shoots, capsule diameter, yield of seed per individual capsule) were processed with analysis of variance for complete randomized block design for two-factor experiment. Treatments were determined in all combinations of the two tested factors: fertilising (NPK 15-15-15, KAN, ENTEC®) and control with no fertilising) and time of sowing (autumn, spring). The linear regression models were used to examine the dependence of average yield on the number of lateral shoots, yield of seed per capsule, capsule diameter, number of lateral shoots and number of plants per $m^2$, that is from the average density at harvest. All explanatory variables were centred for easier interpretation of the estimated regression parameters. Statistical analysis was performed with the R program (R Core Team, 2015).

## 3 RESULTS AND DISCUSSION

### 3.1 Yield of seed

Analysis of variance for crop yield per plot revealed no statistically significant interaction ($p = 0.87$) between the time of sowing and fertilisation, there was no statistically significant effects for fertilisation ($p = 0.61$) neither for time of sowing ($p = 0.24$). Table 2 shows the average yield across all four fertilisations for each sowing times separately. Average yield of poppy seed sown in autumn was recorded at 2.95±0.24 kg per plot, which is around 1544 kg/ha. Average yield of the spring sowing was 3.33±0.15 kg per plot or calculated to kg/ha - 1741 kg/ha.

**Table 2:** Average humidity of seed at harvest and yield of poppy seed (*Papaver somniferum* L.) for the autumn and spring sowing in Cerklje ob Krki in the years 2013/14.

| Sowing term | Average humidity of seed at harvest (%) | Average yield of seed per plot at 8 -percent humidity (g) | Standard error (g) | Average yield of seed per hectare at 8-percent humidity (kg) | Standard error (kg) |
|---|---|---|---|---|---|
| Autumn | 8.2 | 2950 | 235 | 1544.5 | 122.0 |
| Spring | 9.3 | 3326 | 146 | 1741.5 | 76.5 |

An important aim of the trial was to determine the difference between the same quantity of added nitrogen (60 kg/ha) through different mineral fertilizers and the control without fertilizing. Figure 1 shows there were no statistically significant differences between different treatments (NPK 15-15-15, KAN in ENTEC® (N-26) and control). Our results did not confirm our expectations raised from previous trial results published in the article by Bernáth and Némethova (1998).

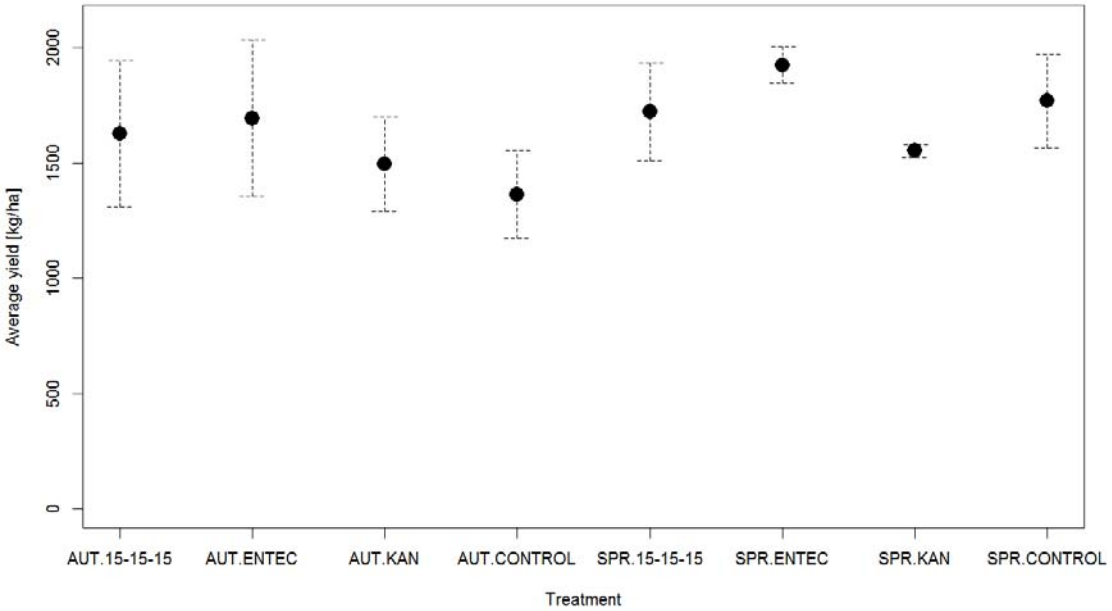


**Figure 1:** Average yield of poppy seed (*Papaver somniferum* L.) per hectare with 8-percent humidity per treatment for fertilisation in Cerklje ob Krki in the years 2013/14.

Results of previous trials (Laughlin, 1978) showed positive effect of fertilising with nitrogen on the yield of capsules. To expand our findings an analysis of nitrogen content in seeds and straw would be needed so that we could calculate the total nitrogen uptake.

With the analysis of seed yield per poppy plant according to the time of sowing and fertilizing, we were able to determine that the average yield of seed per individual plant was higher in the autumn sowing compared to the sowing in spring ($p$ = 0.002) (figure 2). There was no statistically significant impact of fertilizers on average seed yield per poppy ($p$ = 0.15).

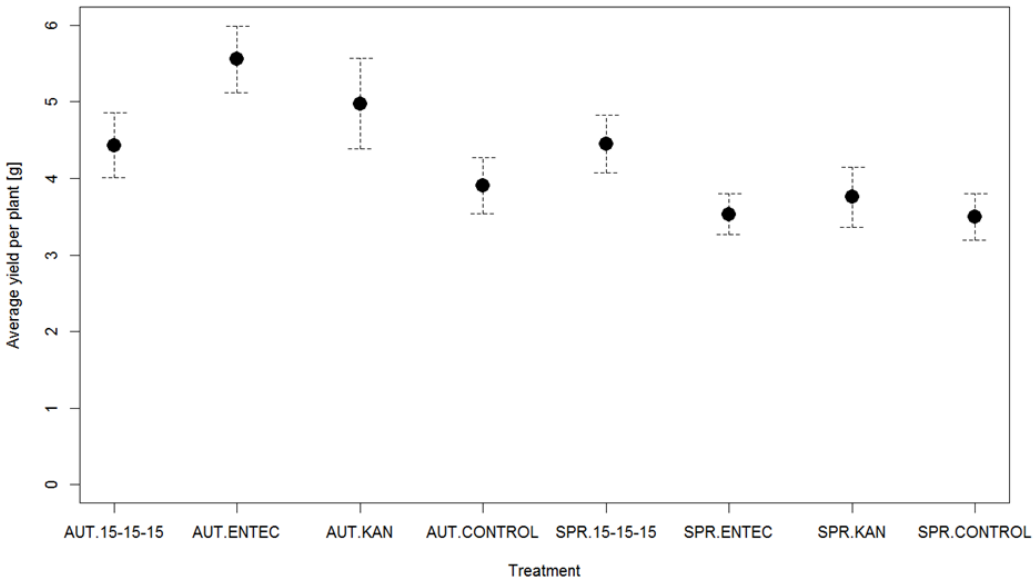


**Figure 2:** Average yield of poppy seed (*Papaver somniferum* L.) per plant with 8-percent humidity per treatment for fertilization in field trials in Cerklje ob Krki in the years 2013/14.

The recorded yield of poppy seed in both sowing terms was high, exceeding the average yields per hectare in major poppy producing countries in 2013 (FAOSTAT, 2013). Closer inspection of recorded yields for other poppy varieties cultivated around Europe (Németh, 1998) shows that higher yields are a common result on micro plots. Realised potential yield for different varieties is around 2 tons of seed per hectare. With recorded yields our trials confirmed that the conditions in Cerklje ob Krki are favourable for poppy production and allow high yields. When reviewing the literature, we found no research that would establish a difference in yields between the autumn and spring sowing for the same variety. However, research by Bernáth and Tétényi (1982) shows that in moderate climate conditions (southern parts of Hungary and Austria) that are comparable to our climate, we can apply autumn sowing but have to be prepared to assume the risk of poor overwintering of plants. In northern parts of Europe farmers are advised against the autumn sowing (Ruminska, 1973. quoted after Németh 1998). According to its breeder dr. Georg Dobos (Zeno projekte, 2015), the 'Zeno 2002' variety is the most commonly used poppy variety in Austria, suitable also for autumn sowing. Results of our trials however confirm the statements that overwintering of poppy plants can be lower than desired.

### 3.2 Crop density

The two sowing terms gave statistically different ($p$ = 0.0000) results for the number of plants per $m^2$. We recorded higher density of plants harvested after spring sowing. Fertilisation had no statistically significant effect on plant density. The fact that during winter part of the crop failed might be the reason for such results, which according to Némethova (1998) is no surprise. Average density of both crops, the autumn and the spring crop (table 3) definitely exceed the optimum crop yield at the time of harvest that had been determined in previous trials abroad at the level of 300,000 to 400,000 plants per hectare (Földesi, 1992); this parameter still has to be established for the Slovenian conditions.

**Table 3:** Average number of poppy plants (*Papaver somniferum* L.) per surface with standard errors at the time of harvest in field trials in Cerklje ob Krki in the years 2013/14 per different fertilization treatment.

| Time of sowing | Fertilizing | Average number of plants per $m^2$ | Standard error | Number of plants per hectare |
|---|---|---|---|---|
| Autumn | NPK 15-15-15 | 56.3 | 3.92 | 563,333 |
| | ENTEC | 52.3 | 3.17 | 523,333 |
| | KAN | 55.3 | 2.84 | 553,333 |
| | Control | 50.0 | 3.61 | 500,000 |
| | Average | 53.6 | 1.64 | 535,000 |
| Spring | NPK 15-15-15 | 66.0 | 2.31 | 660,000 |
| | ENTEC | 66.3 | 0.88 | 663,333 |
| | KAN | 67.3 | 0.67 | 673,333 |
| | Control | 64.7 | 2.97 | 646,667 |
| | Average | 66.1 | 0.88 | 660,833 |

### 3.3 Plant height

The most significant difference between the autumn and spring sowing was recorded for the average height of poppy plants ($p < 0.0001$) (table 4). The interaction between fertilisation and date of sawing was statistically significant ($p$ = 0.002) while the average height of AUT control plants was statistically significant lower than fertilised plants. There is no statistically significant impact of fertilisation for the plants sawed in spring. Poppy plants from the autumn sowing were higher from the plants sown in sprig for almost 60 cm in average. Plants height is mostly influenced by different temperatures during the growth period and related duration of different phases of plant development. Different trials from the nineteen-eighties proved that higher temperatures in early

growing phases promote generative development and early flowering. Also Bérnath and Tétényi (1981) reached the same conclusions after the results of their trials on poppy showed that with rapid increase of temperature from 12 °C to 26 °C plants started flowering 10 to 15 days earlier and their final height remained for 10 to 15 cm lower.

**Table 4:** Average height of poppy plants (*Papaver somniferum* L.) at the time of harvest in field trials in Cerklje ob Krki in the years 2013/14 per different fertilization treatment. There is no statistically significant difference between averages denoted with the same letter at $\alpha$ =0.05.

| Time of sowing | Fertilizing | Average plant height (cm) | Standard error (cm) |
|---|---|---|---|
| Autumn | NPK 15-15-15 | 140.4a | 2.26 |
| | ENTEC | 142.0a | 1.77 |
| | KAN | 140.9a | 2.06 |
| | Control | 132.5b | 1.95 |
| | Average | 139.0a | 1.03 |
| Spring | NPK 15-15-15 | 83.5c | 1.13 |
| | ENTEC | 80.9c | 1.11 |
| | KAN | 79.5c | 1.23 |
| | Control | 82.3c | 1.31 |
| | Average | 81.6c | 0.60 |

### 3.4 Seed yield per capsule in dependence on capsule diameter

Statistical analysis showed statistically significant linear dependence of seed yield per capsule on diameter of the capsule (capsule size) (figure 3). The determination coefficient ($R^2$) is 76 %. For better interpretation of results capsule diameter was cantered; for the average capsule diameter the average seed yield per capsule equals 3 g (95 % interval of confidence is from 2.9 g to 3.2 g); with capsule diameter increasing for 10 mm, the seed yield in the capsule increases for 2.1 to 2.3 g with 95 % confidence.

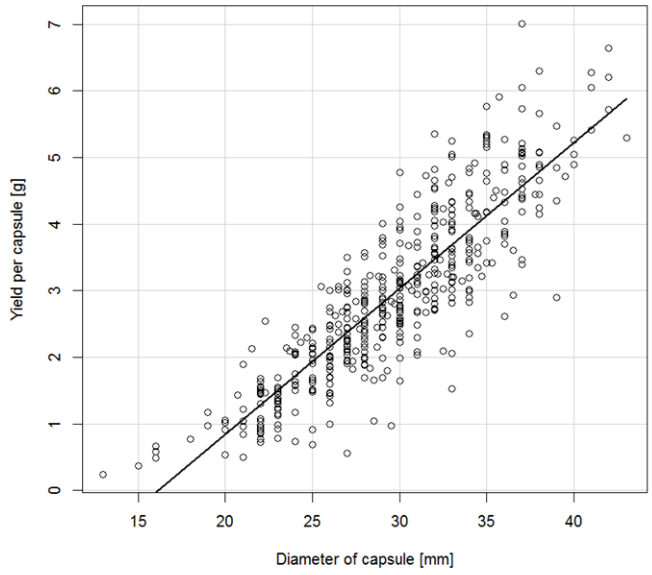


**Figure 3:** Dependence of poppy seed yield (*Papaver somniferum* L.) per capsule on the capsule diameter in Cerklje ob Krki in the years 2013/14.

### 3.5 Seed yield per plant in dependence on number of lateral shoots

Figure 4 shows that there is a statistically significant dependence of seed yield per plant on the number of lateral shoots on the poppy plant. Linear model that we used to compare the four lines showed that the two lines representing poppy from the autumn sowing and the spring sowing at CONTROL and ENTEC are statistically significantly different; the slope is bigger for the autumn poppy. Determination coefficient ($R^2$) of the model is 65 %.

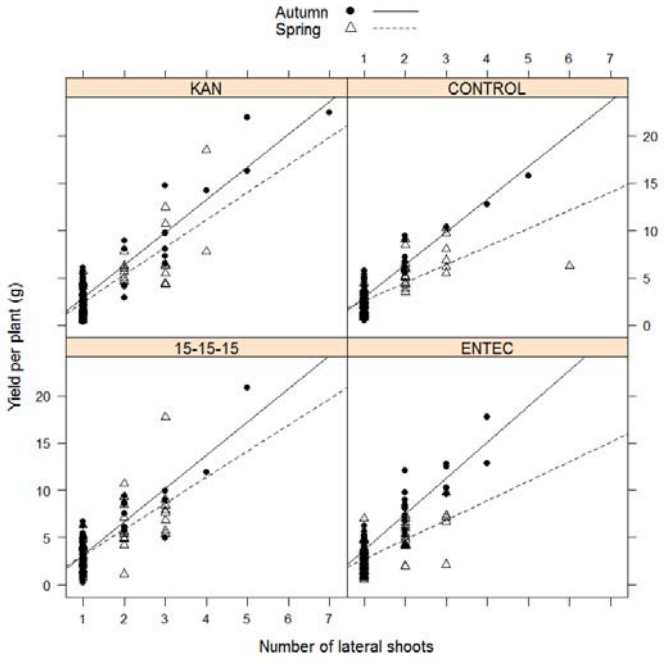


**Figure 4:** Dependence of the average poppy seed yield (*Papaver somniferum* L.) per plant on the number of lateral shoots in Cerklje ob Krki in the years 2013/14.

Considering the number of lateral shoots results of the model show that the average yield of poppy seed per plant for the autumn sowing is statistically significantly different between the two applied fertilizers - KAN and ENTEC. For the average number of lateral shoots the yield per plant for the autumn sowing reached 0.97 g more when fertilised with KAN than if fertilised with ENTEC (95 % interval of confidence for the difference is from 0.02 g to 1.95 g). For the average plot density of 59.79 plants per $m^2$, that translates to 580 kg per hectare higher yield of poppy fertilised with ENTEC.

With average number of lateral shoots (1.5 shoots per plant) the yield of the autumn sowing on the CONTROL plot was for 1.1 g lower than the spring sowing yield (95 % interval of confidence 0.06 to 2.05).

### 3.6 Correlation between number of lateral shoots and crop density

Correlation between the number of plants per $m^2$ (density) at the time of harvest and number of lateral shoots did not prove to be statistically significant (figure 5). Based on our results we can draw a conclusion that the number of lateral shoots on poppy plants should be as low as possible. We assumed that lower number of plants per $m^2$ would cause more branching, however we could not confirm that supposition with our analysis – even for the density that exceeded 60 plants per $m^2$ there was no statistically significant lower number of lateral shoots. To achieve higher number of plants at the same plant density, distribution of plants should be optimised. Plants growing at the mutual distance of 3 to 4 cm can form only one capsule (with no lateral shoots). Plants that grow at the distance of 10 to 20 cm form in principal 3 to 4 capsules, however the number of lateral shoots is

also influenced by climate and agro-technical conditions (Muchova et al., 1993).

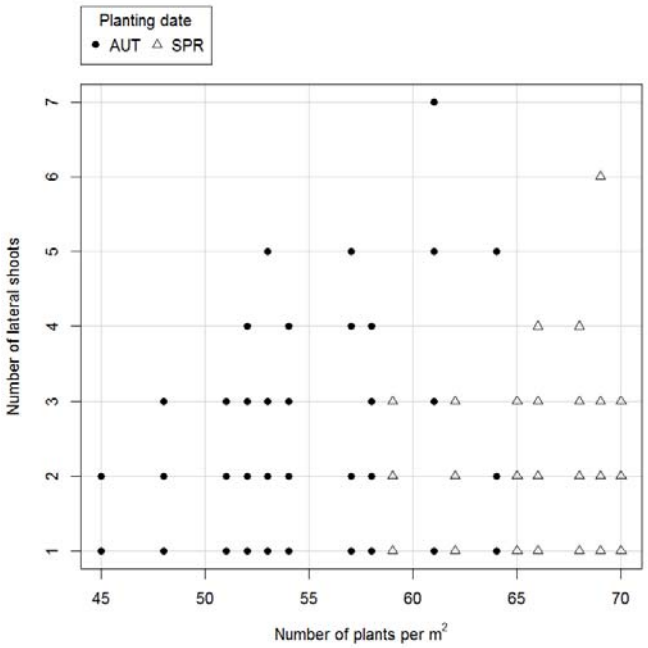


**Figure 5:** Correlation between number of lateral shoots on poppy plants (*Papaver somniferum* L.) and crop density in Cerklje ob Krki in the years 2013/14.

## 4 CONCLUSIONS

Our trials have shown that poppy is a plant that could be cultivated successfully in agricultural areas of eastern Slovenia with conditions similar to those in Cerklje ob Krki. The average yield of 1643 kg/ha from both trials was considerably above the world average. Considering the time of sowing, for the growing season of 2013/14 spring sowing proved to be the better choice; we should repeat the trial at least one more time to confirm the relevance of these results. We should definitely not disregard all the findings from the literature where higher yields are expected from the autumn sowing term. Autumn sowing also brings some other advantages (wider time frame for optimum sowing, avoiding the summer drought, early harvesting date of poppy also allows sowing of catch crops).

In case of fertilizing the results of our trials gave no clear and significant difference among applied fertilizers. Following recommendations in professional literature fertilizers should be applied several times during the growing period to increase the effect of fertilizing however in practice that would require more driving routes through the field like at the time of sowing. For more accurate findings and recommendations, multiannual trials should be performed that would also include analysis of nitrogen residue in seed and straw.

Within the two main aims of our research we have already reached the first practical advice for the production of poppy in eastern Slovenia. Particular challenge in cultivation of poppy is the sowing technique and the quantity of seed. Our results from measured parameters per individual plant show that in majority of cases plants from autumn sowing performed better, however that was not reflected in the total yield, mostly due to lower number of plants per $m^2$ at the time of harvest. Perhaps it would be suitable to use slightly higher quantity of seed for the autumn sowing and then perform manual thinning or machine combing of the crop if needed. Manual thinning takes a lot of time and costs a lot, so a product calculation should be considered first. We advise against autumn sowing in areas with strong winds since much higher plants with fragile stems and weak roots are prone to flattening and breaking that can subsequently cause a loss of crop and problems at

machine harvesting. Finally poppy is a crop that can be used to extend the rather narrow crop rotation on the majority of livestock and arable farms in south-eastern Slovenia, definitely the yield of seed and perhaps also the production of oil could become an additional income source on the farm.

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